Sedna

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Kubeedge

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GUIDE

Sedna is an edge-cloud synergy AI project incubated in KubeEdge SIG AI. Benefiting from the edge-cloud synergy capabilities provided by KubeEdge, Sedna can implement across edge-cloud collaborative training and collaborative inference capabilities, such as joint inference, incremental learning, federated learning, and lifelong learning. Sedna supports popular AI frameworks, such as TensorFlow, Pytorch, PaddlePaddle, MindSpore.

Sedna can simply enable edge-cloud synergy capabilities to existing training and inference scripts, bringing the benefits of reducing costs, improving model performance, and protecting data privacy.

CHAPTER

ONE

GUIDE

- If you are new to Sedna, you can try the command step by step in quick start.
- If you have played the above example, you can find more examples.
- If you want to know more about sedna's architecture and component, you can find them in sedna home.
- If you're looking to contribute documentation improvements, you'll specifically want to see the kubernetes documentation style guide before filing an issue.
- If you're planning to contribute code changes, you'll want to read the development preparation guide next.
- If you're planning to add a new synergy feature directly, you'll want to read the guide next.

CHAPTER

TWO

QUICK START

The following is showing how to run a joint inference job by sedna.

2.1 Quick Start

2.1.1 0. Check the Environment

For Sedna all-in-one installation, it requires you:

- 1 VM **(one machine is OK, cluster is not required)**
- 2 CPUs or more
- 2GB+ free memory, depends on node number setting
- 10GB+ free disk space
- Internet connection(docker hub, github etc.)
- Linux platform, such as ubuntu/centos
- Docker 17.06+

you can check the docker version by the following command,

```
docker -v
```

after doing that, the output will be like this, that means your version fits the bill.

```
Docker version 19.03.6, build 369ce74a3c
```

2.1.2 1. Deploy Sedna

Sedna provides three deployment methods, which can be selected according to your actual situation:

- Install Sedna AllinOne. (used for development, here we use it)
- Install Sedna local up.
- Install Sedna on a cluster.

The all-in-one script is used to install Sedna along with a mini Kubernetes environment locally, including:

- A Kubernetes v1.21 cluster with multi worker nodes, default zero worker node.
- KubeEdge with multi edge nodes, default is latest KubeEdge and one edge node.

- Sedna, default is the latest version.

```
curl https://raw.githubusercontent.com/kubeedge/sedna/master/scripts/installation/
↪all-in-one.sh | NUM_EDGE_NODES=1 bash -
```

Then you get two nodes `sedna-mini-control-plane` and `sedna-mini-edge0`,you can get into each node by following command:

```
# get into cloud node
docker exec -it sedna-mini-control-plane bash
```

```
# get into edge node
docker exec -it sedna-mini-edge0 bash
```

2.1.3 1. Prepare Data and Model File

- step1: download little model to your edge node.

```
mkdir -p /data/little-model
cd /data/little-model
wget https://kubeedge.obs.cn-north-1.myhuaweicloud.com/examples/helmet-detection-
↪inference/little-model.tar.gz
tar -zxvf little-model.tar.gz
```

- step2: download big model to your cloud node.

```
mkdir -p /data/big-model
cd /data/big-model
wget https://kubeedge.obs.cn-north-1.myhuaweicloud.com/examples/helmet-detection-
↪inference/big-model.tar.gz
tar -zxvf big-model.tar.gz
```

2.1.4 2. Create Big Model Resource Object for Cloud

In cloud node:

```
kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind:  Model
metadata:
  name: helmet-detection-inference-big-model
  namespace: default
spec:
  url: "/data/big-model/yolov3_darknet.pb"
  format: "pb"
EOF
```

2.1.5 3. Create Little Model Resource Object for Edge

In cloud node:

```
kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind: Model
metadata:
  name: helmet-detection-inference-little-model
  namespace: default
spec:
  url: "/data/little-model/yolov3_resnet18.pb"
  format: "pb"
EOF
```

2.1.6 4. Create JointInferenceService

Note the setting of the following parameters, which have to same as the script little_model.py:

- hardExampleMining: set hard example algorithm from {IBT, CrossEntropy} for inferring in edge side.
- video_url: set the url for video streaming.
- all_examples_inference_output: set your output path for the inference results.
- hard_example_edge_inference_output: set your output path for results of inferring hard examples in edge side.
- hard_example_cloud_inference_output: set your output path for results of inferring hard examples in cloud side.

Make preparation in edge node

```
mkdir -p /joint_inference/output
```

Create joint inference service

```
CLOUD_NODE="sedna-mini-control-plane"
EDGE_NODE="sedna-mini-edge0"

kubectl create -f https://raw.githubusercontent.com/jaypume/sedna/main/examples/joint_
↪inference/helmet_detection_inference/helmet_detection_inference.yaml
```

2.1.7 5. Check Joint Inference Status

```
kubectl get jointinferenceservices.sedna.io
```

2.1.8 6. Mock Video Stream for Inference in Edge Side

- step1: install the open source video streaming server EasyDarwin.
- step2: start EasyDarwin server.
- step3: download video.
- step4: push a video stream to the url (e.g., `rtsp://localhost/video`) that the inference service can connect.

```
wget https://github.com/EasyDarwin/EasyDarwin/releases/download/v8.1.0/EasyDarwin-linux-
↪8.1.0-1901141151.tar.gz
tar -zxvf EasyDarwin-linux-8.1.0-1901141151.tar.gz
cd EasyDarwin-linux-8.1.0-1901141151
./start.sh

mkdir -p /data/video
cd /data/video
wget https://kubeedge.obs.cn-north-1.myhuaweicloud.com/examples/helmet-detection-
↪inference/video.tar.gz
tar -zxvf video.tar.gz

ffmpeg -re -i /data/video/video.mp4 -vcodec libx264 -f rtsp rtsp://localhost/video
```

Check Inference Result

You can check the inference results in the output path (e.g. `/joint_inference/output`) defined in the JointInferenceService config.

- the result of edge inference vs the result of joint inference

../images/inference-result.png

2.2 API

- control-plane: Please refer to this link.
- Lib: Please refer to this link.

2.3 Contributing

Contributions are very welcome!

- control-plane: Please refer to this link.
- Lib: Please refer to this link.

2.4 Community

Sedna is an open source project and in the spirit of openness and freedom, we welcome new contributors to join us. You can get in touch with the community according to the ways:

- Github Issues
- Regular Community Meeting
- slack channel

This guide covers how to install Sedna on an existing Kubernetes environment.

For interested readers, Sedna also has two important components that would be mentioned below, i.e., GM(GlobalManager) and LC(LocalController) for workerload generation and maintenance.

If you don't have an existing Kubernetes, you can: 1) Install Kubernetes by following the Kubernetes website. 2) Or follow quick start for other options.

CHAPTER

THREE

PREREQUISITES

- Kubectl with right kubeconfig
- Kubernetes 1.16+ cluster running
- KubeEdge v1.8+ along with **EdgeMesh** running

3.1 Deploy Sedna

Currently GM is deployed as a deployment, and LC is deployed as a daemonset.

Run the one liner:

```
curl https://raw.githubusercontent.com/kubeedge/sedna/main/scripts/installation/install.
↪sh | SEDNA_ACTION=create bash -
```

It requires the network to access github since it will download the sedna crd yamls. If you have unstable network to access github or existing sedna source, you can try the way:

```
# SEDNA_ROOT is the sedna git source directory or cached directory
export SEDNA_ROOT=/opt/sedna
curl https://raw.githubusercontent.com/kubeedge/sedna/main/scripts/installation/install.
↪sh | SEDNA_ACTION=create bash -
```

3.2 Debug

1. Check the GM status:

```
kubectl get deploy -n sedna gm
```

2. Check the LC status:

```
kubectl get ds lc -n sedna
```

3. Check the pod status:

```
kubectl get pod -n sedna
```

3.3 Uninstall Sedna

```
curl https://raw.githubusercontent.com/kubeedge/sedna/main/scripts/installation/install.
↪sh | SEDNA_ACTION=delete bash -
```

CHAPTER

FOUR

DEPLOY ALL IN ONE SEDNA

The all-in-one script is used to install Sedna along with a mini Kubernetes environment locally, including:

- A Kubernetes v1.21 cluster with multi worker nodes, default zero worker node.
- KubeEdge with multi edge nodes, default is latest KubeEdge and one edge node.
- Sedna, default is the latest version.

It requires you:

- 2 CPUs or more
- 2GB+ free memory, depends on node number setting
- 10GB+ free disk space
- Internet connection(docker hub, github etc.)
- Linux platform, such as ubuntu/centos
- Docker 17.06+

For example:

```
curl https://raw.githubusercontent.com/kubeedge/sedna/master/scripts/installation/all-in-
↪one.sh | KUBEEDGE_VERSION=v1.8.0 NUM_EDGE_NODES=2 bash -
```

Above command installs a mini Sedna environment, including:

- A Kubernetes v1.21 cluster with only one master node.
- KubeEdge with two edge nodes.
- The latest Sedna.

You can play it online on katacoda.

Advanced options: | Env Variable | Description| Default Value| | — | — | — | **|NUM_EDGE_NODES | Number of KubeEdge nodes|** 1 | **|NUM_CLOUD_WORKER_NODES | Number of cloud **worker** nodes, not master node|** 0| **|SEDNA_VERSION | The Sedna version to be installed. |The latest version| |KUBEEDGE_VERSION | The KubeEdge version to be installed. |The latest version| |CLUSTER_NAME | The all-in-one cluster name|** sedna-mini| **|FORCE_INSTALL_SEDNA | If 'true', force to reinstall Sedna|false| |NODE_IMAGE | Custom node image|** kubeedge/sedna-allinone-node:v1.21.1| **|REUSE_EDGE_CONTAINER | Whether reuse edge node containers or not|true|**

Clean all-in-one Sedna:

```
curl https://raw.githubusercontent.com/kubeedge/sedna/main/scripts/installation/all-in-
↪one.sh | bash /dev/stdin clean
```

CHAPTER

FIVE

DEPLOY LOCAL SEDNA CLUSTER

The local-up script boots a local Kubernetes cluster, installs latest KubeEdge, and deploys Sedna based on the Sedna local repository.

5.1 Use Case

When one is contributing new features for Sedna, codes like AI algorithms under testing can be frequently changed before final deployment. When coding in that case, s/he would suffer from tortured re-installations and frequent failures of the whole complicated system. To get rid of the torments, one can use the local-up installation, embraced the single-machine simulation for agiler development and testing.

5.2 Setup

It requires:

- 2 CPUs or more
- 1GB+ free memory
- 5GB+ free disk space
- Internet connection(docker hub, github etc.)
- Linux platform, such as ubuntu/centos
- Docker 17.06+
- A local Sedna code repository

Then you can enter Sedna local code repository, and create a local Sedna cluster with:

```
bash hack/local-up.sh
```

In more details, this local-up script uses kind to create a local K8S cluster with one master node, and joins the K8S cluster by running KubeEdge.

In another terminal, you can see them by using `kubectl get nodes -o wide`:

```
NAME                STATUS   ROLES                  AGE     VERSION                 ␣
↪INTERNAL-IP     EXTERNAL-IP   OS-IMAGE             KERNEL-VERSION       CONTAINER-
↪RUNTIME
edge-node           Ready    agent,edge             3d21h   v1.19.3-kubeedge-v1.6.1  ␣
↪192.168.0.233   <none>        Ubuntu 18.04.5 LTS   4.15.0-128-generic   docker://20.10.
```

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```
↪2
sedna-control-plane   Ready    control-plane,master   3d21h   v1.20.2                  ␣
↪172.18.0.2       <none>        Ubuntu 20.10         4.15.0-128-generic   containerd://1.
↪5.0-beta.3-24-g95513021e
```

You can login the master node with:

```
docker exec -it --detach-keys=ctrl-@ sedna-control-plane bash
# since the master node just uses containerd CRI runtime, you can alias the CRI cli
↪'crictl' as 'docker'
alias docker=crictl
```

After you have done developing, built worker image and want to run your worker into master node, your worker image should be loaded into the cluster nodes with:

```
kind load docker-image --name sedna <your-custom-worker-image>
```

CHAPTER

SIX

EDGE CLOUD COLLABORATIVE AI FRAMEWORK

6.1 Motivation

Currently, "Edge AI" in the industry is at an early stage of training on the cloud and inference on the edge. However, the future trend has emerged, and related research and practice are booming, bringing new value growth points for edge computing and AI. Also, edge AI applications have much room for optimization in terms of cost, model effect, and privacy protection. For example:

This proposal provides a basic framework for edge-cloud collaborative training and inference, so that AI applications running at the edge can benefit from cost reduction, model performance improvement, and data privacy protection.

6.1.1 Goals

For AI applications running at the edge, the goals of edge cloud collaborative framework are:

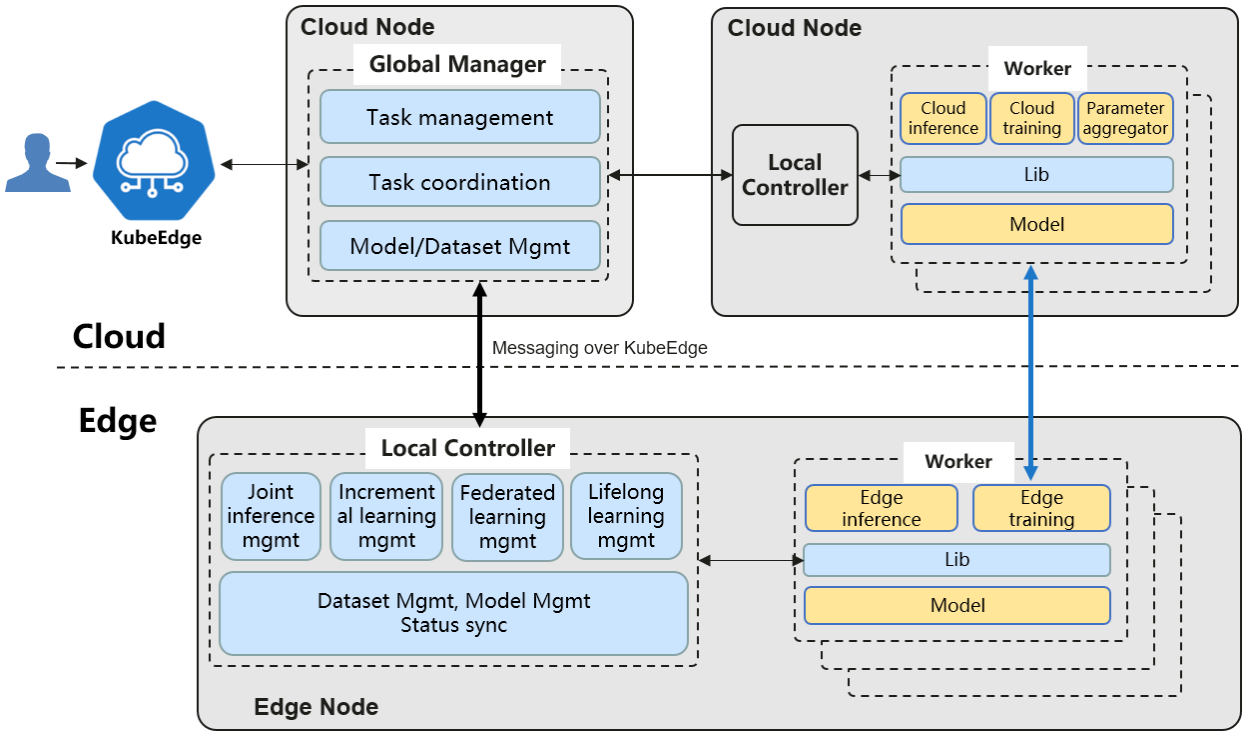
- reducing resource cost on the edge
- improving model performance
- protecting data privacy

6.2 Proposal

- What we propose:
  - an edge-cloud collaborative AI framework based on KubeEdge
  - with embed collaborative training and joint inferencing algorithm
  - working with existing AI framework like Tensorflow, etc
- 3 Features
  - joint inference
  - incremental learning
  - federated learning
- Targeting Users
  - Domain-specific AI Developers: build and publish edge-cloud collaborative AI services/functions easily
  - Application Developers: use edge-cloud collaborative AI capabilities.
- We are NOT:

- to re-invent existing ML framework, i.e., tensorflow, pytorch, mindspore, etc.
- to re-invent existing edge platform, i.e., kubeedge, etc.
- to offer domain/application-specific algorithms, i.e., facial recognition, text classification, etc.

6.2.1 Architecture



- GlobalManager: implements the Edge AI features controllers based on the k8s operator pattern
  - Federated Learning Controller: Implements the federated learning feature based on user created CRDs
  - Incremental Learning Controller: Implements the incremental learning feature based on user created CRDs
  - Joint Inference Controller: Implements the joint inference feature based on user created CRDs
- LocalController: manages the Edge AI features, the extra dataset/model resources on the edge nodes
- Workers: includes the training/evaluation/inference/aggregator
  - do inference or training, based on existing ML framework
  - launch on demand, imagine they are docker containers
  - different workers for different features
  - could run on edge or cloud
- Lib: exposes the Edge AI features to applications, i.e. training or inference programs
- Dataset and Model
  - Motivation
    - Goals
    - Non-goals

CHAPTER

SEVEN

DATASET AND MODEL

7.1 Motivation

Currently, the Edge AI features depend on the object `dataset` and `model`.

This proposal provides the definitions of dataset and model as the first class of k8s resources.

7.1.1 Goals

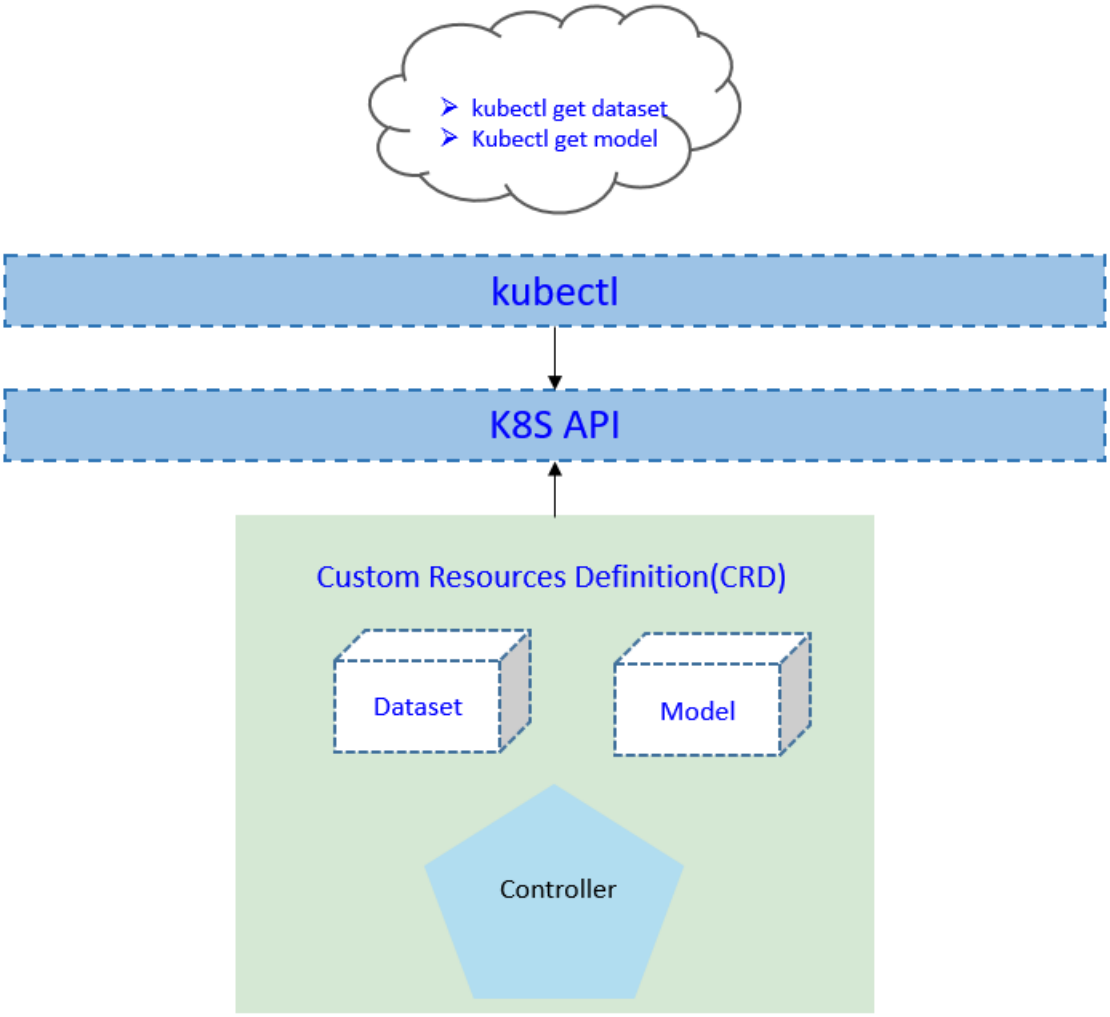
- Metadata of `dataset` and `model` objects.
- Used by the Edge AI features

7.1.2 Non-goals

- The truly format of the AI `dataset`, such as `imagenet`, `coco` or `tf-record` etc.
- The truly format of the AI `model`, such as `ckpt`, `saved_model` of tensorflow etc.
- The truly operations of the AI `dataset`, such as `shuffle`, `crop` etc.
- The truly operations of the AI `model`, such as `train`, `inference` etc.

7.2 Proposal

We propose using Kubernetes Custom Resource Definitions (CRDs) to describe the dataset/model specification/status and a controller to synchronize these updates between edge and cloud.



7.2.1 Use Cases

- Users can create the dataset resource, by providing the `dataset url`, `format` and the `nodeName` which owns the dataset.
- Users can create the model resource by providing the `model url` and `format`.
- Users can show the information of dataset/model.
- Users can delete the dataset/model.

7.3 Design Details

7.3.1 CRD API Group and Version

The `Dataset` and `Model` CRDs will be namespace-scoped. The tables below summarize the group, kind and API version details for the CRDs.

- Dataset

Field	Description
Group	sedna.io
APIVersion	v1alpha1
Kind	Dataset

- Model

Field	Description
Group	sedna.io
APIVersion	v1alpha1
Kind	Model

7.3.2 CRDs

`Dataset` CRD

crd source

```yaml
apiVersion: apiextensions.k8s.io/v1
kind: CustomResourceDefinition
metadata:
  name: datasets.sedna.io
spec:
  group: sedna.io
  names:
    kind: Dataset
    plural: datasets
  scope: Namespaced
  versions:
    - name: v1alpha1
      subresources:
        # status enables the status subresource.
        status: {}
      served: true
      storage: true
      schema:
        openAPIV3Schema:
          type: object
          properties:
            spec:
              type: object
              required:
```

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```
              - url
              - format
            properties:
              url:
                type: string
              format:
                type: string
              nodeName:
                type: string
          status:
            type: object
            properties:
              numberOfSamples:
                type: integer
              updateTime:
                type: string
                format: datatime


    additionalPrinterColumns:
      - name: NumberOfSamples
        type: integer
        description: The number of samples in the dataset
        jsonPath: ".status.numberOfSamples"
      - name: Node
        type: string
        description: The node name of the dataset
        jsonPath: ".spec.nodeName"
      - name: spec
        type: string
        description: The spec of the dataset
        jsonPath: ".spec"
```

1. `format` of dataset

We use this field to report the number of samples for the dataset and do dataset splitting.

Current we support these below formats:

- txt: one nonempty line is one sample

`Model` CRD

crd source

```
apiVersion: apiextensions.k8s.io/v1
kind: CustomResourceDefinition
metadata:
  name: models.sedna.io
spec:
  group: sedna.io
  names:
    kind: Model
```

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```
    plural: models
  scope: Namespaced
  versions:
    - name: v1alpha1
      subresources:
        # status enables the status subresource.
        status: {}
      served: true
      storage: true
      schema:
        openAPIV3Schema:
          type: object
          properties:
            spec:
              type: object
              required:
                - url
                - format
              properties:
                url:
                  type: string
                format:
                  type: string
            status:
              type: object
              properties:
                updateTime:
                  type: string
                  format: datetime
                metrics:
                  type: array
                  items:
                    type: object
                    properties:
                      key:
                        type: string
                      value:
                        type: string


      additionalPrinterColumns:
        - name: updateAGE
          type: date
          description: The update age
          jsonPath: ".status.updateTime"
        - name: metrics
          type: string
          description: The metrics
          jsonPath: ".status.metrics"
```

7.3.3 CRD type definition

- Dataset

go source

```
package v1alpha1

import (
    metav1 "k8s.io/apimachinery/pkg/apis/meta/v1"
)

// +genclient
// +k8s:deepcopy-gen:interfaces=k8s.io/apimachinery/pkg/runtime.Object

// Dataset describes the data that a dataset resource should have
type Dataset struct {
    metav1.TypeMeta `json:",inline"`

    metav1.ObjectMeta `json:"metadata,omitempty"`

    Spec   DatasetSpec   `json:"spec"`
    Status DatasetStatus `json:"status"`
}

// DatasetSpec is a description of a dataset
type DatasetSpec struct {
    URL  string `json:"url"`
    Format   string `json:"format"`
    NodeName string `json:"nodeName"`
}

// DatasetStatus represents information about the status of a dataset
// including the time a dataset updated, and number of samples in a dataset
type DatasetStatus struct {
    UpdateTime      *metav1.Time `json:"updateTime,omitempty" protobuf:"bytes,1,opt,
↪name=updateTime"`
    NumberOfSamples int          `json:"numberOfSamples"`
}

// +k8s:deepcopy-gen:interfaces=k8s.io/apimachinery/pkg/runtime.Object

// DatasetList is a list of Datasets
type DatasetList struct {
    metav1.TypeMeta `json:",inline"`
    metav1.ListMeta `json:"metadata"`

    Items []Dataset `json:"items"`
}
```

- Model

go source

```go
package v1alpha1

import (
    metav1 "k8s.io/apimachinery/pkg/apis/meta/v1"
)

// +genclient
// +k8s:deepcopy-gen:interfaces=k8s.io/apimachinery/pkg/runtime.Object

// Model describes the data that a model resource should have
type Model struct {
    metav1.TypeMeta `json:",inline"`

    metav1.ObjectMeta `json:"metadata,omitempty"`

    Spec   ModelSpec   `json:"spec"`
    Status ModelStatus `json:"status"`
}

// ModelSpec is a description of a model
type ModelSpec struct {
    URL string `json:"url"`
    Format   string `json:"format"`
}

// ModelStatus represents information about the status of a model
// including the time a model updated, and metrics in a model
type ModelStatus struct {
    UpdateTime *metav1.Time `json:"updateTime,omitempty" protobuf:"bytes,1,opt,
↪name=updateTime"`
    Metrics    []Metric     `json:"metrics,omitempty" protobuf:"bytes,2,rep,name=metrics
↪"`
}

// +k8s:deepcopy-gen:interfaces=k8s.io/apimachinery/pkg/runtime.Object

//  ModelList is a list of Models
type ModelList struct {
    metav1.TypeMeta `json:",inline"`
    metav1.ListMeta `json:"metadata"`

    Items []Model `json:"items"`
}
```

7.3.4 Crd samples

- Dataset

```yaml
apiVersion: sedna.io/v1alpha1
kind: Dataset
metadata:
  name: "dataset-examp"
spec:
  url: "/code/data"
  format: "txt"
  nodeName: "edge0"
```

- Model

```yaml
apiVersion: sedna.io/v1alpha1
kind: Model
metadata:
  name: model-examp
spec:
  url: "/model/frozen.pb"
  format: pb
```

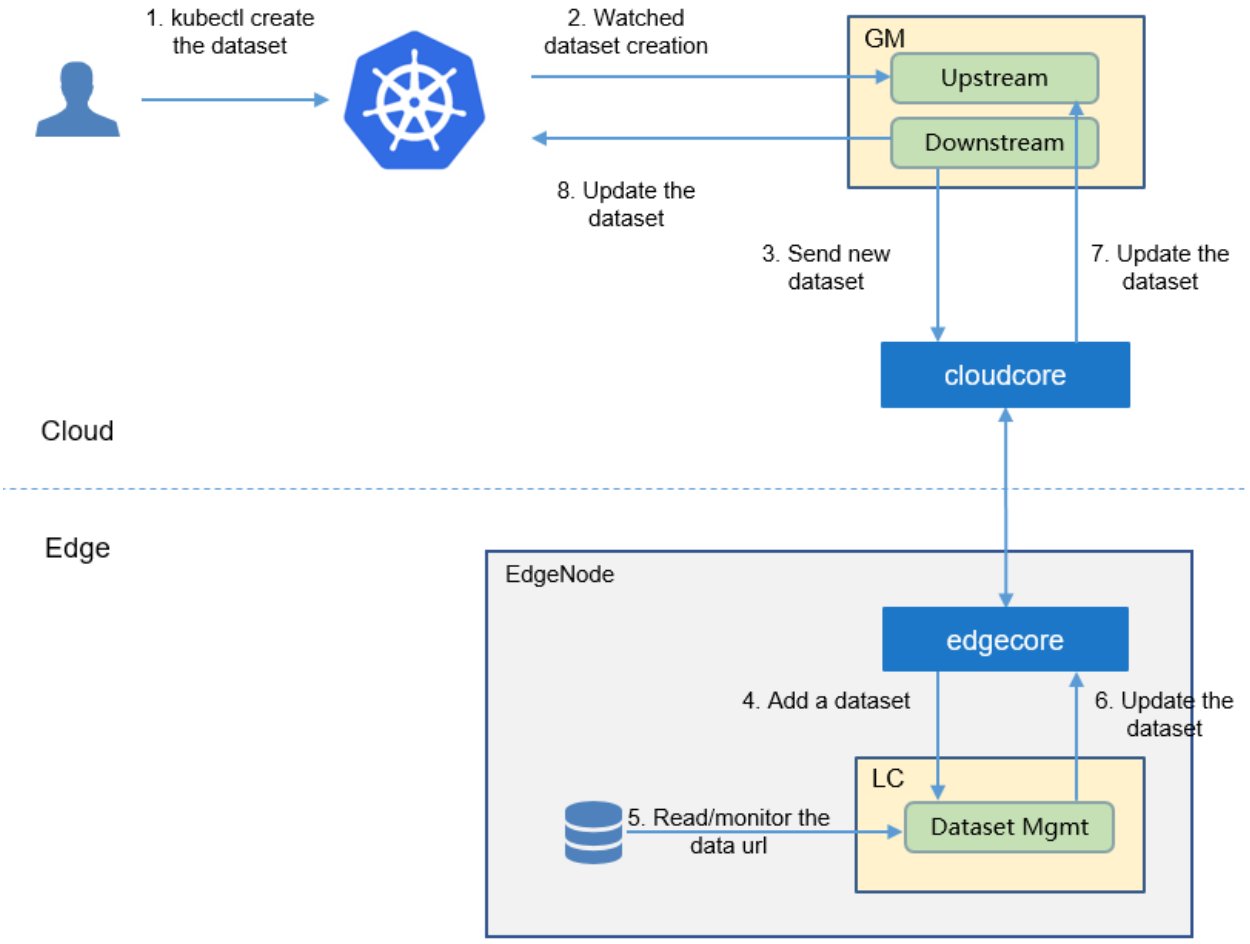
7.4 Controller Design

In the current design there is downstream/upstream controller for `dataset`, no downstream/upstream controller for `model`.

The dataset controller synchronizes the dataset between the cloud and edge.

- downstream: synchronize the dataset info from the cloud to the edge node.
- upstream: synchronize the dataset status from the edge to the cloud node, such as the information how many samples the dataset has.

Here is the flow of the dataset creation:



For the model:

1. Model's info will be synced when sync the federated-task etc which uses the model.
2. Model's status will be updated when the corresponding training/inference work has completed.

CHAPTER

EIGHT

FEDERATED LEARNING

8.1 Motivation

For edge AI, data is naturally generated at the edge. based on these assumptions:

- Users are unwilling to upload raw data to the cloud because of data privacy.
- Users do not want to purchase new devices for centralized training at the edge.
- The sample size at the edge is usually small, and it is often difficult to train a good model at a single edge node.

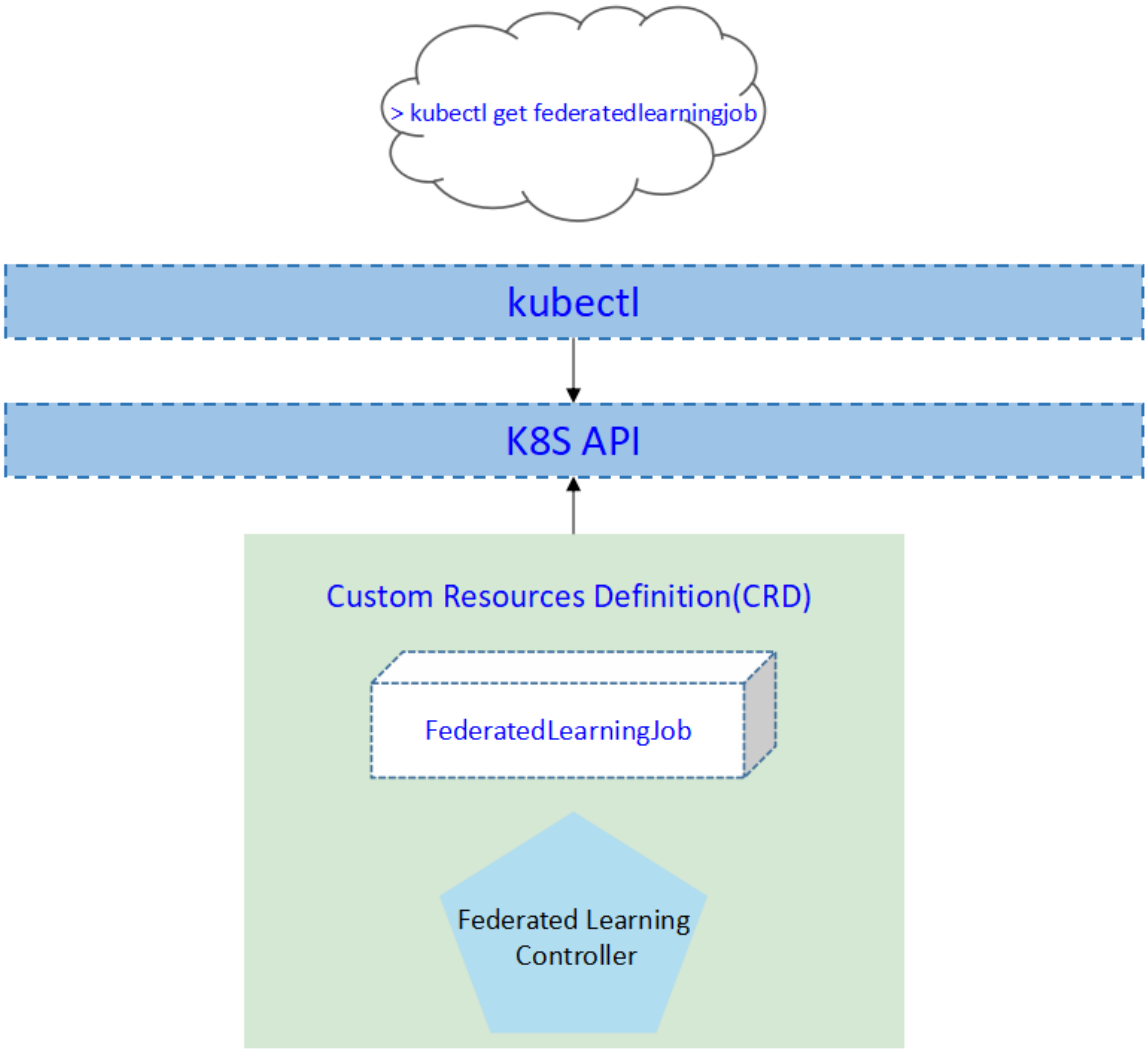
Therefore, we propose a edge cloud federated learning framework to help to train a model **without uploading raw data**, and **higher precision** and **less convergence time** are also benefits.

8.1.1 Goals

- The framework can combine data on multiple edge nodes to complete training.
- The framework provides the functions of querying the training status and result.
- The framework integrates some common aggregation algorithms, FedAvg and so on.
- The framework integrates some common weight/gradient compression algorithm to reduce the cloud-edge traffic required for aggregation operations.
- The framework integrates some common multi-job migration algorithms to resolve the problem of low precision caused by small size samples.

8.2 Proposal

We propose using Kubernetes Custom Resource Definitions (CRDs) to describe the federated learning specification/status and a controller to synchronize these updates between edge and cloud.



8.2.1 Use Cases

- User can create a federated learning job, with providing a training script, specifying the aggregation algorithm, configuring training hyperparameters, configuring training datasets.
- Users can get the federated learning status, including the nodes participating in training, current training status, samples size of each node, current iteration times, and current aggregation times.
- Users can get the saved aggregated model. The model file can be stored on the cloud or edge node.

8.3 Design Details

8.3.1 CRD API Group and Version

The `FederatedLearningJob` CRD will be namespace-scoped. The tables below summarize the group, kind and API version details for the CRD.

- FederatedLearningJob

Field	Description
Group	sedna.io
APIVersion	v1alpha1
Kind	FederatedLearningJob

8.3.2 Federated learning CRD

Below is the CustomResourceDefinition yaml for `FederatedLearningJob`: crd source

8.3.3 Federated learning type definition

go source

Validation

Open API v3 Schema based validation can be used to guard against bad requests. Invalid values for fields (example string value for a boolean field etc) can be validated using this.

Here is a list of validations we need to support :

1. The `dataset` specified in the crd should exist in k8s.
2. The `model` specified in the crd should exist in k8s.
3. The edgenode name specified in the crd should exist in k8s.

8.3.4 federated learning sample

see sample source

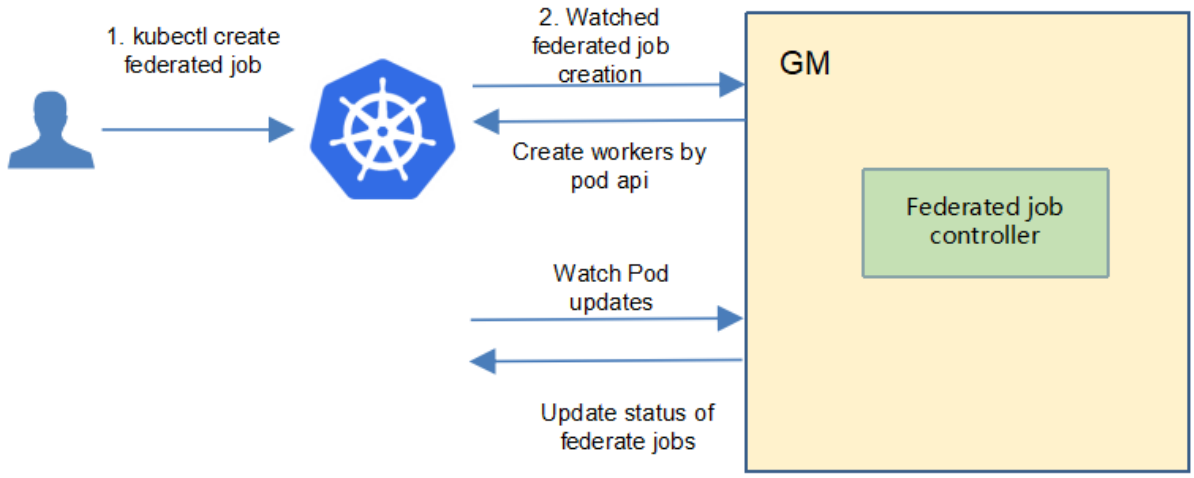
8.3.5 Creation of the federated learning job

8.4 Controller Design

The federated learning controller starts three separate goroutines called `upstream`, `downstream` and `federated-learning`controller. These are not separate controllers as such but named here for clarity.

- federated learning: watch the updates of federated-learning-job crds, and create the workers to complete the job.
- downstream: synchronize the federated-learning updates from the cloud to the edge node.
- upstream: synchronize the federated-learning updates from the edge to the cloud node.

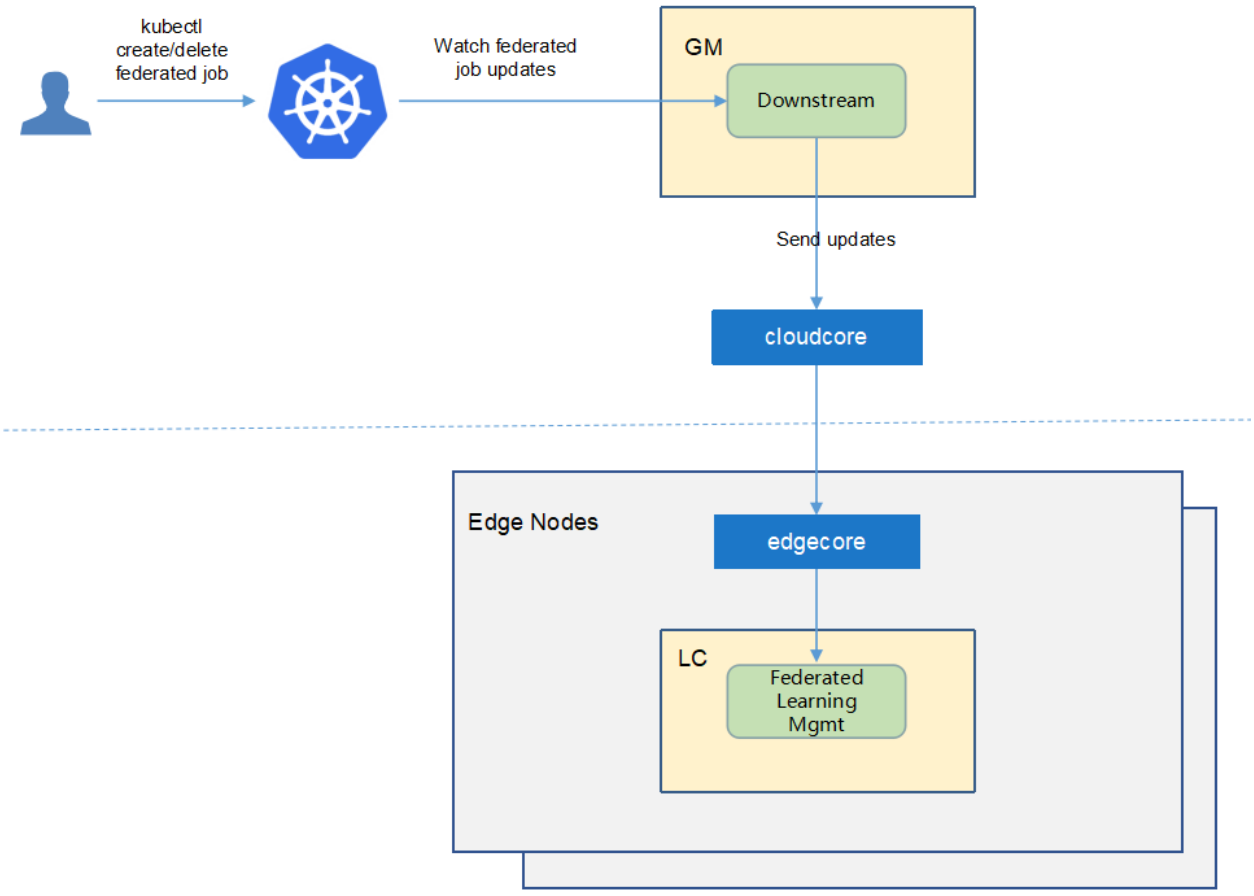
8.4.1 Federated Learning Controller



The federated-learning controller watches for the updates of federated-learning jobs and the corresponding pods against the K8S API server. Updates are categorized below along with the possible actions:

Update Type	Action
New Federated-learning-job Created	Create the aggregation worker and these local-training workers
Federated-learning-job Deleted	NA. These workers will be deleted by k8s gc.
The corresponding pod created/running/completed/failed	Update the status of federated-learning job.

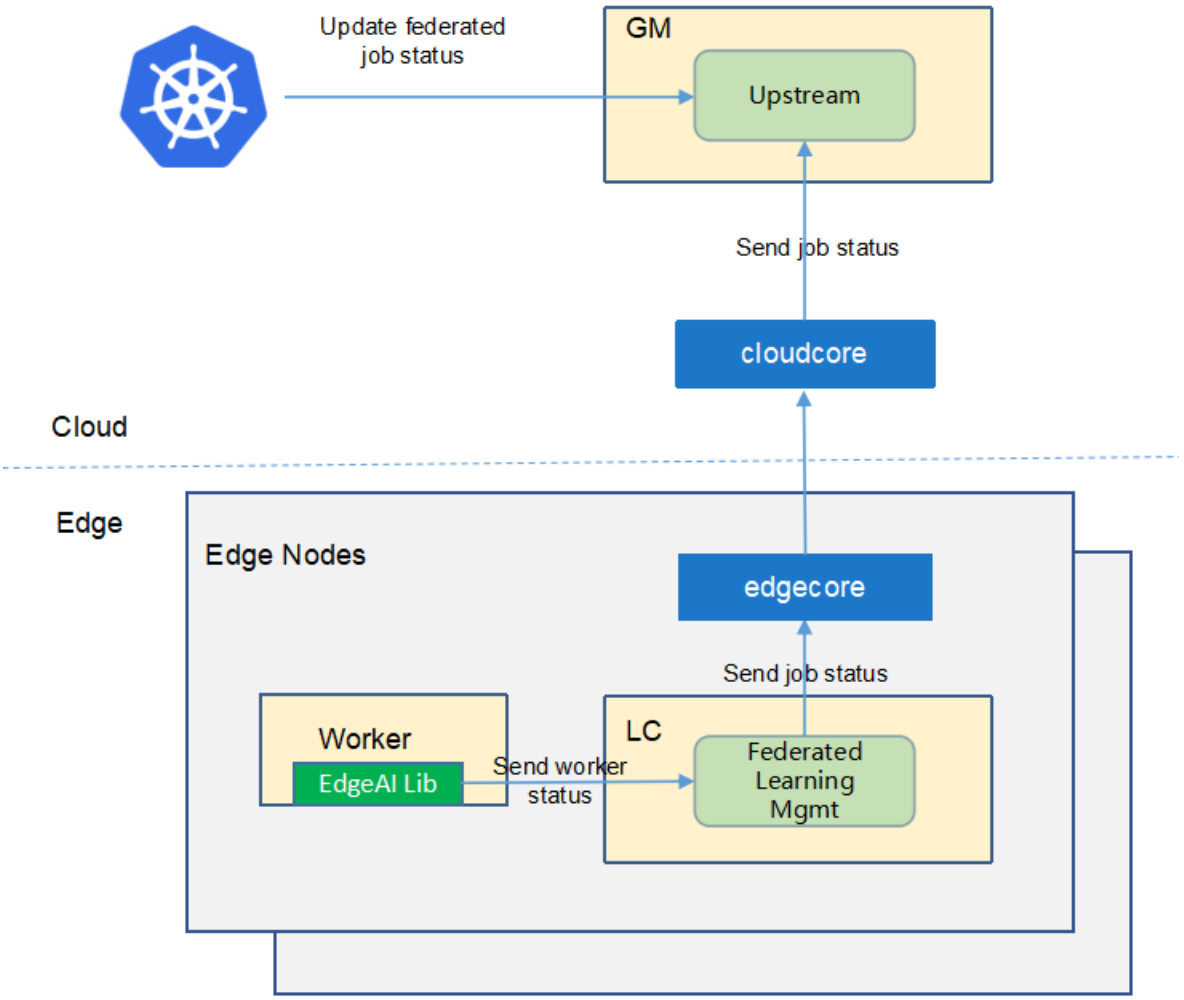
8.4.2 Downstream Controller



The downstream controller watches for federated-learning updates against the K8S API server. Updates are categorized below along with the possible actions that the downstream controller can take:

Update Type	Action
New Federated-learning-job Created	Sends the job information to LCs.
Federated-learning-job Deleted	The controller sends the delete event to LCs.

8.4.3 Upstream Controller



The upstream controller watches for federated-learning-job updates from the edge node and applies these updates against the API server in the cloud. Updates are categorized below along with the possible actions that the upstream controller can take:

Update Type	Action
Federated-learning-job Reported State Updated	The controller appends the reported status of the Federated-learning-job in the cloud.

8.4.4 Details of api between GM(cloud) and LC(edge)

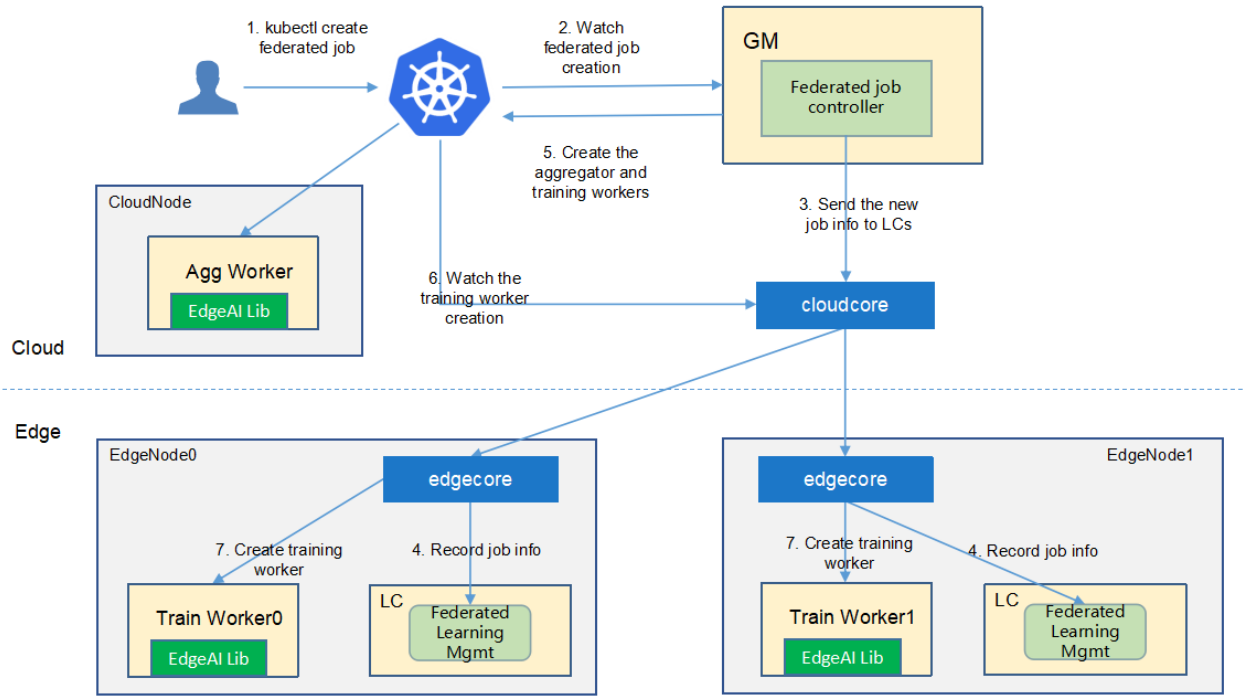
1. GM(downstream controller) syncs the job info to LC:

```
// POST <namespace>/federatedlearningjobs/<job-name>
// body same to the job crd of k8s api, omitted here.
```

2. LC uploads the job status which reported by the worker to GM(upstream controller):

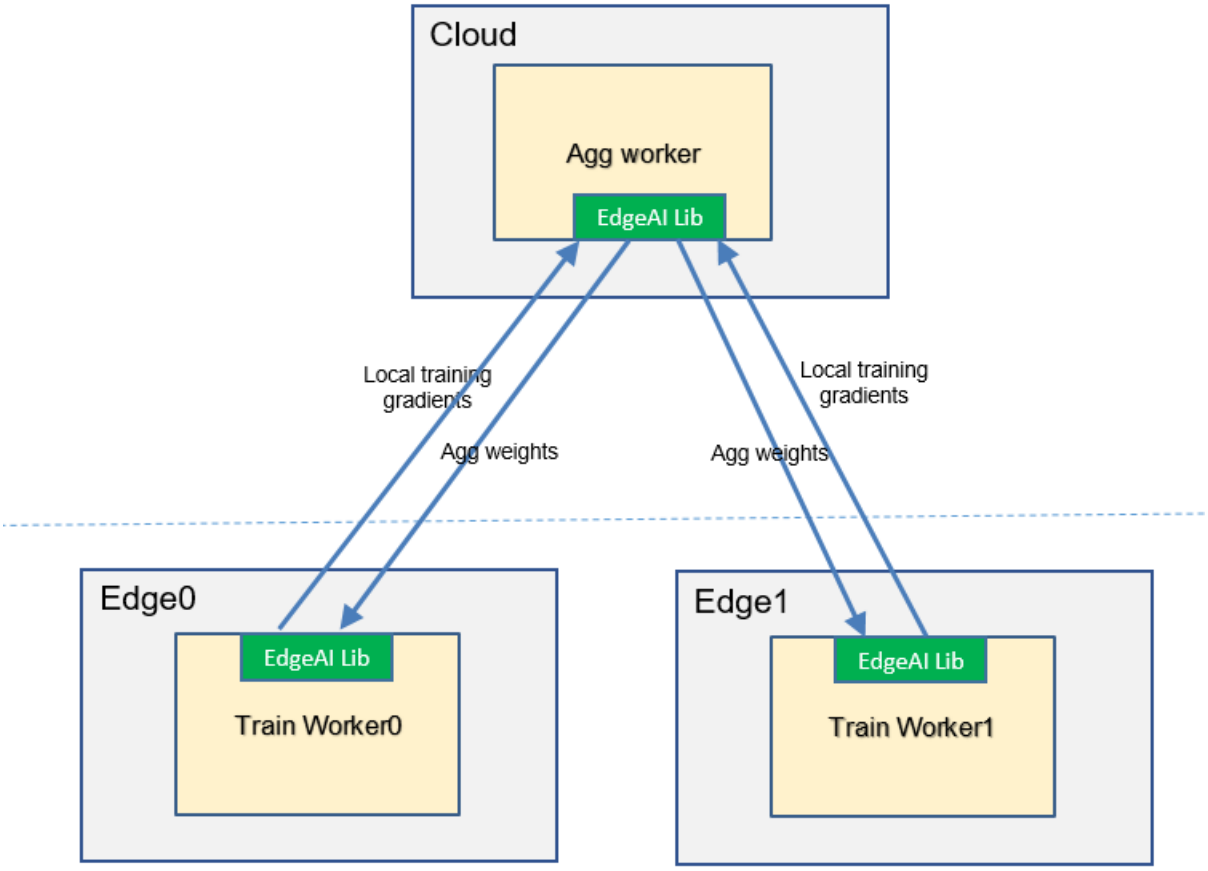
```
// POST <namespace>/federatedlearningjobs/<job-name>/status

// WorkerMessage defines the message from that the training worker. It will send to␣
↪GM.
type WorkerMessage struct {
    Phase  string        `json:"phase"`
    Status string        `json:"status"`
    Output *WorkerOutput `json:"output"`
}
//
type WorkerOutput struct {
    Models   []*Model  `json:"models"`
    JobInfo *JobInfo `json:"jobInfo"`
}

// Model defines the model information
type Model struct {
    Format  string             `json:"format"`
    URL     string             `json:"url"`
    // Including the metrics, e.g. precision/recall
    Metrics map[string]float64 `json:"metrics"`
}

// JobInfo defines the job information
type JobInfo struct {
    // Current training round
    CurrentRound int    `json:"currentRound"`
    UpdateTime   string `json:"updateTime"`
    SampleCount  int    `json:"sampleCount"`
}
```

8.4.5 The flow of federated learning job creation



The federated-learning controller watches the creation of federatedlearningjob crd in the cloud, syncs them to lc via the cloudhub-to-edgehub channel, and creates the aggregator worker on the cloud nodes and the training workers on the edge nodes specified by the user. The aggregator worker is started by the native k8s at the cloud nodes. These training workers are started by the kubeedge at the edge nodes.

8.5 Workers Communication



CHAPTER

NINE

INCREMENTAL LEARNING

9.1 Motivation

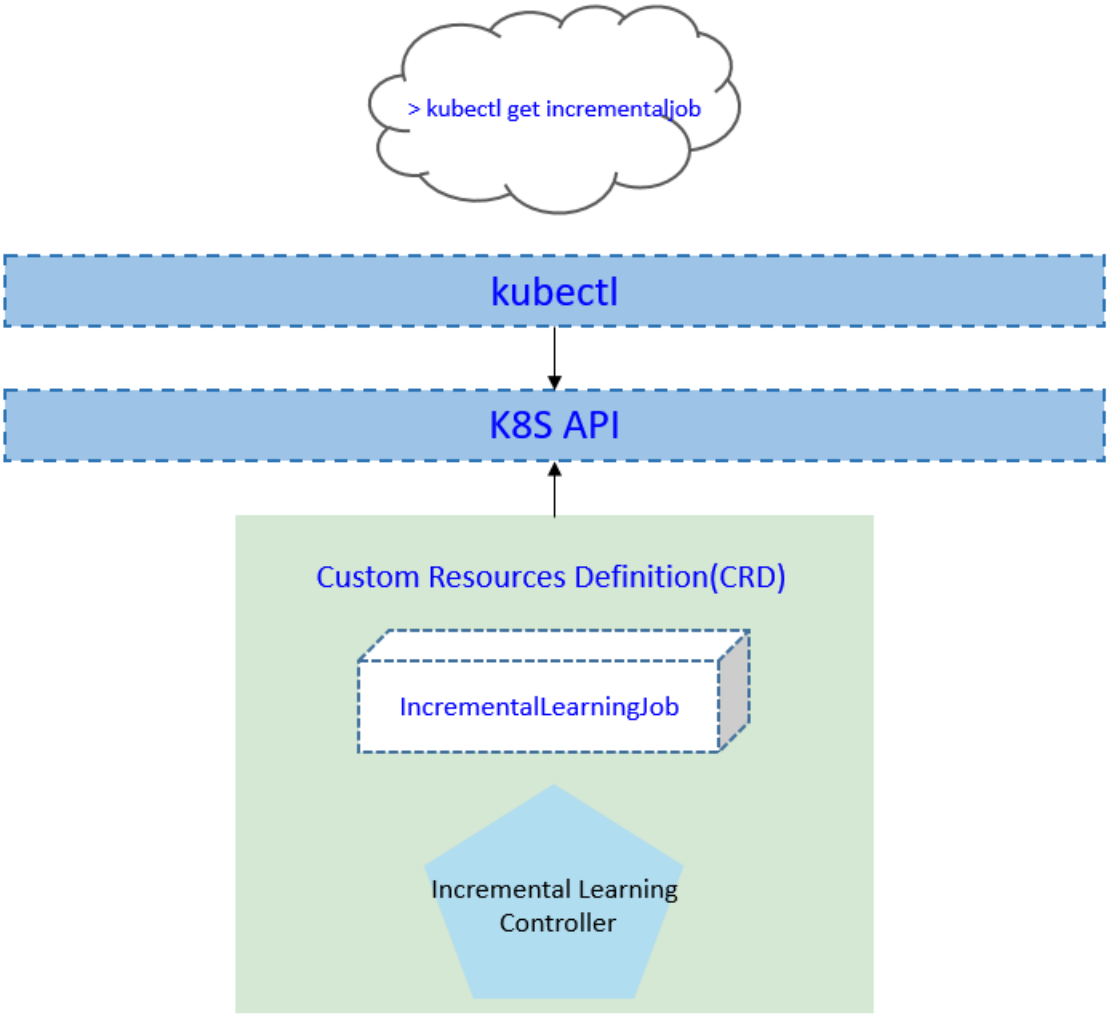
Data is continuously generated on the edge side. Traditionally, the data is collected manually and periodically retrained on the cloud to improve the model effect. This method wastes a lot of human resources, and the model update frequency is slow. Incremental learning allows users to continuously monitor the newly generated data and by configuring some triggering rules to determine whether to start training, evaluation, and deployment automatically, and continuously improve the model performance.

9.1.1 Goals

- Automatically retrains, evaluates, and updates models based on the data generated at the edge.
- Support time trigger, sample size trigger, and precision-based trigger.
- Support manual triggering of training, evaluation, and model update.
- support hard sample discovering of unlabeled data, for reducing the manual labeling workload.
- Support lifelong learning that reserves historical knowledge to avoid frequent re-training/ re-fine-tuning, and tackles samples uncovered in historical knowledge base.

9.2 Proposal

We propose using Kubernetes Custom Resource Definitions (CRDs) to describe the incremental learning specification/status and a controller to synchronize these updates between edge and cloud.



9.2.1 Use Cases

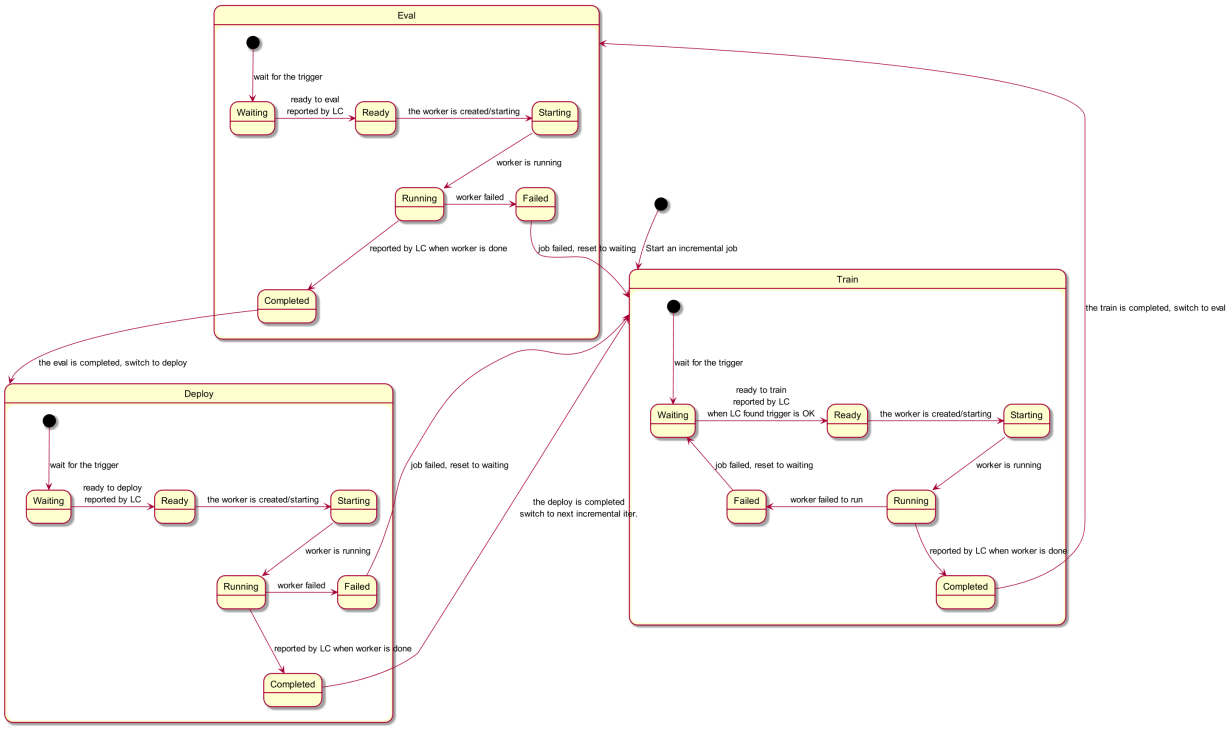
- Users can create the incremental learning jobs, by providing training scripts, configuring training hyperparameters, providing training datasets, configuring training and deployment triggers.

9.3 Design Details

There are three stages in a incremental learning job: train/eval/deploy.

Each stage contains these below states:

1. Waiting: wait to trigger satisfied, i.e. wait to train/eval/deploy
2. Ready: the corresponding trigger satisfied, now ready to train/eval/deploy
3. Starting: the corresponding stage is starting
4. Running: the corresponding stage is running
5. Failed: the corresponding stage failed
6. Completed: the corresponding stage completed



9.3.1 CRD API Group and Version

The `IncrementalLearningJob` CRD will be namespace-scoped. The tables below summarize the group, kind and API version details for the CRD.

- IncrementalLearningJob

Field	Description
Group	sedna.io
APIVersion	v1alpha1
Kind	IncrementalLearningJob

9.3.2 Incremental learning CRD

See the crd source for details.

9.3.3 Incremental learning job type definition

See the golang source for details.

Validation

Open API v3 Schema based validation can be used to guard against bad requests. Invalid values for fields (example string value for a boolean field etc) can be validated using this.

Here is a list of validations we need to support :

1. The `dataset` specified in the crd should exist in k8s.
2. The `model` specified in the crd should exist in k8s.
3. The edgenode name specified in the crd should exist in k8s.

9.3.4 Incremental learning job sample

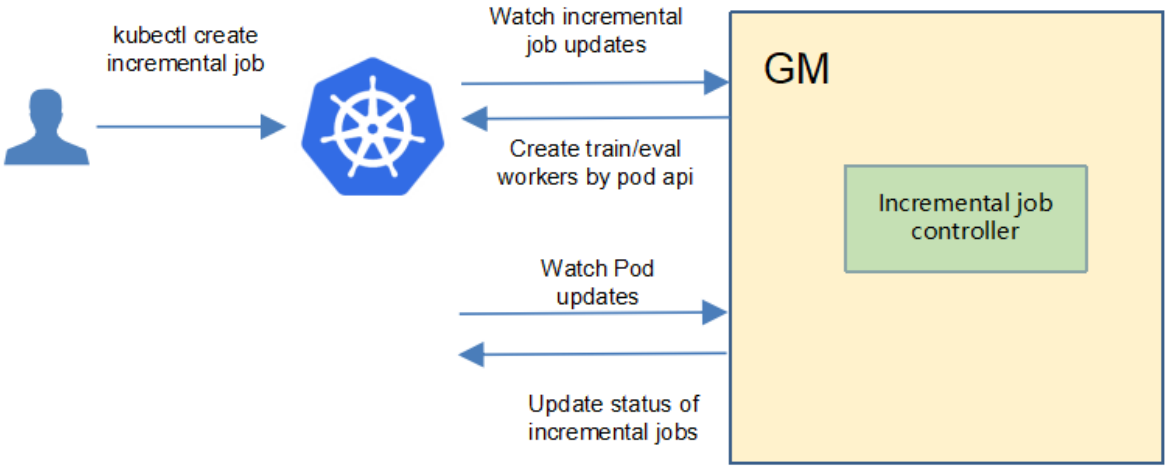
See the source for an example.

9.4 Controller Design

The incremental learning controller starts three separate goroutines called `upstream`, `downstream` and `incrementallearningjob`controller. These are not separate controllers as such but named here for clarity.

- incremental learning: watch the updates of incremental-learning job crds, and create the workers depending on the state machine.
- downstream: synchronize the incremental-learning-job updates from the cloud to the edge node.
- upstream: synchronize the incremental-learning-job updates from the edge to the cloud node.

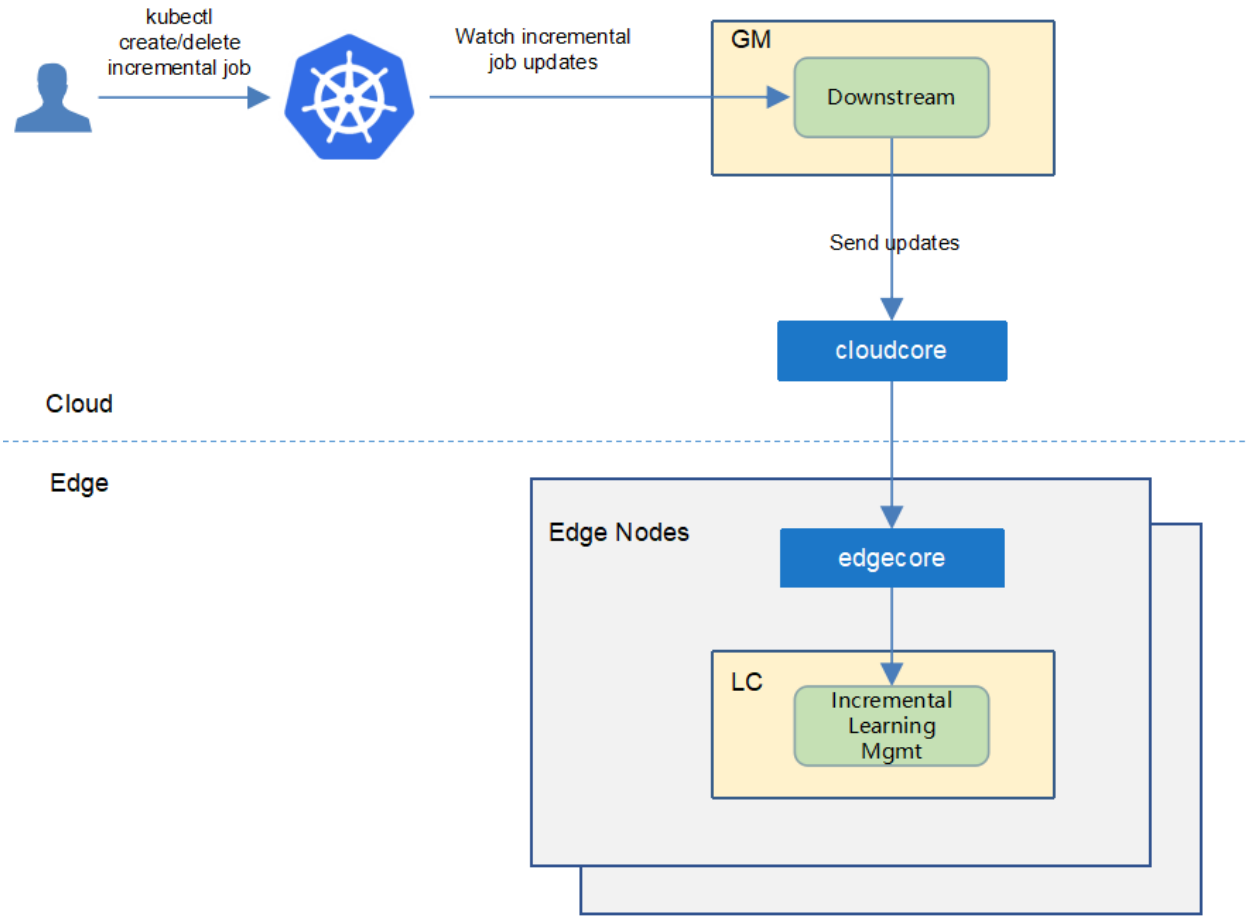
9.4.1 Incremental Learning Controller



The incremental-learning controller watches for the updates of incremental-learning jobs and the corresponding pods against the K8S API server. Updates are categorized below along with the possible actions:

Update Type	Action
New Incremental-learning-job Created	Wait to train trigger satisfied
Incremental-learning-job Deleted	NA. These workers will be deleted by k8s gc.
The Status of Incremental-learning-job Updated	Create the train/eval worker if it's ready.
The corresponding pod created/running/completed/failed	Update the status of incremental-learning job.

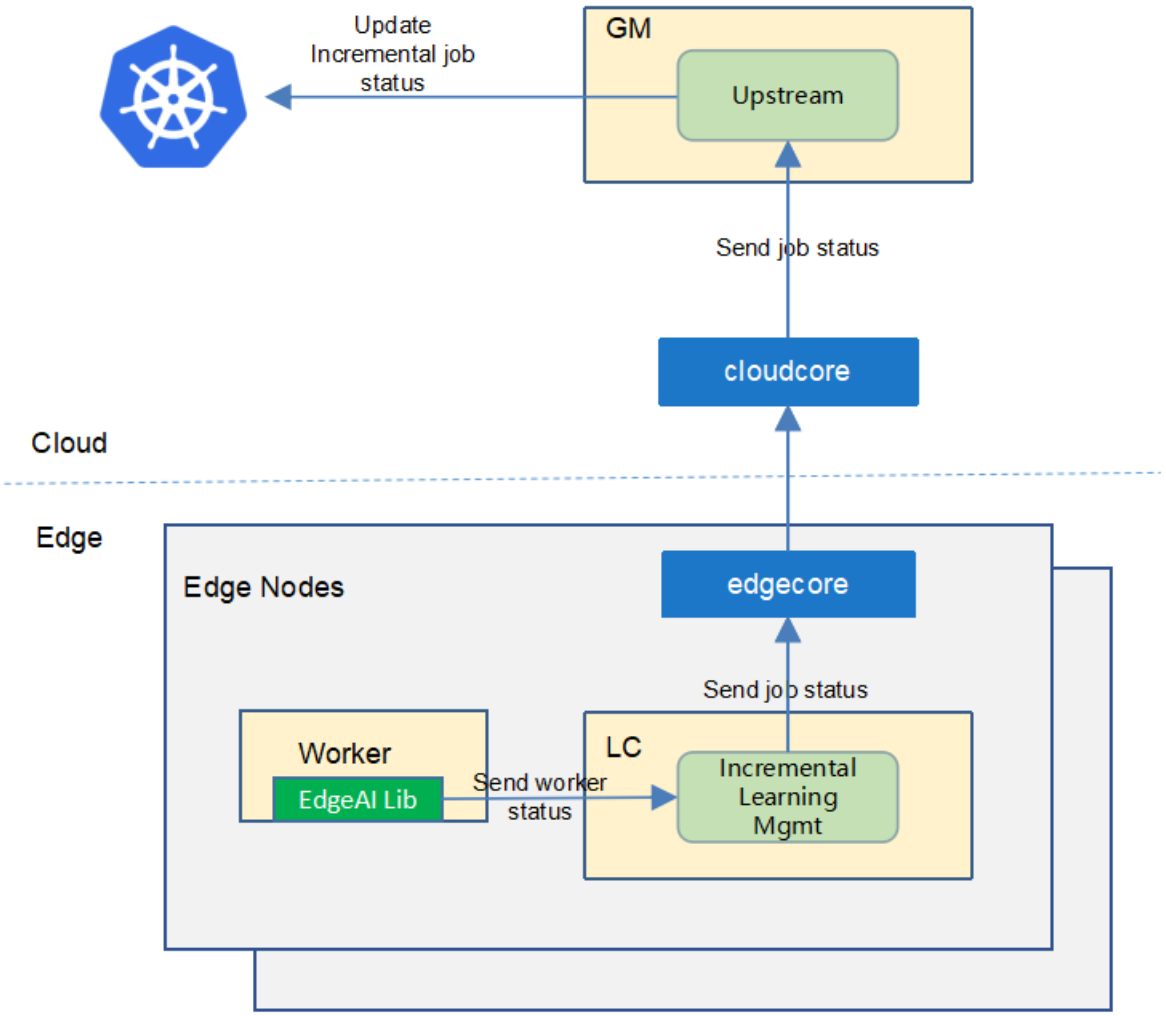
9.4.2 Downstream Controller



The downstream controller watches for the incremental-learning job updates against the K8S API server. Updates are categorized below along with the possible actions that the downstream controller can take:

Update Type	Action
New Incremental-learning-job Created	Sends the job information to LCs.
Incremental-learning-job Deleted	The controller sends the delete event to LCs.

9.4.3 Upstream Controller



The upstream controller watches for the incremental-learning job updates from the edge node and applies these updates against the API server in the cloud. Updates are categorized below along with the possible actions that the upstream controller can take:

Update Type	Action
Incremental-learning-job Reported State Updated	The controller appends the reported status of the job by LC in the cloud.

9.4.4 Details of api between GM(cloud) and LC(edge)

1. GM(downstream controller) syncs the job info to LC:

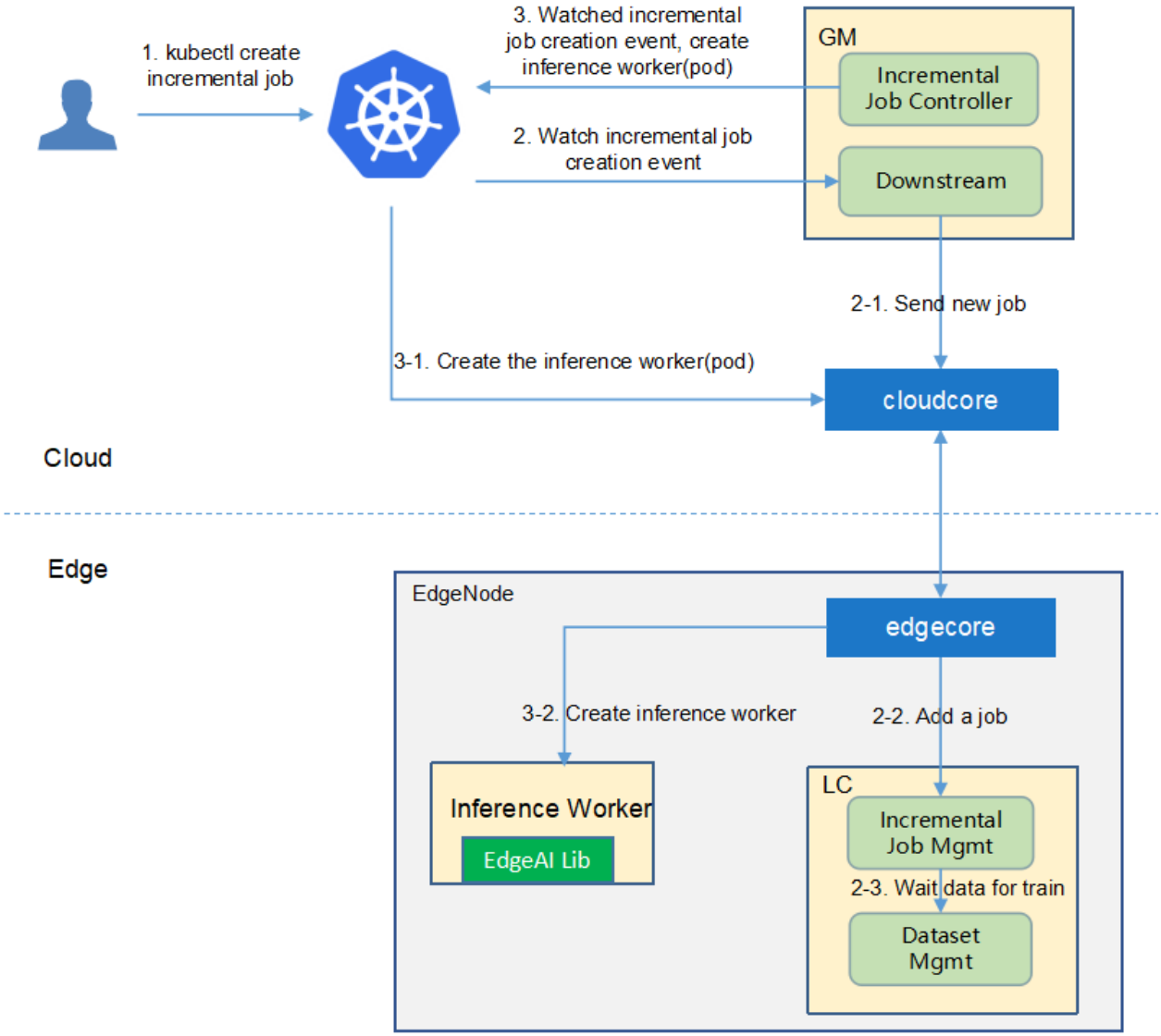
```
// POST <namespace>/incrementallearningjobs/<job-name>
// body same to the job crd of k8s api, omitted here.
```

2. LC uploads the job status which reported by the worker to GM(upstream controller):

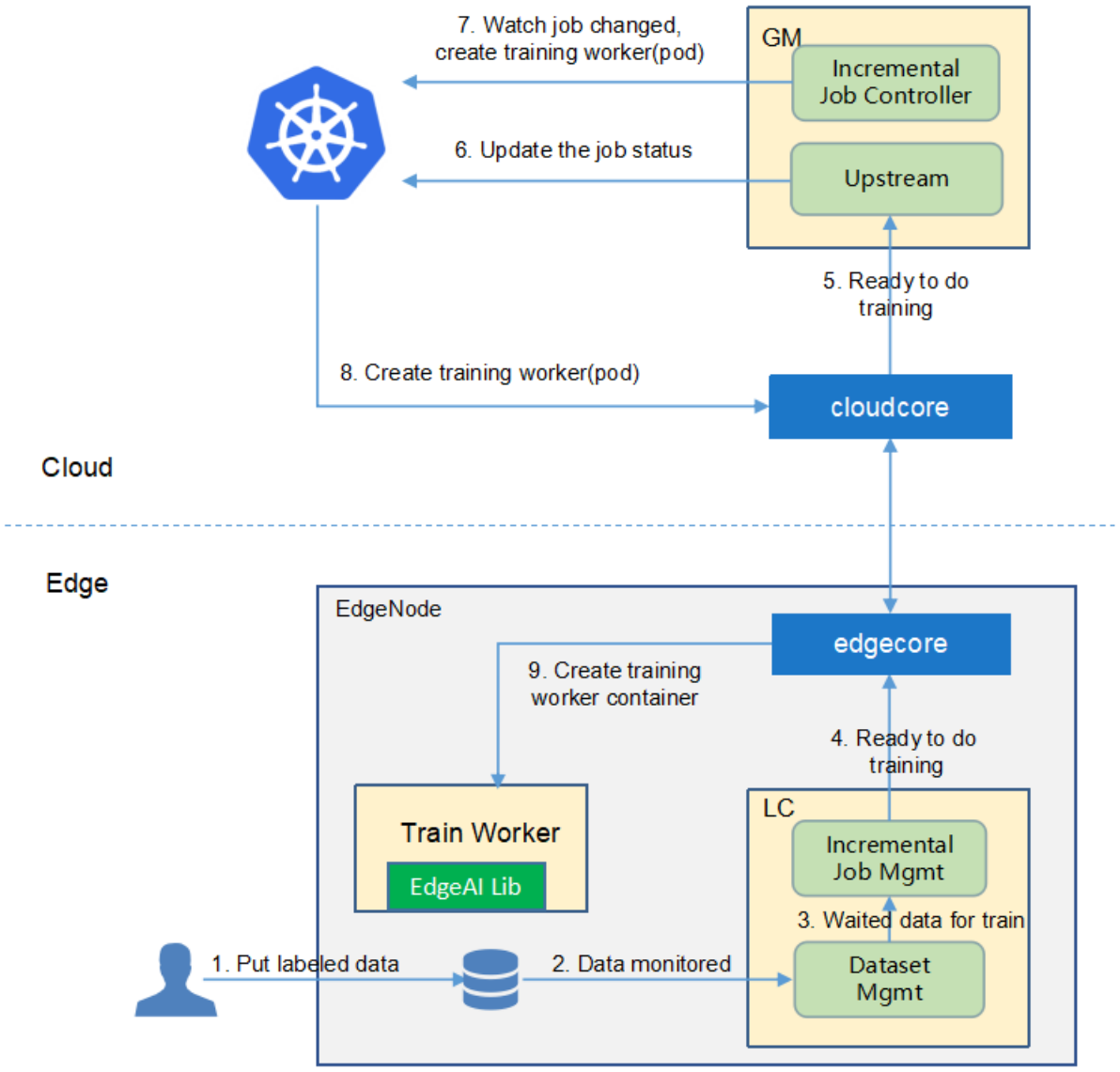
```
// POST <namespace>/incrementallearningjobs/<job-name>/status

// WorkerMessage defines the message from that the training worker. It will send to␣
↪GM.
type WorkerMessage struct {
    Phase  string        `json:"phase"`
    Status string        `json:"status"`
    Output *WorkerOutput `json:"output"`
}
//
type WorkerOutput struct {
    Models   []*Model  `json:"models"`
    OwnerInfo *OwnerInfo `json:"ownerInfo"`
}

// Model defines the model information
type Model struct {
    Format  string             `json:"format"`
    URL     string             `json:"url"`
    // Including the metrics, e.g. precision/recall
    Metrics map[string]float64 `json:"metrics"`
}

// TaskInfo defines the task information
type TaskInfo struct {
    // Current training round
    CurrentRound int    `json:"currentRound"`
    UpdateTime   string `json:"updateTime"`
}
```

9.4.5 The flows of incremental learning job

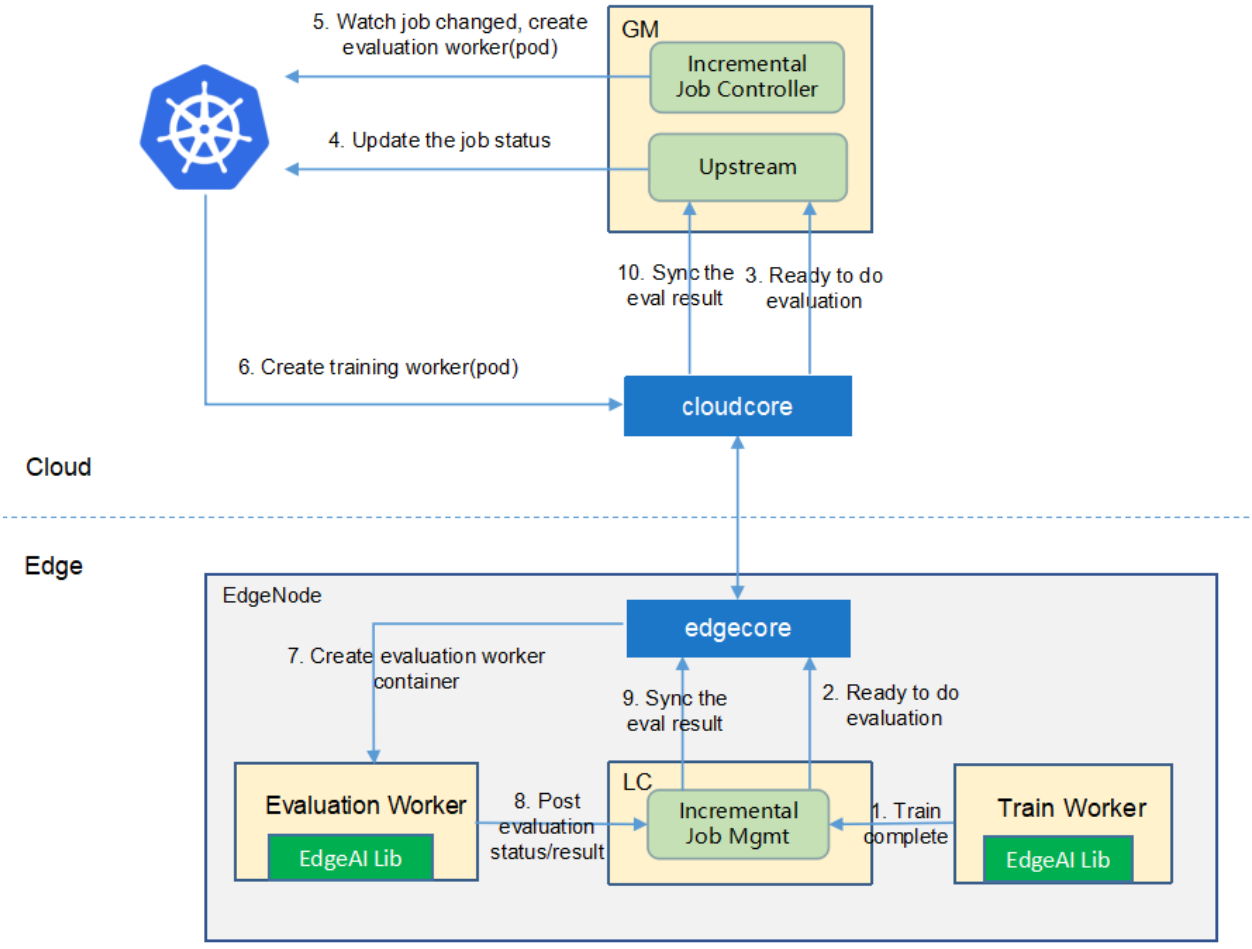
- Flow of the job creation:



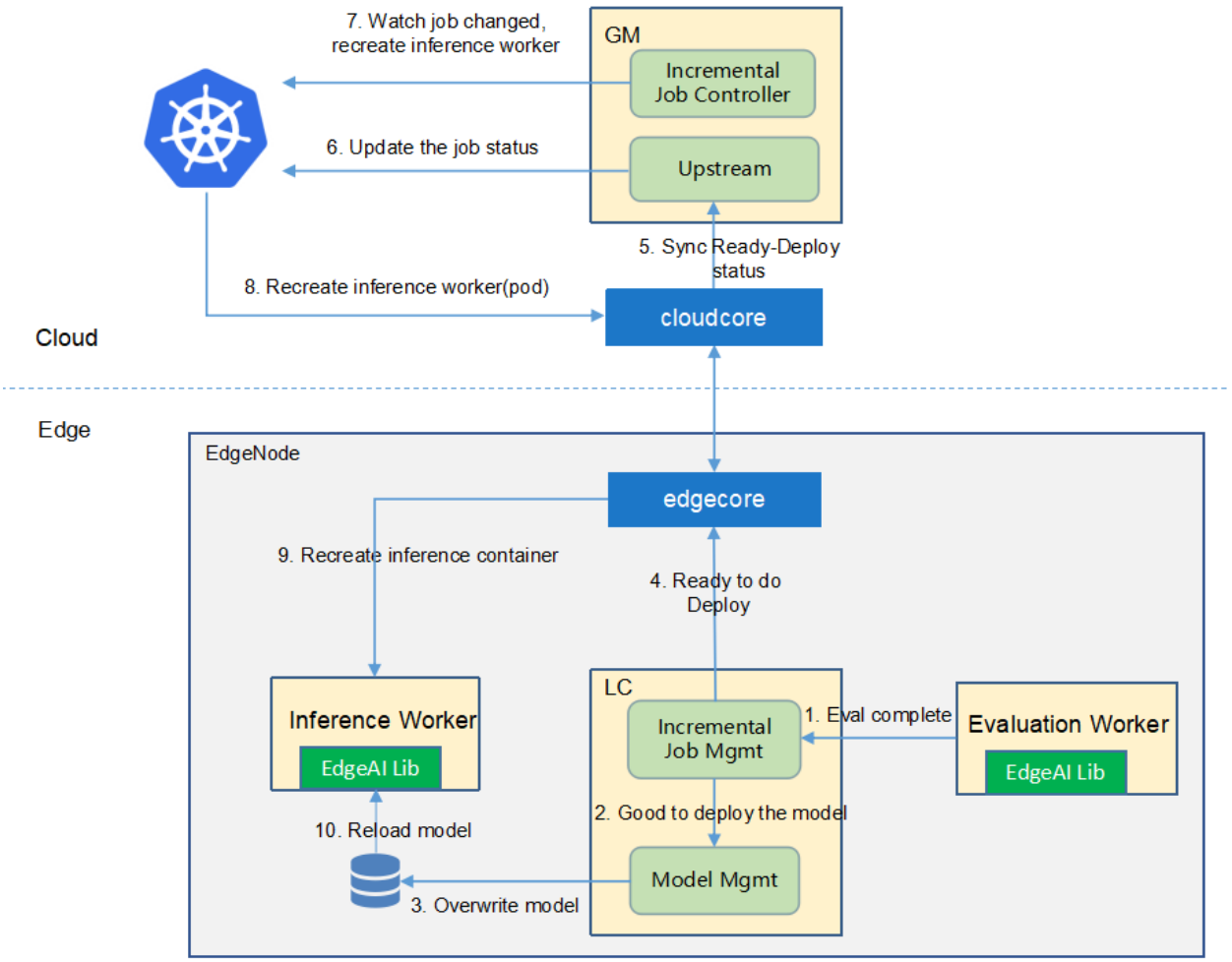
- Flow of the `train` stage:



- Flow of the `eval` stage:



- Flow of the `deploy` stage:



9.5 Workers Communication

No need to communicate between workers.

- Joint Inference
  - Motivation
    - Goals
    - Non-goals
  - Proposal
    - Use Cases
  - Design Details
    - CRD API Group and Version
    - Joint inference CRD
    - Joint inference type definition
    - Joint inference sample

CHAPTER

TEN

JOINT INFERENCE

10.1 Motivation

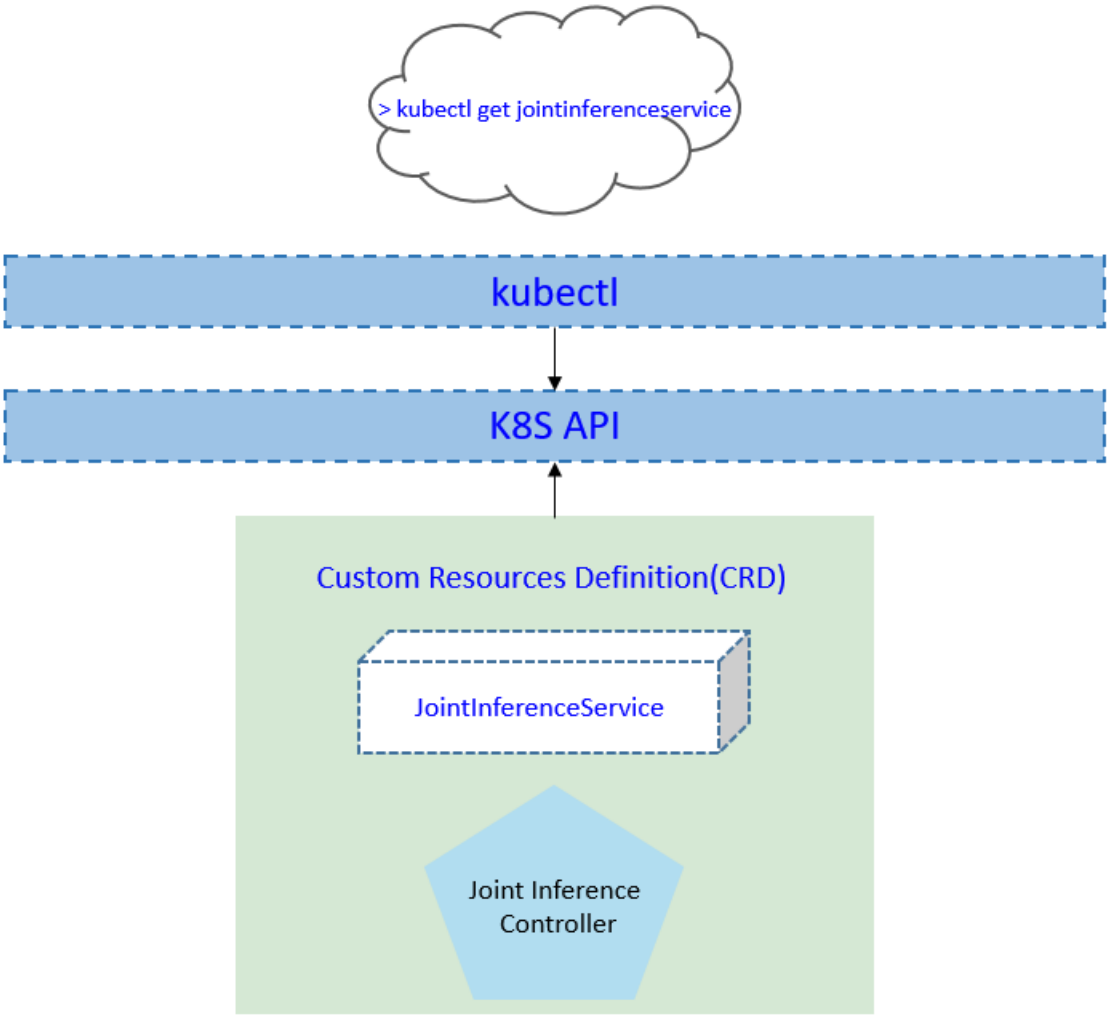
Inference on the edge can get a shorter latency and a higher throughput, and inference on the cloud can get better inference precision. The collaborative inference technology detects hard samples on the edge and sends them to the cloud for inference. **In this way, simple samples inference on the edge ensures latency and throughput, while hard samples inference on the cloud improves the overall precision.**

10.1.1 Goals

- Joint inference improves the inference precision without significantly reducing the time and throughput.

10.2 Proposal

We propose using Kubernetes Custom Resource Definitions (CRDs) to describe the joint inference specification/status and a controller to synchronize these updates between edge and cloud.



10.2.1 Use Cases

- User can create a joint inference service with providing a training script, specifying the aggregation algorithm, configuring training hyper parameters, configuring training datasets.
- Users can get the joint inference status, including the counts of inference at the edge/cloud.

10.3 Design Details

10.3.1 CRD API Group and Version

The `JointInferenceService` CRD will be namespace-scoped. The tables below summarize the group, kind and API version details for the CRD.

- JointInferenceService

Field	Description
Group	sedna.io
APIVersion	v1alpha1
Kind	JointInferenceService

10.3.2 Joint inference CRD

see crd source

10.3.3 Joint inference type definition

see go source

Validation

Open API v3 Schema based validation can be used to guard against bad requests. Invalid values for fields (example string value for a boolean field etc) can be validated using this.

Here is a list of validations we need to support :

1. The `dataset` specified in the crd should exist in k8s.
2. The `model` specified in the crd should exist in k8s.
3. The edgenode name specified in the crd should exist in k8s.

10.3.4 joint inference sample

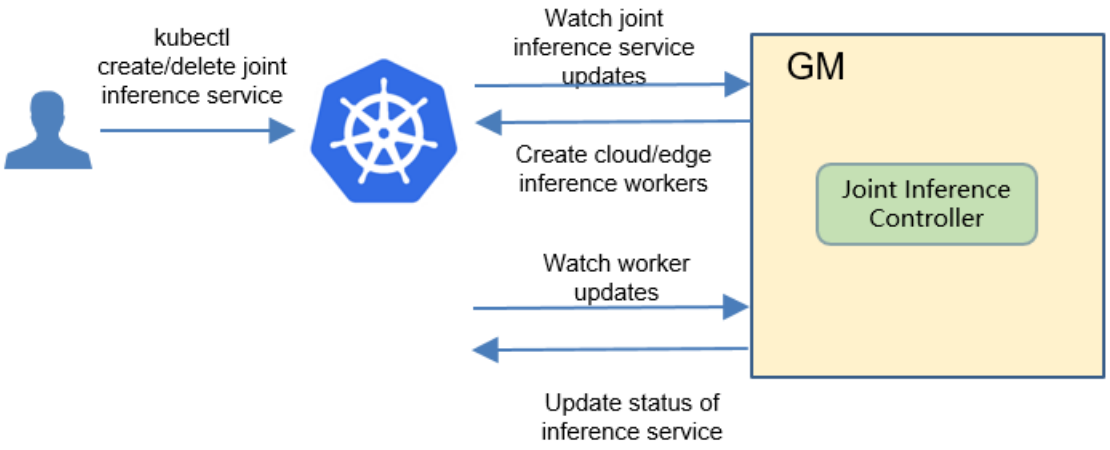
see sample source

10.4 Controller Design

The joint inference controller starts three separate goroutines called `upstream`, `downstream` and `joint-inference`controller. These are not separate controllers as such but named here for clarity.

- joint inference: watch the updates of joint-inference-task crds, and create the workers to complete the task.
- downstream: synchronize the joint-inference updates from the cloud to the edge node.
- upstream: synchronize the joint-inference updates from the edge to the cloud node.

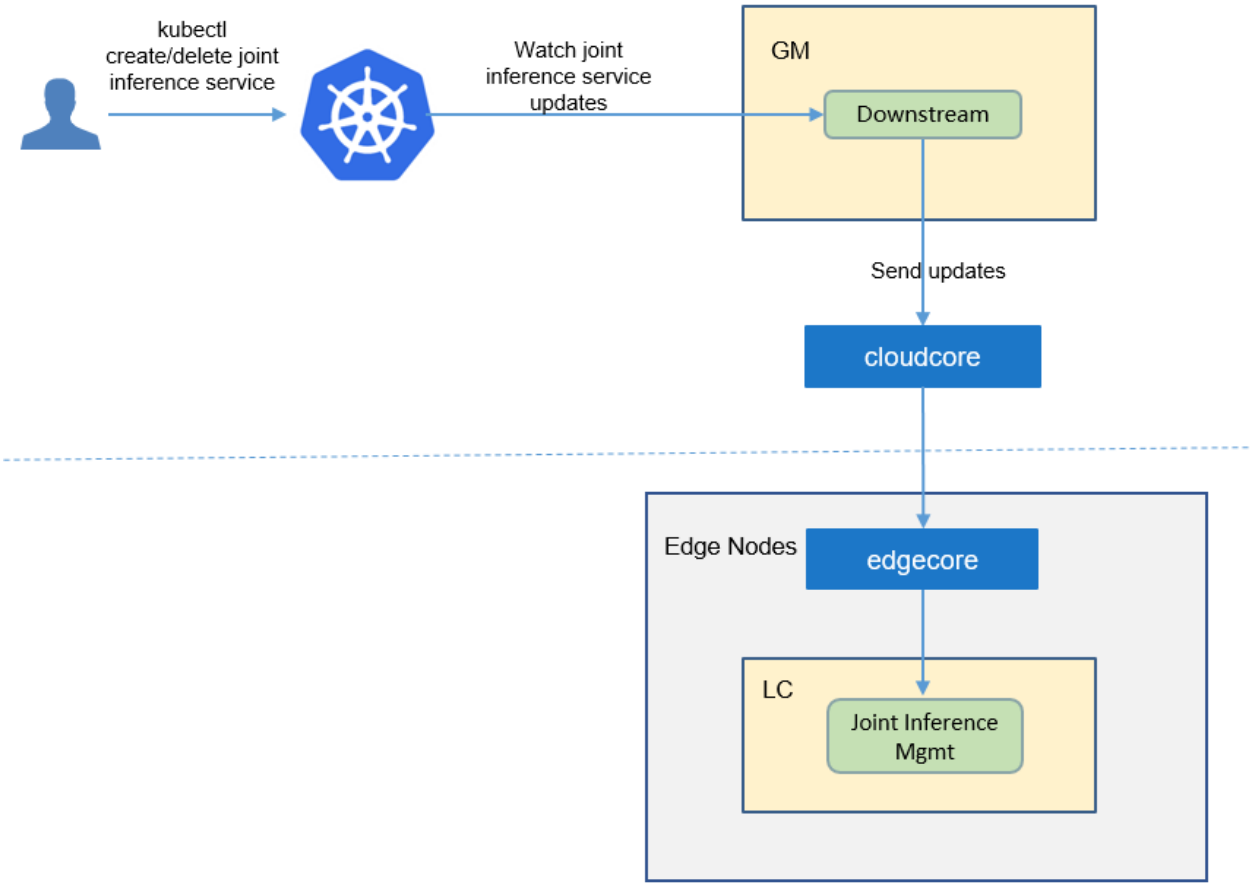
10.4.1 Joint Inference Controller



The joint-inference controller watches for the updates of joint-inference tasks and the corresponding pods against the K8S API server. Updates are categorized below along with the possible actions:

Update Type	Action
New Joint-inference-service Created	Create the cloud/edge worker
Joint-inference-service Deleted	NA. These workers will be deleted by GM.
The corresponding pod created/running/completed/failed	Update the status of joint-inference task.

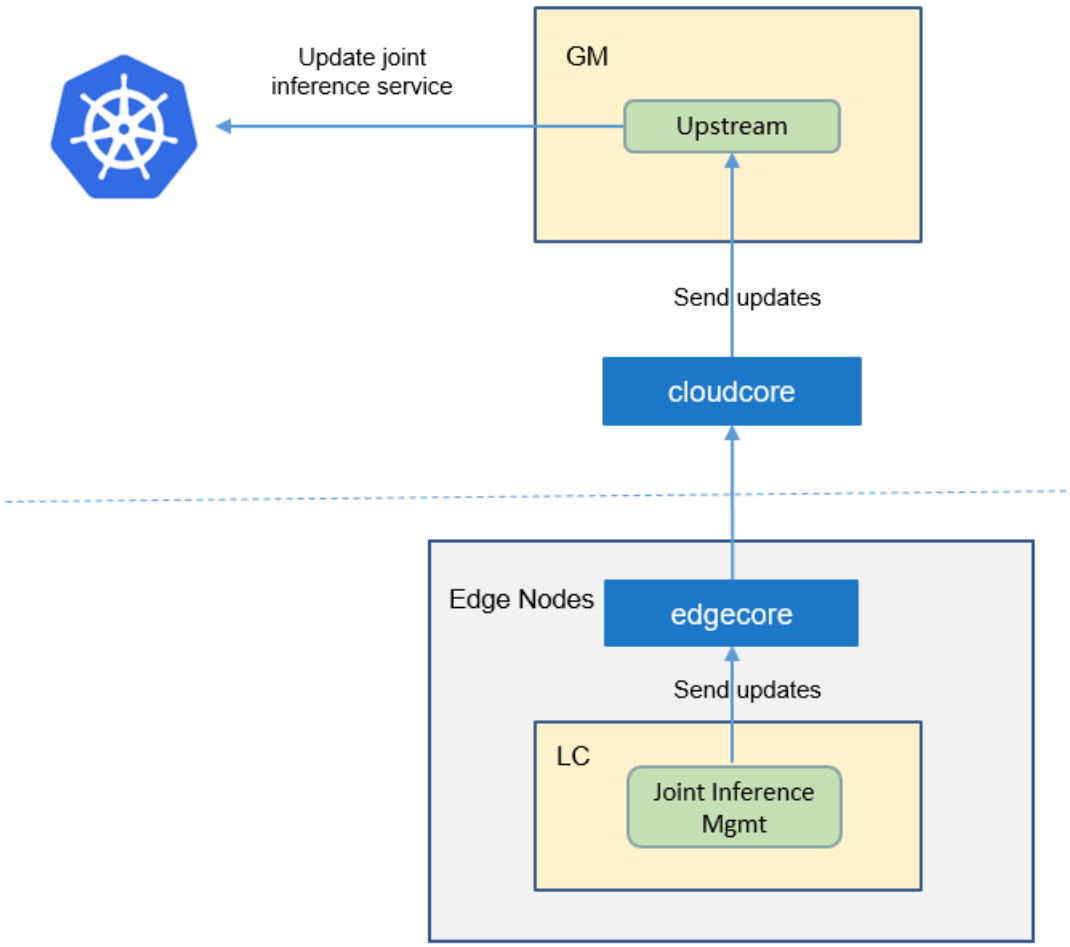
10.4.2 Downstream Controller



The downstream controller watches for joint-inference updates against the K8S API server. Updates are categorized below along with the possible actions that the downstream controller can take:

Update Type	Action
New Joint-inference-service Created	Sends the task information to LCs.
Joint-inference-service Deleted	The controller sends the delete event to LCs.

10.4.3 Upstream Controller



The upstream controller watches for joint-inference-task updates from the edge node and applies these updates against the API server in the cloud. Updates are categorized below along with the possible actions that the upstream controller can take:

Update Type	Action
Joint-inference-service Reported State Updated	The controller appends the reported status of the Joint-inference-service in the cloud.

10.4.4 Details of api between GM(cloud) and LC(edge)

1. GM(downstream controller) syncs the task info to LC:

```
// POST <namespace>/sedna/downstream/jointinferenceservices/<name>/insert
// body same to the task crd of k8s api, omitted here.
```

2. LC uploads the task status which reported by the worker to GM(upstream controller):

```
// POST <namespace>/sedna/upstream/jointinferenceservices/<name>/status

// JoinInferenceServiceStatus defines status that send to GlobalManager
type JoinInferenceServiceStatus struct {
    Phase  string  `json:"phase"`
    Status string  `json:"status"`
    Output *Output `json:"output"`
}

// Output defines task output information
type Output struct {
    Models   []Model   `json:"models"`
    TaskInfo *TaskInfo `json:"taskInfo"`
}

// Model defines the model information
type Model struct {
    Format string `json:"format"`
    URL    string `json:"url"`
}

// TaskInfo defines the task information
type TaskInfo struct {
    InferenceNumber   int     `json:"inferenceNumber"`
    HardExampleNumber int     `json:"hardExampleNumber"`
    UploadCloudRatio  float64 `json:"uploadCloudRatio"`
    StartTime         string  `json:"startTime"`
    CurrentTime       string  `json:"currentTime"`
}
```

10.4.5 Details of api between Worker(edge) and LC(edge)

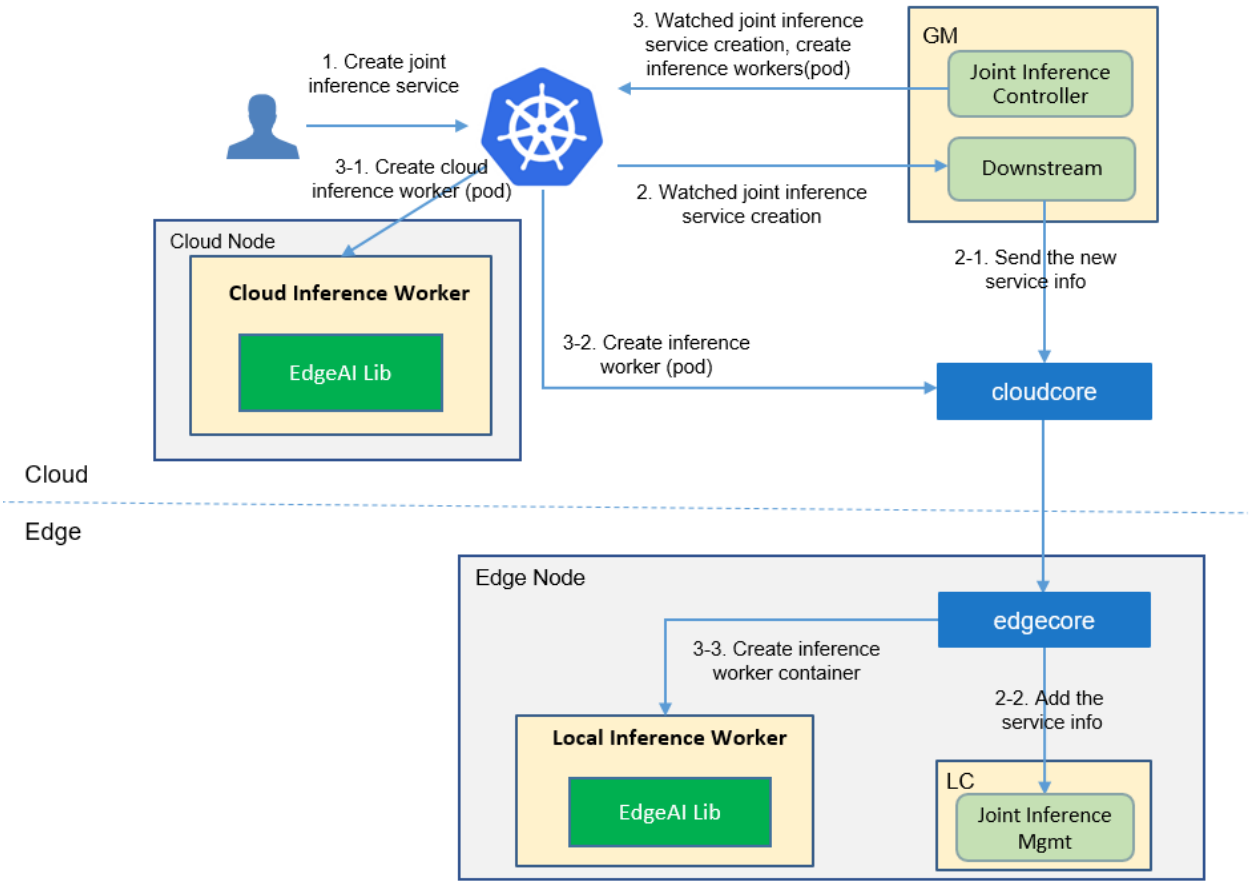
1. Worker sends inference info to LC in same edge node:

```
// POST /sedna/workers/<worker-name>/info
```

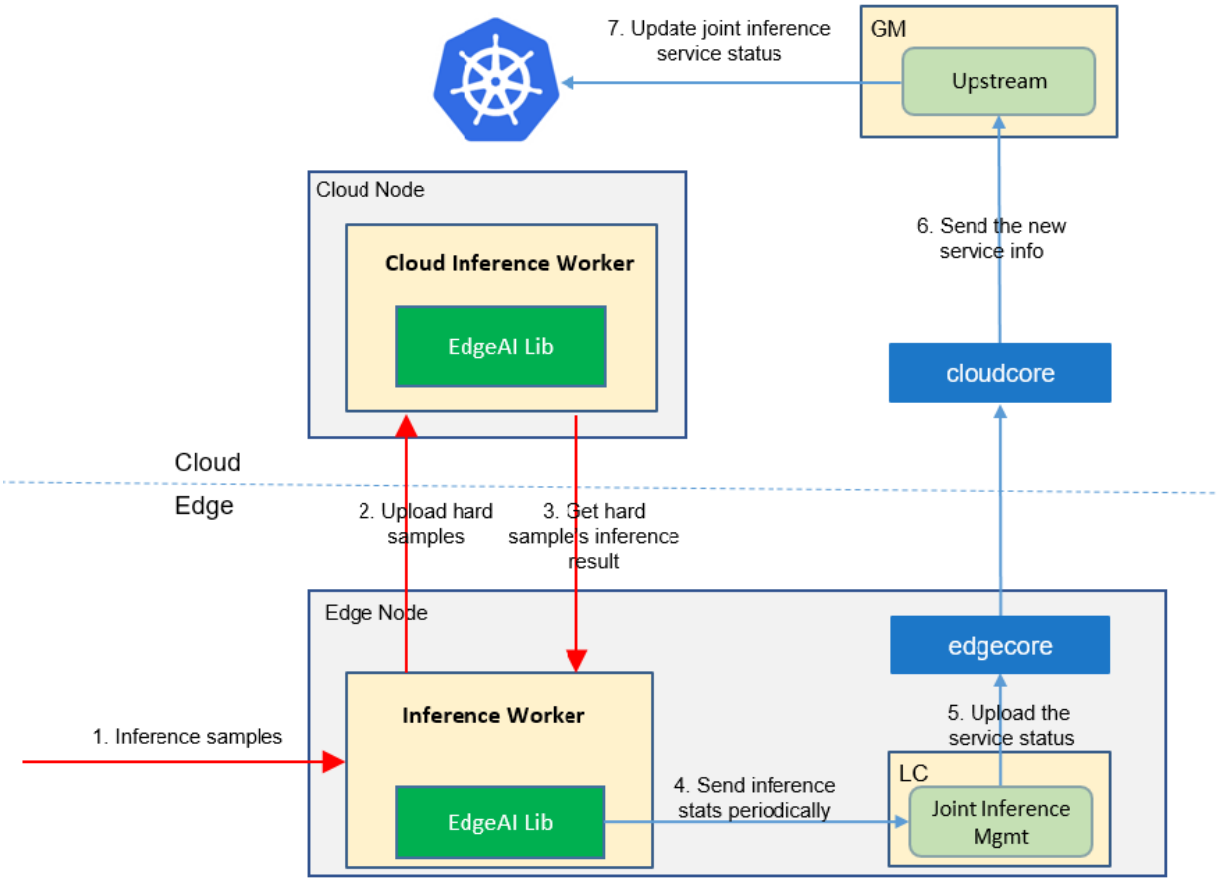
```
{
    "name": "worker-name",
    "namespace": "default",
    "ownerName": "jointinferenceservice-name",
    "ownerKind": "jointinferenceservice",
    "kind": "inference",
    "status": "completed/failed/running",
    "taskInfo": {
        "inferenceNumber": 1000,
        "hardExampleNumber": 100,
        "uploadCloudRatio": 0.1,
        "startTime": "2020-11-03T08:39:22.517Z",
        "updateTime": "2020-11-03T08:50:22.517Z"
    }
}
```

10.4.6 Flow of Joint Inference

- The flow of joint inference service creation:



10.5 Workers Communication



CHAPTER

ELEVEN

OBJECT SEARCH SERVICE

11.1 Motivation

Object search is an important technology in the field of computer vision, which is widely used in security monitoring, intelligent transportation, etc. Generally, online object search applications have stringent latency constraints, which cannot be met by cloud computing schemes. Object search schemes based on edge computing have the characteristics of low latency and data privacy security, and are the mainstream technology trend.

However, the amount of feature matching computation increases exponentially with the expansion of the search object scale, and a single edge computing node is difficult to support large-scale object search. Multi-edge collaborative computing can accelerate large-scale object search applications and improve the search accuracy, which is the future development trend.

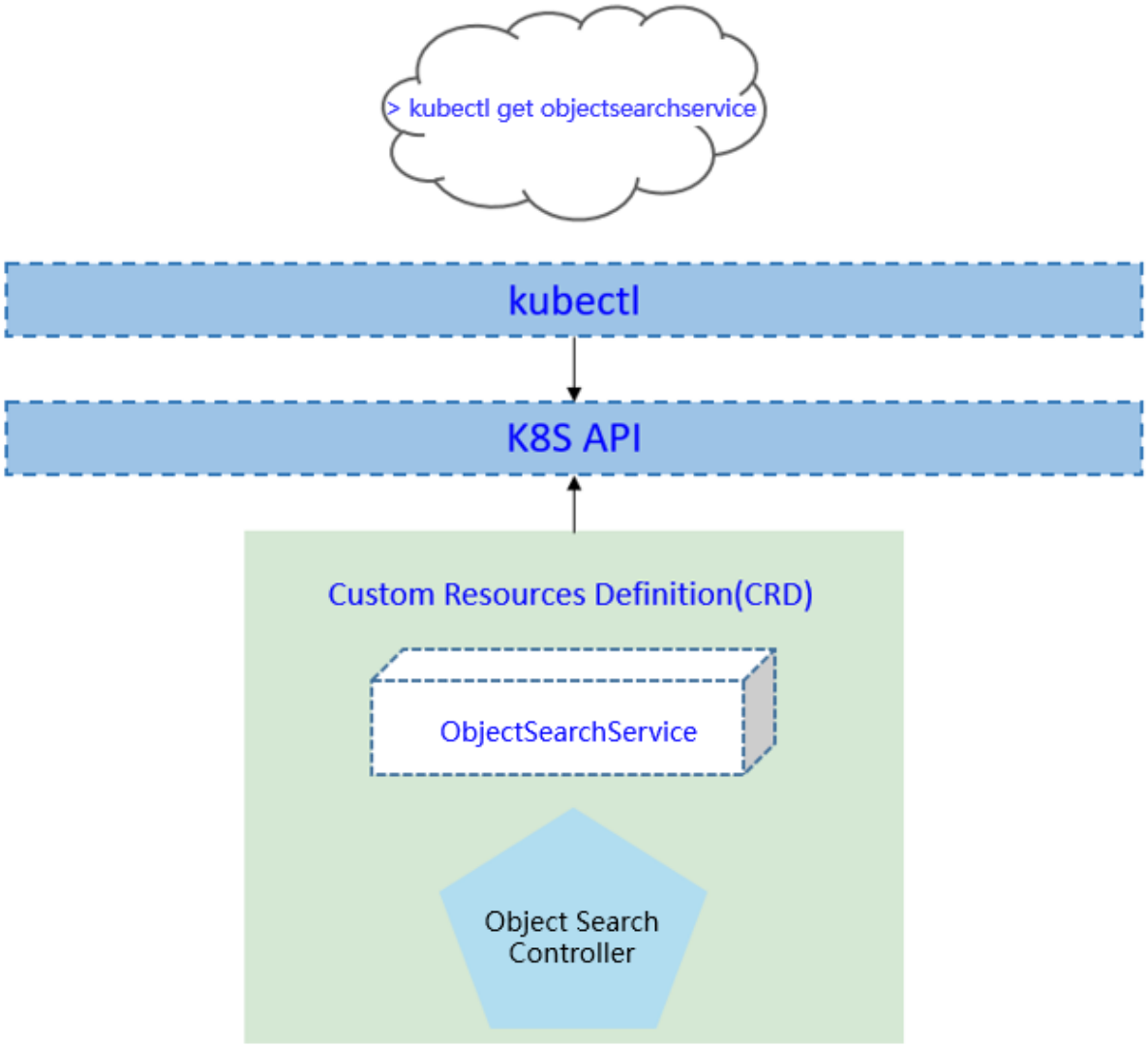
We propose the first open source end-to-end multi-edge collaborative object search solution. Based on KubeEdge's cloud-edge collaboration and resource management capabilities, we utilize multiple edge computing nodes to execute the AI inference tasks of object search in parallel. Our solution can not only reduce delay and improve throughput, but also will bring accuracy promotion. In addition, our solution will also support efficient offline object search.

11.1.1 Goals

- Support single/multi-object search
- Support across-camera object search
- Support parallel object re-identification(ReID)
- Support historical video data object search
- Support multi-camera data joint analysis and decision making
- Provide a user entry for submitting search tasks and result queries

11.2 Proposal

We propose using Kubernetes Custom Resource Definitions (CRDs) to describe the object search service specification/status and a controller to synchronize these updates between edge and cloud.



11.2.1 Use Cases

- User can create typical multi-edge collaborative object search applications with providing AI models.

11.3 Design Details

11.3.1 CRD API Group and Version

The `ObjectSearchService` CRD will be namespace-scoped. The tables below summarize the group, kind and API version details for the CRD.

- ObjectSearchService

Field	Description
Group	sedna.io
APIVersion	v1alpha1
Kind	ObjectSearchService

11.3.2 Object search service type definition

go source

Validation

Open API v3 Schema based validation can be used to guard against bad requests. Invalid values for fields (example string value for a boolean field etc) can be validated using this.

11.3.3 Object search service sample

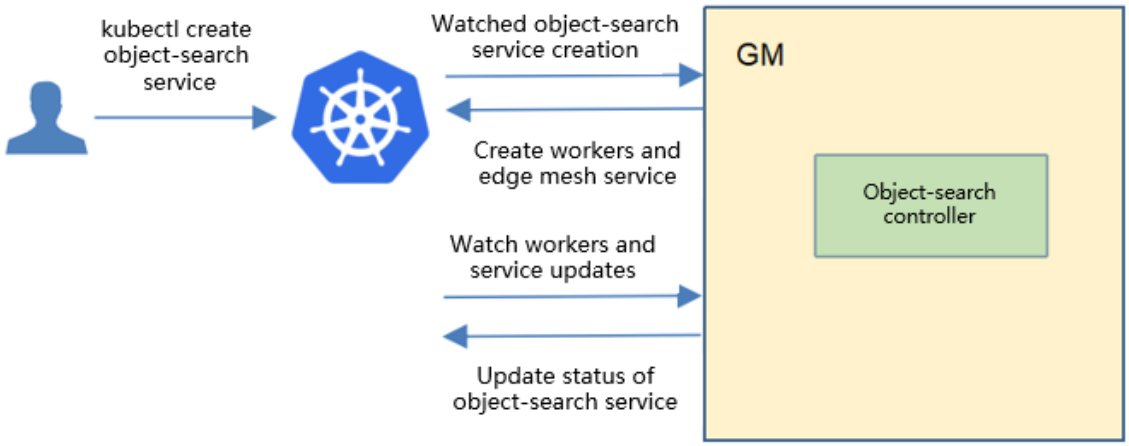
See the source for an example.

11.4 Controller Design

The object search service controller starts three separate goroutines called `upstream`, `downstream` and `object-search-service` controller. These are not separate controllers as such but named here for clarity.

- object-search-service: watch the updates of object-search-service task crds, and create the workers to complete the task.
- downstream: synchronize the object-search-service updates from the cloud to the edge node.
- upstream: synchronize the object-search-service updates from the edge to the cloud node.

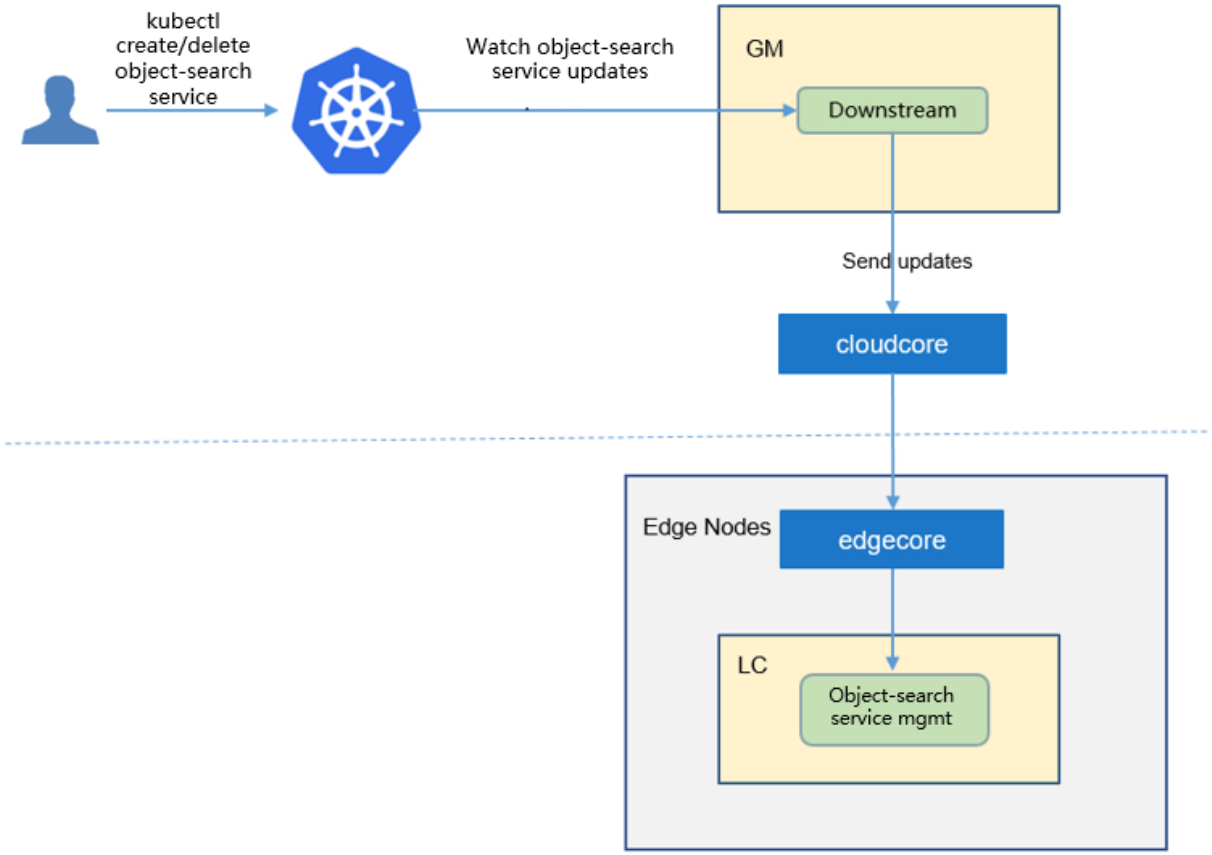
11.4.1 Object search service Controller



The object-search-service controller watches for the updates of object-search-service tasks and the corresponding pods against the K8S API server. Updates are categorized below along with the possible actions:

Update Type	Action
New Object-search-service Created	Create the cloud/edge worker
Object-search-service Deleted	NA. These workers will be deleted by GM.
The corresponding pod created/running/completed/failed	Update the status of object-search-service task.

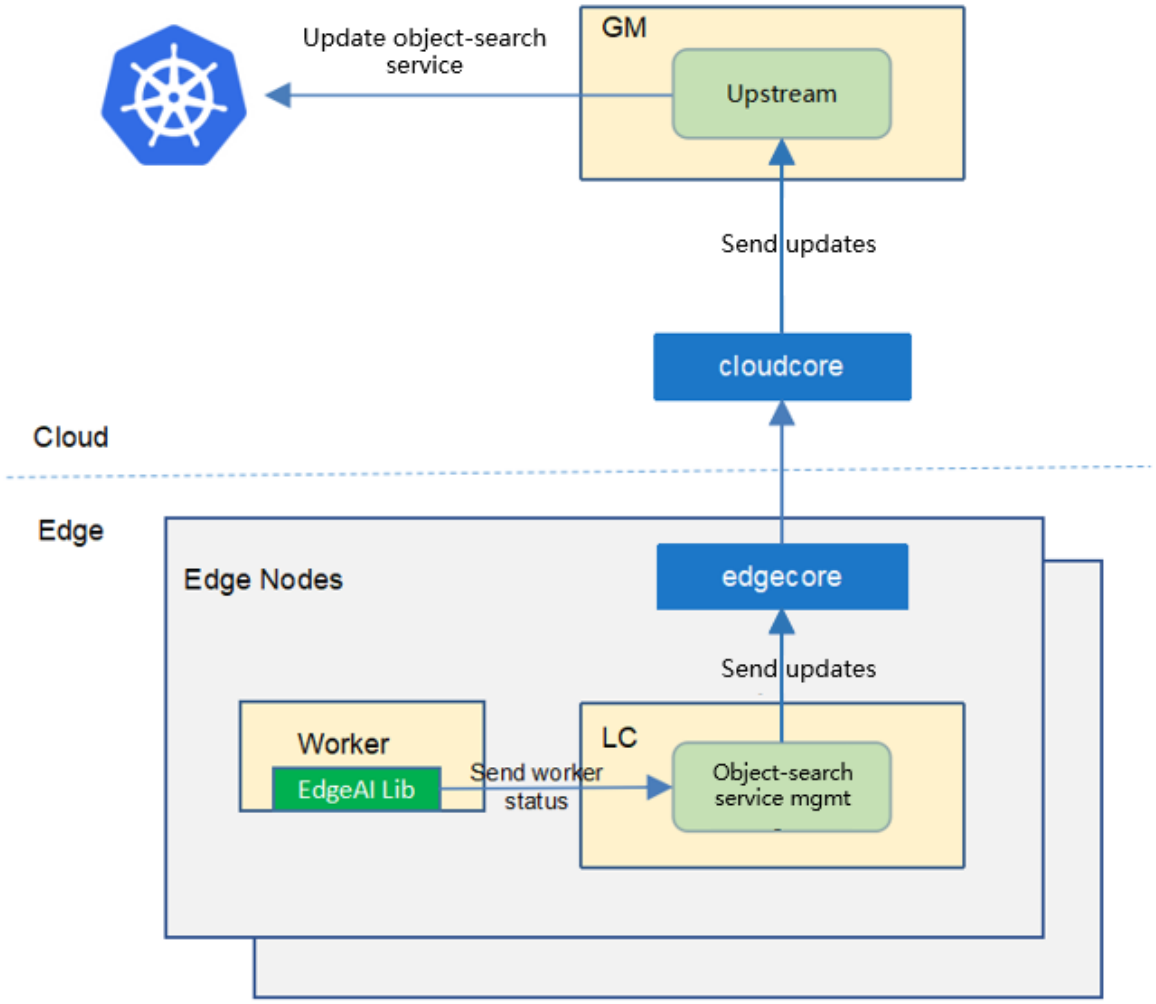
11.4.2 Downstream Controller



The downstream controller watches for object-search-service updates against the K8S API server. Updates are categorized below along with the possible actions that the downstream controller can take:

Update Type	Action
New Object-search-service Created	Sends the task information to LCs.
Object-search-service Deleted	The controller sends the delete event to LCs.

11.4.3 Upstream Controller



The upstream controller watches for object-search-service task updates from the edge node and applies these updates against the API server in the cloud. Updates are categorized below along with the possible actions that the upstream controller can take:

Update Type	Action
Object-search-service Reported State Updated	The controller appends the reported status of the object-search-service in the cloud.

11.4.4 Details of api between GM(cloud) and LC(edge)

1. GM(downstream controller) syncs the task info to LC:

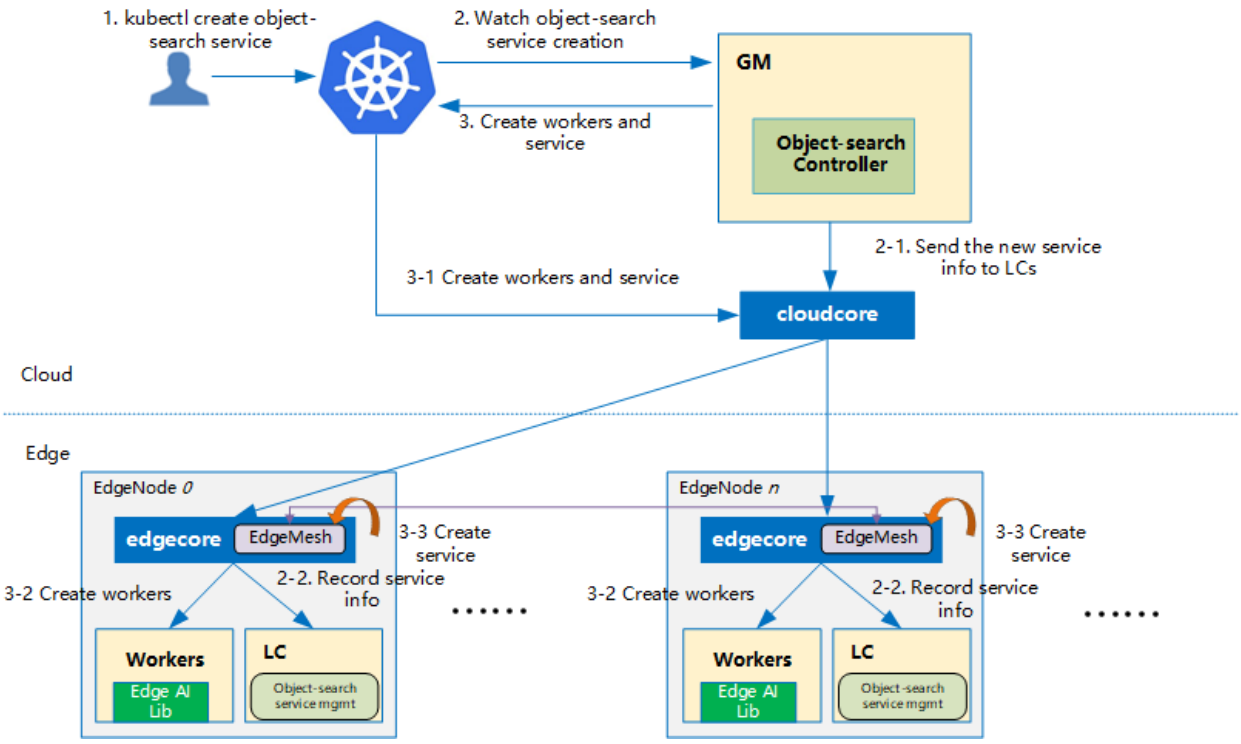
```
// POST <namespace>/sedna/downstream/objectsearchservices/<name>/insert
// body same to the task crd of k8s api, omitted here.
```

2. LC uploads the task status which reported by the worker to GM(upstream controller):

```
// POST <namespace>/sedna/upstream/objectsearchservices/<name>/status

// ObjectSearchServiceStatus defines status that send to GlobalManager
type ObjectSearchServiceStatus struct {
    Phase  string  `json:"phase"`
    Status string  `json:"status"`
    Output *Output `json:"output"`
}

// Output defines task output information
type Output struct {
    TaskInfo *TaskInfo `json:"taskInfo"`
}

// TaskInfo defines the task information
type TaskInfo struct {
    SearchingObjectNumber      int     `json:"searchingObjectNumber"`
    SearchedObjectNumber       int     `json:"searchedObjectNumber"`
    StartTime                  string  `json:"startTime"`
    CurrentTime                string  `json:"currentTime"`
}
```

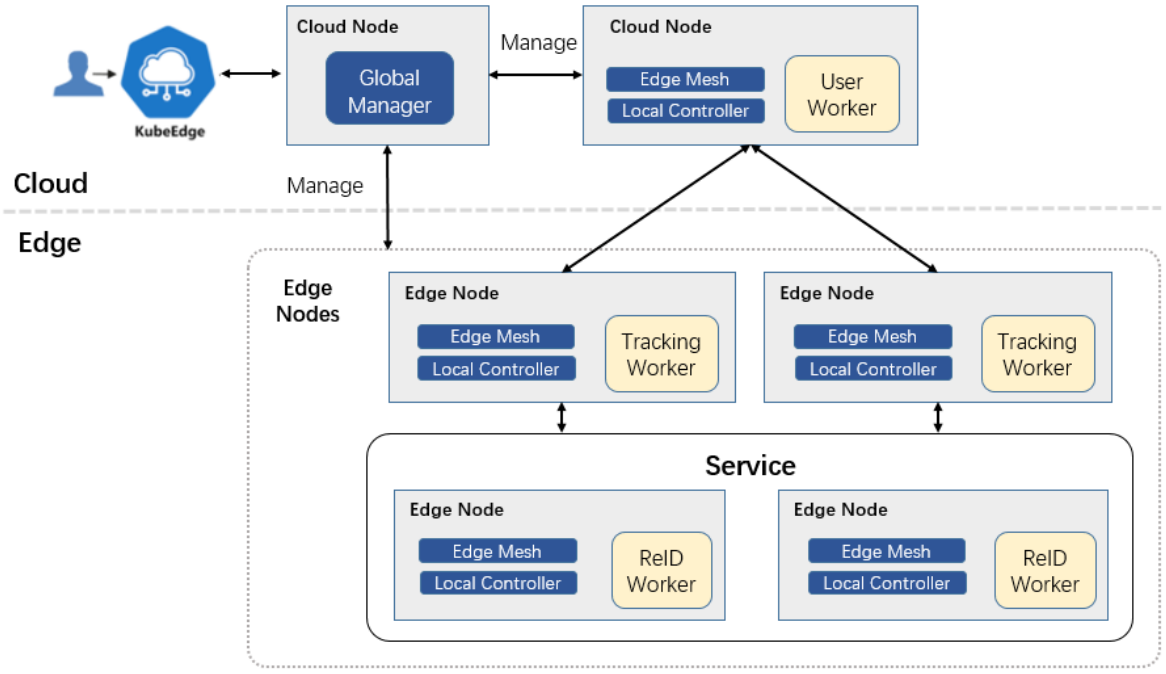
11.4.5 Flow of object search service creation

- The flow of object search service creation:



The object search service controller watches the creation of object search service crd in the cloud, syncs them to lc via the cloudhub-to-edgehub channel, and creates the workers on the edge nodes specified by the user.

- The components of object search service:

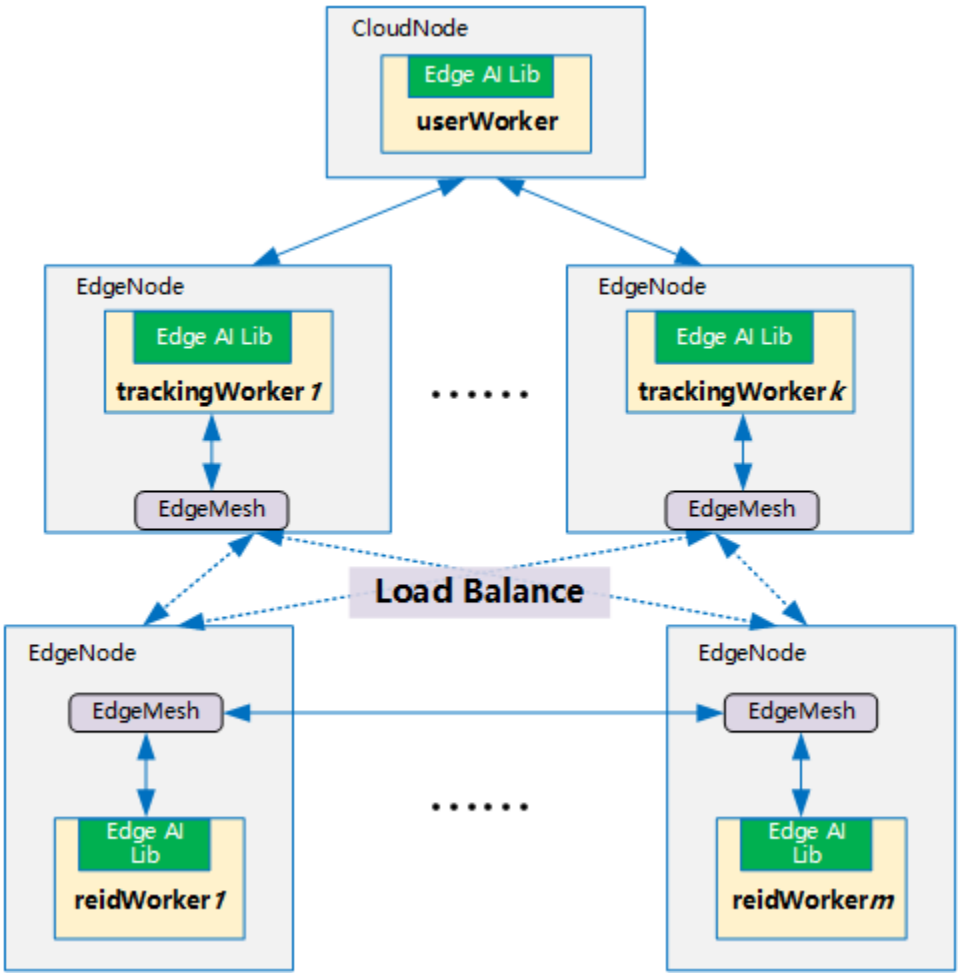


The object search service includes three types of workers: 1) User worker; 2) Tracking worker; 3ReID worker. An user worker is used to provide API interface to users, and users can submit the object images to be searched through the API interface. There are usually multiple tracking workers and ReID workers, which can perform inference tasks

of object search in parallel. Tracking workers are used to read camera data and perform object detection. Different tracking workers read data from different cameras. ReID worker is used for object feature extraction and matching to determine whether the detected object is the object to be searched.

The user worker, tracking workers, and ReID workers are started by the kubeedge at the edge nodes.

11.5 Workers Communication



CHAPTER

TWELVE

OBJECT TRACKING SERVICE

12.1 Motivation

Object tracking is an important technology in the field of computer vision, which is widely used in security monitoring, intelligent transportation, etc. Generally, object tracking applications have high latency requirements, which cannot be met by cloud computing schemes. The object tracking schemes based on edge computing have the characteristics of low latency and data privacy security, and are the mainstream technology trend.

However, it is difficult for a single edge computing node to provide high-quality object tracking services. On the one hand, the coordination of multiple edge computing nodes is often required for across-camera object tracking. On the other hand, when there are large-scale tracking objects, a single computing node is difficult to handle. Multi-edge collaborative computing can accelerate large-scale object tracking applications and improve the tracking accuracy, which is the future development trend.

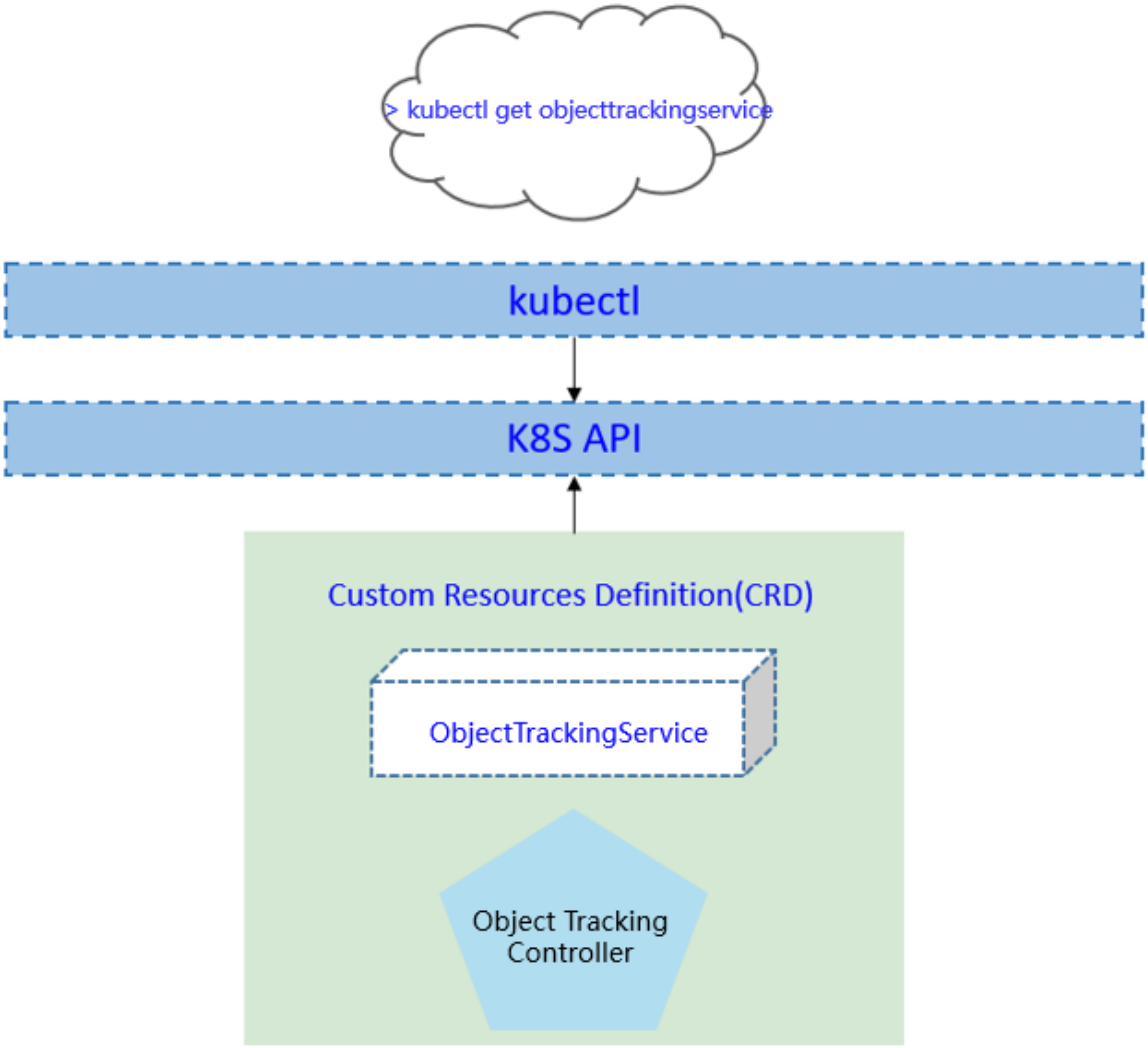
We propose the first open source end-to-end multi-edge collaborative object tracking solution. Based on KubeEdge's cloud-edge collaboration and resource management capabilities, we use multiple edge computing nodes to execute the AI inference tasks of object tracking in parallel. Our solution can not only reduce delay and improve throughput, but also will bring accuracy promotion.

12.1.1 Goals

- Support single/multi-object tracking
- Support across-camera object tracking
- Support parallel object re-identification(ReID)
- Support multi-camera data joint analysis and decision making

12.2 Proposal

We propose using Kubernetes Custom Resource Definitions (CRDs) to describe the object tracking service specification/status and a controller to synchronize these updates between edge and cloud.



12.2.1 Use Cases

- User can create typical multi-edge collaborative object tracking applications with providing AI models.

12.3 Design Details

12.3.1 CRD API Group and Version

The `ObjectTrackingService` CRD will be namespace-scoped. The tables below summarize the group, kind and API version details for the CRD.

- ObjectTrackingService

Field	Description
Group	sedna.io
APIVersion	v1alpha1
Kind	ObjectTrackingService

12.3.2 Object tracking service type definition

go source

Validation

Open API v3 Schema based validation can be used to guard against bad requests. Invalid values for fields (example string value for a boolean field etc) can be validated using this.

12.3.3 Object tracking service sample

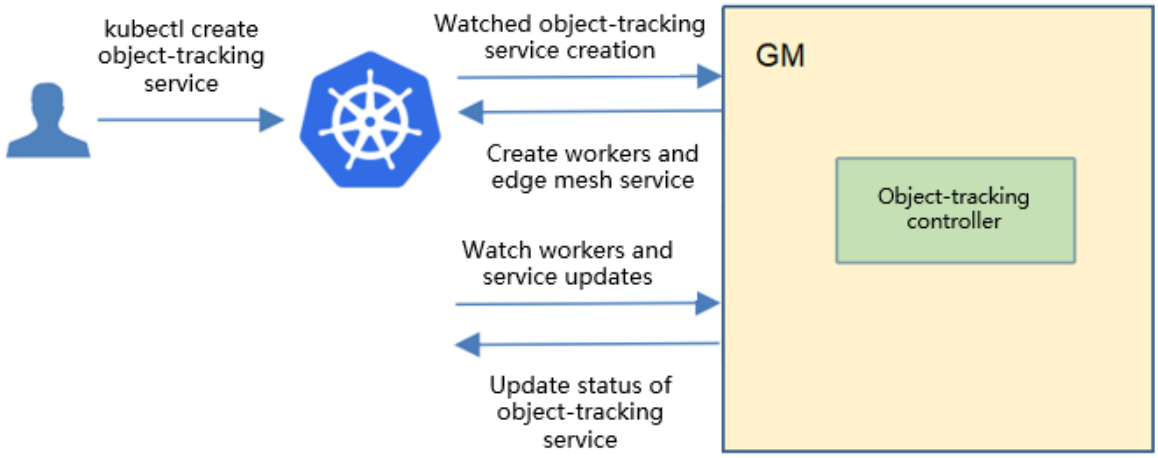
See the source for an example.

12.4 Controller Design

The object tracking service controller starts three separate goroutines called `upstream`, `downstream` and `object-tracking-service` controller. These are not separate controllers as such but named here for clarity.

- object-tracking-service: watch the updates of object-tracking-service task crds, and create the workers to complete the task.
- downstream: synchronize the object-tracking-service updates from the cloud to the edge node.
- upstream: synchronize the object-tracking-service updates from the edge to the cloud node.

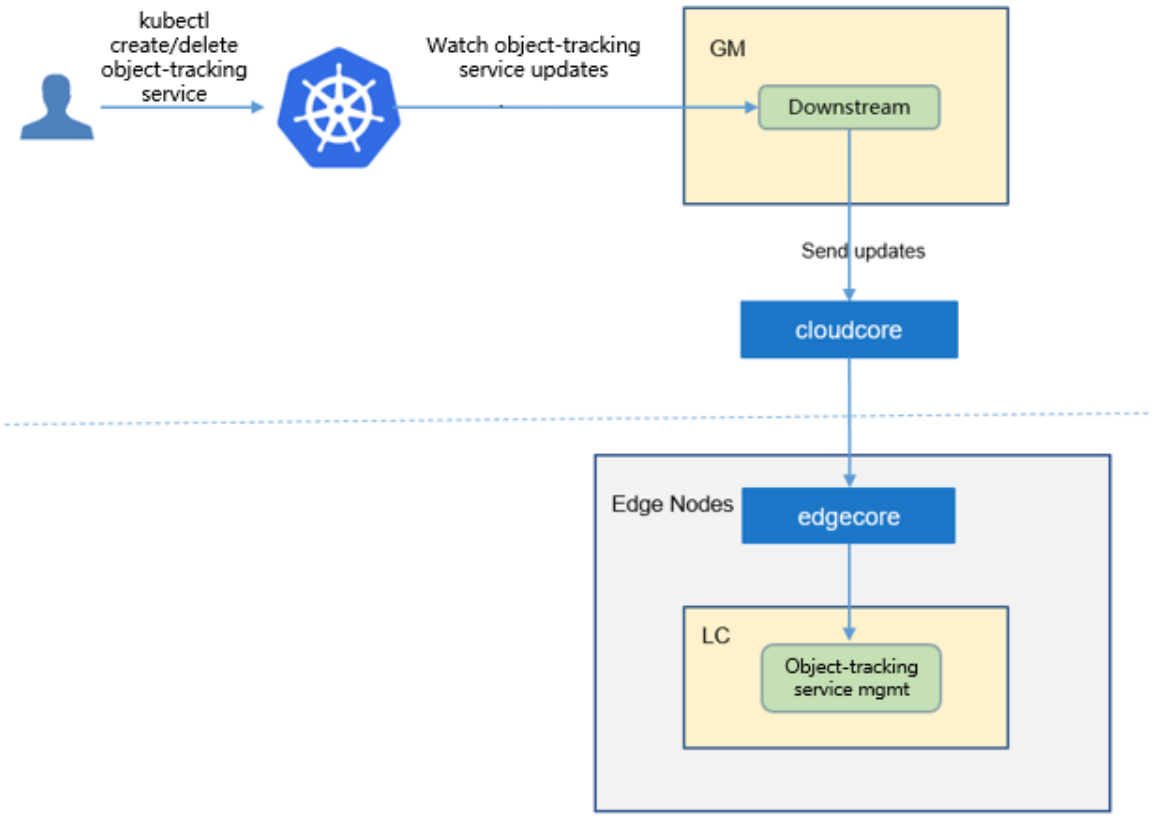
12.4.1 Object tracking service Controller



The object-tracking-service controller watches for the updates of object-tracking-service tasks and the corresponding pods against the K8S API server. Updates are categorized below along with the possible actions:

Update Type	Action
New Object-tracking-service Created	Create the cloud/edge worker
Object-tracking-service Deleted	NA. These workers will be deleted by GM.
The corresponding pod created/running/completed/failed	Update the status of object-tracking-service task.

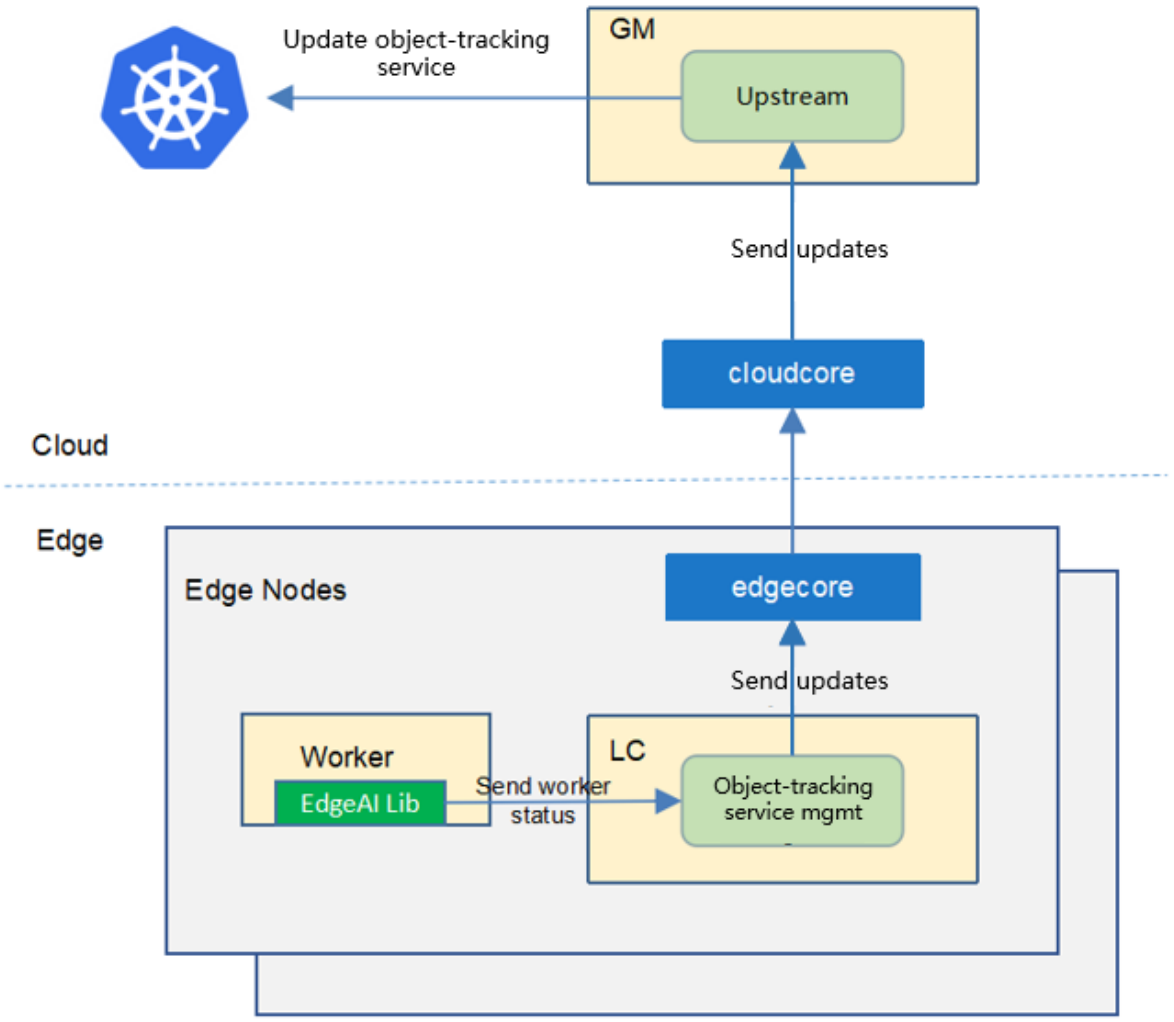
12.4.2 Downstream Controller



The downstream controller watches for object-tracking-service updates against the K8S API server. Updates are categorized below along with the possible actions that the downstream controller can take:

Update Type	Action
New Object-tracking-service Created	Sends the task information to LCs.
Object-tracking-service Deleted	The controller sends the delete event to LCs.

12.4.3 Upstream Controller



The upstream controller watches for object-tracking-service task updates from the edge node and applies these updates against the API server in the cloud. Updates are categorized below along with the possible actions that the upstream controller can take:

Update Type	Action
Object-tracking-service Reported State Updated	The controller appends the reported status of the object-tracking-service in the cloud.

12.4.4 Details of api between GM(cloud) and LC(edge)

1. GM(downstream controller) syncs the task info to LC:

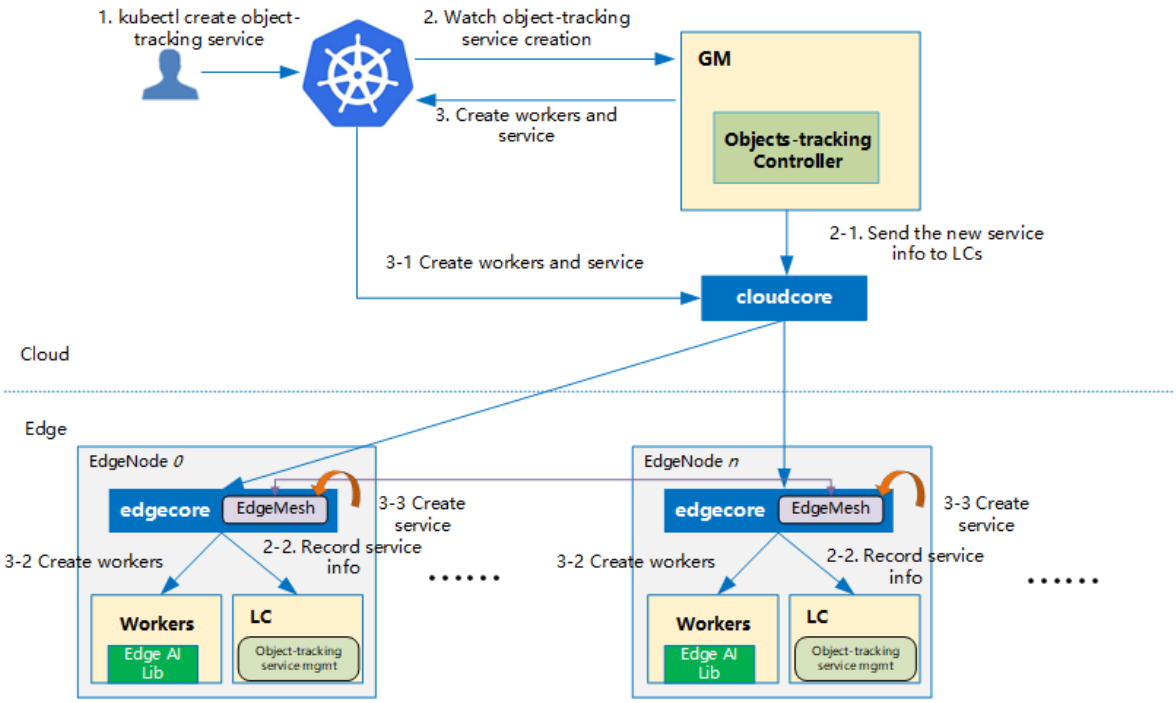
```
// POST <namespace>/sedna/downstream/objecttrackingservices/<name>/insert
// body same to the task crd of k8s api, omitted here.
```

2. LC uploads the task status which reported by the worker to GM(upstream controller):

```
// POST <namespace>/sedna/upstream/objecttrackingservices/<name>/status

// ObjectTrackingServiceStatus defines status that send to GlobalManager
type ObjectTrackingServiceStatus struct {
    Phase  string  `json:"phase"`
    Status string  `json:"status"`
    Output *Output `json:"output"`
}

// Output defines task output information
type Output struct {
    TaskInfo *TaskInfo `json:"taskInfo"`
}

// TaskInfo defines the task information
type TaskInfo struct {
    TrackingObjectNumber      int     `json:"trackingObjectNumber"`
    FindUnknownObject         bool    `json:"findUnkownObject"`
    StartTime                 string  `json:"startTime"`
    CurrentTime               string  `json:"currentTime"`
}
```

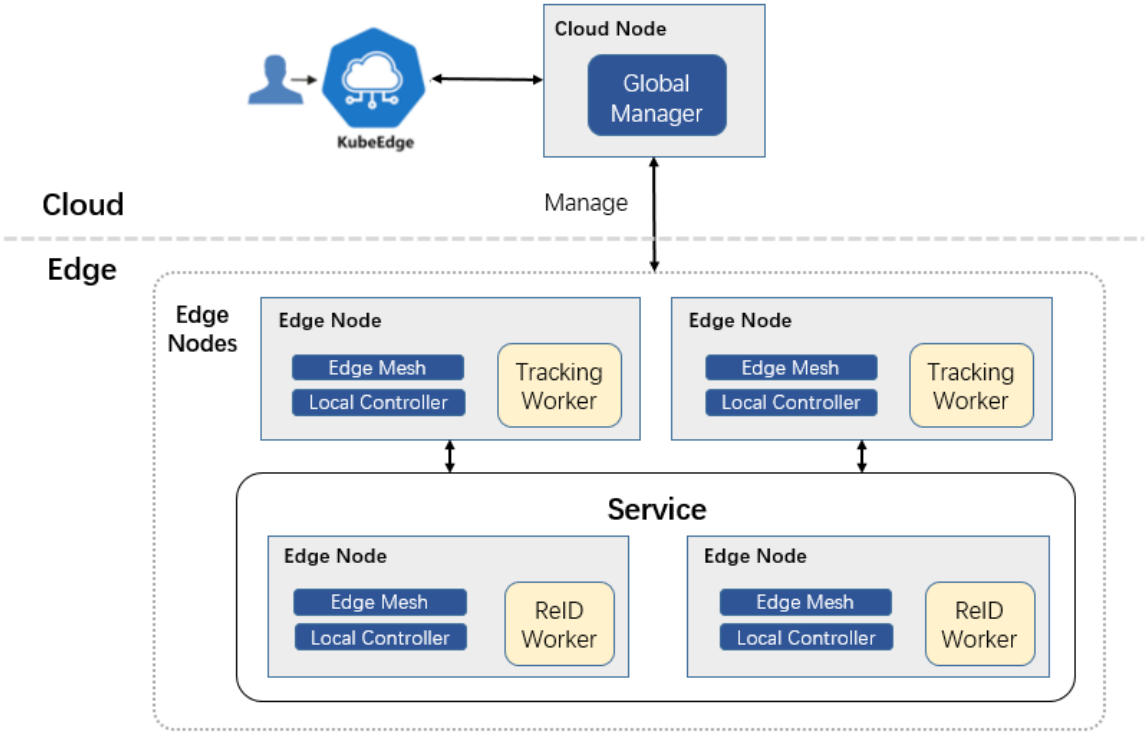
12.4.5 Flow of object tracking service creation

- The flow of object tracking service creation:



The object tracking service controller watches the creation of object tracking service crd in the cloud, syncs them to lc via the cloudhub-to-edgehub channel, and creates the inference workers on the edge nodes specified by the user.

- The components of object tracking service:

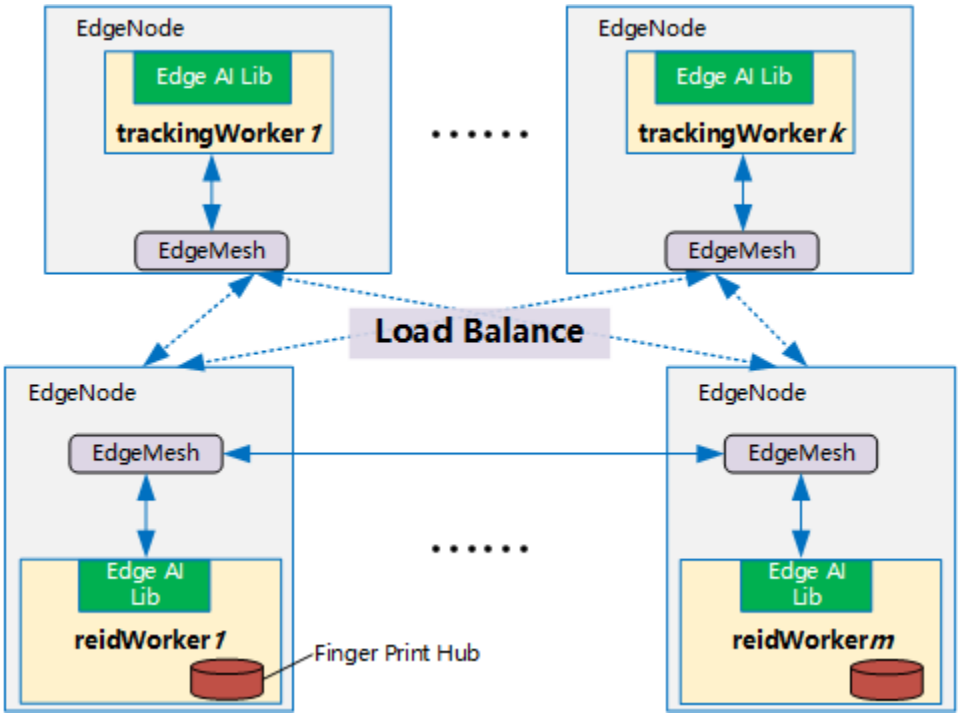


The object tracking service includes two types of workers: 1) Tracking worker; 2ReID worker. There are usually multiple tracking workers and ReID workers, which can perform inference tasks of object tracking in parallel. Tracking

workers are used to read camera data and perform object detection and tracking. Different tracking workers read data from different cameras. ReID worker is used for object feature extraction and matching to determine the identity of the objects.

The tracking workers, and ReID workers are started by the kubeedge at the edge nodes.

12.5 Workers Communication



CHAPTER

THIRTEEN

USING JOINT INFERENCE SERVICE IN HELMET DETECTION SCENARIO

This case introduces how to use joint inference service in helmet detection scenario. In the safety helmet detection scenario, the helmet detection shows lower performance due to limited resources in edge. However, the joint inference service can improve overall performance, which uploads hard examples that identified by the hard example mining algorithm to the cloud and infers them. The data used in the experiment is a video of workers wearing safety helmets. The joint inference service requires to detect the wearing of safety helmets in the video.

13.1 Helmet Detection Experiment

13.1.1 Install Sedna

Follow the Sedna installation document to install Sedna.

13.1.2 Prepare Data and Model

- step1: download little model to your edge node.

```
mkdir -p /data/little-model
cd /data/little-model
wget https://kubeedge.obs.cn-north-1.myhuaweicloud.com/examples/helmet-detection-
↪inference/little-model.tar.gz
tar -zxvf little-model.tar.gz
```

- step2: download big model to your cloud node.

```
mkdir -p /data/big-model
cd /data/big-model
wget https://kubeedge.obs.cn-north-1.myhuaweicloud.com/examples/helmet-detection-
↪inference/big-model.tar.gz
tar -zxvf big-model.tar.gz
```

13.1.3 Prepare Images

This example uses these images:

1. little model inference worker: `kubeedge/sedna-example-joint-inference-helmet-detection-little:v0.3.0`
2. big model inference worker: `kubeedge/sedna-example-joint-inference-helmet-detection-big:v0.3.0`

These images are generated by the script build_images.sh.

13.1.4 Create Joint Inference Service

Create Big Model Resource Object for Cloud

```
kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind:  Model
metadata:
  name: helmet-detection-inference-big-model
  namespace: default
spec:
  url: "/data/big-model/yolov3_darknet.pb"
  format: "pb"
EOF
```

Create Little Model Resource Object for Edge

```
kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind: Model
metadata:
  name: helmet-detection-inference-little-model
  namespace: default
spec:
  url: "/data/little-model/yolov3_resnet18.pb"
  format: "pb"
EOF
```

Create JointInferenceService

Note the setting of the following parameters, which have to same as the script little_model.py:

- hardExampleMining: set hard example algorithm from {IBT, CrossEntropy} for inferring in edge side.
- video_url: set the url for video streaming.
- all_examples_inference_output: set your output path for the inference results.
- hard_example_edge_inference_output: set your output path for results of inferring hard examples in edge side.
- hard_example_cloud_inference_output: set your output path for results of inferring hard examples in cloud side.

Make preparation in edge node

```
mkdir -p /joint_inference/output
```

Create joint inference service

```
CLOUD_NODE="cloud-node-name"
EDGE_NODE="edge-node-name"


kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind: JointInferenceService
metadata:
  name: helmet-detection-inference-example
  namespace: default
spec:
  edgeWorker:
    model:
      name: "helmet-detection-inference-little-model"
    hardExampleMining:
      name: "IBT"
      parameters:
        - key: "threshold_img"
          value: "0.9"
        - key: "threshold_box"
          value: "0.9"
    template:
      spec:
        nodeName: $EDGE_NODE
        dnsPolicy: ClusterFirstWithHostNet
        containers:
        - image: kubeedge/sedna-example-joint-inference-helmet-detection-little:v0.3.0
          imagePullPolicy: IfNotPresent
          name:  little-model
          env:  # user defined environments
          - name: input_shape
            value: "416,736"
          - name: "video_url"
            value: "rtsp://localhost/video"
          - name: "all_examples_inference_output"
            value: "/data/output"
          - name: "hard_example_cloud_inference_output"
            value: "/data/hard_example_cloud_inference_output"
          - name: "hard_example_edge_inference_output"
            value: "/data/hard_example_edge_inference_output"
          resources:  # user defined resources
            requests:
              memory: 64M
              cpu: 100m
            limits:
              memory: 2Gi
          volumeMounts:
            - name: outputdir
```

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```
              mountPath: /data/
        volumes:   # user defined volumes
          - name: outputdir
            hostPath:
              # user must create the directory in host
              path: /joint_inference/output
              type: Directory

  cloudWorker:
    model:
      name: "helmet-detection-inference-big-model"
    template:
      spec:
        nodeName: $CLOUD_NODE
        dnsPolicy: ClusterFirstWithHostNet
        containers:
          - image: kubeedge/sedna-example-joint-inference-helmet-detection-big:v0.3.0
            name:  big-model
            imagePullPolicy: IfNotPresent
            env:  # user defined environments
              - name: "input_shape"
                value: "544,544"
            resources:  # user defined resources
              requests:
                memory: 2Gi
EOF
```

13.1.5 Check Joint Inference Status

```
kubectl get jointinferenceservices.sedna.io
```

13.1.6 Mock Video Stream for Inference in Edge Side

- step1: install the open source video streaming server EasyDarwin.
- step2: start EasyDarwin server.
- step3: download video.
- step4: push a video stream to the url (e.g., `rtsp://localhost/video`) that the inference service can connect.

```
wget https://github.com/EasyDarwin/EasyDarwin/releases/download/v8.1.0/EasyDarwin-linux-
↪8.1.0-1901141151.tar.gz
tar -zxvf EasyDarwin-linux-8.1.0-1901141151.tar.gz
cd EasyDarwin-linux-8.1.0-1901141151
./start.sh

mkdir -p /data/video
cd /data/video
wget https://kubeedge.obs.cn-north-1.myhuaweicloud.com/examples/helmet-detection-
↪inference/video.tar.gz
```

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```
tar -zxvf video.tar.gz

ffmpeg -re -i /data/video/video.mp4 -vcodec libx264 -f rtsp rtsp://localhost/video
```

13.1.7 Check Inference Result

You can check the inference results in the output path (e.g. `/joint_inference/output`) defined in the JointInferenceService config.

- the result of edge inference vs the result of joint inference

CHAPTER

FOURTEEN

USING INCREMENTAL LEARNING JOB IN HELMET DETECTION SCENARIO

This document introduces how to use incremental learning job in helmet detection scenario. Using the incremental learning job, our application can automatically retrains, evaluates, and updates models based on the data generated at the edge.

14.1 Helmet Detection Experiment

14.1.1 Install Sedna

Follow the Sedna installation document to install Sedna.

14.1.2 Prepare Model

In this example, we need to prepare base model and deploy model in advance. download models, including base model and deploy model.

```
cd /
wget https://kubeedge.obs.cn-north-1.myhuaweicloud.com/examples/helmet-detection/models.
↪tar.gz
tar -zxvf models.tar.gz
```

14.1.3 Prepare for Inference Worker

In this example, we simulate a inference worker for helmet detection, the worker will upload hard examples to `HE_SAVED_URL`, while it inferences data from local video. We need to make following preparations:

- make sure following localdirs exist

```
mkdir -p /incremental_learning/video/
mkdir -p /incremental_learning/he/
mkdir -p /data/helmet_detection
mkdir /output
```

- download video, unzip video.tar.gz, and put it into `/incremental_learning/video/`

```
cd /incremental_learning/video/
wget https://kubeedge.obs.cn-north-1.myhuaweicloud.com/examples/helmet-detection/video.
↪tar.gz
tar -zxvf video.tar.gz
```

14.1.4 Prepare Image

This example uses the image:

```
kubeedge/sedna-example-incremental-learning-helmet-detection:v0.4.0
```

This image is generated by the script build_images.sh, used for creating training, eval and inference worker.

14.1.5 Create Incremental Job

In this example, $WORKER_NODE is a custom node, you can fill it which you actually run.

```
WORKER_NODE="edge-node"
```

Create Dataset

```
kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind: Dataset
metadata:
  name: incremental-dataset
spec:
  url: "/data/helmet_detection/train_data/train_data.txt"
  format: "txt"
  nodeName: $WORKER_NODE
EOF
```

Create Initial Model to simulate the initial model in incremental learning scenario.

```
kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind: Model
metadata:
  name: initial-model
spec:
  url : "/models/base_model"
  format: "ckpt"
EOF
```

Create Deploy Model

```
kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind: Model
metadata:
  name: deploy-model
```

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```
spec:
  url : "/models/deploy_model/saved_model.pb"
  format: "pb"
EOF
```

Start The Incremental Learning Job

- incremental learning supports hot model updates and cold model updates. Job support cold model updates default. If you want to use hot model updates, please to add the following fields:

```
deploySpec:
  model:
    hotUpdateEnabled: true
    pollPeriodSeconds: 60  # default value is 60
```

- create the job:

```
IMAGE=kubeedge/sedna-example-incremental-learning-helmet-detection:v0.4.0

kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind: IncrementalLearningJob
metadata:
  name: helmet-detection-demo
spec:
  initialModel:
    name: "initial-model"
  dataset:
    name: "incremental-dataset"
    trainProb: 0.8
  trainSpec:
    template:
      spec:
        nodeName: $WORKER_NODE
        containers:
          - image: $IMAGE
            name:  train-worker
            imagePullPolicy: IfNotPresent
            args: ["train.py"]
            env:
              - name: "batch_size"
                value: "32"
              - name: "epochs"
                value: "1"
              - name: "input_shape"
                value: "352,640"
              - name: "class_names"
                value: "person,helmet,helmet-on,helmet-off"
              - name: "nms_threshold"
                value: "0.4"
              - name: "obj_threshold"
                value: "0.3"
    trigger:
```

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```
    checkPeriodSeconds: 60
    timer:
      start: 02:00
      end: 20:00
    condition:
      operator: ">"
      threshold: 500
      metric: num_of_samples
evalSpec:
  template:
    spec:
      nodeName: $WORKER_NODE
      containers:
        - image: $IMAGE
          name:  eval-worker
          imagePullPolicy: IfNotPresent
          args: ["eval.py"]
          env:
            - name: "input_shape"
              value: "352,640"
            - name: "class_names"
              value: "person,helmet,helmet-on,helmet-off"
deploySpec:
  model:
    name: "deploy-model"
    hotUpdateEnabled: true
    pollPeriodSeconds: 60
  trigger:
    condition:
      operator: ">"
      threshold: 0.1
      metric: precision_delta
  hardExampleMining:
    name: "IBT"
    parameters:
      - key: "threshold_img"
        value: "0.9"
      - key: "threshold_box"
        value: "0.9"
  template:
    spec:
      nodeName: $WORKER_NODE
      containers:
      - image: $IMAGE
        name:  infer-worker
        imagePullPolicy: IfNotPresent
        args: ["inference.py"]
        env:
          - name: "input_shape"
            value: "352,640"
          - name: "video_url"
            value: "file://video/video.mp4"
```

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```
            - name: "HE_SAVED_URL"
              value: "/he_saved_url"
          volumeMounts:
          - name: localvideo
            mountPath: /video/
          - name: hedir
            mountPath: /he_saved_url
          resources:  # user defined resources
            limits:
              memory: 2Gi
        volumes:   # user defined volumes
          - name: localvideo
            hostPath:
              path: /incremental_learning/video/
              type: DirectoryOrCreate
          - name: hedir
            hostPath:
              path:  /incremental_learning/he/
              type: DirectoryOrCreate
  outputDir: "/output"
EOF
```

1. The `Dataset` describes data with labels and `HE_SAVED_URL` indicates the address of the deploy container for uploading hard examples. Users will mark label for the hard examples in the address.
2. Ensure that the path of outputDir in the YAML file exists on your node. This path will be directly mounted to the container.

14.1.6 Check Incremental Learning Job

Query the service status:

```
kubectl get incrementallearningjob helmet-detection-demo
```

In the `IncrementalLearningJob` resource helmet-detection-demo, the following trigger is configured:

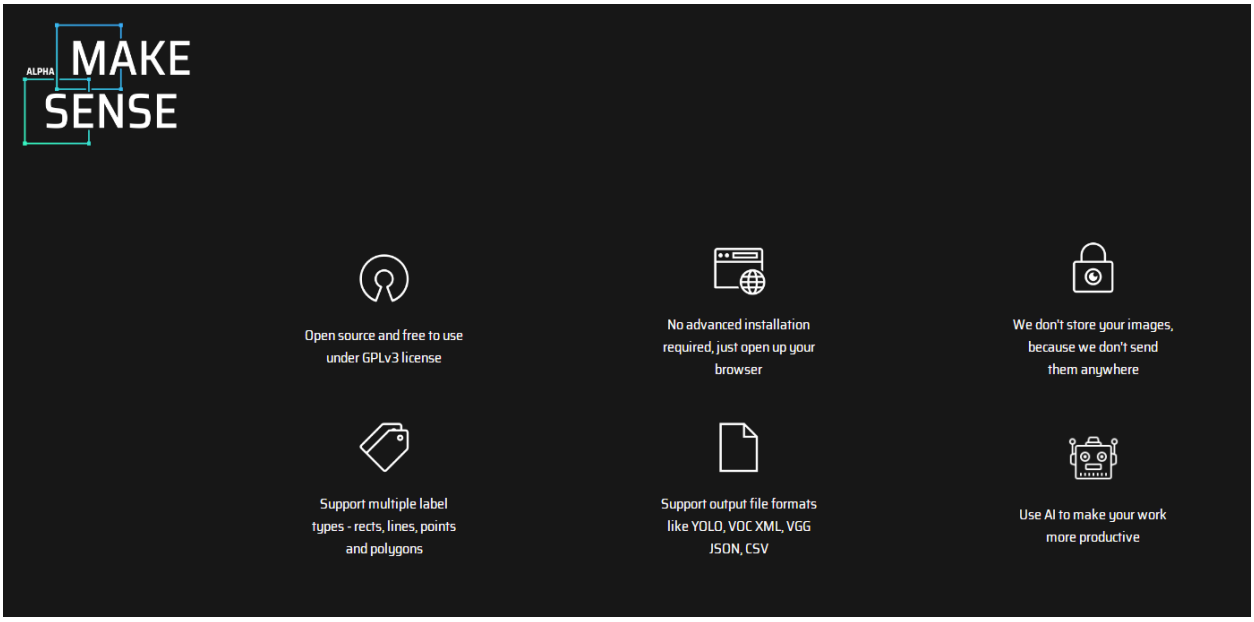
```
trigger:
  checkPeriodSeconds: 60
  timer:
    start: 02:00
    end: 20:00
  condition:
    operator: ">"
    threshold: 500
    metric: num_of_samples
```

14.1.7 Hard Example Labeling

In a real word, we need to label the hard examples in `HE_SAVED_URL` with annotation tools and then put the examples to `Dataset`'s url.

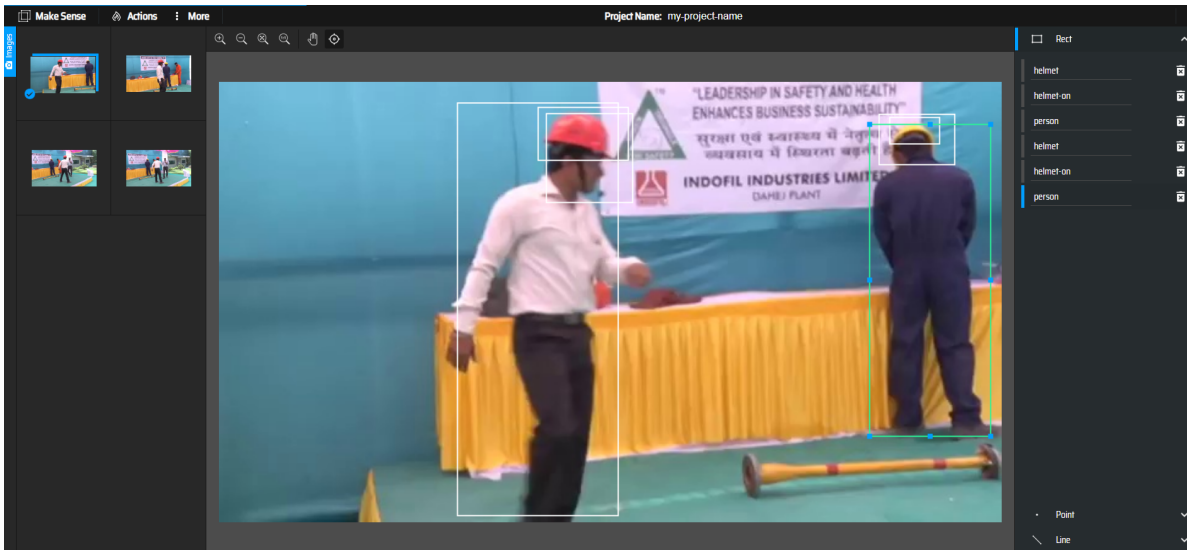
You can use Open-Source annotation tools to label hard examples, such as MAKE SENSE, which has following main advantages:

- Open source and free to use under GPLv3 license
- Support outputfile formats like YOLO, VOC XML, VGG JSON, CSV
- No advanced installation required, just open up your browser
- Use AI to make your work more productive
- Offline running as a container, ensuring data security

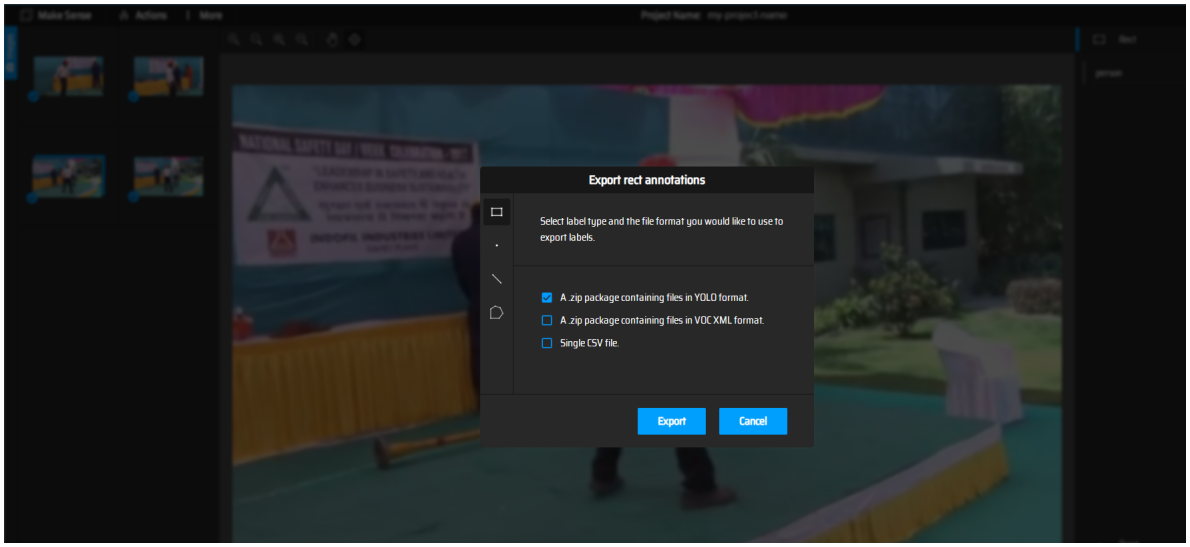


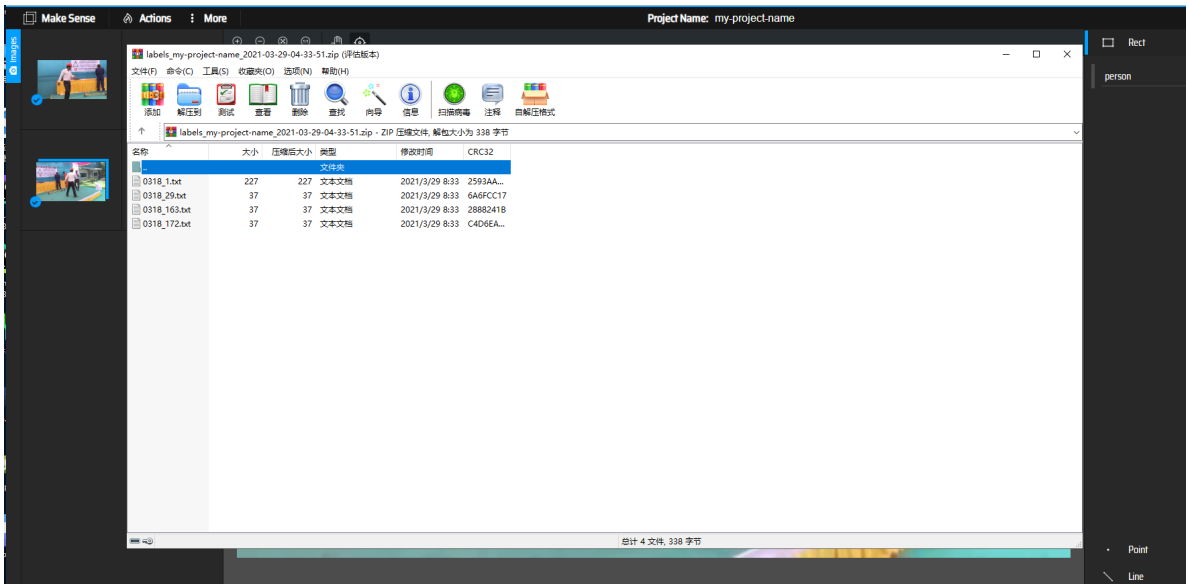
the details labeling are not described here, main steps in this demo are as follows:

- import unlabeled hard example to anonotation tools



- label and export annotations





- you will get YOLO format annotations, so you need convert them to the type which can be used by your own training code. in this example, the following scripts are provided for reference:

```
import os

annotation_dir_path = "C:/Users/Administrator/Desktop/labeled_data"
save_path = "C:/Users/Administrator/Desktop/labeled_data/save_label.txt"

def convert_single_line(line):
    line_list = []
    line = line.split(" ")
    for i in range(1, len(line)):
        line[i] = float(line[i])
        line[i] = line[i] * 1000
        line_list.append(str(int(line[i])))
    line_list.append(line[0])
    return ",".join(line_list)

if __name__ == '__main__':
    results = []
    g = os.walk(annotation_dir_path)
    for path, dir_list, file_list in g:
        for file_name in file_list:
            file_path = os.path.join(path, file_name)
            file_name = file_name.split("txt")
            file_name = file_name[0] + 'jpg'
            single_label_string = file_name
            f = open(file_path)
            lines = f.readlines()
            for line in lines:
                line = line.strip('\n')
                single_label_string = single_label_string + " " + convert_single_
↪line(line)
            results.append(single_label_string)
    save_file = open(save_path, "w")
```

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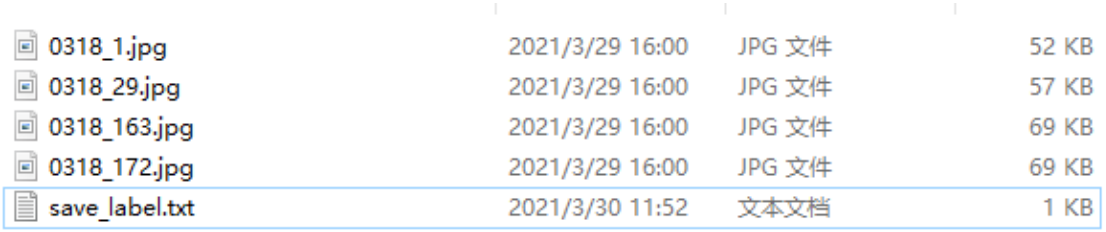
```
    for result in results:
        save_file.write(result + "\n")
    save_file.close()
```

How to use: `annotation_dir_path`: location for labeled annotations from MAKESENSE `save_path`: location for label txt which converted from annotations

- run above script, you can get a txt which includes all label information
- put the text with examples in the same dir
- you will get labeled examples which meet training requirements



- put these examples and annotations above to `Dataset`'s url

Without annotation tools, we can simulate the condition of `num_of_samples` in the following ways: Download dataset to $WORKER_NODE.

```
cd /data/helmet_detection
wget  https://kubeedge.obs.cn-north-1.myhuaweicloud.com/examples/helmet-detection/
↪dataset.tar.gz
tar -zxvf dataset.tar.gz
```

The LocalController component will check the number of the sample, realize trigger conditions are met and notice the GlobalManager Component to start train worker. When the train worker finish, we can view the updated model in the `/output` directory in `$WORKER_NODE` node. Then the eval worker will start to evaluate the model that train worker generated.

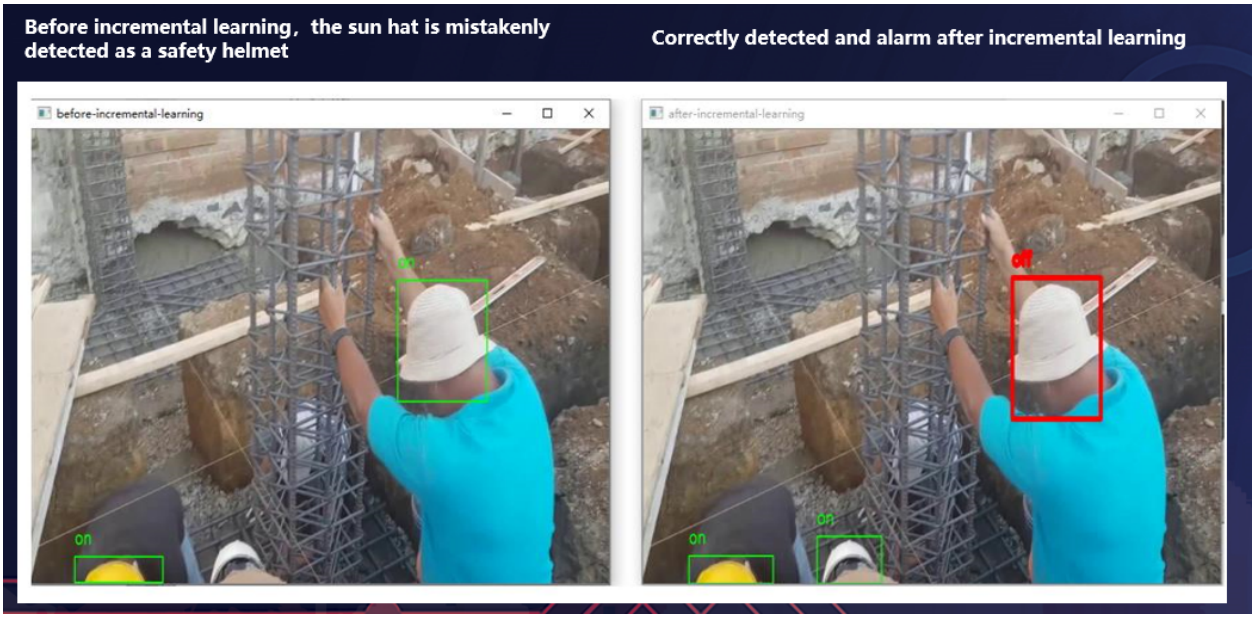
If the eval result satisfy the `deploySpec`'s trigger

```
trigger:
  condition:
    operator: ">"
    threshold: 0.1
    metric: precision_delta
```

the deploy worker will load the new model and provide service.

14.1.8 Effect Display

In this example, false and failed detections occur at stage of inference before incremental learning, after incremental learning, all targets are correctly detected.



CHAPTER

FIFTEEN

USING FEDERATED LEARNING JOB IN SURFACE DEFECT DETECTION SCENARIO

This case introduces how to use federated learning job in surface defect detection scenario. In the safety surface defect detection, data is scattered in different places (such as server node, camera or others) and cannot be aggregated due to data privacy and bandwidth. As a result, we cannot use all the data for training. Using Federated Learning, we can solve the problem. Each place uses its own data for model training ,uploads the weight to the cloud for aggregation, and obtains the aggregation result for model update.

15.1 Surface Defect Detection Experiment

> Assume that there are two edge nodes and a cloud node. Data on the edge nodes cannot be migrated to the cloud due to privacy issues. Base on this scenario, we will demonstrate the surface inspection.

15.1.1 Prepare Nodes

```
CLOUD_NODE="cloud-node-name"
EDGE1_NODE="edge1-node-name"
EDGE2_NODE="edge2-node-name"
```

15.1.2 Install Sedna

Follow the Sedna installation document to install Sedna.

15.1.3 Prepare Dataset

Download dataset and the label file to `/data` of `EDGE1_NODE`.

```
mkdir -p /data
cd /data
git clone https://github.com/abin24/Magnetic-tile-defect-datasets..git Magnetic-tile-
↪defect-datasets
curl -o 1.txt https://raw.githubusercontent.com/kubeedge/sedna/main/examples/federated_
↪learning/surface_defect_detection/data/1.txt
```

Download dataset and the label file to `/data` of `EDGE2_NODE`.

```
mkdir -p /data
cd /data
git clone https://github.com/abin24/Magnetic-tile-defect-datasets..git Magnetic-tile-
↪defect-datasets
curl -o 2.txt https://raw.githubusercontent.com/kubeedge/sedna/main/examples/federated_
↪learning/surface_defect_detection/data/2.txt
```

15.1.4 Prepare Images

This example uses these images:

1. aggregation worker: `kubeedge/sedna-example-federated-learning-surface-defect-detection-aggregation:v0.3.0`
2. train worker: `kubeedge/sedna-example-federated-learning-surface-defect-detection-train:v0.3.0`

These images are generated by the script build_images.sh.

15.1.5 Create Federated Learning Job

Create Dataset

create dataset for `$EDGE1_NODE`

```
kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind: Dataset
metadata:
  name: "edge1-surface-defect-detection-dataset"
spec:
  url: "/data/1.txt"
  format: "txt"
  nodeName: $EDGE1_NODE
EOF
```

create dataset for `$EDGE2_NODE`

```
kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind: Dataset
metadata:
  name: "edge2-surface-defect-detection-dataset"
spec:
  url: "/data/2.txt"
  format: "txt"
  nodeName: $EDGE2_NODE
EOF
```

Create Model

create the directory /model in the host of $EDGE1_NODE

```
mkdir /model
```

create the directory /model in the host of $EDGE2_NODE

```
mkdir /model
```

create model

```
kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind: Model
metadata:
  name: "surface-defect-detection-model"
spec:
  url: "/model"
  format: "pb"
EOF
```

Start Federated Learning Job

```
kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind: FederatedLearningJob
metadata:
  name: surface-defect-detection
spec:
  aggregationWorker:
    model:
      name: "surface-defect-detection-model"
    template:
      spec:
        nodeName: $CLOUD_NODE
        containers:
          - image: kubeedge/sedna-example-federated-learning-surface-defect-detection-
↪aggregation:v0.3.0
            name:  agg-worker
            imagePullPolicy: IfNotPresent
            env: # user defined environments
              - name: "exit_round"
                value: "3"
            resources:  # user defined resources
              limits:
                memory: 2Gi
  trainingWorkers:
    - dataset:
        name: "edge1-surface-defect-detection-dataset"
      template:
        spec:
```

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```
          nodeName: $EDGE1_NODE
          containers:
            - image: kubeedge/sedna-example-federated-learning-surface-defect-detection-
↪train:v0.3.0
              name:  train-worker
              imagePullPolicy: IfNotPresent
              env:  # user defined environments
                - name: "batch_size"
                  value: "32"
                - name: "learning_rate"
                  value: "0.001"
                - name: "epochs"
                  value: "2"
              resources:  # user defined resources
                limits:
                  memory: 2Gi
    - dataset:
        name: "edge2-surface-defect-detection-dataset"
      template:
        spec:
          nodeName: $EDGE2_NODE
          containers:
            - image: kubeedge/sedna-example-federated-learning-surface-defect-detection-
↪train:v0.3.0
              name:  train-worker
              imagePullPolicy: IfNotPresent
              env:  # user defined environments
                - name: "batch_size"
                  value: "32"
                - name: "learning_rate"
                  value: "0.001"
                - name: "epochs"
                  value: "2"
              resources:  # user defined resources
                limits:
                  memory: 2Gi
EOF
```

15.1.6 Check Federated Learning Status

```
kubectl get federatedlearningjob surface-defect-detection
```

15.1.7 Check Federated Learning Train Result

After the job completed, you will find the model generated on the directory `/model` in `$EDGE1_NODE` and `$EDGE2_NODE`.

CHAPTER

SIXTEEN

COLLABORATIVELY TRAIN YOLO-V5 USING MISTNET ON COCO128 DATASET

This case introduces how to train a federated learning job with an aggregation algorithm named MistNet in MNIST handwritten digit classification scenario. Data is scattered in different places (such as edge nodes, cameras, and others) and cannot be aggregated at the server due to data privacy and bandwidth. As a result, we cannot use all the data for training. In some cases, edge nodes have limited computing resources and even have no training capability. The edge cannot gain the updated weights from the training process. Therefore, traditional algorithms (e.g., federated average), which usually aggregate the updated weights trained by different edge clients, cannot work in this scenario. MistNet is proposed to address this issue.

MistNet partitions a DNN model into two parts, a lightweight feature extractor at the edge side to generate meaningful features from the raw data, and a classifier including the most model layers at the cloud to be iteratively trained for specific tasks. MistNet achieves acceptable model utility while greatly reducing privacy leakage from the released intermediate features.

16.1 Object Detection Experiment

> Assume that there are two edge nodes and a cloud node. Data on the edge nodes cannot be migrated to the cloud due to privacy issues. Base on this scenario, we will demonstrate the mnist example.

16.1.1 Prepare Nodes

```
CLOUD_NODE="cloud-node-name"
EDGE1_NODE="edge1-node-name"
EDGE2_NODE="edge2-node-name"
```

16.1.2 Install Sedna

Follow the Sedna installation document to install Sedna.

16.1.3 Prepare Dataset

Download dataset

Create data interface for EDGE1_NODE.

```
mkdir -p /data/1
cd /data/1
wget https://github.com/ultralytics/yolov5/releases/download/v1.0/coco128.zip
unzip coco128.zip -d COCO
```

Create data interface for EDGE2_NODE.

```
mkdir -p /data/2
cd /data/2
wget https://github.com/ultralytics/yolov5/releases/download/v1.0/coco128.zip
unzip coco128.zip -d COCO
```

16.1.4 Prepare Images

This example uses these images:

1. aggregation worker: kubeedge/sedna-example-federated-learning-mistnet-yolo-aggregator:v0.4.0
2. train worker: kubeedge/sedna-example-federated-learning-mistnet-yolo-client:v0.4.0

These images are generated by the script build_images.sh.

16.1.5 Create Federated Learning Job

Create Dataset

create dataset for $EDGE1_NODE and $EDGE2_NODE

```
kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind: Dataset
metadata:
  name: "coco-dataset-1"
spec:
  url: "/data/1/COCO"
  format: "dir"
  nodeName: $EDGE1_NODE
EOF
```

```
kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind: Dataset
metadata:
  name: "coco-dataset-2"
spec:
  url: "/data/2/COCO"
```

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```
  format: "dir"
  nodeName: $EDGE2_NODE
EOF
```

Create Model

create the directory `/model` and `/pretrained` in `$EDGE1_NODE` and `$EDGE2_NODE`.

```
mkdir -p /model
mkdir -p /pretrained
```

create the directory `/model` and `/pretrained` in the host of `$CLOUD_NODE` (download links here)

```
# on the cloud side
mkdir -p /model
mkdir -p /pretrained
cd /pretrained
wget https://kubeedge.obs.cn-north-1.myhuaweicloud.com/examples/yolov5_coco128_mistnet/
↪yolov5.pth
```

create model

```
kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind: Model
metadata:
  name: "yolo-v5-model"
spec:
  url: "/model/yolov5.pth"
  format: "pth"
EOF

kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind: Model
metadata:
  name: "yolo-v5-pretrained-model"
spec:
  url: "/pretrained/yolov5.pth"
  format: "pth"
EOF
```

16.1.6 Create a secret with your S3 user credential. (Optional)

```
kubectl create -f - <<EOF
apiVersion: v1
kind: Secret
metadata:
  name: mysecret
  annotations:
    s3-endpoint: s3.amazonaws.com
    s3-usehttps: "1"
stringData:
  ACCESS_KEY_ID: XXXX
  SECRET_ACCESS_KEY: XXXXXXXX
EOF
```

Start Federated Learning Job

```
kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind: FederatedLearningJob
metadata:
  name: yolo-v5
spec:
  pretrainedModel: # option
    name: "yolo-v5-pretrained-model"
  transmitter: # option
    ws: { } # option, by default
    s3: # optional, but at least one
      aggDataPath: "s3://sedna/fl/aggregation_data"
      credentialName: mysecret
  aggregationWorker:
    model:
      name: "yolo-v5-model"
    template:
      spec:
        nodeName: $CLOUD_NODE
        containers:
          - image: kubeedge/sedna-example-federated-learning-mistnet-yolo-aggregator:v0.
↪4.0
            name: agg-worker
            imagePullPolicy: IfNotPresent
            env: # user defined environments
              - name: "cut_layer"
                value: "4"
              - name: "epsilon"
                value: "100"
              - name: "aggregation_algorithm"
                value: "mistnet"
              - name: "batch_size"
                value: "32"
              - name: "epochs"
```

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```
              value: "100"
          resources: # user defined resources
            limits:
              memory: 8Gi
trainingWorkers:
  - dataset:
      name: "coco-dataset-1"
    template:
      spec:
        nodeName: $EDGE1_NODE
        containers:
          - image: kubeedge/sedna-example-federated-learning-mistnet-yolo-client:v0.4.0
            name: train-worker
            imagePullPolicy: IfNotPresent
            args: [ "-i", "1" ]
            env: # user defined environments
              - name: "cut_layer"
                value: "4"
              - name: "epsilon"
                value: "100"
              - name: "aggregation_algorithm"
                value: "mistnet"
              - name: "batch_size"
                value: "32"
              - name: "learning_rate"
                value: "0.001"
              - name: "epochs"
                value: "1"
            resources: # user defined resources
              limits:
                memory: 2Gi
  - dataset:
      name: "coco-dataset-2"
    template:
      spec:
        nodeName: $EDGE2_NODE
        containers:
          - image: kubeedge/sedna-example-federated-learning-mistnet-yolo-client:v0.4.0
            name: train-worker
            imagePullPolicy: IfNotPresent
            args: [ "-i", "2" ]
            env: # user defined environments
              - name: "cut_layer"
                value: "4"
              - name: "epsilon"
                value: "100"
              - name: "aggregation_algorithm"
                value: "mistnet"
              - name: "batch_size"
                value: "32"
              - name: "learning_rate"
                value: "0.001"
```

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```
                - name: "epochs"
                  value: "1"
              resources: # user defined resources
                limits:
                  memory: 2Gi
EOF
```

CHAPTER

SEVENTEEN

USING LIFELONG LEARNING JOB IN THERMAL COMFORT PREDICTION SCENARIO

This document introduces how to use lifelong learning job in thermal comfort prediction scenario. Using the lifelong learning job, our application can automatically retrain, evaluate, and update models based on the data generated at the edge.

17.1 Thermal Comfort Prediction Experiment

17.1.1 Install Sedna

Follow the Sedna installation document to install Sedna.

17.1.2 Prepare Dataset

In this example, you can use ASHRAE Global Thermal Comfort Database II to initial lifelong learning job.

We provide a well-processed datasets, including train (`trainData.csv`), evaluation (`testData.csv`) and incremental (`trainData2.csv`) dataset.

```
cd /data
wget https://kubeedge.obs.cn-north-1.myhuaweicloud.com/examples/atcii-classifier/dataset.
↪tar.gz
tar -zxvf dataset.tar.gz
```

17.1.3 Create Lifelong Job

In this example, `$WORKER_NODE` is a custom node, you can fill it which you actually run.

```
WORKER_NODE="edge-node"
```

Create Dataset

```
kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind: Dataset
metadata:
  name: lifelong-dataset
spec:
```

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```
  url: "/data/trainData.csv"
  format: "csv"
  nodeName: $WORKER_NODE
EOF
```

Also, you can replace `trainData.csv` with `trainData2.csv` which contained in `dataset` to trigger retraining.

Start The Lifelong Learning Job

```
kubectl create -f - <<EOF
apiVersion: sedna.io/v1alpha1
kind: LifelongLearningJob
metadata:
  name: atcii-classifier-demo
spec:
  dataset:
    name: "lifelong-dataset"
    trainProb: 0.8
  trainSpec:
    template:
      spec:
        nodeName: $WORKER_NODE
        containers:
          - image: kubeedge/sedna-example-lifelong-learning-atcii-classifier:v0.3.0
            name:  train-worker
            imagePullPolicy: IfNotPresent
            args: ["train.py"]  # training script
            env:  # Hyperparameters required for training
              - name: "early_stopping_rounds"
                value: "100"
              - name: "metric_name"
                value: "mlogloss"
    trigger:
      checkPeriodSeconds: 60
      timer:
        start: 02:00
        end: 24:00
      condition:
        operator: ">"
        threshold: 500
        metric: num_of_samples
  evalSpec:
    template:
      spec:
        nodeName: $WORKER_NODE
        containers:
          - image: kubeedge/sedna-example-lifelong-learning-atcii-classifier:v0.3.0
            name:  eval-worker
            imagePullPolicy: IfNotPresent
            args: ["eval.py"]
            env:
              - name: "metrics"
                value: "precision_score"
```

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```
              - name: "metric_param"
                value: "{'average': 'micro'}"
              - name: "model_threshold"  # Threshold for filtering deploy models
                value: "0.5"
  deploySpec:
    template:
      spec:
        nodeName: $WORKER_NODE
        containers:
        - image: kubeedge/sedna-example-lifelong-learning-atcii-classifier:v0.3.0
          name:  infer-worker
          imagePullPolicy: IfNotPresent
          args: ["inference.py"]
          env:
          - name: "UT_SAVED_URL"  # unseen tasks save path
            value: "/ut_saved_url"
          - name: "infer_dataset_url"  # simulation of the inference samples
            value: "/data/testData.csv"
          volumeMounts:
          - name: utdir
            mountPath: /ut_saved_url
          - name: inferdata
            mountPath: /data/
          resources:  # user defined resources
            limits:
              memory: 2Gi
        volumes:   # user defined volumes
          - name: utdir
            hostPath:
              path: /lifelong/unseen_task/
              type: DirectoryOrCreate
          - name: inferdata
            hostPath:
              path:  /data/
              type: DirectoryOrCreate
  outputDir: "/output"
EOF
```

> **Note**: `outputDir` can be set as s3 storage url to save artifacts(model, sample, etc.) into s3, and follow this to set the credentials.

17.1.4 Check Lifelong Learning Job

query the service status

```
kubectl get lifelonglearningjob atcii-classifier-demo
```

In the `lifelonglearningjob` resource atcii-classifier-demo, the following trigger is configured:

```
trigger:
  checkPeriodSeconds: 60
```

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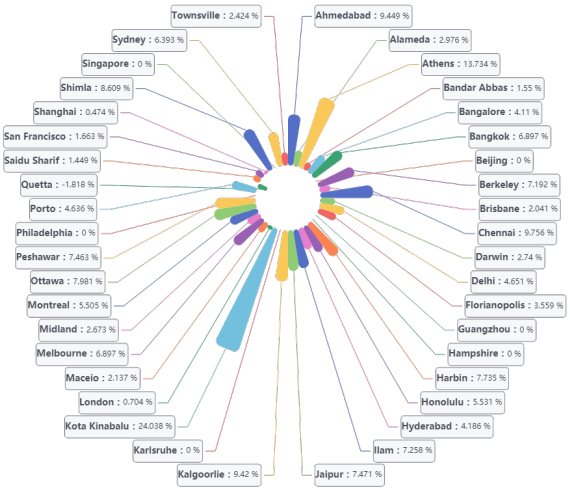
```
  timer:
    start: 02:00
    end: 20:00
  condition:
    operator: ">"
    threshold: 500
    metric: num_of_samples
```

17.1.5 Unseen Tasks samples Labeling

In a real word, we need to label the hard examples in our unseen tasks which storage in `UT_SAVED_URL` with annotation tools and then put the examples to `Dataset`'s url.

17.1.6 Effect Display

In this example, **false** and **failed** detections occur at stage of inference before lifelong learning. After lifelong learning, the precision of the dataset have been improved by 5.12%.



CHAPTER

EIGHTEEN

PYTHON API USE GUIDE

18.1 Sedna Python SDK

The Sedna Python Software Development Kit (SDK) aims to provide developers with a convenient yet flexible tool to write the Sedna applications.

This document introduces how to obtain and call Sedna Python SDK.

18.1.1 Introduction

Expose the Edge AI features to applications, i.e. training or inference programs.

18.1.2 Requirements and Installation

The build process is tested with Python 3.6, Ubuntu 18.04.5 LTS

```
# Clone the repo
git clone --recursive https://github.com/kubeedge/sedna.git
cd sedna/lib

# Build the pip package
python setup.py bdist_wheel

# Install the pip package
pip install dist/sedna*.whl
```

Install via Setuptools

```
# Install dependence
pip install -r requirements.txt

# Install sedna
python setup.py install --user
```

18.1.3 Use Python SDK

1. (optional) Check Sedna version

```
$ python -c "import sedna; print(sedna.__version__)"
```

2. Import the required modules as follows:

```
from sedna.core.joint_inference import JointInference, BigModelService
from sedna.core.federated_learning import FederatedLearning
from sedna.core.incremental_learning import IncrementalLearning
from sedna.core.lifelong_learning import LifelongLearning
```

3. Define an Estimator:

```
import os

# Keras
import keras
from keras.layers import Dense, MaxPooling2D, Conv2D, Flatten, Dropout
from keras.models import Sequential

os.environ['BACKEND_TYPE'] = 'KERAS'

def KerasEstimator():
    model = Sequential()
    model.add(Conv2D(64, kernel_size=(3, 3),
                     activation="relu", strides=(2, 2),
                     input_shape=(128, 128, 3)))
    model.add(MaxPooling2D(pool_size=(2, 2)))
    model.add(Conv2D(32, kernel_size=(3, 3), activation="relu"))
    model.add(MaxPooling2D(pool_size=(2, 2)))
    model.add(Flatten())
    model.add(Dropout(0.25))
    model.add(Dense(64, activation="relu"))
    model.add(Dense(32, activation="relu"))
    model.add(Dropout(0.5))
    model.add(Dense(2, activation="softmax"))

    model.compile(loss="categorical_crossentropy",
                  optimizer="adam",
                  metrics=["accuracy"])
    loss = keras.losses.CategoricalCrossentropy(from_logits=True)
    metrics = [keras.metrics.categorical_accuracy]
    optimizer = keras.optimizers.Adam(learning_rate=0.1)
    model.compile(loss=loss, optimizer=optimizer, metrics=metrics)
    return model
```

```
# XGBOOST

import os
import xgboost
```

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```
os.environ['BACKEND_TYPE'] = 'SKLEARN'

XGBEstimator = xgboost.XGBClassifier(
        learning_rate=0.1,
        n_estimators=600,
        max_depth=2,
        min_child_weight=1,
        gamma=0,
        subsample=0.8,
        colsample_bytree=0.8,
        objective="multi:softmax",
        num_class=3,
        nthread=4,
        seed=27
 )
```

```
# Customize

class Estimator:

    def __init__(self, **kwargs):
        ...

    def load(self, model_url=""):
        ...

    def save(self, model_path=None):
        ...

    def predict(self, data, **kwargs):
        ...

    def evaluate(self, valid_data, **kwargs):
        ...

    def train(self, train_data, valid_data=None, **kwargs):
        ...
```

Notes: Estimator is a high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your model.

4. Initialize a Incremental Learning Job:

```
  # get hard exmaple mining algorithm from config
  hard_example_mining = IncrementalLearning.get_hem_algorithm_from_config(
      threshold_img=0.9
  )

  # create Incremental Learning infernece instance
  il_job = IncrementalLearning(
      estimator=Estimator,
      hard_example_mining=hard_example_mining
```

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```
    )

where:
```

- `IncrementalLearning` is the Cloud-edge job you want to access.
- `Estimator` is the base model for your ML job.
- `hard_example_mining` is the parameters of incremental learning job.

  Inference

  Note: The `job parameters` of each feature are different.

5. Running Job - training / inference / evaluation.

```
    results, final_res, is_hard_example = il_job.inference(
            img_rgb,
            post_process=deal_infer_rsl,
            input_shape=input_shape
    )

where:
```

- `img_rgb` is the sample used to inference
- `deal_infer_rsl` is a function used to process result after model predict
- `input_shape` is the parameters of `Estimator` in inference
- `results` is the result predicted by model
- `final_res` is the result after process by `deal_infer_rsl`
- `is_hard_example` tells if the sample is hard sample or not

18.1.4 Customize algorithm

Sedna provides a class called `class_factory.py` in `common` package, in which only a few lines of changes are required to become a module of sedna.

Two classes are defined in `class_factory.py`, namely `ClassType` and `ClassFactory`.

`ClassFactory` can register the modules you want to reuse through decorators. For example, in the following code example, you have customized an **hard_example_mining algorithm**, you only need to add a line of `ClassFactory.register(ClassType.HEM)` to complete the registration.

```
@ClassFactory.register(ClassType.HEM, alias="Threshold")
class ThresholdFilter(BaseFilter, abc.ABC):
    def __init__(self, threshold=0.5, **kwargs):
        self.threshold = float(threshold)

    def __call__(self, infer_result=None):
        # if invalid input, return False
        if not (infer_result
                and all(map(lambda x: len(x) > 4, infer_result))):
            return False
```

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```
        image_score = 0

        for bbox in infer_result:
            image_score += bbox[4]

        average_score = image_score / (len(infer_result) or 1)
        return average_score < self.threshold
```

After registration, you only need to change the name of the hem and parameters in the yaml file, and then the corresponding class will be automatically called according to the name.

```
deploySpec:
    hardExampleMining:
      name: "Threshold"
      parameters:
        - key: "threshold"
          value: "0.9"
```

CHAPTER

NINETEEN

LIB.SEDNA

19.1 Subpackages

19.1.1 lib.sedna.algorithms

Subpackages

lib.sedna.algorithms.aggregation

Submodules

lib.sedna.algorithms.aggregation.aggregation

Aggregation algorithms

Module Contents

Classes

AggClient	Client that interacts with cloud aggregator
FedAvg	Federated averaging algorithm

class lib.sedna.algorithms.aggregation.aggregation.**AggClient**

Client that interacts with cloud aggregator

Parameters

- **num_samples** (*int*) – number of samples for the current weights
- **weights** (*List*) – weights of the layer as a list of number-like array, such as [[0, 0, 0, 0], [0, 0, 0, 0] …]

num_samples: int

weights: List

class lib.sedna.algorithms.aggregation.aggregation.**FedAvg**

Bases: BaseAggregation, abc.ABC

Federated averaging algorithm

aggregate(*clients: List[*AggClient*]*)

Calculate the average weight according to the number of samples

Parameters
clients (*List*) – All clients in federated learning job

Returns
update_weights – final weights use to update model layer

Return type
Array-like

Package Contents

Classes

FedAvg	Federated averaging algorithm
MistNet	Abstract class of aggregator
AggClient	Client that interacts with cloud aggregator
FedAvgV2	Abstract class of aggregator

class lib.sedna.algorithms.aggregation.**FedAvg**

Bases: BaseAggregation, abc.ABC

Federated averaging algorithm

aggregate(*clients: List[*AggClient*]*)

Calculate the average weight according to the number of samples

Parameters
clients (*List*) – All clients in federated learning job

Returns
update_weights – final weights use to update model layer

Return type
Array-like

class lib.sedna.algorithms.aggregation.**MistNet**(*cut_layer*, *epsilon=100*)

Bases: BaseAggregation, abc.ABC

Abstract class of aggregator

aggregate(*clients: List[*AggClient*]*)

Some algorithms can be aggregated in sequence, but some can be calculated only after all aggregated data is uploaded. therefore, this abstractmethod should consider that all weights are uploaded.

Parameters
clients (*List*) – All clients in federated learning job

Returns
final weights use to update model layer

Return type
Array-like

class lib.sedna.algorithms.aggregation.**AggClient**

Client that interacts with cloud aggregator

Parameters

- **num_samples** (*int*) – number of samples for the current weights
- **weights** (*List*) – weights of the layer as a list of number-like array, such as [[0, 0, 0, 0], [0, 0, 0, 0] . . .]

num_samples: int

weights: List

class lib.sedna.algorithms.aggregation.**FedAvgV2**

Bases: BaseAggregation, abc.ABC

Abstract class of aggregator

aggregate(*clients: List[*AggClient*]*)

Some algorithms can be aggregated in sequence, but some can be calculated only after all aggregated data is uploaded. therefore, this abstractmethod should consider that all weights are uploaded.

Parameters
clients (*List*) – All clients in federated learning job

Returns
final weights use to update model layer

Return type
Array-like

lib.sedna.algorithms.client_choose

Submodules

lib.sedna.algorithms.client_choose.client_choose

Module Contents

Classes

AbstractClientChoose	Abstract class of ClientChoose, which provides base client choose
SimpleClientChoose	A Simple Implementation of Client Choose.

class lib.sedna.algorithms.client_choose.client_choose.**AbstractClientChoose**

Abstract class of ClientChoose, which provides base client choose algorithm interfaces in federated learning.

class lib.sedna.algorithms.client_choose.client_choose.**SimpleClientChoose**(*per_round=1*)

Bases: *AbstractClientChoose*

A Simple Implementation of Client Choose.

Package Contents

Classes

SimpleClientChoose	A Simple Implementation of Client Choose.

class lib.sedna.algorithms.client_choose.**SimpleClientChoose**(*per_round=1*)

Bases: `AbstractClientChoose`

A Simple Implementation of Client Choose.

lib.sedna.algorithms.hard_example_mining

Submodules

lib.sedna.algorithms.hard_example_mining.hard_example_mining

Hard Example Mining Algorithms

Module Contents

Classes

ThresholdFilter	**Object detection** Hard samples discovery methods named *Threshold*
CrossEntropyFilter	**Object detection** Hard samples discovery methods named *CrossEntropy*
IBTFilter	**Object detection** Hard samples discovery methods named *IBT*

class lib.sedna.algorithms.hard_example_mining.hard_example_mining.**ThresholdFilter**(*threshold: float = 0.5*, ***kwargs*)

Bases: `BaseFilter`, `abc.ABC`

Object detection Hard samples discovery methods named *Threshold*

Parameters

threshold (*float*) – hard coefficient threshold score to filter img, default to 0.5.

__call__(*infer_result=None*) → bool

predict function, judge the sample is hard or not.

Parameters

infer_result (*array_like*) – prediction result

Returns

is_hard_sample – *True* means hard sample, *False* means not.

Return type
bool

class lib.sedna.algorithms.hard_example_mining.hard_example_mining.**CrossEntropyFilter**(*threshold_cross_entro*
**kwargs*)

Bases: BaseFilter, abc.ABC

Object detection Hard samples discovery methods named *CrossEntropy*

Parameters
threshold_cross_entropy (*float*) – hard coefficient threshold score to filter img, default to 0.5.

__call__(*infer_result=None*) → bool

judge the img is hard sample or not.

Parameters
infer_result (*array_like*) – prediction classes list, such as [class1-score, class2-score, class2-score,....], where class-score is the score corresponding to the class, class-score value is in [0,1], who will be ignored if its value not in [0,1].

Returns
is hard sample – *True* means hard sample, *False* means not.

Return type
bool

class lib.sedna.algorithms.hard_example_mining.hard_example_mining.**IBTFilter**(*threshold_img=0.5*, *threshold_box=0.5*, ***kwargs*)

Bases: BaseFilter, abc.ABC

Object detection Hard samples discovery methods named *IBT*

Parameters

- **threshold_img** (*float*) – hard coefficient threshold score to filter img, default to 0.5.
- **threshold_box** (*float*) – threshold_box to calculate hard coefficient, formula is hard coefficient = number(prediction_boxes less than threshold_box) / number(prediction_boxes)

__call__(*infer_result=None*) → bool

Judge the img is hard sample or not.

Parameters
infer_result (*array_like*) – prediction boxes list, such as [bbox1, bbox2, bbox3,....], where bbox = [xmin, ymin, xmax, ymax, score, label] score should be in [0,1], who will be ignored if its value not in [0,1].

Returns
is hard sample – *True* means hard sample, *False* means not.

Return type
bool

lib.sedna.algorithms.multi_task_learning

Subpackages

lib.sedna.algorithms.multi_task_learning.task_jobs

Submodules

lib.sedna.algorithms.multi_task_learning.task_jobs.artifact

Module Contents

Classes

Task	
TaskGroup	
Model	

class lib.sedna.algorithms.multi_task_learning.task_jobs.artifact.**Task**(*entry*, *samples*, *meta_attr=None*)

class lib.sedna.algorithms.multi_task_learning.task_jobs.artifact.**TaskGroup**(*entry*, *tasks: List[*Task*]*)

class lib.sedna.algorithms.multi_task_learning.task_jobs.artifact.**Model**(*index: int*, *entry*, *model*, *result*)

lib.sedna.algorithms.multi_task_learning.task_jobs.inference_integrate

Integrate the inference results of all related tasks

Module Contents

Classes

DefaultInferenceIntegrate	Default calculation algorithm for inference integration

class lib.sedna.algorithms.multi_task_learning.task_jobs.inference_integrate.**DefaultInferenceIntegrate**(

Default calculation algorithm for inference integration

Parameters

models (*All models used for sample inference*) –

__call__(*tasks: List[*lib.sedna.algorithms.multi_task_learning.task_jobs.artifact.Task*]*)

Parameters
tasks (*All tasks with sample result*) –

Returns
result

Return type
minimum result

lib.sedna.algorithms.multi_task_learning.task_jobs.task_definition

Divide multiple tasks based on data

param samples Train data
param see *sedna.datasources.BaseDataSource* for more detail.
returns

- **tasks** (*All tasks based on training data.*)
- **task_extractor** (*Model with a method to predicting target tasks*)

Module Contents

Classes

TaskDefinitionBySVC	Dividing datasets with *AgglomerativeClustering* based on kernel distance,
TaskDefinitionByDataAttr	Dividing datasets based on the common attributes,

class lib.sedna.algorithms.multi_task_learning.task_jobs.task_definition.**TaskDefinitionBySVC**(**kwargs*)

Dividing datasets with *AgglomerativeClustering* based on kernel distance, Using SVC to fit the clustering result.

Parameters
None (*n_class int or*) – The number of clusters to find, default=2.

__call__(*samples:* sedna.datasources.BaseDataSource) → Tuple[List[*lib.sedna.algorithms.multi_task_learning.task_jobs.artifact.Task*], Any, *sedna.datasources.BaseDataSource*]

class lib.sedna.algorithms.multi_task_learning.task_jobs.task_definition.**TaskDefinitionByDataAttr**(**kwa

Dividing datasets based on the common attributes, generally used for structured data.

Parameters
List[Metadata] (*attribute*) – metadata is usually a class feature label with a finite values.

__call__(*samples:* sedna.datasources.BaseDataSource) → Tuple[List[*lib.sedna.algorithms.multi_task_learning.task_jobs.artifact.Task*], Any, *sedna.datasources.BaseDataSource*]

lib.sedna.algorithms.multi_task_learning.task_jobs.task_mining

Mining tasks of inference sample base on task attribute extractor

param samples infer sample
param see *sedna.datasources.BaseDataSource* **for more detail.**
returns
allocations

rtype
tasks that assigned to each sample

Module Contents

Classes

TaskMiningBySVC	Corresponding to *TaskDefinitionBySVC*
TaskMiningByDataAttr	Corresponding to *TaskDefinitionByDataAttr*

class lib.sedna.algorithms.multi_task_learning.task_jobs.task_mining.**TaskMiningBySVC**(*task_extractor*, ***kwargs*)

Corresponding to *TaskDefinitionBySVC*

Parameters
task_extractor (Model) – SVC Model used to predicting target tasks

__call__(*samples:* sedna.datasources.BaseDataSource)

class lib.sedna.algorithms.multi_task_learning.task_jobs.task_mining.**TaskMiningByDataAttr**(*task_extractor*, ***kwargs*)

Corresponding to *TaskDefinitionByDataAttr*

Parameters

- **task_extractor** (*Dict*) – used to match target tasks
- **attr_filed** (*List[Metadata]*) – metadata is usually a class feature label with a finite values.

__call__(*samples:* sedna.datasources.BaseDataSource)

lib.sedna.algorithms.multi_task_learning.task_jobs.task_relation_discover

Discover relationships between all tasks

param tasks all tasks form *task_definition*
returns
task_groups

rtype
List of groups which including at least 1 task.

Module Contents

Classes

DefaultTaskRelationDiscover	Assume that each task is independent of each other

class lib.sedna.algorithms.multi_task_learning.task_jobs.task_relation_discover.**DefaultTaskRelationDisc**

Assume that each task is independent of each other

__call__(*tasks: List[*lib.sedna.algorithms.multi_task_learning.task_jobs.artifact.Task*]*) → List[*lib.sedna.algorithms.multi_task_learning.task_jobs.artifact.TaskGroup*]

lib.sedna.algorithms.multi_task_learning.task_jobs.task_remodeling

Remodeling tasks based on their relationships

param mappings all assigned tasks get from the *task_mining*
param samples
type samples
input samples

returns
models

rtype
List of groups which including at least 1 task.

Module Contents

Classes

DefaultTaskRemodeling	Assume that each task is independent of each other

class lib.sedna.algorithms.multi_task_learning.task_jobs.task_remodeling.**DefaultTaskRemodeling**(*models: list*, ***kwargs*)

Assume that each task is independent of each other

__call__(*samples:* sedna.datasources.BaseDataSource, *mappings: List*)

Grouping based on assigned tasks

Submodules

lib.sedna.algorithms.multi_task_learning.multi_task_learning

Multiple task transfer learning algorithms

Module Contents

Classes

MulTaskLearning	An auto machine learning framework for edge-cloud multitask learning

class lib.sedna.algorithms.multi_task_learning.multi_task_learning.**MulTaskLearning**(*estimator=None*, *task_definition=None*, *task_relationship_discover*, *task_mining=None*, *task_remodeling=None*, *inference_integrate=None*)

An auto machine learning framework for edge-cloud multitask learning

See also:

Train
Data + Estimator -> Task Definition -> Task Relationship Discovery -> Feature Engineering -> Training

Inference
Data -> Task Allocation -> Task Mining -> Feature Engineering -> Task Remodeling -> Inference

Parameters

- **estimator** (*Instance*) – An instance with the high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your model.
- **task_definition** (*Dict*) – Divide multiple tasks based on data, see *task_jobs.task_definition* for more detail.
- **task_relationship_discovery** (*Dict*) – Discover relationships between all tasks, see *task_jobs.task_relationship_discovery* for more detail.
- **task_mining** (*Dict*) – Mining tasks of inference sample, see *task_jobs.task_mining* for more detail.
- **task_remodeling** (*Dict*) – Remodeling tasks based on their relationships, see *task_jobs.task_remodeling* for more detail.
- **inference_integrate** (*Dict*) – Integrate the inference results of all related tasks, see *task_jobs.inference_integrate* for more detail.

Examples

```
>>> from xgboost import XGBClassifier
>>> from sedna.algorithms.multi_task_learning import MulTaskLearning
>>> estimator = XGBClassifier(objective="binary:logistic")
>>> task_definition = {
        "method": "TaskDefinitionByDataAttr",
        "param": {"attribute": ["season", "city"]}
    }
>>> task_relationship_discovery = {
        "method": "DefaultTaskRelationDiscover", "param": {}
    }
>>> task_mining = {
        "method": "TaskMiningByDataAttr",
        "param": {"attribute": ["season", "city"]}
    }
>>> task_remodeling = None
>>> inference_integrate = {
        "method": "DefaultInferenceIntegrate", "param": {}
    }
>>> mul_task_instance = MulTaskLearning(
        estimator=estimator,
        task_definition=task_definition,
        task_relationship_discovery=task_relationship_discovery,
        task_mining=task_mining,
        task_remodeling=task_remodeling,
        inference_integrate=inference_integrate
    )
```

Notes

All method defined under *task_jobs* and registered in *ClassFactory*.

train(*train_data:* sedna.datasources.BaseDataSource, *valid_data:* sedna.datasources.BaseDataSource = *None*, *post_process=None*, ***kwargs*)

fit for update the knowledge based on training data.

Parameters

- **train_data** (BaseDataSource) – Train data, see *sedna.datasources.BaseDataSource* for more detail.
- **valid_data** (BaseDataSource) – Valid data, BaseDataSource or None.
- **post_process** (*function*) – function or a registered method, callback after *estimator* train.
- **kwargs** (*Dict*) – parameters for *estimator* training, Like: *early_stopping_rounds* in Xgboost.XGBClassifier

Returns

- **feedback** (*Dict*) – contain all training result in each tasks.
- **task_index_url** (*str*) – task extractor model path, used for task mining.

load(*task_index_url=None*)

load task_detail (tasks/models etc . . .) from task index file. It'll automatically loaded during *inference* and *evaluation* phases.

Parameters

task_index_url (*str*) – task index file path, default self.task_index_url.

predict(*data:* sedna.datasources.BaseDataSource, *post_process=None*, ***kwargs*)

predict the result for input data based on training knowledge.

Parameters

- **data** (BaseDataSource) – inference sample, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function*) – function or a registered method, effected after *estimator* prediction, like: label transform.
- **kwargs** (*Dict*) – parameters for *estimator* predict, Like: *ntree_limit* in Xgboost.XGBClassifier

Returns

- **result** (*array_like*) – results array, contain all inference results in each sample.
- **tasks** (*List*) – tasks assigned to each sample.

evaluate(*data:* sedna.datasources.BaseDataSource, *metrics=None*, *metrics_param=None*, ***kwargs*)

evaluated the performance of each task from training, filter tasks based on the defined rules.

Parameters

- **data** (BaseDataSource) – valid data, see *sedna.datasources.BaseDataSource* for more detail.
- **metrics** (*function / str*) – Metrics to assess performance on the task by given prediction.
- **metrics_param** (*Dict*) – parameter for metrics function.
- **kwargs** (*Dict*) – parameters for *estimator* evaluate, Like: *ntree_limit* in Xgboost.XGBClassifier

Returns

- **task_eval_res** (*Dict*) – all metric results.
- **tasks_detail** (*List[Object]*) – all metric results in each task.

Package Contents

Classes

MulTaskLearning	An auto machine learning framework for edge-cloud multitask learning

class lib.sedna.algorithms.multi_task_learning.**MulTaskLearning**(*estimator=None*, *task_definition=None*, *task_relationship_discovery=None*, *task_mining=None*, *task_remodeling=None*, *inference_integrate=None*)

An auto machine learning framework for edge-cloud multitask learning

See also:

Train
Data + Estimator -> Task Definition -> Task Relationship Discovery -> Feature Engineering -> Training

Inference
Data -> Task Allocation -> Task Mining -> Feature Engineering -> Task Remodeling -> Inference

Parameters

- **estimator** (*Instance*) – An instance with the high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your model.
- **task_definition** (*Dict*) – Divide multiple tasks based on data, see *task_jobs.task_definition* for more detail.
- **task_relationship_discovery** (*Dict*) – Discover relationships between all tasks, see *task_jobs.task_relationship_discovery* for more detail.
- **task_mining** (*Dict*) – Mining tasks of inference sample, see *task_jobs.task_mining* for more detail.
- **task_remodeling** (*Dict*) – Remodeling tasks based on their relationships, see *task_jobs.task_remodeling* for more detail.
- **inference_integrate** (*Dict*) – Integrate the inference results of all related tasks, see *task_jobs.inference_integrate* for more detail.

Examples

```
>>> from xgboost import XGBClassifier
>>> from sedna.algorithms.multi_task_learning import MulTaskLearning
>>> estimator = XGBClassifier(objective="binary:logistic")
>>> task_definition = {
        "method": "TaskDefinitionByDataAttr",
        "param": {"attribute": ["season", "city"]}
    }
>>> task_relationship_discovery = {
        "method": "DefaultTaskRelationDiscover", "param": {}
    }
>>> task_mining = {
        "method": "TaskMiningByDataAttr",
        "param": {"attribute": ["season", "city"]}
    }
>>> task_remodeling = None
>>> inference_integrate = {
        "method": "DefaultInferenceIntegrate", "param": {}
```

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```
    }
>>> mul_task_instance = MulTaskLearning(
        estimator=estimator,
        task_definition=task_definition,
        task_relationship_discovery=task_relationship_discovery,
        task_mining=task_mining,
        task_remodeling=task_remodeling,
        inference_integrate=inference_integrate
    )
```

Notes

All method defined under *task_jobs* and registered in *ClassFactory*.

train(*train_data:* sedna.datasources.BaseDataSource, *valid_data:* sedna.datasources.BaseDataSource = *None*, *post_process=None*, ***kwargs*)

fit for update the knowledge based on training data.

Parameters

- **train_data** (BaseDataSource) – Train data, see *sedna.datasources.BaseDataSource* for more detail.
- **valid_data** (BaseDataSource) – Valid data, BaseDataSource or None.
- **post_process** (*function*) – function or a registered method, callback after *estimator* train.
- **kwargs** (*Dict*) – parameters for *estimator* training, Like: *early_stopping_rounds* in Xgboost.XGBClassifier

Returns

- **feedback** (*Dict*) – contain all training result in each tasks.
- **task_index_url** (*str*) – task extractor model path, used for task mining.

load(*task_index_url=None*)

load task_detail (tasks/models etc . . .) from task index file. It'll automatically loaded during *inference* and *evaluation* phases.

Parameters

task_index_url (*str*) – task index file path, default self.task_index_url.

predict(*data:* sedna.datasources.BaseDataSource, *post_process=None*, ***kwargs*)

predict the result for input data based on training knowledge.

Parameters

- **data** (BaseDataSource) – inference sample, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function*) – function or a registered method, effected after *estimator* prediction, like: label transform.
- **kwargs** (*Dict*) – parameters for *estimator* predict, Like: *ntree_limit* in Xgboost.XGBClassifier

Returns

- **result** (*array_like*) – results array, contain all inference results in each sample.
- **tasks** (*List*) – tasks assigned to each sample.

evaluate(*data:* sedna.datasources.BaseDataSource, *metrics=None*, *metrics_param=None*, ***kwargs*)

evaluated the performance of each task from training, filter tasks based on the defined rules.

Parameters

- **data** (BaseDataSource) – valid data, see *sedna.datasources.BaseDataSource* for more detail.
- **metrics** (*function / str*) – Metrics to assess performance on the task by given prediction.
- **metrics_param** (*Dict*) – parameter for metrics function.
- **kwargs** (*Dict*) – parameters for *estimator* evaluate, Like: *ntree_limit* in Xgboost.XGBClassifier

Returns

- **task_eval_res** (*Dict*) – all metric results.
- **tasks_detail** (*List[Object]*) – all metric results in each task.

lib.sedna.algorithms.optical_flow

Optical Flow Algorithms

lib.sedna.algorithms.reid

Submodules

lib.sedna.algorithms.reid.close_contact_estimation

Module Contents

Classes

ContactTracker	The ContactTracker object is invoked in frames where the

class lib.sedna.algorithms.reid.close_contact_estimation.**ContactTracker**(*draw_top_view=False*)

Bases: object

The ContactTracker object is invoked in frames where the target person was identified.

prep_homography(*img_shape*, *bbox_target*, *h_ratio: float = 0.5*, *v_ratio: float = 0.5*)

compute_homography(*img_shape: List[int]*) → None

Calculate homography @param img_shape: List [h,w]

in_risk_zone(*img: numpy.ndarray*, *bbox_candidate: List[int] = None*) → bool

create_ellipse(*bbox_list: List[List[int]] = None*) → Tuple[List, List]

Create ellipses for each of the generated bounding boxes. @param bbox_list:

check_bbox_overlap(*ellipse1: Tuple*, *ellipse2: Tuple*) → bool

Check if ellipse bounding rectangles overlap or not. :param ellipse1: ellipse one :type ellipse1: tuple :param ellipse2: ellipse two :type ellipse2: tuple

Return type
boolean

to_rectangle(*ellipse: Tuple*) → Tuple

Convert ellipse to rectangle (top, left, bottom, right) :param ellipse: bounding rectangle descriptor :type ellipse: tuple

get_homography_matrix()

lib.sedna.algorithms.reid.multi_img_matching

Module Contents

Functions

cosine_similarity_score([query, candidates])	Computes the cosine similarity score between the
tensor_reshape(→ torch.Tensor)	
match_query_to_targets(→ Tuple[int, float])	Query features refer to the features of

lib.sedna.algorithms.reid.multi_img_matching.**cosine_similarity_score**(*query: numpy.ndarray = None*, *candidates: numpy.ndarray = None*)

Computes the cosine similarity score between the
query feature and the candidate features.

@param query: Feature map of dimension
[1, n_feat_dim] representing the query.

@param candidates: Feature map of dimension
[n_candidates, n_feat_dim] representing the candidate for match.

lib.sedna.algorithms.reid.multi_img_matching.**tensor_reshape**(*data: Any*) → torch.Tensor

lib.sedna.algorithms.reid.multi_img_matching.**match_query_to_targets**(*query_feats: List*, *candidate_feats: List*, *avg_mode: bool = False*) → Tuple[int, float]

Query features refer to the features of the person we are looking for in the video. Candidate features refers to features of the persons found by the detector in the current scene. :param query_feats: [M x d] M being the number of target images in the query :param candidate_feats: [N x d] N is the number of persons detected in the scene :param avg_mode: If set, use an average representation of the query.

Query feats becomes [1 x d]

Returns
Id of the candidate which best matches the query

lib.sedna.algorithms.seen_task_learning

Subpackages

lib.sedna.algorithms.seen_task_learning.inference_integration

Submodules

lib.sedna.algorithms.seen_task_learning.inference_integration.base_inference_integrate

Integrate the inference results of all related tasks

Module Contents

Classes

BaseInferenceIntegrate	Base class for default calculation algorithm for inference integration

class lib.sedna.algorithms.seen_task_learning.inference_integration.base_inference_integrate.**BaseInferen**

Base class for default calculation algorithm for inference integration

Parameters
models (*All models used for sample inference*) –

abstract __call__(*tasks: List[*lib.sedna.algorithms.seen_task_learning.artifact.Task*]*)

Parameters
tasks (*All tasks with sample result*) –

Returns
result

Return type
inference results for all the inference samples

lib.sedna.algorithms.seen_task_learning.inference_integration.inference_integrate

Integrate the inference results of all related tasks

Module Contents

Classes

DefaultInferenceIntegrate	Default calculation algorithm for inference integration

class lib.sedna.algorithms.seen_task_learning.inference_integration.inference_integrate.**DefaultInferenc**

Bases: *lib.sedna.algorithms.seen_task_learning.inference_integration.base_inference_integrate.BaseInferenceIntegrate*

Default calculation algorithm for inference integration

Parameters
models (*All models used for sample inference*) –

__call__(*tasks: List[*lib.sedna.algorithms.seen_task_learning.artifact.Task*]*)

Parameters
tasks (*All tasks with sample result*) –

Returns
result

Return type
minimum result

lib.sedna.algorithms.seen_task_learning.task_allocation

Submodules

lib.sedna.algorithms.seen_task_learning.task_allocation.base_task_allocation

Mining tasks of inference sample based on task attribute extractor

param samples infer sample
param see *sedna.datasources.BaseDataSource* for more detail.
returns
allocations

rtype
tasks that assigned to each sample

Module Contents

Classes

BaseTaskAllocation	Base class of task allocation algorithm

class lib.sedna.algorithms.seen_task_learning.task_allocation.base_task_allocation.**BaseTaskAllocation**(*ta*
*

Base class of task allocation algorithm

Parameters
task_extractor (*Model or dict*) – task extractor is used to predict target tasks

abstract __call__(*samples:* sedna.datasources.BaseDataSource)

lib.sedna.algorithms.seen_task_learning.task_allocation.task_allocation

Mining tasks of inference sample based on task attribute extractor

param samples infer sample
param see *sedna.datasources.BaseDataSource* for more detail.
returns
allocations

rtype
tasks that assigned to each sample

Module Contents

Classes

TaskAllocationBySVC	Corresponding to *TaskDefinitionBySVC*
TaskAllocationByDataAttr	Corresponding to *TaskDefinitionByDataAttr*
TaskAllocationDefault	Task allocation specifically for unstructured data

class lib.sedna.algorithms.seen_task_learning.task_allocation.task_allocation.**TaskAllocationBySVC**(*task_ex*
***kwa*

Corresponding to *TaskDefinitionBySVC*

Parameters
task_extractor (*Model*) – SVC Model used to predicting target tasks

__call__(*samples:* sedna.datasources.BaseDataSource)

class lib.sedna.algorithms.seen_task_learning.task_allocation.task_allocation.**TaskAllocationByDataAttr**(*

Corresponding to *TaskDefinitionByDataAttr*

Parameters

- **task_extractor** (*Dict*) – used to match target tasks

- **attr_filed** (*List[Metadata]*) – metadata is usually a class feature label with a finite values.

__call__(*samples:* sedna.datasources.BaseDataSource)

class lib.sedna.algorithms.seen_task_learning.task_allocation.task_allocation.**TaskAllocationDefault**(*task*
**k

Task allocation specifically for unstructured data

Parameters
task_extractor (*Dict*) – used to match target tasks

__call__(*samples:* sedna.datasources.BaseDataSource)

lib.sedna.algorithms.seen_task_learning.task_allocation.task_allocation_by_origin

Module Contents

Classes

TaskAllocationByOrigin	Corresponding to *TaskDefinitionByOrigin*

class lib.sedna.algorithms.seen_task_learning.task_allocation.task_allocation_by_origin.**TaskAllocationB**

Bases: *lib.sedna.algorithms.seen_task_learning.task_allocation.base_task_allocation.BaseTaskAllocation*

Corresponding to *TaskDefinitionByOrigin*

Parameters

- **task_extractor** (*Dict*) – used to predict target tasks for each inference samples
- **origins** (*List[Metadata]*) – metadata is usually a class feature label with a finite values.

__call__(*samples:* sedna.datasources.BaseDataSource)

lib.sedna.algorithms.seen_task_learning.task_allocation.task_allocation_stream

Module Contents

Classes

TaskAllocationStream	Corresponding to *TaskDefinitionByOrigin*

class lib.sedna.algorithms.seen_task_learning.task_allocation.task_allocation_stream.**TaskAllocationStrea**

Bases: *lib.sedna.algorithms.seen_task_learning.task_allocation.base_task_allocation.BaseTaskAllocation*

Corresponding to *TaskDefinitionByOrigin*

Parameters

- **task_extractor** (*Dict*) – used to predict target tasks for each inference sample
- **origins** (*List[Metadata]*) – metadata is usually a class feature label with a finite values.

__call__(*samples:* sedna.datasources.BaseDataSource)

lib.sedna.algorithms.seen_task_learning.task_definition

Submodules

lib.sedna.algorithms.seen_task_learning.task_definition.base_task_definition

Divide multiple tasks based on data

param samples Train data
param see *sedna.datasources.BaseDataSource* for more detail.
returns

- **tasks** (*All tasks based on training data.*)
- **task_extractor** (*Model or dict with a method to predict target tasks*)

Module Contents

Classes

BaseTaskDefinition	Dividing datasets with all sorts of methods

class lib.sedna.algorithms.seen_task_learning.task_definition.base_task_definition.**BaseTaskDefinition**(*

Dividing datasets with all sorts of methods

abstract __call__(*samples:* sedna.datasources.BaseDataSource) → Tuple[List[*lib.sedna.algorithms.seen_task_learning.artifact.Task*], Any, *sedna.datasources.BaseDataSource*]

lib.sedna.algorithms.seen_task_learning.task_definition.task_definition

Divide multiple tasks based on data

param samples Train data
param see *sedna.datasources.BaseDataSource* for more detail.
returns

- **tasks** (*All tasks based on training data.*)
- **task_extractor** (*Model with a method to predicting target tasks*)

Module Contents

Classes

TaskDefinitionBySVC	Dividing datasets with *AgglomerativeClustering* based on kernel distance,
TaskDefinitionByDataAttr	Dividing datasets based on the common attributes,

class lib.sedna.algorithms.seen_task_learning.task_definition.task_definition.**TaskDefinitionBySVC**(**kwa

Dividing datasets with *AgglomerativeClustering* based on kernel distance, Using SVC to fit the clustering result.

Parameters

None (*n_class int or*) – The number of clusters to find, default=2.

__call__(*samples:* sedna.datasources.BaseDataSource) →
Tuple[List[*lib.sedna.algorithms.seen_task_learning.artifact.Task*], Any,
sedna.datasources.BaseDataSource]

class lib.sedna.algorithms.seen_task_learning.task_definition.task_definition.**TaskDefinitionByDataAttr**(

Dividing datasets based on the common attributes, generally used for structured data.

Parameters

List[Metadata] (*attribute*) – metadata is usually a class feature label with a finite values.

__call__(*samples:* sedna.datasources.BaseDataSource, ***kwargs*) →
Tuple[List[*lib.sedna.algorithms.seen_task_learning.artifact.Task*], Any,
sedna.datasources.BaseDataSource]

lib.sedna.algorithms.seen_task_learning.task_definition.task_definition_by_origin

Module Contents

Classes

TaskDefinitionByOrigin	Dividing datasets based on the their origins.

class lib.sedna.algorithms.seen_task_learning.task_definition.task_definition_by_origin.**TaskDefinitionB**

Bases: *lib.sedna.algorithms.seen_task_learning.task_definition.base_task_definition.BaseTaskDefinition*

Dividing datasets based on the their origins.

Parameters

Tuple[Metadata] (*attr_filed*) – metadata is usually a class feature label with a finite values.

__call__(*samples:* sedna.datasources.BaseDataSource, ***kwargs*) →
Tuple[List[*lib.sedna.algorithms.seen_task_learning.artifact.Task*], Any,
sedna.datasources.BaseDataSource]

lib.sedna.algorithms.seen_task_learning.task_relation_discovery

Submodules

lib.sedna.algorithms.seen_task_learning.task_relation_discovery.base_task_relation_discovery

Discover relationships between all tasks

param tasks all tasks form *task_definition*
returns
task_groups

rtype
List of groups which including at least 1 task.

Module Contents

Classes

BaseTaskRelationDiscover	Assume that each task is independent of each other

class lib.sedna.algorithms.seen_task_learning.task_relation_discovery.base_task_relation_discovery.**Base**

Assume that each task is independent of each other

abstract **__call__**(*tasks: List[*lib.sedna.algorithms.seen_task_learning.artifact.Task*]*) → List[*lib.sedna.algorithms.seen_task_learning.artifact.TaskGroup*]

lib.sedna.algorithms.seen_task_learning.task_relation_discovery.task_relation_discovery

Discover relationships between all tasks

param tasks all tasks form *task_definition*
returns
task_groups

rtype
List of groups which including at least 1 task.

Module Contents

Classes

DefaultTaskRelationDiscover	Assume that each task is independent of each other

class lib.sedna.algorithms.seen_task_learning.task_relation_discovery.task_relation_discovery.**DefaultTa**

Bases: *lib.sedna.algorithms.seen_task_learning.task_relation_discovery.base_task_relation_discovery.BaseTaskRelationDiscover*

Assume that each task is independent of each other

__call__(*tasks: List[*lib.sedna.algorithms.seen_task_learning.artifact.Task*]*) → List[*lib.sedna.algorithms.seen_task_learning.artifact.TaskGroup*]

lib.sedna.algorithms.seen_task_learning.task_remodeling

Submodules

lib.sedna.algorithms.seen_task_learning.task_remodeling.base_task_remodeling

Remodeling tasks based on their relationships

param mappings all assigned tasks get from the *task_allocation*
param samples
type samples
input samples

returns
models

rtype
List of groups which including at least 1 task.

Module Contents

Classes

BaseTaskRemodeling	Assume that each task is independent of each other

class lib.sedna.algorithms.seen_task_learning.task_remodeling.base_task_remodeling.**BaseTaskRemodeling**(*m*
li
*

Assume that each task is independent of each other

abstract __call__(*samples:* sedna.datasources.BaseDataSource, *mappings: List*)
Grouping based on assigned tasks

lib.sedna.algorithms.seen_task_learning.task_remodeling.task_remodeling

Remodeling tasks based on their relationships

param mappings all assigned tasks get from the *task_mining*
param samples
type samples
input samples

returns
models

rtype
List of groups which including at least 1 task.

Module Contents

Classes

DefaultTaskRemodeling	Assume that each task is independent of each other

class lib.sedna.algorithms.seen_task_learning.task_remodeling.task_remodeling.**DefaultTaskRemodeling**(*mod*
list,
***kv*

Bases: *lib.sedna.algorithms.seen_task_learning.task_remodeling.base_task_remodeling.BaseTaskRemodeling*

Assume that each task is independent of each other

__call__(*samples:* sedna.datasources.BaseDataSource, *mappings: List*)

Grouping based on assigned tasks

lib.sedna.algorithms.seen_task_learning.task_update_decision

Submodules

lib.sedna.algorithms.seen_task_learning.task_update_decision.base_task_update_decision

Divide multiple tasks based on data

param samples Train data
param see *sedna.datasources.BaseDataSource* for more detail.
returns

- **tasks** (*All tasks based on training data.*)
- **task_extractor** (*Model or dict with a method to predict target tasks*)

Module Contents

Classes

BaseTaskUpdateDecision	Decide processing strategies for different tasks

class lib.sedna.algorithms.seen_task_learning.task_update_decision.base_task_update_decision.**BaseTaskUp**

Decide processing strategies for different tasks with labeled unseen samples. Turn unseen samples to be seen.

Parameters
task_index (*str or Dict*) –

abstract __call__(*samples:* sedna.datasources.BaseDataSource) → Tuple[List[*lib.sedna.algorithms.seen_task_learning.artifact.Task*], Dict]

lib.sedna.algorithms.seen_task_learning.task_update_decision.task_update_decision_finetune

Submodules

lib.sedna.algorithms.seen_task_learning.artifact

Module Contents

Classes

Task	
TaskGroup	
Model	

class lib.sedna.algorithms.seen_task_learning.artifact.**Task**(*entry*, *samples*, *meta_attr=None*)

class lib.sedna.algorithms.seen_task_learning.artifact.**TaskGroup**(*entry*, *tasks: List[*Task*]*)

class lib.sedna.algorithms.seen_task_learning.artifact.**Model**(*index: int*, *entry*, *model*, *result*)

lib.sedna.algorithms.seen_task_learning.seen_task_learning

Multiple task transfer learning algorithms

Module Contents

Classes

SeenTaskLearning	An auto machine learning framework for edge-cloud multitask learning

class lib.sedna.algorithms.seen_task_learning.seen_task_learning.**SeenTaskLearning**(*estimator=None*, *task_definition=None*, *task_relationship_discovery*, *seen_task_allocation=None*, *task_remodeling=None*, *inference_integrate=None*)

An auto machine learning framework for edge-cloud multitask learning

See also:

Train
Data + Estimator -> Task Definition -> Task Relationship Discovery -> Feature Engineering -> Training

Inference

Data -> Task Allocation -> Feature Engineering -> Task Remodeling -> Inference

Parameters

- **estimator** (*Instance*) – An instance with the high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your model.
- **task_definition** (*Dict*) – Divide multiple tasks based on data, see *task_jobs.task_definition* for more detail.
- **task_relationship_discovery** (*Dict*) – Discover relationships between all tasks, see *task_jobs.task_relationship_discovery* for more detail.
- **seen_task_allocation** (*Dict*) – Mining tasks of inference sample, see *task_jobs.task_mining* for more detail.
- **task_remodeling** (*Dict*) – Remodeling tasks based on their relationships, see *task_jobs.task_remodeling* for more detail.
- **inference_integrate** (*Dict*) – Integrate the inference results of all related tasks, see *task_jobs.inference_integrate* for more detail.

Examples

```
>>> from xgboost import XGBClassifier
>>> from sedna.algorithms.multi_task_learning import MulTaskLearning
>>> estimator = XGBClassifier(objective="binary:logistic")
>>> task_definition = {
        "method": "TaskDefinitionByDataAttr",
        "param": {"attribute": ["season", "city"]}
    }
>>> task_relationship_discovery = {
        "method": "DefaultTaskRelationDiscover", "param": {}
    }
>>> seen_task_allocation = {
        "method": "TaskAllocationByDataAttr",
        "param": {"attribute": ["season", "city"]}
    }
>>> task_remodeling = None
>>> inference_integrate = {
        "method": "DefaultInferenceIntegrate", "param": {}
    }
>>> mul_task_instance = MulTaskLearning(
        estimator=estimator,
        task_definition=task_definition,
        task_relationship_discovery=task_relationship_discovery,
        seen_task_allocation=seen_task_allocation,
        task_remodeling=task_remodeling,
        inference_integrate=inference_integrate
    )
```

Notes

All method defined under *task_jobs* and registered in *ClassFactory*.

train(*train_data:* sedna.datasources.BaseDataSource, *valid_data:* sedna.datasources.BaseDataSource = *None*, *post_process=None*, ***kwargs*)

fit for update the knowledge based on training data.

Parameters

- **train_data** (BaseDataSource) – Train data, see *sedna.datasources.BaseDataSource* for more detail.
- **valid_data** (BaseDataSource) – Valid data, BaseDataSource or None.
- **post_process** (*function*) – function or a registered method, callback after *estimator* train.
- **kwargs** (*Dict*) – parameters for *estimator* training, Like: *early_stopping_rounds* in Xgboost.XGBClassifier

Returns

- **feedback** (*Dict*) – contain all training result in each tasks.
- **task_index_url** (*str*) – task extractor model path, used for task allocation.

update(*tasks*, *task_update_strategies*, ***kwargs*)

Parameters:

tasks: List[Task]
from the output of module task_update_decision

task_update_strategies: object
from the output of module task_update_decision

returns
task_index – updated seen task index of knowledge base

rtype
Dict

load(*task_index*)

load task_detail (tasks/models etc . . .) from task index file. It'll automatically loaded during *inference* and *evaluation* phases.

Parameters
task_index (*str or Dict*) – task index file path, default self.task_index_url.

predict(*data:* sedna.datasources.BaseDataSource, *post_process=None*, ***kwargs*)

predict the result for input data based on training knowledge.

Parameters

- **data** (BaseDataSource) – inference sample, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function*) – function or a registered method, effected after *estimator* prediction, like: label transform.

- **kwargs** (*Dict*) – parameters for *estimator* predict, Like: *ntree_limit* in Xgboost.XGBClassifier

Returns

- **result** (*array_like*) – results array, contain all inference results in each sample.
- **tasks** (*List*) – tasks assigned to each sample.

evaluate(*data:* sedna.datasources.BaseDataSource, *metrics=None*, *metrics_param=None*, ***kwargs*)

evaluated the performance of each task from training, filter tasks based on the defined rules.

Parameters

- **data** (BaseDataSource) – valid data, see *sedna.datasources.BaseDataSource* for more detail.
- **metrics** (*function / str*) – Metrics to assess performance on the task by given prediction.
- **metrics_param** (*Dict*) – parameter for metrics function.
- **kwargs** (*Dict*) – parameters for *estimator* evaluate, Like: *ntree_limit* in Xgboost.XGBClassifier

Returns

- **task_eval_res** (*Dict*) – all metric results.
- **tasks_detail** (*List[Object]*) – all metric results in each task.

Package Contents

Classes

SeenTaskLearning	An auto machine learning framework for edge-cloud multitask learning

class lib.sedna.algorithms.seen_task_learning.**SeenTaskLearning**(*estimator=None*, *task_definition=None*, *task_relationship_discovery=None*, *seen_task_allocation=None*, *task_remodeling=None*, *inference_integrate=None*)

An auto machine learning framework for edge-cloud multitask learning

See also:

Train
Data + Estimator -> Task Definition -> Task Relationship Discovery -> Feature Engineering -> Training

Inference
Data -> Task Allocation -> Feature Engineering -> Task Remodeling -> Inference

Parameters

- **estimator** (*Instance*) – An instance with the high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your model.

- **task_definition** (*Dict*) – Divide multiple tasks based on data, see *task_jobs.task_definition* for more detail.
- **task_relationship_discovery** (*Dict*) – Discover relationships between all tasks, see *task_jobs.task_relationship_discovery* for more detail.
- **seen_task_allocation** (*Dict*) – Mining tasks of inference sample, see *task_jobs.task_mining* for more detail.
- **task_remodeling** (*Dict*) – Remodeling tasks based on their relationships, see *task_jobs.task_remodeling* for more detail.
- **inference_integrate** (*Dict*) – Integrate the inference results of all related tasks, see *task_jobs.inference_integrate* for more detail.

Examples

```
>>> from xgboost import XGBClassifier
>>> from sedna.algorithms.multi_task_learning import MulTaskLearning
>>> estimator = XGBClassifier(objective="binary:logistic")
>>> task_definition = {
        "method": "TaskDefinitionByDataAttr",
        "param": {"attribute": ["season", "city"]}
    }
>>> task_relationship_discovery = {
        "method": "DefaultTaskRelationDiscover", "param": {}
    }
>>> seen_task_allocation = {
        "method": "TaskAllocationByDataAttr",
        "param": {"attribute": ["season", "city"]}
    }
>>> task_remodeling = None
>>> inference_integrate = {
        "method": "DefaultInferenceIntegrate", "param": {}
    }
>>> mul_task_instance = MulTaskLearning(
        estimator=estimator,
        task_definition=task_definition,
        task_relationship_discovery=task_relationship_discovery,
        seen_task_allocation=seen_task_allocation,
        task_remodeling=task_remodeling,
        inference_integrate=inference_integrate
    )
```

Notes

All method defined under *task_jobs* and registered in *ClassFactory*.

train(*train_data:* sedna.datasources.BaseDataSource, *valid_data:* sedna.datasources.BaseDataSource = *None*, *post_process=None*, ***kwargs*)

fit for update the knowledge based on training data.

Parameters

- **train_data** (BaseDataSource) – Train data, see *sedna.datasources.BaseDataSource* for more detail.
- **valid_data** (BaseDataSource) – Valid data, BaseDataSource or None.
- **post_process** (*function*) – function or a registered method, callback after *estimator* train.
- **kwargs** (*Dict*) – parameters for *estimator* training, Like: *early_stopping_rounds* in Xgboost.XGBClassifier

Returns

- **feedback** (*Dict*) – contain all training result in each tasks.
- **task_index_url** (*str*) – task extractor model path, used for task allocation.

update(*tasks*, *task_update_strategies*, ***kwargs*)

Parameters:

tasks: List[Task]
from the output of module task_update_decision

task_update_strategies: object
from the output of module task_update_decision

returns
task_index – updated seen task index of knowledge base

rtype
Dict

load(*task_index*)

load task_detail (tasks/models etc . . .) from task index file. It'll automatically loaded during *inference* and *evaluation* phases.

Parameters
task_index (*str or Dict*) – task index file path, default self.task_index_url.

predict(*data:* sedna.datasources.BaseDataSource, *post_process=None*, ***kwargs*)

predict the result for input data based on training knowledge.

Parameters

- **data** (BaseDataSource) – inference sample, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function*) – function or a registered method, effected after *estimator* prediction, like: label transform.
- **kwargs** (*Dict*) – parameters for *estimator* predict, Like: *ntree_limit* in Xgboost.XGBClassifier

Returns

- **result** (*array_like*) – results array, contain all inference results in each sample.
- **tasks** (*List*) – tasks assigned to each sample.

evaluate(*data:* sedna.datasources.BaseDataSource, *metrics=None*, *metrics_param=None*, ***kwargs*)

evaluated the performance of each task from training, filter tasks based on the defined rules.

Parameters

- **data** (BaseDataSource) – valid data, see *sedna.datasources.BaseDataSource* for more detail.
- **metrics** (*function / str*) – Metrics to assess performance on the task by given prediction.
- **metrics_param** (*Dict*) – parameter for metrics function.
- **kwargs** (*Dict*) – parameters for *estimator* evaluate, Like: *ntree_limit* in Xgboost.XGBClassifier

Returns

- **task_eval_res** (*Dict*) – all metric results.
- **tasks_detail** (*List[Object]*) – all metric results in each task.

lib.sedna.algorithms.transmitter

Submodules

lib.sedna.algorithms.transmitter.transmitter

Module Contents

Classes

AbstractTransmitter	Abstract class of Transmitter, which provides base transmission
WSTransmitter	An implementation of Transmitter based on WebSocket.
S3Transmitter	An implementation of Transmitter based on S3 protocol.

class lib.sedna.algorithms.transmitter.transmitter.**AbstractTransmitter**

Bases: abc.ABC

Abstract class of Transmitter, which provides base transmission interfaces between edge and cloud.

abstract recv()

abstract send(*data*)

class lib.sedna.algorithms.transmitter.transmitter.**WSTransmitter**

Bases: *AbstractTransmitter*, abc.ABC

An implementation of Transmitter based on WebSocket.

recv()

send(*data*)

class lib.sedna.algorithms.transmitter.transmitter.**S3Transmitter**(*s3_endpoint_url*, *access_key*, *secret_key*, *transmitter_url*)

Bases: *AbstractTransmitter*, abc.ABC

An implementation of Transmitter based on S3 protocol.

recv()

send(*data*)

Package Contents

Classes

S3Transmitter	An implementation of Transmitter based on S3 protocol.
WSTransmitter	An implementation of Transmitter based on WebSocket.

class lib.sedna.algorithms.transmitter.**S3Transmitter**(*s3_endpoint_url*, *access_key*, *secret_key*, *transmitter_url*)

Bases: AbstractTransmitter, abc.ABC

An implementation of Transmitter based on S3 protocol.

recv()

send(*data*)

class lib.sedna.algorithms.transmitter.**WSTransmitter**

Bases: AbstractTransmitter, abc.ABC

An implementation of Transmitter based on WebSocket.

recv()

send(*data*)

lib.sedna.algorithms.unseen_task_detect

Submodules

lib.sedna.algorithms.unseen_task_detect.unseen_task_detect

Unseen task detection algorithms for Lifelong Learning

Module Contents

Classes

ModelProbeFilter	Judgment based on the confidence of the prediction result,
TaskAttrFilter	Judgment based on whether the metadata of the sample has been found in KB

class lib.sedna.algorithms.unseen_task_detect.unseen_task_detect.**ModelProbeFilter**

Bases: BaseFilter, abc.ABC

Judgment based on the confidence of the prediction result, typically used for classification problems

__call__(*tasks: List[*sedna.algorithms.multi_task_learning.task_jobs.artifact.Task*] = None*, *threshold=0.5*, ***kwargs*)

Parameters

- **tasks** (*inference task*) –
- **threshold** (*float*) – threshold considered credible

Returns
is unseen task – *True* means unseen task, *False* means not.

Return type
bool

class lib.sedna.algorithms.unseen_task_detect.unseen_task_detect.**TaskAttrFilter**

Bases: BaseFilter, abc.ABC

Judgment based on whether the metadata of the sample has been found in KB

__call__(*tasks: List[*sedna.algorithms.multi_task_learning.task_jobs.artifact.Task*] = None*, ***kwargs*)

Parameters
tasks (*inference task*) –

Returns
is unseen task – *True* means unseen task, *False* means not.

Return type
bool

Package Contents

Classes

ModelProbeFilter	Judgment based on the confidence of the prediction result,
TaskAttrFilter	Judgment based on whether the metadata of the sample has been found in KB

class lib.sedna.algorithms.unseen_task_detect.**ModelProbeFilter**

Bases: BaseFilter, abc.ABC

Judgment based on the confidence of the prediction result, typically used for classification problems

__call__(*tasks: List[*sedna.algorithms.multi_task_learning.task_jobs.artifact.Task*] = None*, *threshold=0.5*, ***kwargs*)

Parameters

- **tasks** (*inference task*) –
- **threshold** (*float*) – threshold considered credible

Returns
is unseen task – *True* means unseen task, *False* means not.

Return type
bool

class lib.sedna.algorithms.unseen_task_detect.**TaskAttrFilter**

Bases: BaseFilter, abc.ABC

Judgment based on whether the metadata of the sample has been found in KB

__call__(*tasks: List[*sedna.algorithms.multi_task_learning.task_jobs.artifact.Task*] = None*, ***kwargs*)

Parameters
tasks (*inference task*) –

Returns
is unseen task – *True* means unseen task, *False* means not.

Return type
bool

lib.sedna.algorithms.unseen_task_detection

Subpackages

lib.sedna.algorithms.unseen_task_detection.unseen_sample_re_recognition

Submodules

lib.sedna.algorithms.unseen_task_detection.unseen_sample_re_recognition.base_unseen_sample_re_recognition

Divide labeled unseen samples into seen tasks and unseen tasks.

param task_index
knowledge base index which includes indexes of tasks, samples, models, etc.

type task_index
str or Dict

returns

- **seen_task_samples** (seen samples, see *sedna.datasources.BaseDataSource*)
- *for more detail*

- **unseen_task_samples** (unseen samples, see *sedna.datasources.BaseDataSource*)
- *for more detail*

Module Contents

Classes

BaseSampleReRegonition	Divide labeled unseen samples into seen tasks and unseen tasks.

class lib.sedna.algorithms.unseen_task_detection.unseen_sample_re_recognition.base_unseen_sample_re_rec

Divide labeled unseen samples into seen tasks and unseen tasks.

Parameters
task_index (*str or Dict*) – knowledge base index which includes indexes of tasks, samples, models, etc.

abstract __call__(*samples:* sedna.datasources.BaseDataSource)

Parameters
samples (*training samples*) –

Returns

- **seen_task_samples** (*BaseDataSource*)
- **unseen_task_samples** (*BaseDataSource*)

lib.sedna.algorithms.unseen_task_detection.unseen_sample_re_recognition.unseen_sample_re_recognition

Module Contents

Classes

SampleReRegonitionDefault	Divide labeled unseen samples into seen tasks and unseen tasks.

class lib.sedna.algorithms.unseen_task_detection.unseen_sample_re_recognition.unseen_sample_re_recogni

Bases: *lib.sedna.algorithms.unseen_task_detection.unseen_sample_re_recognition.base_unseen_sample_re_recognition.BaseSampleReRegonition*

Divide labeled unseen samples into seen tasks and unseen tasks.

Parameters
task_index (*str or Dict*) – knowledge base index which includes indexes of tasks, samples, models, etc.

__call__(*samples:* sedna.datasources.BaseDataSource)

Parameters
samples (*training samples*) –

Returns

- **seen_task_samples** (*BaseDataSource*)
- **unseen_task_samples** (*BaseDataSource*)

lib.sedna.algorithms.unseen_task_detection.unseen_sample_recognition

Submodules

lib.sedna.algorithms.unseen_task_detection.unseen_sample_recognition.base_unseen_sample_recognition

Divide inference samples into seen samples and unseen samples

param task_index
knowledge base index which includes indexes of tasks, samples and etc.

type task_index
str or dict

returns

- **seen_task_samples** (seen samples, see *sedna.datasources.BaseDataSource*)
- *for more detail*
- **unseen_task_samples** (unseen samples, see *sedna.datasources.BaseDataSource*)
- *for more detail*

Module Contents

Classes

BaseSampleRegonition	Divide inference samples into seen samples and unseen samples

class lib.sedna.algorithms.unseen_task_detection.unseen_sample_recognition.base_unseen_sample_recognitio

Divide inference samples into seen samples and unseen samples

Parameters
task_index (*str or dict*) – knowledge base index which includes indexes of tasks, samples and etc.

abstract __call__(*samples:* sedna.datasources.BaseDataSource) → Tuple[*sedna.datasources.BaseDataSource*, *sedna.datasources.BaseDataSource*]

Parameters
samples (BaseDataSource) – inference samples

Returns

- **seen_task_samples** (*BaseDataSource*)
- **unseen_task_samples** (*BaseDataSource*)

lib.sedna.algorithms.unseen_task_detection.unseen_sample_recognition.unseen_sample_detection

Module Contents

Classes

UnseenSampleDetection	Divide inference samples into seen samples and unseen samples

class lib.sedna.algorithms.unseen_task_detection.unseen_sample_recognition.unseen_sample_detection.**Unse**

Bases: threading.Thread

Divide inference samples into seen samples and unseen samples

Parameters

task_index (*str or dict*) – knowledge base index which includes indexes of tasks, samples and etc.

run()

Method representing the thread's activity.

You may override this method in a subclass. The standard run() method invokes the callable object passed to the object's constructor as the target argument, if any, with sequential and keyword arguments taken from the args and kwargs arguments, respectively.

get_index(*samples*, *timestamp*)

get_environ_varia()

lib.sedna.algorithms.unseen_task_detection.unseen_sample_recognition.unseen_sample_recognition

Module Contents

Classes

SampleRegonitionDefault	Divide inference samples into seen samples and unseen samples

class lib.sedna.algorithms.unseen_task_detection.unseen_sample_recognition.unseen_sample_recognition.**Sa**

Bases: *lib.sedna.algorithms.unseen_task_detection.unseen_sample_recognition.base_unseen_sample_recognition.BaseSampleRegonition*

Divide inference samples into seen samples and unseen samples

Parameters
task_index (*str or dict*) – knowledge base index which includes indexes of tasks, samples and etc.

__call__(*samples:* sedna.datasources.BaseDataSource) → Tuple[*sedna.datasources.BaseDataSource*, *sedna.datasources.BaseDataSource*]

Parameters
samples (BaseDataSource) – inference samples

Returns

- **seen_task_samples** (*BaseDataSource*)
- **unseen_task_samples** (*BaseDataSource*)

lib.sedna.algorithms.unseen_task_processing

Subpackages

lib.sedna.algorithms.unseen_task_processing.unseen_task_allocation

Submodules

lib.sedna.algorithms.unseen_task_processing.unseen_task_allocation.base_unseen_task_allocation

Mining tasks of inference unseen sample base on unseen task attribute extractor

param samples infer unseen sample

:param : :param see *sedna.datasources.BaseDataSource* for more detail.:

returns
allocations

rtype
tasks that assigned to each sample

Module Contents

Classes

BaseUnseenTaskAllocation	Task allocation for unseen data

class lib.sedna.algorithms.unseen_task_processing.unseen_task_allocation.base_unseen_task_allocation.**Ba**

Task allocation for unseen data

Parameters
task_extractor (*Dict*) – used to match target tasks

abstract __call__(*samples:* sedna.datasources.BaseDataSource)

Parameters
samples (*samples to be allocated*) –

Returns

- **samples** (*BaseDataSource*) – grouped samples based on allocations
- **allocations** (*List*) – allocation decision for actual inference

lib.sedna.algorithms.unseen_task_processing.unseen_task_allocation.unseen_task_allocation

Module Contents

Classes

UnseenTaskAllocationDefault	Task allocation for unseen data

class lib.sedna.algorithms.unseen_task_processing.unseen_task_allocation.unseen_task_allocation.**UnseenTa**

Bases: *lib.sedna.algorithms.unseen_task_processing.unseen_task_allocation.base_unseen_task_allocation.BaseUnseenTaskAllocation*

Task allocation for unseen data

Parameters
task_extractor (*Dict*) – used to match target tasks

__call__(*samples:* sedna.datasources.BaseDataSource)

Parameters
samples (*samples to be allocated*) –

Returns

- **samples** (*BaseDataSource*)
- **allocations** (*List*) – allocation decision for actual inference

Submodules

lib.sedna.algorithms.unseen_task_processing.unseen_task_processing

Module Contents

Classes

UnseenTaskProcessing	Process unseen tasks given task update strategies

class lib.sedna.algorithms.unseen_task_processing.unseen_task_processing.**UnseenTaskProcessing**(*estimator*, *unseen_task_a* ***kwargs*)

Process unseen tasks given task update strategies

Parameters:

estimator: Instance
An instance with the high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your model.

cloud_knowledge_management: Instance of class CloudKnowledgeManagement unseen_task_allocation: Dict

Mining tasks of unseen inference sample.

`train`()

Intialize unseen task groups

Returns: res: Dict

evaluation result.

task_index: Dict or str
unseen task index which includes models, samples, extractor and etc.

`update`(*tasks*, *task_update_strategies*, ***kwargs*)

Parameters:

tasks: List[Task]
from the output of module task_update_decision

task_update_strategies: Dict
from the output of module task_update_decision

returns
task_index – updated unseen task index of knowledge base

rtype
Dict

`predict`(*data*, *post_process=None*, ***kwargs*)

Predict the result for unseen data.

Parameters

- **data** (BaseDataSource) – inference sample, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function*) – function or a registered method, effected after *estimator* prediction, like: label transform.

Returns

- **result** (*array_like*) – results array, contain all inference results in each sample.

- **tasks** (*List*) – tasks assigned to each sample.

load(*task_index*)

load task_detail (tasks/models etc ...) from task index file. It'll automatically loaded during *inference* phases.

Parameters
task_index_url (*str*) – task index file path.

Package Contents

Classes

UnseenTaskProcessing	Process unseen tasks given task update strategies

class lib.sedna.algorithms.unseen_task_processing.**UnseenTaskProcessing**(*estimator*, *unseen_task_allocation=None*, ***kwargs*)

Process unseen tasks given task update strategies

Parameters:

estimator: Instance
An instance with the high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your model.

cloud_knowledge_management: Instance of class CloudKnowledgeManagement unseen_task_allocation: Dict

Mining tasks of unseen inference sample.

train()

Intialize unseen task groups

Returns: res: Dict

evaluation result.

task_index: Dict or str
unseen task index which includes models, samples, extractor and etc.

update(*tasks*, *task_update_strategies*, ***kwargs*)

Parameters:

tasks: List[Task]
from the output of module task_update_decision

task_update_strategies: Dict
from the output of module task_update_decision

returns
task_index – updated unseen task index of knowledge base

rtype
Dict

predict(*data*, *post_process=None*, ***kwargs*)

Predict the result for unseen data.

Parameters

- **data** (BaseDataSource) – inference sample, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function*) – function or a registered method, effected after *estimator* prediction, like: label transform.

Returns

- **result** (*array_like*) – results array, contain all inference results in each sample.
- **tasks** (*List*) – tasks assigned to each sample.

load(*task_index*)

load task_detail (tasks/models etc ...) from task index file. It'll automatically loaded during *inference* phases.

Parameters
task_index_url (*str*) – task index file path.

19.1.2 lib.sedna.backend

Framework Backend class.

Subpackages

lib.sedna.backend.mindspore

Package Contents

Classes

MSBackend	ML Framework Backend base Class

class lib.sedna.backend.mindspore.**MSBackend**(*estimator*, *fine_tune=True*, ***kwargs*)

Bases: sedna.backend.base.BackendBase

ML Framework Backend base Class

train(*train_data*, *valid_data=None*, ***kwargs*)

Train model.

predict(*data*, ***kwargs*)

Inference model.

evaluate(*data*, ***kwargs*)

evaluate model.

finetune()
todo: no support yet

load_weights()

get_weights()
todo: no support yet

set_weights(*weights*)
todo: no support yet

lib.sedna.backend.tensorflow

Package Contents

Classes

TFBackend	Tensorflow Framework Backend base Class
KerasBackend	Keras Framework Backend base Class

Attributes

ConfigProto

lib.sedna.backend.tensorflow.**ConfigProto**

class lib.sedna.backend.tensorflow.**TFBackend**(*estimator*, *fine_tune=True*, ***kwargs*)
Bases: sedna.backend.base.BackendBase

Tensorflow Framework Backend base Class

train(*train_data*, *valid_data=None*, ***kwargs*)
Train model.

predict(*data*, ***kwargs*)
Inference model.

evaluate(*data*, ***kwargs*)
evaluate model.

finetune()
todo: no support yet

load_weights()

get_weights()
todo: no support yet

set_weights(*weights*)
todo: no support yet

model_info(*model*, *relpath=None*, *result=None*)

class lib.sedna.backend.tensorflow.**KerasBackend**(*estimator*, *fine_tune=True*, ***kwargs*)

Bases: *TFBackend*

Keras Framework Backend base Class

set_session()

finetune()

todo: no support yet

get_weights()

todo: no support yet

set_weights(*weights*)

todo: no support yet

lib.sedna.backend.torch

Package Contents

Classes

TorchBackend	ML Framework Backend base Class

class lib.sedna.backend.torch.**TorchBackend**(*estimator*, *fine_tune=True*, ***kwargs*)

Bases: sedna.backend.base.BackendBase

ML Framework Backend base Class

evaluate(***kwargs*)

evaluate model.

train(***kwargs*)

Not implemented!

predict(*data*, ***kwargs*)

Inference model.

load(*model_url=''*, *model_name=None*, ***kwargs*)

Submodules

lib.sedna.backend.base

Module Contents

Classes

BackendBase	ML Framework Backend base Class

class lib.sedna.backend.base.**BackendBase**(*estimator*, *fine_tune=True*, ***kwargs*)

ML Framework Backend base Class

property model_name

static parse_kwargs(*func*, ***kwargs*)

train(**args*, ***kwargs*)

Train model.

update(**args*, ***kwargs*)

Update model.

predict(**args*, ***kwargs*)

Inference model.

predict_proba(**args*, ***kwargs*)

Compute probabilities of possible outcomes for samples in X.

evaluate(**args*, ***kwargs*)

evaluate model.

save(*model_url=''*, *model_name=None*)

model_info(*model*, *relpath=None*, *result=None*)

load(*model_url=''*, *model_name=None*, ***kwargs*)

abstract set_weights(*weights*)

Set weight with memory tensor.

abstract get_weights()

Get the weights.

Package Contents

Functions

set_backend([estimator, config])	Create Trainer class

lib.sedna.backend.**set_backend**(*estimator=None*, *config=None*)

Create Trainer class

19.1.3 lib.sedna.common

Submodules

lib.sedna.common.class_factory

Management class registration and bind configuration properties, provides the type of class supported.

Module Contents

Classes

ClassType	Const class saved defined class type.
ClassFactory	A Factory Class to manage all class need to register with config.

class lib.sedna.common.class_factory.**ClassType**

Const class saved defined class type.

GENERAL = 'general'

HEM = 'hard_example_mining'

FL_AGG = 'aggregation'

MTL = 'multi_task_learening'

UTD = 'unseen_task_detect'

OF = 'optical_flow'

ALGORITHM = 'algorithm'

DATASET = 'data_process'

CALLBACK = 'post_process_callback'

UTP = 'unseen_task_processing'

KM = 'knowledge_management'

STP = 'seen_task_processing'

class lib.sedna.common.class_factory.**ClassFactory**

Bases: object

A Factory Class to manage all class need to register with config.

__registry__

classmethod register(*type_name=ClassType.GENERAL*, *alias=None*)

Register class into registry.

Parameters

- **type_name** – type_name: type name of class registry
- **alias** – alias of class name

Returns

wrapper

classmethod register_cls(*t_cls*, *type_name=ClassType.GENERAL*, *alias=None*)

Register class with type name.

Parameters

- **t_cls** – class need to register.

- **type_name** – type name.
- **alias** – class name.

Returns

classmethod register_from_package(*package*, *type_name=ClassType.GENERAL*)

Register all public class from package.

Parameters

- **package** – package need to register.
- **type_name** – type name.

Returns

classmethod is_exists(*type_name*, *cls_name=None*)

Determine whether class name is in the current type group.

Parameters

- **type_name** – type name of class registry
- **cls_name** – class name

Returns
True/False

classmethod get_cls(*type_name*, *t_cls_name=None*)

Get class and bind config to class.

Parameters

- **type_name** – type name of class registry
- **t_cls_name** – class name

Returns
t_cls

lib.sedna.common.config

Module Contents

Classes

BaseConfig	The base config
Context	The Context provides the capability of obtaining the context

class lib.sedna.common.config.**BaseConfig**

Bases: ConfigSerializable

The base config

device_category

backend_type

lc_server

original_dataset_url

train_dataset_url

test_dataset_url

data_path_prefix

namespace

worker_name

service_name

job_name

pretrained_model_url

model_url

model_name

log_level

transmitter

agg_data_path

s3_endpoint_url

access_key_id

secret_access_key

parameters

class lib.sedna.common.config.**Context**

The Context provides the capability of obtaining the context

parameters

classmethod get_parameters(*param*, *default=None*)

get the value of the key *param* in *PARAMETERS*, if not exist, the default value is returned

classmethod get_algorithm_from_api(*algorithm*, ***param*) → dict

get the algorithm and parameter from api

lib.sedna.common.constant

Module Contents

Classes

K8sResourceKind	Sedna job/service kind
K8sResourceKindStatus	Job/Service status
KBResourceConstant	Knowledge used constant

class lib.sedna.common.constant.K8sResourceKind

Bases: enum.Enum

Sedna job/service kind

DEFAULT = 'default'

REID_JOB = 'reidjob'

VIDEO_ANALYTICS_JOB = 'videoanalyticsjob'

FEATURE_EXTRACTION_SERVICE = 'featureextractionservice'

JOINT_INFERENCE_SERVICE = 'jointinferenceservice'

FEDERATED_LEARNING_JOB = 'federatedlearningjob'

INCREMENTAL_JOB = 'incrementallearningjob'

LIFELONG_JOB = 'lifelonglearningjob'

class lib.sedna.common.constant.K8sResourceKindStatus

Bases: enum.Enum

Job/Service status

COMPLETED = 'completed'

FAILED = 'failed'

RUNNING = 'running'

class lib.sedna.common.constant.KBResourceConstant

Bases: enum.Enum

Knowledge used constant

MIN_TRAIN_SAMPLE = 10

KB_INDEX_NAME = 'index.pkl'

TASK_EXTRACTOR_NAME = 'task_attr_extractor.pkl'

SEEN_TASK = 'seen_task'

UNSEEN_TASK = 'unseen_task'

TASK_GROUPS = 'task_groups'

EXTRACTOR = 'extractor'

EDGE_KB_DIR = '/var/lib/sedna/kb'

lib.sedna.common.file_ops

FileOps class.

Module Contents

Classes

FileOps	This is a class with some class methods

class lib.sedna.common.file_ops.**FileOps**

This is a class with some class methods to handle some files or folder.

classmethod make_dir(**args*)

Make new a local directory.

Parameters
args (*) – list of str path to joined as a new directory to make.

classmethod get_file_hash(*filepath*)

classmethod clean_folder(*target*, *clean=True*)

clean the target directories. create path if *target* not exists, initial path if *clean* be True

Parameters

- **target** (*list*) – list of str path need to clean.
- **clean** (*bool*) – clear target if exists.

classmethod delete(*path*)

classmethod make_base_dir(**args*)

Make new a base directory.

Parameters
args (*) – list of str path to joined as a

new base directory to make.

classmethod join_path(**args*)

Join list of path and return.

Parameters
args (*) – list of str path to be joined.

Returns
joined path str.

Return type
str

classmethod remove_path_prefix(*org_str: str*, *prefix: str*)

remove the prefix, for converting path in container to path in host.

classmethod dump_pickle(*obj*, *filename*)

Dump a object to a file using pickle.

Parameters

- **obj** (*object*) – target object.
- **filename** (*str*) – target pickle file path.

classmethod load_pickle(*filename*)

Load a pickle file and return the object.

Parameters
filename (*str*) – target pickle file path.

Returns
return the loaded original object.

Return type
object or None.

classmethod copy_folder(*src*, *dst*)

Copy a folder from source to destination.

Parameters

- **src** (*str*) – source path.
- **dst** (*str*) – destination path.

classmethod copy_file(*src*, *dst*)

Copy a file from source to destination.

Parameters

- **src** (*str*) – source path.
- **dst** (*str*) – destination path.

classmethod dump(*obj*, *dst=None*) → str

classmethod load(*src: str*)

classmethod is_remote(*src*)

classmethod download(*src*, *dst=None*, *unzip=False*) → str

classmethod upload(*src*, *dst*, *tar=False*, *clean=True*) → str

classmethod is_local(*src*)

classmethod gcs_download(*src*, *dst*)

todo: not support now

classmethod gcs_upload(*src*, *dst*)

todo: not support now

classmethod s3_download(*src*, *dst*)

classmethod s3_upload(*src*, *dst*)

classmethod http_download(*src*, *dst*)

Download data from http or https web site.

Parameters

- **src** (*str*) – the data path
- **dst** (*str*) – the data path

Raises

FileNotFoundError – if the file path is not exist, an error will raise

classmethod exists(*folder*)

Is folder existed or not.

Parameters

folder (*str*) – folder

Returns

folder existed or not.

Return type

bool

classmethod obj_to_pickle_string(*x*)

classmethod pickle_string_to_obj(*s*)

lib.sedna.common.log

Base logger

Module Contents

Classes

Logger	Deafult logger in sedna

Attributes

LOG_LEVEL
LOGGER

lib.sedna.common.log.**LOG_LEVEL**

class lib.sedna.common.log.**Logger**(*name: str = BaseConfig.job_name*)

Deafult logger in sedna :param name: Logger name, default is 'sedna' :type name: str

lib.sedna.common.log.**LOGGER**

lib.sedna.common.utils

This script contains some common tools.

Module Contents

Functions

get_host_ip()	Get local ip address.
singleton(cls)	Set class to singleton class.

lib.sedna.common.utils.**get_host_ip**()

Get local ip address.

lib.sedna.common.utils.**singleton**(*cls*)

Set class to singleton class.

Parameters
cls – class

Returns
instance

19.1.4 lib.sedna.core

Subpackages

lib.sedna.core.federated_learning

Submodules

lib.sedna.core.federated_learning.federated_learning

Module Contents

Classes

FederatedLearning	Federated learning enables multiple actors to build a common, robust
FederatedLearningV2	

class lib.sedna.core.federated_learning.federated_learning.**FederatedLearning**(*estimator*, *aggregation='FedAvg'*)

Bases: sedna.core.base.JobBase

Federated learning enables multiple actors to build a common, robust machine learning model without sharing data, thus allowing to address critical issues such as data privacy, data security, data access rights and access to heterogeneous data.

Sedna provide the related interfaces for application development.

Parameters

- **estimator** (*Instance*) – An instance with the high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your model.
- **aggregation** (*str*) – aggregation algo which has registered to ClassFactory, see *sedna.algorithms.aggregation* for more detail.

Examples

```
>>> Estimator = keras.models.Sequential()
>>> fl_model = FederatedLearning(
        estimator=Estimator,
        aggregation="FedAvg"
    )
```

register(*timeout=300*)

Deprecated, Client proactively subscribes to the aggregation service.

Parameters

timeout (*int, connect timeout. Default: 300*) –

train(*train_data*, *valid_data=None*, *post_process=None*, ***kwargs*)

Training task for FederatedLearning

Parameters

- **train_data** (BaseDataSource) – datasource use for train, see *sedna.datasources.BaseDataSource* for more detail.
- **valid_data** (BaseDataSource) – datasource use for evaluation, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function or a registered method*) – effected after *estimator* training.
- **kwargs** (*Dict*) – parameters for *estimator* training, Like: *early_stopping_rounds* in Xgboost.XGBClassifier

class lib.sedna.core.federated_learning.federated_learning.**FederatedLearningV2**(*data=None*, *estimator=None*, *aggregation=None*, *transmitter=None*)

classmethod get_transmitter_from_config()

train()

Package Contents

Classes

FederatedLearning	Federated learning enables multiple actors to build a common, robust
FederatedLearningV2	

class lib.sedna.core.federated_learning.**FederatedLearning**(*estimator*, *aggregation='FedAvg'*)

Bases: sedna.core.base.JobBase

Federated learning enables multiple actors to build a common, robust machine learning model without sharing data, thus allowing to address critical issues such as data privacy, data security, data access rights and access to heterogeneous data.

Sedna provide the related interfaces for application development.

Parameters

- **estimator** (*Instance*) – An instance with the high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your model.
- **aggregation** (*str*) – aggregation algo which has registered to ClassFactory, see *sedna.algorithms.aggregation* for more detail.

Examples

```
>>> Estimator = keras.models.Sequential()
>>> fl_model = FederatedLearning(
        estimator=Estimator,
        aggregation="FedAvg"
    )
```

register(*timeout=300*)

Deprecated, Client proactively subscribes to the aggregation service.

Parameters

timeout (*int, connect timeout. Default: 300*) –

train(*train_data*, *valid_data=None*, *post_process=None*, ***kwargs*)

Training task for FederatedLearning

Parameters

- **train_data** (BaseDataSource) – datasource use for train, see *sedna.datasources.BaseDataSource* for more detail.
- **valid_data** (BaseDataSource) – datasource use for evaluation, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function or a registered method*) – effected after *estimator* training.
- **kwargs** (*Dict*) – parameters for *estimator* training, Like: *early_stopping_rounds* in Xgboost.XGBClassifier

class lib.sedna.core.federated_learning.**FederatedLearningV2**(*data=None*, *estimator=None*, *aggregation=None*, *transmitter=None*)

classmethod get_transmitter_from_config()

train()

lib.sedna.core.incremental_learning

Submodules

lib.sedna.core.incremental_learning.incremental_learning

Module Contents

Classes

IncrementalLearning	Incremental learning is a method of machine learning in which input data

class lib.sedna.core.incremental_learning.incremental_learning.**IncrementalLearning**(*estimator*, *hard_example_mining: dict = None*)

Bases: sedna.core.base.JobBase

Incremental learning is a method of machine learning in which input data is continuously used to extend the existing model's knowledge i.e. to further train the model. It represents a dynamic technique of supervised learning and unsupervised learning that can be applied when training data becomes available gradually over time.

Sedna provide the related interfaces for application development.

Parameters

- **estimator** (*Instance*) – An instance with the high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your model.
- **hard_example_mining** (*Dict*) – HEM algorithms with parameters which has registered to ClassFactory, see *sedna.algorithms.hard_example_mining* for more detail.

Examples

```
>>> Estimator = keras.models.Sequential()
>>> il_model = IncrementalLearning(
        estimator=Estimator,
        hard_example_mining={
            "method": "IBT",
            "param": {
                "threshold_img": 0.9
            }
        }
    )
```

Notes

Sedna provide an interface call *get_hem_algorithm_from_config* to build the *hard_example_mining* parameter from CRD definition.

classmethod get_hem_algorithm_from_config(***param*)

get the *algorithm* name and *param* of hard_example_mining from crd

Parameters

param (*Dict*) – update value in parameters of hard_example_mining

Returns

e.g.: {"method": "IBT", "param": {"threshold_img": 0.5}}

Return type

dict

Examples

```
>>> IncrementalLearning.get_hem_algorithm_from_config(
        threshold_img=0.9
    )
{"method": "IBT", "param": {"threshold_img": 0.9}}
```

train(*train_data*, *valid_data=None*, *post_process=None*, ***kwargs*)

Training task for IncrementalLearning

Parameters

- **train_data** (BaseDataSource) – datasource use for train, see *sedna.datasources.BaseDataSource* for more detail.
- **valid_data** (BaseDataSource) – datasource use for evaluation, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function or a registered method*) – effected after *estimator* training.
- **kwargs** (*Dict*) – parameters for *estimator* training, Like: *early_stopping_rounds* in Xgboost.XGBClassifier

Return type

estimator

inference(*data=None*, *post_process=None*, ***kwargs*)

Inference task for IncrementalLearning

Parameters

- **data** (BaseDataSource) – datasource use for inference, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function or a registered method*) – effected after *estimator* inference.
- **kwargs** (*Dict*) – parameters for *estimator* inference, Like: *ntree_limit* in Xgboost.XGBClassifier

Returns

- **inference result** (*object*)
- **result after post_process** (*object*)
- **if is hard sample** (*bool*)

evaluate(*data*, *post_process=None*, ***kwargs*)

Evaluate task for IncrementalLearning

Parameters

- **data** (BaseDataSource) – datasource use for evaluation, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function or a registered method*) – effected after *estimator* evaluation.
- **kwargs** (*Dict*) – parameters for *estimator* evaluate, Like: *metric_name* in Xgboost.XGBClassifier

Returns
evaluate metrics

Return type
List

Package Contents

Classes

IncrementalLearning	Incremental learning is a method of machine learning in which input data

class lib.sedna.core.incremental_learning.**IncrementalLearning**(*estimator*, *hard_example_mining: dict = None*)

Bases: sedna.core.base.JobBase

Incremental learning is a method of machine learning in which input data is continuously used to extend the existing model's knowledge i.e. to further train the model. It represents a dynamic technique of supervised learning and unsupervised learning that can be applied when training data becomes available gradually over time.

Sedna provide the related interfaces for application development.

Parameters

- **estimator** (*Instance*) – An instance with the high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your model.
- **hard_example_mining** (*Dict*) – HEM algorithms with parameters which has registered to ClassFactory, see *sedna.algorithms.hard_example_mining* for more detail.

Examples

```
>>> Estimator = keras.models.Sequential()
>>> il_model = IncrementalLearning(
        estimator=Estimator,
        hard_example_mining={
            "method": "IBT",
            "param": {
                "threshold_img": 0.9
            }
        }
    )
```

Notes

Sedna provide an interface call *get_hem_algorithm_from_config* to build the *hard_example_mining* parameter from CRD definition.

classmethod get_hem_algorithm_from_config(***param*)

get the *algorithm* name and *param* of hard_example_mining from crd

Parameters
param (*Dict*) – update value in parameters of hard_example_mining

Returns
e.g.: {"method": "IBT", "param": {"threshold_img": 0.5}}

Return type
dict

Examples

```
>>> IncrementalLearning.get_hem_algorithm_from_config(
        threshold_img=0.9
    )
{"method": "IBT", "param": {"threshold_img": 0.9}}
```

train(*train_data*, *valid_data=None*, *post_process=None*, ***kwargs*)

Training task for IncrementalLearning

Parameters

- **train_data** (BaseDataSource) – datasource use for train, see *sedna.datasources.BaseDataSource* for more detail.

- **valid_data** (BaseDataSource) – datasource use for evaluation, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function or a registered method*) – effected after *estimator* training.
- **kwargs** (*Dict*) – parameters for *estimator* training, Like: *early_stopping_rounds* in Xgboost.XGBClassifier

Return type
estimator

inference(*data=None*, *post_process=None*, ***kwargs*)

Inference task for IncrementalLearning

Parameters

- **data** (BaseDataSource) – datasource use for inference, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function or a registered method*) – effected after *estimator* inference.
- **kwargs** (*Dict*) – parameters for *estimator* inference, Like: *ntree_limit* in Xgboost.XGBClassifier

Returns

- **inference result** (*object*)
- **result after post_process** (*object*)
- **if is hard sample** (*bool*)

evaluate(*data*, *post_process=None*, ***kwargs*)

Evaluate task for IncrementalLearning

Parameters

- **data** (BaseDataSource) – datasource use for evaluation, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function or a registered method*) – effected after *estimator* evaluation.
- **kwargs** (*Dict*) – parameters for *estimator* evaluate, Like: *metric_name* in Xgboost.XGBClassifier

Returns
evaluate metrics

Return type
List

lib.sedna.core.joint_inference

Submodules

lib.sedna.core.joint_inference.joint_inference

Module Contents

Classes

BigModelService	Large model services implemented
JointInference	Sedna provide a framework make sure under the condition of limited

class lib.sedna.core.joint_inference.joint_inference.**BigModelService**(*estimator=None*)

Bases: sedna.core.base.JobBase

Large model services implemented Provides RESTful interfaces for large-model inference.

Parameters

estimator (*Instance, big model*) – An instance with the high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your model.

Examples

```
>>> Estimator = xgboost.XGBClassifier()
>>> BigModelService(estimator=Estimator).start()
```

start()

Start inference rest server

train(*train_data*, *valid_data=None*, *post_process=None*, ***kwargs*)

todo: no support yet

inference(*data=None*, *post_process=None*, ***kwargs*)

Inference task for JointInference

Parameters

- **data** (BaseDataSource) – datasource use for inference, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function or a registered method*) – effected after *estimator* inference.
- **kwargs** (*Dict*) – parameters for *estimator* inference, Like: *ntree_limit* in Xgboost.XGBClassifier

Return type

inference result

class lib.sedna.core.joint_inference.joint_inference.**JointInference**(*estimator=None*, *hard_example_mining: dict = None*)

Bases: sedna.core.base.JobBase

Sedna provide a framework make sure under the condition of limited resources on the edge, difficult inference tasks are offloaded to the cloud to improve the overall performance, keeping the throughput.

Parameters

- **estimator** (*Instance*) – An instance with the high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your model.
- **hard_example_mining** (*Dict*) – HEM algorithms with parameters which has registered to ClassFactory, see *sedna.algorithms.hard_example_mining* for more detail.

Examples

```
>>> Estimator = keras.models.Sequential()
>>> ji_service = JointInference(
        estimator=Estimator,
        hard_example_mining={
            "method": "IBT",
            "param": {
                "threshold_img": 0.9
            }
        }
    )
```

Notes

Sedna provide an interface call *get_hem_algorithm_from_config* to build the *hard_example_mining* parameter from CRD definition.

classmethod get_hem_algorithm_from_config(***param*)

get the *algorithm* name and *param* of hard_example_mining from crd

Parameters
param (*Dict*) – update value in parameters of hard_example_mining

Returns
e.g.: {“method”: “IBT”, “param”: {“threshold_img”: 0.5}}

Return type
dict

Examples

```
>>> JointInference.get_hem_algorithm_from_config(
        threshold_img=0.9
    )
{"method": "IBT", "param": {"threshold_img": 0.9}}
```

inference(*data=None*, *post_process=None*, ***kwargs*)

Inference task with JointInference

Parameters

- **data** (BaseDataSource) – datasource use for inference, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function or a registered method*) – effected after *estimator* inference.
- **kwargs** (*Dict*) – parameters for *estimator* inference, Like: *ntree_limit* in Xgboost.XGBClassifier

Returns

- **if is hard sample** (*bool*)
- **inference result** (*object*)
- **result from little-model** (*object*)
- **result from big-model** (*object*)

Package Contents

Classes

JointInference	Sedna provide a framework make sure under the condition of limited
BigModelService	Large model services implemented

class lib.sedna.core.joint_inference.**JointInference**(*estimator=None*, *hard_example_mining: dict = None*)

Bases: sedna.core.base.JobBase

Sedna provide a framework make sure under the condition of limited resources on the edge, difficult inference tasks are offloaded to the cloud to improve the overall performance, keeping the throughput.

Parameters

- **estimator** (*Instance*) – An instance with the high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your model.
- **hard_example_mining** (*Dict*) – HEM algorithms with parameters which has registered to ClassFactory, see *sedna.algorithms.hard_example_mining* for more detail.

Examples

```
>>> Estimator = keras.models.Sequential()
>>> ji_service = JointInference(
        estimator=Estimator,
        hard_example_mining={
            "method": "IBT",
            "param": {
                "threshold_img": 0.9
            }
        }
    )
```

Notes

Sedna provide an interface call *get_hem_algorithm_from_config* to build the *hard_example_mining* parameter from CRD definition.

classmethod get_hem_algorithm_from_config(***param*)

get the *algorithm* name and *param* of hard_example_mining from crd

Parameters
param (*Dict*) – update value in parameters of hard_example_mining

Returns
e.g.: {"method": "IBT", "param": {"threshold_img": 0.5}}

Return type
dict

Examples

```
>>> JointInference.get_hem_algorithm_from_config(
        threshold_img=0.9
    )
{"method": "IBT", "param": {"threshold_img": 0.9}}
```

inference(*data=None*, *post_process=None*, ***kwargs*)

Inference task with JointInference

Parameters

- **data** (BaseDataSource) – datasource use for inference, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function or a registered method*) – effected after *estimator* inference.
- **kwargs** (*Dict*) – parameters for *estimator* inference, Like: *ntree_limit* in Xgboost.XGBClassifier

Returns

- **if is hard sample** (*bool*)
- **inference result** (*object*)

- **result from little-model** (*object*)
- **result from big-model** (*object*)

class lib.sedna.core.joint_inference.**BigModelService**(*estimator=None*)

Bases: sedna.core.base.JobBase

Large model services implemented Provides RESTful interfaces for large-model inference.

Parameters

estimator (*Instance, big model*) – An instance with the high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your model.

Examples

```
>>> Estimator = xgboost.XGBClassifier()
>>> BigModelService(estimator=Estimator).start()
```

start()

Start inference rest server

train(*train_data*, *valid_data=None*, *post_process=None*, ***kwargs*)

todo: no support yet

inference(*data=None*, *post_process=None*, ***kwargs*)

Inference task for JointInference

Parameters

- **data** (BaseDataSource) – datasource use for inference, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function or a registered method*) – effected after *estimator* inference.
- **kwargs** (*Dict*) – parameters for *estimator* inference, Like: *ntree_limit* in Xgboost.XGBClassifier

Return type

inference result

lib.sedna.core.lifelong_learning

Subpackages

lib.sedna.core.lifelong_learning.knowledge_management

Submodules

lib.sedna.core.lifelong_learning.knowledge_management.base_knowledge_management

Module Contents

Classes

BaseKnowledgeManagement	Base class of knowledge management.

class lib.sedna.core.lifelong_learning.knowledge_management.base_knowledge_management.**BaseKnowledgeManag**

Base class of knowledge management. It includes model and sample update to knowledge base server.

Parameters: config: BaseConfig, see 'sedna.common.config.BaseConfig' for more details.

It sets basic configs for knowledge management.

seen_estimator: Instance
An instance with the high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for a model.

unseen_estimator: Instance
An instance with the high-level API that greatly simplifies mechanism model learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for a mechanism model.

abstract update_kb(*task_index*)

abstract save_task_index(*task_index*, *task_type=None*, ***kwargs*)

lib.sedna.core.lifelong_learning.knowledge_management.cloud_knowledge_management

Module Contents

Classes

CloudKnowledgeManagement	Manage task processing, kb update and task deployment, etc., at cloud.

class lib.sedna.core.lifelong_learning.knowledge_management.cloud_knowledge_management.**CloudKnowledgeMa**

Bases: *lib.sedna.core.lifelong_learning.knowledge_management.base_knowledge_management.BaseKnowledgeManagement*

Manage task processing, kb update and task deployment, etc., at cloud.

update_kb(*task_index*)

save_task_index(*task_index*, *task_type='seen_task'*)

evaluate_tasks(*tasks_detail*, ***kwargs*)

Parameters
tasks_detail (*List[Task]*) – output of module task_update_decision, consisting of results of evaluation.

Returns
drop_task – names of the tasks which will not to be deployed to the edge.

Return type
List[str]

lib.sedna.core.lifelong_learning.knowledge_management.edge_knowledge_management

Module Contents

Classes

EdgeKnowledgeManagement	Manage inference, knowledge base update, etc., at the edge.

class lib.sedna.core.lifelong_learning.knowledge_management.edge_knowledge_management.**EdgeKnowledgeManag**

Bases: *lib.sedna.core.lifelong_learning.knowledge_management.base_knowledge_management.BaseKnowledgeManagement*

Manage inference, knowledge base update, etc., at the edge.

update_kb(*task_index*)

save_task_index(*task_index*, *task_type='seen_task'*)

save_unseen_samples(*samples*, *post_process*)

start_services()

Package Contents

Classes

BaseKnowledgeManagement	Base class of knowledge management.
CloudKnowledgeManagement	Manage task processing, kb update and task deployment, etc., at cloud.
EdgeKnowledgeManagement	Manage inference, knowledge base update, etc., at the edge.

class lib.sedna.core.lifelong_learning.knowledge_management.**BaseKnowledgeManagement**(*config*, *seen_estimator*, *unseen_estimator*)

Base class of knowledge management. It includes model and sample update to knowledge base server.

Parameters: config: BaseConfig, see 'sedna.common.config.BaseConfig' for more details.

It sets basic configs for knowledge management.

seen_estimator: Instance
An instance with the high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for a model.

unseen_estimator: Instance
An instance with the high-level API that greatly simplifies mechanism model learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for a mechanism model.

abstract update_kb(*task_index*)

abstract save_task_index(*task_index*, *task_type=None*, ***kwargs*)

class lib.sedna.core.lifelong_learning.knowledge_management.**CloudKnowledgeManagement**(*config*, *seen_estimator*, *unseen_estimator*, ***kwargs*)

Bases: *lib.sedna.core.lifelong_learning.knowledge_management.base_knowledge_management.BaseKnowledgeManagement*

Manage task processing, kb update and task deployment, etc., at cloud.

update_kb(*task_index*)

save_task_index(*task_index*, *task_type='seen_task'*)

evaluate_tasks(*tasks_detail*, ***kwargs*)

Parameters
tasks_detail (*List[Task]*) – output of module task_update_decision, consisting of results of evaluation.

Returns
drop_task – names of the tasks which will not to be deployed to the edge.

Return type
List[str]

class lib.sedna.core.lifelong_learning.knowledge_management.**EdgeKnowledgeManagement**(*config*, *seen_estimator*, *unseen_estimator*, ***kwargs*)

Bases: *lib.sedna.core.lifelong_learning.knowledge_management.base_knowledge_management.BaseKnowledgeManagement*

Manage inference, knowledge base update, etc., at the edge.

update_kb(*task_index*)

save_task_index(*task_index*, *task_type='seen_task'*)

save_unseen_samples(*samples*, *post_process*)

start_services()

Submodules

lib.sedna.core.lifelong_learning.lifelong_learning

Module Contents

Classes

LifelongLearning	Lifelong Learning (LL) is an advanced machine learning (ML) paradigm that

class lib.sedna.core.lifelong_learning.lifelong_learning.**LifelongLearning**(*seen_estimator*, *unseen_estimator=None*, *task_definition=None*, *task_relationship_discovery=None*, *task_allocation=None*, *task_remodeling=None*, *inference_integrate=None*, *task_update_decision=None*, *unseen_task_allocation=None*, *unseen_sample_recognition=None*, *unseen_sample_re_recognition=None*)

Bases: sedna.core.base.JobBase

Lifelong Learning (LL) is an advanced machine learning (ML) paradigm that learns continuously, accumulates the knowledge learned in the past, and uses/adapts it to help future learning and problem solving.

Sedna provide the related interfaces for application development.

Parameters

- **estimator** (*Instance*) – An instance with the high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your model.
- **unseen_estimator** (*Instance*) – An instance with the high-level API that greatly simplifies mechanism model learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your mechanism model.
- **task_definition** (*Dict*) – Divide multiple tasks based on data, see *task_definition.task_definition* for more detail.

- **task_relationship_discovery** (*Dict*) – Discover relationships between all tasks, see *task_relationship_discovery.task_relationship_discovery* for more detail.
- **task_allocation** (*Dict*) – Mining seen tasks of inference sample, see *task_allocation.task_allocation* for more detail.
- **task_remodeling** (*Dict*) – Remodeling tasks based on their relationships, see *task_remodeling.task_remodeling* for more detail.
- **inference_integrate** (*Dict*) – Integrate the inference results of all related tasks, see *inference_integrate.inference_integrate* for more detail.
- **task_update_decision** (*Dict*) – Task update strategy making algorithms, see 'knowledge_management.task_update_decision.task_update_decision' for more detail.
- **unseen_task_allocation** (*Dict*) – Mining unseen tasks of inference sample, see *unseen_task_processing.unseen_task_allocation. unseen_task_allocation* for more detail.
- **unseen_sample_recognition** (*Dict*) – Dividing inference samples into seen tasks and unseen tasks, see 'unseen_task_processing.unseen_sample_recognition. unseen_sample_recognition' for more detail.
- **unseen_sample_re_recognition** (*Dict*) – Dividing unseen training samples into seen tasks and unseen tasks, see 'unseen_task_processing.unseen_sample_re_recognition. unseen_sample_re_recognition' for more detail.

Examples

```
>>> estimator = XGBClassifier(objective="binary:logistic")
>>> unseen_estimator = None
>>> task_definition = {
        "method": "TaskDefinitionByDataAttr",
        "param": {"attribute": ["season", "city"]}
    }
>>> task_relationship_discovery = {
        "method": "DefaultTaskRelationDiscover", "param": {}
    }
>>> task_mining = {
        "method": "TaskMiningByDataAttr",
        "param": {"attribute": ["season", "city"]}
    }
>>> task_remodeling = None
>>> inference_integrate = {
        "method": "DefaultInferenceIntegrate", "param": {}
    }
>>> task_update_decision = {
        "method": "UpdateStrategyDefault", "param": {}
    }
>>> unseen_task_allocation = {
        "method": "UnseenTaskAllocationDefault", "param": {}
    }
>>> unseen_sample_recognition = {
        "method": "SampleRegonitionDefault", "param": {}
    }
>>> unseen_sample_re_recognition = {
        "method": "SampleReRegonitionDefault", "param": {}
```

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```
    }
>>> ll_jobs = LifelongLearning(
        estimator,
        unseen_estimator=None,
        task_definition=None,
        task_relationship_discovery=None,
        task_allocation=None,
        task_remodeling=None,
        inference_integrate=None,
        task_update_decision=None,
        unseen_task_allocation=None,
        unseen_sample_recognition=None,
        unseen_sample_re_recognition=None,
    )
```

train(*train_data*, *valid_data=None*, *post_process=None*, ***kwargs*)

fit for update the knowledge based on training data.

Parameters

- **train_data** (BaseDataSource) – Train data, see *sedna.datasources.BaseDataSource* for more detail.
- **valid_data** (BaseDataSource) – Valid data, BaseDataSource or None.
- **post_process** (*function*) – function or a registered method, callback after *estimator* train.
- **kwargs** (*Dict*) – parameters for *estimator* training, Like: *early_stopping_rounds* in Xgboost.XGBClassifier

Returns

train_history

Return type

object

update(*train_data*, *valid_data=None*, *post_process=None*, ***kwargs*)

fit for update the knowledge based on incremental data.

Parameters

- **train_data** (BaseDataSource) – Train data, see *sedna.datasources.BaseDataSource* for more detail.
- **valid_data** (BaseDataSource) – Valid data, BaseDataSource or None.
- **post_process** (*function*) – function or a registered method, callback after *estimator* train.
- **kwargs** (*Dict*) – parameters for *estimator* training, Like: *early_stopping_rounds* in Xgboost.XGBClassifier

Returns

train_history

Return type

object

evaluate(*data*, *post_process=None*, ***kwargs*)

evaluated the performance of each task from training, filter tasks based on the defined rules.

Parameters

- **data** (BaseDataSource) – valid data, see *sedna.datasources.BaseDataSource* for more detail.
- **kwargs** (*Dict*) – parameters for *estimator* evaluate, Like: *ntree_limit* in Xgboost.XGBClassifier

inference(*data=None*, *post_process=None*, *unseen_sample_postprocess=None*, ***kwargs*)

predict the result for input data based on training knowledge.

Parameters

- **data** (BaseDataSource) – inference sample, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function*) – function or a registered method, effected after *estimator* prediction, like: label transform.
- **unseen_sample_postprocess** (*function*) – function or a registered method, effected when unseen samples need to be saved
- **kwargs** (*Dict*) – parameters for *estimator* predict, Like: *ntree_limit* in Xgboost.XGBClassifier

Package Contents

Classes

LifelongLearning	Lifelong Learning (LL) is an advanced machine learning (ML) paradigm that

class lib.sedna.core.lifelong_learning.**LifelongLearning**(*seen_estimator*, *unseen_estimator=None*, *task_definition=None*, *task_relationship_discovery=None*, *task_allocation=None*, *task_remodeling=None*, *inference_integrate=None*, *task_update_decision=None*, *unseen_task_allocation=None*, *unseen_sample_recognition=None*, *unseen_sample_re_recognition=None*)

Bases: sedna.core.base.JobBase

Lifelong Learning (LL) is an advanced machine learning (ML) paradigm that learns continuously, accumulates the knowledge learned in the past, and uses/adapts it to help future learning and problem solving.

Sedna provide the related interfaces for application development.

Parameters

- **estimator** (*Instance*) – An instance with the high-level API that greatly simplifies machine learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your model.
- **unseen_estimator** (*Instance*) – An instance with the high-level API that greatly simplifies mechanism model learning programming. Estimators encapsulate training, evaluation, prediction, and exporting for your mechanism model.
- **task_definition** (*Dict*) – Divide multiple tasks based on data, see *task_definition.task_definition* for more detail.
- **task_relationship_discovery** (*Dict*) – Discover relationships between all tasks, see *task_relationship_discovery.task_relationship_discovery* for more detail.
- **task_allocation** (*Dict*) – Mining seen tasks of inference sample, see *task_allocation.task_allocation* for more detail.
- **task_remodeling** (*Dict*) – Remodeling tasks based on their relationships, see *task_remodeling.task_remodeling* for more detail.
- **inference_integrate** (*Dict*) – Integrate the inference results of all related tasks, see *inference_integrate.inference_integrate* for more detail.
- **task_update_decision** (*Dict*) – Task update strategy making algorithms, see 'knowledge_management.task_update_decision.task_update_decision' for more detail.
- **unseen_task_allocation** (*Dict*) – Mining unseen tasks of inference sample, see *unseen_task_processing.unseen_task_allocation. unseen_task_allocation* for more detail.
- **unseen_sample_recognition** (*Dict*) – Dividing inference samples into seen tasks and unseen tasks, see 'unseen_task_processing.unseen_sample_recognition. unseen_sample_recognition' for more detail.
- **unseen_sample_re_recognition** (*Dict*) – Dividing unseen training samples into seen tasks and unseen tasks, see 'unseen_task_processing.unseen_sample_re_recognition. unseen_sample_re_recognition' for more detail.

Examples

```
>>> estimator = XGBClassifier(objective="binary:logistic")
>>> unseen_estimator = None
>>> task_definition = {
        "method": "TaskDefinitionByDataAttr",
        "param": {"attribute": ["season", "city"]}
    }
>>> task_relationship_discovery = {
        "method": "DefaultTaskRelationDiscover", "param": {}
    }
>>> task_mining = {
        "method": "TaskMiningByDataAttr",
        "param": {"attribute": ["season", "city"]}
    }
>>> task_remodeling = None
>>> inference_integrate = {
        "method": "DefaultInferenceIntegrate", "param": {}
    }
>>> task_update_decision = {
```

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```
        "method": "UpdateStrategyDefault", "param": {}
    }
>>> unseen_task_allocation = {
        "method": "UnseenTaskAllocationDefault", "param": {}
    }
>>> unseen_sample_recognition = {
        "method": "SampleRegonitionDefault", "param": {}
    }
>>> unseen_sample_re_recognition = {
        "method": "SampleReRegonitionDefault", "param": {}
    }
>>> ll_jobs = LifelongLearning(
        estimator,
        unseen_estimator=None,
        task_definition=None,
        task_relationship_discovery=None,
        task_allocation=None,
        task_remodeling=None,
        inference_integrate=None,
        task_update_decision=None,
        unseen_task_allocation=None,
        unseen_sample_recognition=None,
        unseen_sample_re_recognition=None,
    )
```

train(*train_data*, *valid_data=None*, *post_process=None*, ***kwargs*)

fit for update the knowledge based on training data.

Parameters

- **train_data** (BaseDataSource) – Train data, see *sedna.datasources.BaseDataSource* for more detail.
- **valid_data** (BaseDataSource) – Valid data, BaseDataSource or None.
- **post_process** (*function*) – function or a registered method, callback after *estimator* train.
- **kwargs** (*Dict*) – parameters for *estimator* training, Like: *early_stopping_rounds* in Xgboost.XGBClassifier

Returns

train_history

Return type

object

update(*train_data*, *valid_data=None*, *post_process=None*, ***kwargs*)

fit for update the knowledge based on incremental data.

Parameters

- **train_data** (BaseDataSource) – Train data, see *sedna.datasources.BaseDataSource* for more detail.
- **valid_data** (BaseDataSource) – Valid data, BaseDataSource or None.

- **post_process** (*function*) – function or a registered method, callback after *estimator* train.
- **kwargs** (*Dict*) – parameters for *estimator* training, Like: *early_stopping_rounds* in Xgboost.XGBClassifier

Returns
train_history

Return type
object

evaluate(*data*, *post_process=None*, ***kwargs*)

evaluated the performance of each task from training, filter tasks based on the defined rules.

Parameters

- **data** (BaseDataSource) – valid data, see *sedna.datasources.BaseDataSource* for more detail.
- **kwargs** (*Dict*) – parameters for *estimator* evaluate, Like: *ntree_limit* in Xgboost.XGBClassifier

inference(*data=None*, *post_process=None*, *unseen_sample_postprocess=None*, ***kwargs*)

predict the result for input data based on training knowledge.

Parameters

- **data** (BaseDataSource) – inference sample, see *sedna.datasources.BaseDataSource* for more detail.
- **post_process** (*function*) – function or a registered method, effected after *estimator* prediction, like: label transform.
- **unseen_sample_postprocess** (*function*) – function or a registered method, effected when unseen samples need to be saved
- **kwargs** (*Dict*) – parameters for *estimator* predict, Like: *ntree_limit* in Xgboost.XGBClassifier

lib.sedna.core.multi_edge_inference

Subpackages

lib.sedna.core.multi_edge_inference.components

Submodules

lib.sedna.core.multi_edge_inference.components.detector

Module Contents

Classes

ObjectDetector	In MultiEdgeInference, the Object Detection/Tracking component

class lib.sedna.core.multi_edge_inference.components.detector.**ObjectDetector**(*consumer_topics=['enriched_obje*
pro-
ducer_topics=['object_detection'],
plugins:
*List[*sedna.core.multi_edge_inferer
= [], *models:*
*List[*sedna.core.multi_edge_inferer
= [],
timeout=10,
asyn-
chronous=False)

Bases: sedna.core.multi_edge_inference.components.BaseService, sedna.core.multi_edge_inference.components.FileOperations

In MultiEdgeInference, the Object Detection/Tracking component is deployed as a service at the edge and it used to detect or track objects (for example, pedestrians) and send the result to the cloud for further processing using Kafka or REST API.

Parameters

- **consumer_topics** (*List*) – A list of Kafka topics used to communicate with the Feature Extraction service (to receive data from it). This is accessed only if the Kafka backend is in use.
- **producer_topics** (*List*) – A list of Kafka topics used to communicate with the Feature Extraction service (to send data to it). This is accessed only if the Kafka backend is in use.
- **plugins** (*List*) – A list of PluggableNetworkService. It can be left empty as the ObjectDetector service is already preconfigured to connect to the correct network services.
- **models** (*List*) – A list of PluggableModel. By passing a specific instance of the model, it is possible to customize the ObjectDetector to, for example, track different objects as long as the PluggableModel interface is respected.
- **timeout** (*int*) – It sets a timeout condition to terminate the main fetch loop after the specified amount of seconds has passed since we received the last frame.
- **asynchronous** (*bool*) – If True, the AI processing will be decoupled from the data acquisition step. If False, the processing will be sequential. In general, set it to True when ingesting a stream (e.g., RTSP) and to False when reading from disk (e.g., a video file).

Examples

model = ByteTracker() # A class implementing the PluggableModel abstract class (example in pedestrian_tracking/detector/model/bytetracker.py) objecttracking_service = ObjectDetector(models=[model], asynchronous=True)

Notes

For the parameters described above, only 'models' has to be defined, while for others the default value will work in most cases.

process_data(*ai*, *data*, ***kwargs*)

The user needs to implement this function to call the main processing function of the AI model and decide what to do with the result.

preprocess(*data*)

The user can override this function to inject some preprocessing operation to be executed before the data is added to the data structure by the 'put()' function.

close()

update_operational_mode(*status*)

The user needs to trigger updates to the AI model, if necessary.

lib.sedna.core.multi_edge_inference.components.feature_extraction

Module Contents

Classes

FEService	In MultiEdgeInference, the Feature Extraction component

class lib.sedna.core.multi_edge_inference.components.feature_extraction.**FEService**(*consumer_topics=['object_d*, *producer_topics=['enriched_ob*, *plugins: List[*sedna.core.multi_edge_*] = []*, *models: List[*sedna.core.multi_edge_*] = []*, *timeout=10*, *asynchronous=False*)

Bases: sedna.core.multi_edge_inference.components.BaseService

In MultiEdgeInference, the Feature Extraction component is deployed in the edge or the cloud and it used to extract ReID features from frames received by the ObjectDetector component and send back to it the enriched data using Kafka or REST API.

Parameters

- **consumer_topics** (*List*) – A list of Kafka topics used to communicate with the Object Detector service (to receive data from it). This is accessed only if the Kafka backend is in use.
- **producer_topics** (*List*) – A list of Kafka topics used to communicate with the Object Detector service (to send data to it). This is accessed only if the Kafka backend is in use.
- **plugins** (*List*) – A list of PluggableNetworkService. It can be left empty as the FeatureExtraction service is already preconfigured to connect to the correct network services.
- **models** (*List*) – A list of PluggableModel. By passing a specific instance of the model, it is possible to customize the FeatureExtraction component to, for example, extract differently the objects features.
- **timeout** (*int*) – It sets a timeout condition to terminate the main fetch loop after the specified amount of seconds has passed since we received the last frame.
- **asynchronous** (*bool*) – If True, the AI processing will be decoupled from the data acquisition step. If False, the processing will be sequential. In general, set it to True when ingesting a stream (e.g., RTSP) and to False when reading from disk (e.g., a video file).

Examples

model = FeatureExtractionAI() # A class implementing the PluggableModel abstract class (example pedestrian_tracking/feature_extraction/worker.py)

fe_service = FEService(models=[model], asynchronous=False)

Notes

For the parameters described above, only 'models' has to be defined, while for others the default value will work in most cases.

process_data(*ai*, *data*, ***kwargs*)

The user needs to implement this function to call the main processing function of the AI model and decide what to do with the result.

update_operational_mode(*status*)

The user needs to trigger updates to the AI model, if necessary.

get_target_features(*ldata*)

lib.sedna.core.multi_edge_inference.components.reid

Module Contents

Classes

ReID	In MultiEdgeInference, the ReID component is deployed in the cloud

class lib.sedna.core.multi_edge_inference.components.reid.**ReID**(*consumer_topics=[]*, *producer_topics=[]*, *plugins: List[*sedna.core.multi_edge_inference.plugins.Plugga *= []*, *models: List[*sedna.core.multi_edge_inference.plugins.Plugga *= []*, *timeout=10*, *asynchronous=True*)

Bases: sedna.core.multi_edge_inference.components.BaseService, sedna.core.multi_edge_inference.components.FileOperations

In MultiEdgeInference, the ReID component is deployed in the cloud and it used to identify a target by compairing its features with the ones genereated from the Feature Extraction component.

Parameters

- **consumer_topics** (*List*) – Leave empty.
- **producer_topics** (*List*) – Leave empty.
- **plugins** (*List*) – A list of PluggableNetworkService. It can be left empty as the ReID component is already preconfigured to connect to the correct network services.
- **models** (*List*) – A list of PluggableModel. In this case we abuse of the term model as the ReID doesn't really use an AI model but rather a wrapper for the ReID functions.
- **timeout** (*int*) – It sets a timeout condition to terminate the main fetch loop after the specified amount of seconds has passed since we received the last frame.
- **asynchronous** (*bool*) – If True, the AI processing will be decoupled from the data acquisition step. If False, the processing will be sequential. In general, set it to True when ingesting a stream (e.g., RTSP) and to False when reading from disk (e.g., a video file).

Examples

model = ReIDWorker() # A class implementing the PluggableModel abstract class (example in pedestrian_tracking/reid/worker.py)

self.job = ReID(models=[model], asynchronous=False)

Notes

For the parameters described above, only 'models' has to be defined, while for others the default value will work in most cases.

process_data(*ai*, *data*, ***kwargs*)

The user needs to implement this function to call the main processing function of the AI model and decide what to do with the result.

update_operational_mode(*status*)

The user needs to trigger updates to the AI model, if necessary.

get_target_features(*ldata*)

Package Contents

Classes

BaseService	Base MultiEdgeInference wrapper for video analytics, feature extraction,
FileOperations	Class containing file operations to read/write from disk.

Attributes

POLL_INTERVAL

lib.sedna.core.multi_edge_inference.components.**POLL_INTERVAL = 0.01**

class lib.sedna.core.multi_edge_inference.components.**BaseService**(*consumer_topics=[]*, *producer_topics=[]*, *plugins: List[*sedna.core.multi_edge_inference.plugins.Plug *= []*, *models: List[*sedna.core.multi_edge_inference.plugins.Plug *= []*, *timeout=10*, *asynchronous=False*)

Bases: abc.ABC

Base MultiEdgeInference wrapper for video analytics, feature extraction, and reid components.

put(*data*)

Call this function to push data into the component. For example, after you extract a frame from video stream, you can call put(image). Depending on the value of the 'asynchronous' parameter, the data will be put into a different data structure.

fetch_data()

get_plugin(*plugin_key:* sedna.core.multi_edge_inference.plugins.PLUGIN)

This function allows to select the network service to communicate to based on the name (given that is has been registered before). List of registered plugins can be found in plugins/registered.py.

flatten(*S*)

distribute_data(*data=[]*, ***kwargs*)

This function sends the data to all the AI models passed to with this component during the initialization phase.

abstract process_data(*ai*, *data*, ***kwargs*)

The user needs to implement this function to call the main processing function of the AI model and decide what to do with the result.

abstract update_operational_mode(*status*)

The user needs to trigger updates to the AI model, if necessary.

preprocess(*data*, ***kwargs*)

The user can override this function to inject some preprocessing operation to be executed before the data is added to the data structure by the 'put()' function.

class lib.sedna.core.multi_edge_inference.components.**FileOperations**

Class containing file operations to read/write from disk.

read_from_disk(*path*)

delete_from_disk(*filename*)

write_to_disk(*data*, *folder*, *exts='.dat'*)

get_files_list(*folder*)

lib.sedna.core.multi_edge_inference.plugins

Submodules

lib.sedna.core.multi_edge_inference.plugins.registered

Module Contents

Classes

ReID_Server	Abstract class to wrap a REST service.
ReID_I	Abstract class to wrap a REST service.
Feature_Extraction	Abstract class to wrap a REST service.
Feature_Extraction_I	Abstract class to wrap a REST service.
VideoAnalytics	Abstract class to wrap a REST service.
VideoAnalytics_I	Abstract class to wrap a REST service.

class lib.sedna.core.multi_edge_inference.plugins.registered.**ReID_Server**(*ip=get_parameters('REID_MODEL_BI*
get_host_ip()),
*port=get_parameters('REID_MODEL_*
'5000'),
wrapper=None)

Bases: sedna.core.multi_edge_inference.plugins.PluggableNetworkService

Abstract class to wrap a REST service.

class lib.sedna.core.multi_edge_inference.plugins.registered.**ReID_I**(*ip=get_parameters('REID_MODEL_BIND_U*
'reid-reid'),
*port=get_parameters('REID_MODEL_BIND_*
'5000'))

Bases: sedna.core.multi_edge_inference.plugins.PluggableNetworkService

Abstract class to wrap a REST service.

class lib.sedna.core.multi_edge_inference.plugins.registered.**Feature_Extraction**(*ip=get_parameters('FE_MOD*
get_host_ip()),
port=get_parameters('FE_MO
'6000'),
wrap-
per=None)

Bases: sedna.core.multi_edge_inference.plugins.PluggableNetworkService

Abstract class to wrap a REST service.

class lib.sedna.core.multi_edge_inference.plugins.registered.**Feature_Extraction_I**(*ip=get_parameters('FE_MO*
'feature-
extraction-
fe'),
port=get_parameters('FE_M
'6000'))

Bases: sedna.core.multi_edge_inference.plugins.PluggableNetworkService

Abstract class to wrap a REST service.

class lib.sedna.core.multi_edge_inference.plugins.registered.**VideoAnalytics**(*ip=get_parameters('DET_MODEL_*
get_host_ip()),
port=get_parameters('DET_MODE
'4000'),
wrapper=None)

Bases: sedna.core.multi_edge_inference.plugins.PluggableNetworkService

Abstract class to wrap a REST service.

class lib.sedna.core.multi_edge_inference.plugins.registered.**VideoAnalytics_I**(*ip=get_parameters('DET_MODE*
'video-
analytics-
videoanalytics'),
port=get_parameters('DET_MO
'4000'))

Bases: sedna.core.multi_edge_inference.plugins.PluggableNetworkService

Abstract class to wrap a REST service.

Package Contents

Classes

PLUGIN	Generic enumeration.
PluggableNetworkService	Abstract class to wrap a REST service.
PluggableModel	Abstract class to wrap and AI model.

Attributes

MODEL_NOT_FOUND

lib.sedna.core.multi_edge_inference.plugins.**MODEL_NOT_FOUND** = **'MODEL_UNKNOWN'**

class lib.sedna.core.multi_edge_inference.plugins.**PLUGIN**

Bases: enum.Enum

Generic enumeration.

Derive from this class to define new enumerations.

REID_MANAGER = 'ReIDManager'

REID_MANAGER_I = 'ReIDManager_I'

REID = 'ReID_Server'

REID_I = 'ReID_I'

FEATURE_EXTRACTION = 'Feature_Extraction'

FEATURE_EXTRACTION_I = 'Feature_Extraction_I'

VIDEO_ANALYTICS = 'VideoAnalytics'

VIDEO_ANALYTICS_I = 'VideoAnalytics_I'

class lib.sedna.core.multi_edge_inference.plugins.**PluggableNetworkService**(*ip*, *port*, *plugin_api: object = None*)

Bases: abc.ABC

Abstract class to wrap a REST service.

class lib.sedna.core.multi_edge_inference.plugins.**PluggableModel**

Bases: abc.ABC

Abstract class to wrap and AI model.

property model_path

property model_name

abstract load(***kwargs*)

abstract update_plugin(*update_object*, ***kwargs*)

abstract evaluate(***kwargs*)

abstract train(***kwargs*)

inference(*data=None*, *post_process=None*, ***kwargs*)

Calls the model 'predict' function

evaluate(*data*, *post_process=None*, ***kwargs*)

Submodules

lib.sedna.core.multi_edge_inference.data_classes

Module Contents

Classes

OP_MODE	Generic enumeration.
DetTrackResult	Base data object exchanged by the MultiEdgeInference components.
TargetImages	
Target	

class lib.sedna.core.multi_edge_inference.data_classes.**OP_MODE**

Bases: enum.Enum

Generic enumeration.

Derive from this class to define new enumerations.

DETECTION = 'detection'

TRACKING = 'tracking'

COVID19 = 'covid19'

NOOP = 'noop'

class lib.sedna.core.multi_edge_inference.data_classes.**DetTrackResult**(*frame_index: int = 0*, *bbox: List = None*, *scene=None*, *confidence: List = None*, *detection_time: List = None*, *camera: int = 0*, *bbox_coord: List = []*, *tracking_ids: List = []*, *features: List = []*, *is_target: bool = False*, *ID: List = []*)

Base data object exchanged by the MultiEdgeInference components.

class lib.sedna.core.multi_edge_inference.data_classes.**TargetImages**(*userid*, *targets=[]*)

class lib.sedna.core.multi_edge_inference.data_classes.**Target**(*_userid*, *_features*, *_targetid='0000'*, *_tracking_id=None*, *_location=None*, *_frame_index=0*)

lib.sedna.core.multi_edge_inference.utils

Module Contents

Functions

get_parameters(param[, default])	

lib.sedna.core.multi_edge_inference.utils.**get_parameters**(*param*, *default=None*)

Package Contents

Classes

BaseService	Base MultiEdgeInference wrapper for video analytics, feature extraction,
FileOperations	Class containing file operations to read/write from disk.

Attributes

POLL_INTERVAL

lib.sedna.core.multi_edge_inference.**POLL_INTERVAL = 0.01**

class lib.sedna.core.multi_edge_inference.**BaseService**(*consumer_topics=[]*, *producer_topics=[]*, *plugins: List[*sedna.core.multi_edge_inference.plugins.PluggableNetwork*] = []*, *models: List[*sedna.core.multi_edge_inference.plugins.PluggableModel*] = []*, *timeout=10*, *asynchronous=False*)

Bases: abc.ABC

Base MultiEdgeInference wrapper for video analytics, feature extraction, and reid components.

put(*data*)

Call this function to push data into the component. For example, after you extract a frame from video stream, you can call put(image). Depending on the value of the 'asynchronous' parameter, the data will be put into a different data structure.

fetch_data()

get_plugin(*plugin_key:* sedna.core.multi_edge_inference.plugins.PLUGIN)

This function allows to select the network service to communicate to based on the name (given that is has been registered before). List of registered plugins can be found in plugins/registered.py.

flatten(*S*)

distribute_data(*data=[]*, ***kwargs*)

This function sends the data to all the AI models passed to with this component during the initialization phase.

abstract process_data(*ai*, *data*, ***kwargs*)

The user needs to implement this function to call the main processing function of the AI model and decide what to do with the result.

abstract update_operational_mode(*status*)

The user needs to trigger updates to the AI model, if necessary.

preprocess(*data*, ***kwargs*)

The user can override this function to inject some preprocessing operation to be executed before the data is added to the data structure by the 'put()' function.

class lib.sedna.core.multi_edge_inference.**FileOperations**

Class containing file operations to read/write from disk.

read_from_disk(*path*)

delete_from_disk(*filename*)

write_to_disk(*data*, *folder*, *exts='.dat'*)

get_files_list(*folder*)

Submodules

lib.sedna.core.base

Module Contents

Classes

JobBase	sedna feature base class

class lib.sedna.core.base.**JobBase**(*estimator*, *config=None*)

sedna feature base class

property model_path

parameters

abstract train(***kwargs*)

inference(*x=None*, *post_process=None*, ***kwargs*)

evaluate(*data*, *post_process=None*, ***kwargs*)

get_parameters(*param*, *default=None*)

report_task_info(*task_info*, *status*, *results=None*, *kind='train'*)

19.1.5 lib.sedna.datasources

Subpackages

lib.sedna.datasources.kafka

Submodules

lib.sedna.datasources.kafka.consumer

Module Contents

Classes

Consumer	Helper class that provides a standard way to create an ABC using

class lib.sedna.datasources.kafka.consumer.**Consumer**(*address=['localhost']*, *port=[9092]*, *group_id='default'*, *consumer_timeout_ms=250*)

Bases: sedna.datasources.kafka.Client

Helper class that provides a standard way to create an ABC using inheritance.

connect(*boostrap_servers*)

get_topics()

subscribe(*topic*)

consume_messages()

consume_messages_poll()

pause()

resume()

close()

lib.sedna.datasources.kafka.kafka_manager

Module Contents

Classes

KafkaProducer	
KafkaConsumerThread	A class that represents a thread of control.

class lib.sedna.datasources.kafka.kafka_manager.**KafkaProducer**(*address*, *port*, *topic=[]*, *asynchronous=False*)

write_result(*data*)

class lib.sedna.datasources.kafka.kafka_manager.**KafkaConsumerThread**(*address*, *port*, *topic=[]*, *callback=None*)

Bases: threading.Thread

A class that represents a thread of control.

This class can be safely subclassed in a limited fashion. There are two ways to specify the activity: by passing a callable object to the constructor, or by overriding the run() method in a subclass.

run()

Method representing the thread's activity.

You may override this method in a subclass. The standard run() method invokes the callable object passed to the object's constructor as the target argument, if any, with sequential and keyword arguments taken from the args and kwargs arguments, respectively.

lib.sedna.datasources.kafka.producer

Module Contents

Classes

Producer	Helper class that provides a standard way to create an ABC using

class lib.sedna.datasources.kafka.producer.**Producer**(*address=['localhost']*, *port=[9092]*)

Bases: sedna.datasources.kafka.Client

Helper class that provides a standard way to create an ABC using inheritance.

connect(*boostrap_servers*)

publish_data_synchronous(*data*, *topic='default'*)

publish_data_asynchronous(*data*, *topic='default'*)

on_send_success(*record_metadata*)

on_send_error(*excp*)

close()

Package Contents

Classes

Client	Helper class that provides a standard way to create an ABC using
AdminClient	Helper class that provides a standard way to create an ABC using

class lib.sedna.datasources.kafka.**Client**(*address=['localhost']*, *port=[9092]*)

Bases: abc.ABC

Helper class that provides a standard way to create an ABC using inheritance.

abstract connect(*bootstrap_servers*)

hardened_connect()

class lib.sedna.datasources.kafka.**AdminClient**(*address=['localhost']*, *port=[9092]*)

Bases: *Client*

Helper class that provides a standard way to create an ABC using inheritance.

create_topics(*topics*, *num_partitions=1*, *replication_factor=1*)

delete_topics(*topics*, *num_partitions=1*, *replication_factor=1*)

lib.sedna.datasources.obs

Submodules

lib.sedna.datasources.obs.connector

Module Contents

Classes

OBSClientWrapper	

class lib.sedna.datasources.obs.connector.**OBSClientWrapper**(*file_server_url: string = ''*, *vendor: string = ''*, *region: string = ''*, *bucket_name: string = ''*, *app_token: string = ''*)

download_single_object(*remote_path*, *local_path='.'*, *failed_count=1*, *selected_index=0*)

list_objects(*remote_path*, *next_marker=''*)

upload_file(*local_folder_absolute_path*, *filename*, *bucket_path*, *failed_count=1*, *selected_index=0*)

Package Contents

Classes

BaseDataSource	An abstract class representing a BaseDataSource.
TxtDataParse	txt file which contain image list parser
CSVDataParse	csv file which contain Structured Data parser
JSONDataParse	json file which contain Structured Data parser

class lib.sedna.datasources.**BaseDataSource**(*data_type='train'*, *func=None*)

An abstract class representing a BaseDataSource.

All datasets that represent a map from keys to data samples should subclass it. All subclasses should overwrite parse`, supporting get train/eval/infer data by a function. Subclasses could also optionally overwrite *__len__*, which is expected to return the size of the dataset.overwrite *x* for the feature-embedding, *y* for the target label.

Parameters

- **data_type** (*str*) – define the datasource is train/eval/test
- **func** (*function*) – function use to parse an iter object batch by batch

property is_test_data

num_examples() → int

__len__()

abstract parse(**args*, ***kwargs*)

save(*output=''*)

class lib.sedna.datasources.**TxtDataParse**(*data_type*, *func=None*)

Bases: BaseDataSource, abc.ABC

txt file which contain image list parser

parse(**args*, ***kwargs*)

class lib.sedna.datasources.**CSVDataParse**(*data_type*, *func=None*)

Bases: BaseDataSource, abc.ABC

csv file which contain Structured Data parser

static parse_json(*lines: dict*, ***kwargs*) → pandas.DataFrame

parse(**args*, ***kwargs*)

class lib.sedna.datasources.**JSONDataParse**(*data_type*, *func=None*)

Bases: BaseDataSource, abc.ABC

json file which contain Structured Data parser

parse(**args*, ***kwargs*)

load_anno_from_ids(*id_*)

19.1.6 lib.sedna.service

Subpackages

lib.sedna.service.multi_edge_inference

Subpackages

lib.sedna.service.multi_edge_inference.interface

Submodules

lib.sedna.service.multi_edge_inference.interface.detection_endpoint

Module Contents

Classes

Detection	Endpoint to trigger the Object Tracking component

class lib.sedna.service.multi_edge_inference.interface.detection_endpoint.**Detection**(*service_name*, *version=''*, *ip='127.0.0.1'*, *port='8080'*, *protocol='http'*)

Endpoint to trigger the Object Tracking component

check_server_status()

transmit(*data*, ***kwargs*)

Transfer enriched tracking object to video analytics job

update_service(*data*, ***kwargs*)

lib.sedna.service.multi_edge_inference.interface.fe_endpoint

Module Contents

Classes

FE	Endpoint to trigger the Feature Extraction

class lib.sedna.service.multi_edge_inference.interface.fe_endpoint.**FE**(*service_name*, *version=''*, *ip='127.0.0.1'*, *port='8080'*, *protocol='http'*)

Endpoint to trigger the Feature Extraction

check_server_status()

transmit(*data*, ***kwargs*)

Transfer feature vector to FE worker

get_target_features(*data*, ***kwargs*)

Send target images to FE service and receive back the ReID features

update_service(*data*, ***kwargs*)

lib.sedna.service.multi_edge_inference.interface.reid_endpoint

Module Contents

Classes

ReID_Endpoint	Endpoint to trigger the ReID

class lib.sedna.service.multi_edge_inference.interface.reid_endpoint.**ReID_Endpoint**(*service_name*, *version=''*, *ip='127.0.0.1'*, *port='8080'*, *protocol='http'*)

Endpoint to trigger the ReID

check_server_status()

transmit(*data:* sedna.core.multi_edge_inference.data_classes.DetTrackResult, ***kwargs*)

Transfer feature vector to ReID worker

Package Contents

Classes

Detection	Endpoint to trigger the Object Tracking component
FE	Endpoint to trigger the Feature Extraction
ReID_Endpoint	Endpoint to trigger the ReID

class lib.sedna.service.multi_edge_inference.interface.**Detection**(*service_name*, *version=''*, *ip='127.0.0.1'*, *port='8080'*, *protocol='http'*)

Endpoint to trigger the Object Tracking component

check_server_status()

transmit(*data*, ***kwargs*)

Transfer enriched tracking object to video analytics job

update_service(*data*, ***kwargs*)

class lib.sedna.service.multi_edge_inference.interface.**FE**(*service_name*, *version=''*, *ip='127.0.0.1'*, *port='8080'*, *protocol='http'*)

Endpoint to trigger the Feature Extraction

check_server_status()

transmit(*data*, ***kwargs*)

Transfer feature vector to FE worker

get_target_features(*data*, ***kwargs*)

Send target images to FE service and receive back the ReID features

update_service(*data*, ***kwargs*)

class lib.sedna.service.multi_edge_inference.interface.**ReID_Endpoint**(*service_name*, *version=''*, *ip='127.0.0.1'*, *port='8080'*, *protocol='http'*)

Endpoint to trigger the ReID

check_server_status()

transmit(*data:* sedna.core.multi_edge_inference.data_classes.DetTrackResult, ***kwargs*)

Transfer feature vector to ReID worker

lib.sedna.service.multi_edge_inference.server

Submodules

lib.sedna.service.multi_edge_inference.server.detection

Module Contents

Classes

DetectionServer	REST api server for object detection component

class lib.sedna.service.multi_edge_inference.server.detection.**DetectionServer**(*model*, *service_name*, *ip: str = '127.0.0.1'*, *port: int = 8080*, *max_buffer_size: int = 1004857600*, *workers: int = 1*)

Bases: sedna.service.server.base.BaseServer

REST api server for object detection component

start()

status(*request: fastapi.Request*)

async video_analytics(*request: fastapi.Request*)

async update_service(*request: fastapi.Request*)

lib.sedna.service.multi_edge_inference.server.feature_extraction

Module Contents

Classes

FEServer	rest api server for feature extraction

class lib.sedna.service.multi_edge_inference.server.feature_extraction.**FEServer**(*model*, *service_name*, *ip: str = '127.0.0.1'*, *port: int = 8080*, *max_buffer_size: int = 1004857600*, *workers: int = 1*)

Bases: sedna.service.server.base.BaseServer

rest api server for feature extraction

start()

status(*request: fastapi.Request*)

async feature_extraction(*request: fastapi.Request*)

async get_target_features(*request: fastapi.Request*)

async update_service(*request: fastapi.Request*)

lib.sedna.service.multi_edge_inference.server.reid

Module Contents

Classes

ReIDServer	REST api server for reid

class lib.sedna.service.multi_edge_inference.server.reid.**ReIDServer**(*model*, *service_name*, *ip: str = '127.0.0.1'*, *port: int = 8080*, *max_buffer_size: int = 104857600*, *workers: int = 1*)

Bases: sedna.service.server.base.BaseServer

REST api server for reid

start()

status(*request: fastapi.Request*)

async reid(*request: fastapi.Request*)

Package Contents

Classes

DetectionServer	REST api server for object detection component
FEServer	rest api server for feature extraction
ReIDServer	REST api server for reid

class lib.sedna.service.multi_edge_inference.server.**DetectionServer**(*model*, *service_name*, *ip: str = '127.0.0.1'*, *port: int = 8080*, *max_buffer_size: int = 1004857600*, *workers: int = 1*)

Bases: sedna.service.server.base.BaseServer

REST api server for object detection component

start()

status(*request: fastapi.Request*)

async video_analytics(*request: fastapi.Request*)

async update_service(*request: fastapi.Request*)

class lib.sedna.service.multi_edge_inference.server.**FEServer**(*model*, *service_name*, *ip: str = '127.0.0.1'*, *port: int = 8080*, *max_buffer_size: int = 1004857600*, *workers: int = 1*)

Bases: sedna.service.server.base.BaseServer

rest api server for feature extraction

start()

status(*request: fastapi.Request*)

async feature_extraction(*request: fastapi.Request*)

async get_target_features(*request: fastapi.Request*)

async update_service(*request: fastapi.Request*)

class lib.sedna.service.multi_edge_inference.server.**ReIDServer**(*model*, *service_name*, *ip: str = '127.0.0.1'*, *port: int = 8080*, *max_buffer_size: int = 104857600*, *workers: int = 1*)

Bases: sedna.service.server.base.BaseServer

REST api server for reid

start()

status(*request: fastapi.Request*)

async reid(*request: fastapi.Request*)

Package Contents

Classes

Detection	Endpoint to trigger the Object Tracking component
FE	Endpoint to trigger the Feature Extraction
ReID_Endpoint	Endpoint to trigger the ReID
DetectionServer	REST api server for object detection component
FEServer	rest api server for feature extraction
ReIDServer	REST api server for reid

class lib.sedna.service.multi_edge_inference.**Detection**(*service_name*, *version=''*, *ip='127.0.0.1'*, *port='8080'*, *protocol='http'*)

Endpoint to trigger the Object Tracking component

check_server_status()

transmit(*data*, ***kwargs*)

Transfer enriched tracking object to video analytics job

update_service(*data*, ***kwargs*)

class lib.sedna.service.multi_edge_inference.**FE**(*service_name*, *version=''*, *ip='127.0.0.1'*, *port='8080'*, *protocol='http'*)

Endpoint to trigger the Feature Extraction

check_server_status()

transmit(*data*, ***kwargs*)

Transfer feature vector to FE worker

get_target_features(*data*, ***kwargs*)

Send target images to FE service and receive back the ReID features

update_service(*data*, ***kwargs*)

class lib.sedna.service.multi_edge_inference.**ReID_Endpoint**(*service_name*, *version=''*, *ip='127.0.0.1'*, *port='8080'*, *protocol='http'*)

Endpoint to trigger the ReID

check_server_status()

transmit(*data:* sedna.core.multi_edge_inference.data_classes.DetTrackResult, ***kwargs*)

Transfer feature vector to ReID worker

class lib.sedna.service.multi_edge_inference.**DetectionServer**(*model*, *service_name*, *ip: str = '127.0.0.1'*, *port: int = 8080*, *max_buffer_size: int = 1004857600*, *workers: int = 1*)

Bases: sedna.service.server.base.BaseServer

REST api server for object detection component

start()

status(*request: fastapi.Request*)

async video_analytics(*request: fastapi.Request*)

async update_service(*request: fastapi.Request*)

class lib.sedna.service.multi_edge_inference.**FEServer**(*model*, *service_name*, *ip: str = '127.0.0.1'*, *port: int = 8080*, *max_buffer_size: int = 1004857600*, *workers: int = 1*)

Bases: sedna.service.server.base.BaseServer

rest api server for feature extraction

start()

status(*request: fastapi.Request*)

async feature_extraction(*request: fastapi.Request*)

async get_target_features(*request: fastapi.Request*)

async update_service(*request: fastapi.Request*)

class lib.sedna.service.multi_edge_inference.**ReIDServer**(*model*, *service_name*, *ip: str = '127.0.0.1'*, *port: int = 8080*, *max_buffer_size: int = 104857600*, *workers: int = 1*)

Bases: sedna.service.server.base.BaseServer

REST api server for reid

start()

status(*request: fastapi.Request*)

async reid(*request: fastapi.Request*)

lib.sedna.service.server

Subpackages

lib.sedna.service.server.knowledgeBase

Submodules

lib.sedna.service.server.knowledgeBase.database

Module Contents

lib.sedna.service.server.knowledgeBase.database.**SQLALCHEMY_DATABASE_URL**

lib.sedna.service.server.knowledgeBase.database.**engine**

lib.sedna.service.server.knowledgeBase.database.**SessionLocal**

lib.sedna.service.server.knowledgeBase.database.**Base**

lib.sedna.service.server.knowledgeBase.model

Module Contents

Classes

TaskGrp	Task groups
Tasks	Task table
TaskModel	model belong tasks
TaskRelation	relation between two tasks
Samples	Sample storage
TaskSample	Sample of tasks

Functions

get_or_create(session, model, **kwargs)
init_db()

Attributes

engine

lib.sedna.service.server.knowledgeBase.model.**engine**

class lib.sedna.service.server.knowledgeBase.model.**TaskGrp**

Bases: *lib.sedna.service.server.knowledgeBase.database.Base*

Task groups

__tablename__ = 'll_task_grp'

id

name

deploy

sample_num

task_num

class lib.sedna.service.server.knowledgeBase.model.**Tasks**

Bases: *lib.sedna.service.server.knowledgeBase.database.Base*

Task table

__tablename__ = 'll_tasks'

id

name

task_attr

created_at

updated_at

__repr__()

class lib.sedna.service.server.knowledgeBase.model.**TaskModel**

Bases: *lib.sedna.service.server.knowledgeBase.database.Base*

model belong tasks

__tablename__ = 'll_task_models'

id

task_id

task

model_url

is_current

created_at

class lib.sedna.service.server.knowledgeBase.model.**TaskRelation**

Bases: *lib.sedna.service.server.knowledgeBase.database.Base*

relation between two tasks

__tablename__ = 'll_task_relation'

id

grp_id

grp

task_id

task

transfer_radio

class lib.sedna.service.server.knowledgeBase.model.**Samples**

Bases: *lib.sedna.service.server.knowledgeBase.database.Base*

Sample storage

__tablename__ = 'll_samples'

id

data_url

descr

data_type

updated_at

sample_num

class lib.sedna.service.server.knowledgeBase.model.**TaskSample**

Bases: *lib.sedna.service.server.knowledgeBase.database.Base*

Sample of tasks

__tablename__ = 'll_task_sample'

id

sample_id

sample

task_id

task

lib.sedna.service.server.knowledgeBase.model.**get_or_create**(*session*, *model*, ***kwargs*)

lib.sedna.service.server.knowledgeBase.model.**init_db**()

lib.sedna.service.server.knowledgeBase.server

Module Contents

Classes

KBUpdateResult	result
TaskItem	
KBServer	As knowledge base stored in sqlite, this class realizes creation,

class lib.sedna.service.server.knowledgeBase.server.**KBUpdateResult**

Bases: pydantic.BaseModel

result

status: int

tasks: Optional[str]

class lib.sedna.service.server.knowledgeBase.server.**TaskItem**

Bases: pydantic.BaseModel

tasks: List

class lib.sedna.service.server.knowledgeBase.server.**KBServer**(*host: str*, *http_port: int = 8080*, *workers: int = 1*, *save_dir=''*)

Bases: sedna.service.server.base.BaseServer

As knowledge base stored in sqlite, this class realizes creation, update and query of the sqlite.

start()

query()

async file_download(*files: str*, *name: str = ''*)

async file_upload(*file: fastapi.UploadFile = File(...)*)

update_status(*data:* KBUpdateResult *= Body(...)*)

update(*task: fastapi.UploadFile = File(...)*)

Submodules

lib.sedna.service.server.aggregation

Module Contents

Classes

AggregationServer

AggregationServerV2

class lib.sedna.service.server.aggregation.**AggregationServer**(*aggregation: str*, *host: str = None*, *http_port: int = None*, *exit_round: int = 1*, *participants_count: int = 1*, *ws_size: int = 10 * 1024 * 1024*)

Bases: *lib.sedna.service.server.base.BaseServer*

start()

Start the server

async client_info(*request: starlette.requests.Request*)

class lib.sedna.service.server.aggregation.**AggregationServerV2**(*data=None*, *estimator=None*, *aggregation=None*, *transmitter=None*, *chooser=None*)

start()

lib.sedna.service.server.base

Module Contents

Classes

Server

BaseServer

class lib.sedna.service.server.base.**Server**

Bases: uvicorn.Server

install_signal_handlers()

run_in_thread()

class lib.sedna.service.server.base.**BaseServer**(*servername: str*, *host: str = ''*, *http_port: int = 8080*, *grpc_port: int = 8081*, *workers: int = 1*, *ws_size: int = 16 * 1024 * 1024*, *ssl_key=None*, *ssl_cert=None*, *timeout=300*)

DEBUG = True

WAIT_TIME = 15

run(*app*, ***kwargs*)

wait_stop(*current*)

wait the stop flag to shutdown the server

get_all_urls()

lib.sedna.service.server.inference

Module Contents

Classes

InferenceServer	rest api server for inference

class lib.sedna.service.server.inference.**InferenceServer**(*model*, *servername*, *host: str = '127.0.0.1'*, *http_port: int = 8080*, *max_buffer_size: int = 104857600*, *workers: int = 1*)

Bases: *lib.sedna.service.server.base.BaseServer*

rest api server for inference

start()

model_info()

predict(*data: InferenceItem*)

Package Contents

Classes

InferenceServer	rest api server for inference
AggregationServer	
AggregationServerV2	

class lib.sedna.service.server.**InferenceServer**(*model*, *servername*, *host: str = '127.0.0.1'*, *http_port: int = 8080*, *max_buffer_size: int = 104857600*, *workers: int = 1*)

Bases: *lib.sedna.service.server.base.BaseServer*

rest api server for inference

start()

model_info()

predict(*data: InferenceItem*)

class lib.sedna.service.server.**AggregationServer**(*aggregation: str*, *host: str = None*, *http_port: int = None*, *exit_round: int = 1*, *participants_count: int = 1*, *ws_size: int = 10 * 1024 * 1024*)

Bases: *lib.sedna.service.server.base.BaseServer*

start()

Start the server

async client_info(*request: starlette.requests.Request*)

class lib.sedna.service.server.**AggregationServerV2**(*data=None*, *estimator=None*, *aggregation=None*, *transmitter=None*, *chooser=None*)

start()

Submodules

lib.sedna.service.client

Module Contents

Classes

LCReporter	Inherited thread, which is an entity that periodically report to
LCClient	send info to LC by http
AggregationClient	Client that interacts with the cloud aggregator.
ModelClient	Remote model service
KBClient	Communicate with Knowledge Base server

Functions

http_request(url[, method, timeout, binary, no_decode])	

lib.sedna.service.client.**http_request**(*url*, *method=None*, *timeout=None*, *binary=True*, *no_decode=False*, ***kwargs*)

class lib.sedna.service.client.**LCReporter**(*lc_server*, *message*, *period_interval=30*)

Bases: `threading.Thread`

Inherited thread, which is an entity that periodically report to the lc.

update_for_edge_inference()

update_for_collaboration_inference()

run()

Method representing the thread's activity.

You may override this method in a subclass. The standard run() method invokes the callable object passed to the object's constructor as the target argument, if any, with sequential and keyword arguments taken from the args and kwargs arguments, respectively.

class lib.sedna.service.client.**LCClient**

send info to LC by http

classmethod send(*lc_server*, *worker_name*, *message: dict*)

class lib.sedna.service.client.**AggregationClient**(*url*, *client_id*, ***kwargs*)

Client that interacts with the cloud aggregator.

max_size

async connect()

send(*data*, *msg_type='message'*, *job_name=''*)

recv(*wait_data_type=None*)

class lib.sedna.service.client.**ModelClient**(*service_name*, *version=''*, *host='127.0.0.1'*, *port='8080'*, *protocol='http'*)

Remote model service

check_server_status()

inference(*x*, ***kwargs*)

Use the remote big model server to inference.

class lib.sedna.service.client.**KBClient**(*kbserver*)

Communicate with Knowledge Base server

upload_file(*files*, *name=''*)

update_db(*task_info_file*)

update_task_status(*tasks: str*, *new_status=1*)

lib.sedna.service.run_kb

Module Contents

Functions

main()

lib.sedna.service.run_kb.**main**()

19.2 Submodules

19.2.1 lib.sedna.__version__

sedna version information.

Module Contents

lib.sedna.__version__.**tmp**

This document helps you prepare environment for developing code for Sedna. If you follow this guide and find some problem, please fill an issue to update this file.

CHAPTER

TWENTY

1. INSTALL TOOLS

20.1 Install Git

Sedna is managed with git, and to develop locally you will need to install `git`.

You can check if `git` is already on your system and properly installed with the following command:

```
git --version
```

20.2 Install Go(optional)

All Sedna's control components(i.e. GM/LC) are written in the Go. If you are planning to change them, you need to set up Go.

Sedna currently builds with Go 1.16, install or upgrade Go using the instructions for your operating system.

You can check if Go is in your system with the following command:

```
go version
```

CHAPTER

TWENTYONE

2. CLONE THE CODE

Clone the Sedna repo:

```
git clone http://github.com/kubeedge/sedna.git
```

Note: If you want to add or change API in pkg/apis, you need to checkout the code to `$GOPATH/src/github.com/kubeedge/sedna`.

CHAPTER

TWENTYTWO

3. SET UP KUBERNETES/KUBEEDGE(OPTIONAL)

If you are planning to run or debug Sedna, you need to set up Kubernetes and KubeEdge.

Sedna requires Kubernetes version 1.16 or higher with CRD support.

Sedna requires KubeEdge version 1.5 or higher with edge support.

Note: You need to check the Kubernetes compatibility of KubeEdge.

22.1 Install Kubernetes

Follow Kubernetes setup guides to set up and run Kubernetes, like:

If you're learning Kubernetes, use the tools to set up a Kubernetes cluster on a local machine, e.g.:

- Installing Kubernetes with Kind
- Installing Kubernetes with Minikube

22.2 Install KubeEdge

Please follow the kubeedge instructions to install KubeEdge.

CHAPTER

TWENTYTHREE

4. WHAT'S NEXT?

Once you've set up the prerequisites, continue with:

- See control plane development guide for more details about how to build & test Sedna.
- See lib development guide for more details about how to develop AI algorithms and worker images based on sedna lib code.

CHAPTER

TWENTYFOUR

ROADMAP

This document defines a high level roadmap for sedna development.

The milestones defined in GitHub represent the most up-to-date plans.

24.1 2022 Roadmap

- Integrate some common multi-task migration algorithms to resolve the problem of low precision caused by small size samples.
- Integrate KubeFlow and ONNX into Sedna, to enable interoperability of edge models with diverse formats.
- Integrate typical AI frameworks into Sedna, include Tensorflow, Pytorch, PaddlePaddle and Mindspore etc.
- Support edge model and dataset management.

CHAPTER

TWENTYFIVE

RELATED LINKS

25.1 Release

Sedna0.4.0 KubeEdgeSedna 0.3.0 AIKubeEdgeSedna 0.1 AIKubeEdgeSedna KubeEdge AI SIG

25.2 Meetup and Conference

HDC.Cloud 2021AI KubeEdge SednaAI50%

CHAPTER

TWENTYSIX

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- modindex
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PYTHON MODULE INDEX

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