Huawei HiAI DDK Integration Case

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The method of applying for HiAI is described as follows:

1. **Send an application email to developer@huawei.com.**
2. **The format of the email subject is HUAWEI HiAI+Company name+Product name.**
3. **The format of the email body is Cooperation company+Contact person+Contact information+Contact email address.**
4. **We will send you feedback within five workdays after receiving your email.**

Official website: http://developer.huawei.com/consumer/cn/devunion/ui/server/HiAI.html

Contents

Huawei HiAI DDK Integration Case

This document uses the TensorFlow InceptionV3 network as an example to describe the overall process of device development kit (DDK) access. The development environment is JDK 8 for 64-bit Windows 7+Android Studio 3.0.1.

A complete DDK integration case requires the following steps:

Step 1 Assess the operator compatibility.

Step 2 Convert the model format.

Step 3 Load the model.

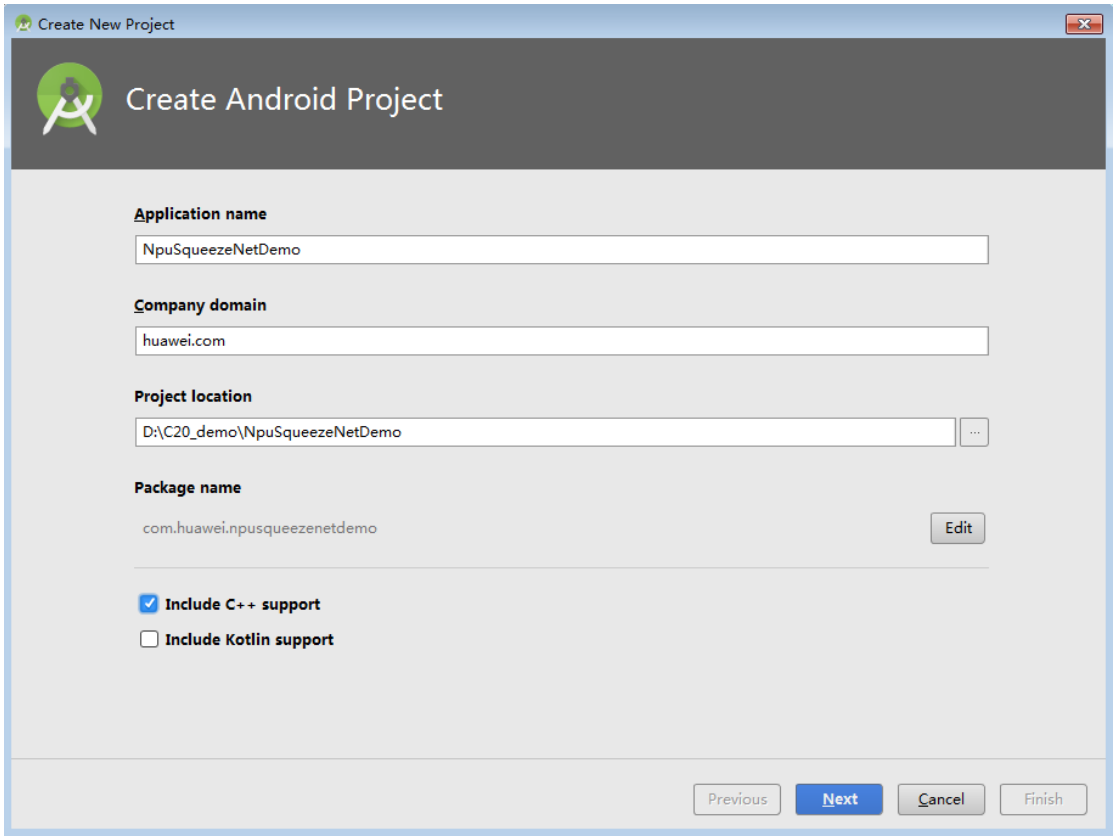
Step 4 Run the model.

Step 5 Unload the model.

----End

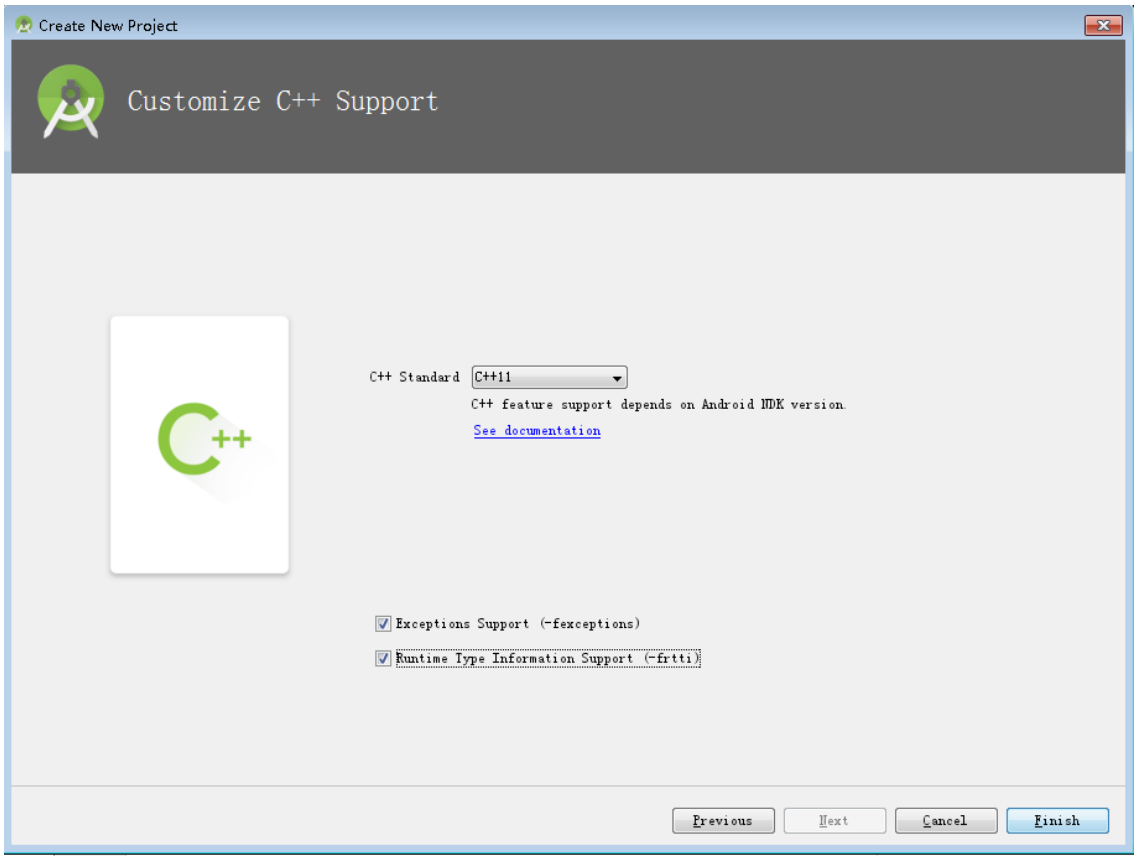
1 Creating a Project

Create an Android Studio project and select **Include C++ support**.

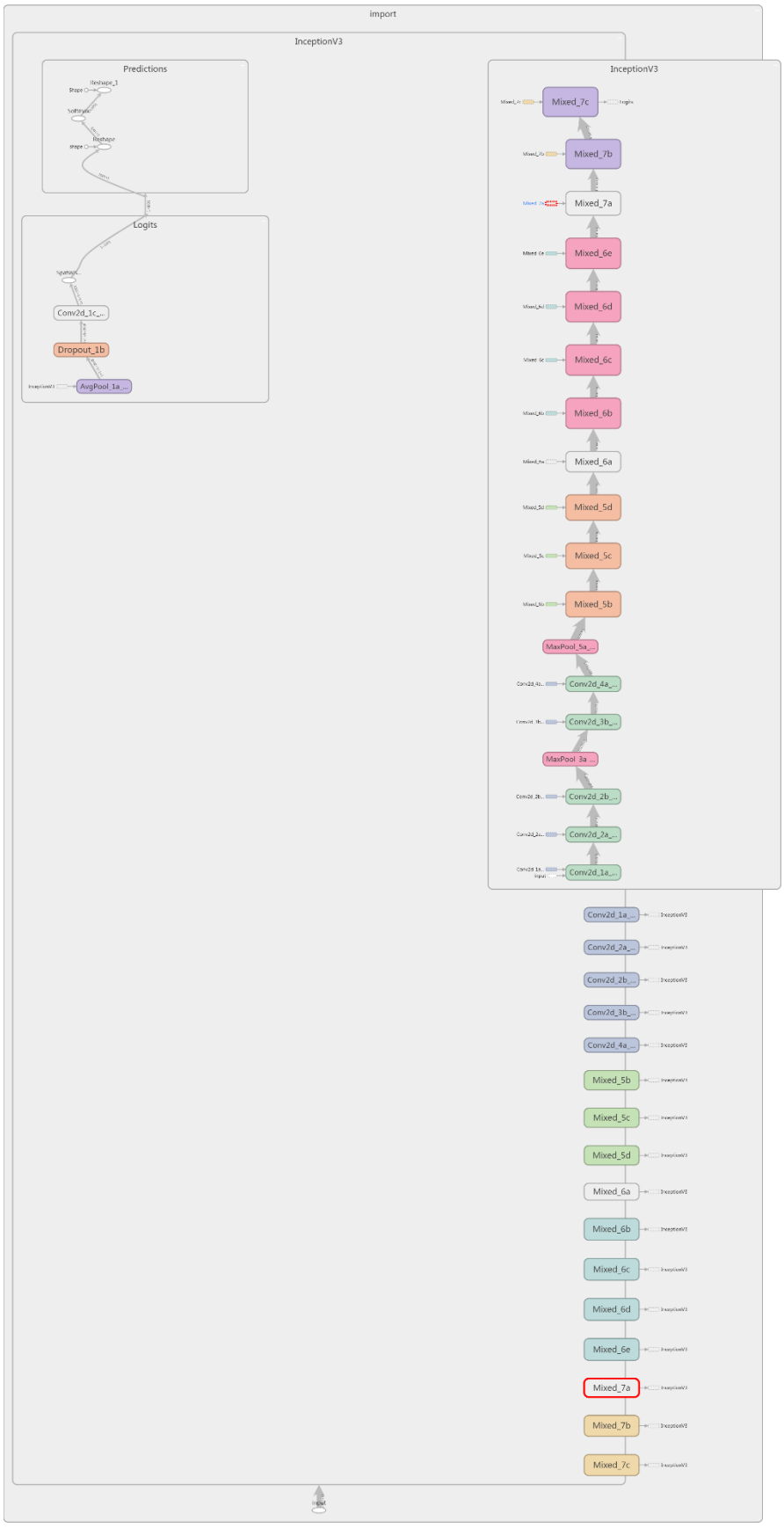


Customize C++ Support:

Choose **C++11** from the **C++ Standard** drop-down list box. Select **Exceptions Support(-fexceptions)** and **Runtime Type Information Support (-frtti)**.



2 Operator Compatibility Assessment


import
InceptionV3
Predictions
Logits
Conv2d_1c_...
Dropout_1b
AvgPool_1a_...
InceptionV3
Mixed_7c
Mixed_7b
Mixed_7a
Mixed_6e
Mixed_6d
Mixed_6c
Mixed_6b
Mixed_6a
Mixed_5d
Mixed_5c
Mixed_5b
MaxPool_5a_...
Conv2d_4a_...
Conv2d_3b_...
MaxPool_3a_...
Conv2d_2b_...
Conv2d_2a_...
Conv2d_1a_...
Conv2d_1a_...
Conv2d_2a_...
Conv2d_2b_...
Conv2d_3b_...
Conv2d_4a_...
Mixed_5b
Mixed_5c
Mixed_5d
Mixed_6a
Mixed_6b
Mixed_6c
Mixed_6d
Mixed_6e
Mixed_7a
Mixed_7b
Mixed_7c

According to the *Huawei HiAI DDK Operator Specification Document*, the last operator softmax is not supported. Therefore, users need to implement the last layer by themselves. Other operators and operator parameters meet the operator specification requirements.

3 Model Format Conversion

To download the InceptionV3 model, visit

https://storage.googleapis.com/download.tensorflow.org/models/inception_v3_2016_08_28_frozen.pb.tar.gz

Compile the InceptionV3 configuration file.

```
model_name: InceptionV3.cambricon
session_run{
input_nodes(1):                          //Specifies the number of input nodes (1).
"input",1,299,299,3                      //Specifies the name and shape of the input node.
output_nodes(1):                         //Specifies the number of output nodes (1).
"InceptionV3/Predictions/Softmax"        //Specifies the name of the output node.
}
```

Use the run.sh conversion tool in tools_tensorflow of the DDK to convert the model. (The original model, configuration file, and run script are placed in directories of the same level.)

```
~/tools_tensorflow$ ./run.sh
"Please input the tensorflow model file such as ***.pb  :" inceptionv3.pb
"Please input the param file such as  ***.txt         :" inceptionv3.txt
```

If the following log information is displayed, the model is successfully converted:

```
I tensorflow/stream_executor/ipu/ipu_model_generator.cc:248] write binary proto done!
I tensorflow/stream_executor/ipu/ipu_executor_common.cc:72] cngen::ipuLibExit
[Info]:ipuMaxMemory used: 83200256       [ipu_lib.cpp:130  96722]
```

4 Interface Introduction

The DDK provides a model manager that is based on C language interfaces. The function declaration is stored in the **HIAIModelManager.h** file.

```
int HIAI ModelManager loadFromModelBuffers(HIAI ModelManager* manager, HIAI ModelBuffer*
bufferArray[], int nBuffers);
int HIAI ModelManager runModel(
       HIAI ModelManager* manager,
       HIAI TensorBuffer* input[],
       int nInput,
       HIAI TensorBuffer* output[],
       int nOutput,
       int ulTimeout,
       const char* modelName);
HIAI ModelManager unloadModel(HIAI ModelManager* manager);
char* HIAI GetVersion();
```

For details about the DDK interfaces, see section 2.6 "Supported Interfaces" in the *Huawei HiAI DDK User Manual*.

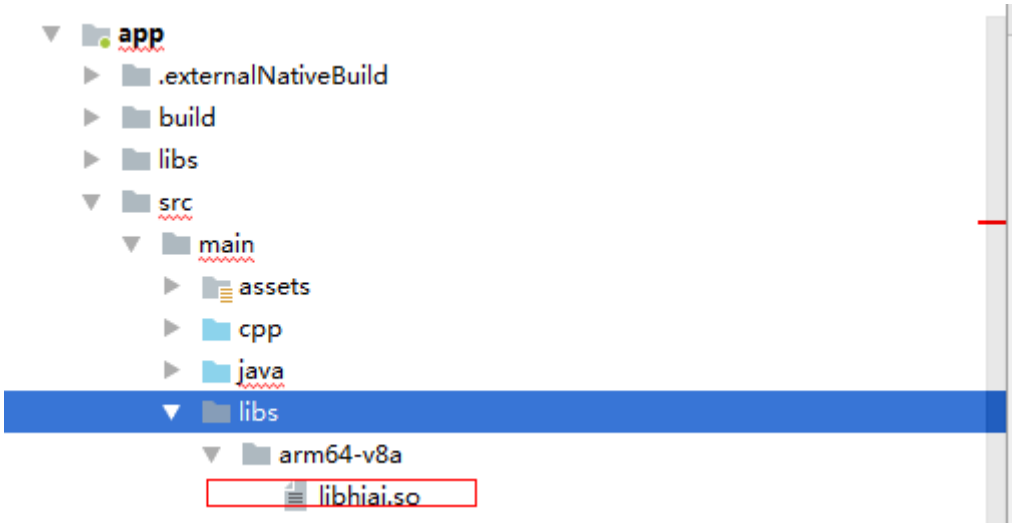
Copy the **classify_jni.cpp**, **classify_async_jni.cpp**, **common.cpp**, **common.h**, and **HIAIModelManager.h** files to the **jni** and **include** directories of the DDK, respectively, and modify the **Android.mk** file.

```
LOCAL_PATH:= $(call my-dir)

HIAI_SDK_HOME := $(LOCAL_PATH)/../../ai_ddk_lib

ifeq ($(TARGET_ARCH_ABI),arm64-v8a)
HIAI_SDK_LIB_PATH := $(HIAI_SDK_HOME)/lib64
else
HIAI_SDK_LIB_PATH := $(HIAI_SDK_HOME)/lib
endif

include $(CLEAR_VARS)
LOCAL_MODULE := hiai

#LOCAL_CFLAGS += -D__ndk1=__1

LOCAL_SRC_FILES :=  \
    classify_asynchronous_jni.cpp \
    classify_jni.cpp \
    common.cpp \

LOCAL_C_INCLUDES := \
   $(HIAI_SDK_HOME)/include \
    $(LOCAL_PATH)/../../ai_ddk_demo/jni \


LOCAL_LDLIBS += \
   -lai_client \
    -llog \
   -landroid \
    -ljnigraphics \

LOCAL_LDFLAGS := \
-Wl,-rpath-link=$(HIAI_SDK_LIB_PATH) \
-L $(HIAI_SDK_LIB_PATH) \

ifeq ($(VERBOSE_BUILD),true)
LOCAL_LDFLAGS += -v
endif
CPPFLAGS=-stdlib=libstdc++ LDLIBS=-lstdc++
LOCAL_CFLAGS += -std=c++14

include $(BUILD_SHARED_LIBRARY)
#include $(BUILD_EXECUTABLE)
```

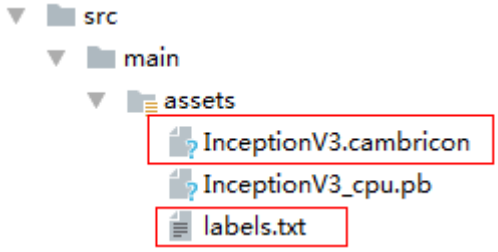
In the **jni** directory, run the **ndk-build** command to compile the file. **libhiai.so** is the compiled .so file. In this case, **arm64-v8a** is used as an example.

```
[arm64-v8a] SharedLibrary  : libhiai.so
[arm64-v8a] Install        : libhiai.so => libs/arm64-v8a/libhiai.so
```

Copy the **libhiai.so** file to the **/src/main/libs/arm64-v8a** directory in Android Studio.



Copy the generated offline model and tag file (**labels.txt** in the Android source code directory **src/main/assets/** provided by the DDK) to the **/src/main/assets** directory of the created project.



5 Interface Integration

The model usage process includes six steps: obtaining the DDK version number, creating the model manager, loading the model, calculating the model, unloading the model, and destroying the model manager. The DDK provides synchronous and asynchronous interfaces. App developers can select synchronous or asynchronous interfaces based on actual requirements. This section describes the use of a single model in synchronous and asynchronous modes and the implementation and invocation of each step in the process at the DDK, JNI, and application layers. For details about the code, see the DDK demo. For details about the DDK interfaces, see section 2.6 "Supported Interfaces" in the *Huawei HiAI DDK User Manual*.

In the demo, the related files of the synchronous and asynchronous modes are as follows.

Synchronous Mode	Asynchronous Mode
Application-layer code file: **SyncClassifyActivity.java**	Application-layer code file: **AsyncClassifyActivity.java**
JNI-layer code file: **classify_jni.cpp**	JNI-layer code file: classify_asynchronous_jni.cpp

The demo APK supports selection of pictures from the gallery or use of the camera to take pictures. Figure 5-1 shows the running effect of the demo APK.

Figure 5-1 Running effect of the demo app

5.2 Obtaining the DDK Version Number

Before using HiAI DDK for acceleration, you need to obtain the DDK version number and determine whether the system supports NPU acceleration based on the returned value. In the case, the CPU is used to run the model when the NPU is unavailable

5.2.1 Invoking the Model Manager to Obtain the DDK Version Number at the Application Layer

```
String VersionName = ModelManager.getHiAiVersion();
```

If the returned value is **000.000.000.000**, the version does not support NPU acceleration. For details, see section 2.5.1 "Obtaining the DDK Version Number" in the *Huawei HiAI DDK User Manual*.

5.2.2 Obtaining the DDK Version Number at the JNI Layer

```
Java com huawei hiaidemo ModelManager getHiAiVersion(JNIEnv *env, jobject instance) {

    char* versionName;
    jstring rtstr ;
    try{
        versionName = HIAI GetVersion();
        rtstr = env->NewStringUTF(versionName);
    }catch(...){
          rtstr = env->NewStringUTF("000.000.000.000");
       }
     return rtstr;
}
```

at this layer, the HIAI_GetVersion function is invoked to obtain the DDK version number and convert the returned value to java characters for output.

5.2.3 Obtaining the DDK Version Number at the DDK Layer

Execute the following code to obtain the DDK version number:

```
char* HIAI_GetVersion();
```

The type of the returned value is the string pointer.

5.3 Creating a Model Manager

5.3.1 Creating a Model Manager at the Application Layer

- Synchronous mode:

  Invoke the loadModelSync function at the JNI layer to create the synchronous model manager before the model is loaded.

  ```
  private class loadModelTask extends AsyncTask<Void, Void, Integer> {
        @Override
        protected Integer doInBackground(Void... voids) {
            int ret = ModelManager.loadModelSync("InceptionV3", mgr);
            return ret;
        }
  ```

- Asynchronous mode:

  Invoke the registerListenerJNI function at the JNI layer to create the model manager in asynchronous mode.

  ```
  protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        getSupportActionBar().hide();
        setContentView(R.layout.activity asynchronous classify);
        mgr = getResources().getAssets();
        int ret = ModelManager.registerListenerJNI(listener);
      ……
     }
  ```

5.3.2 Creating a Model Manager at the JNI Layer

Invoke the DDK interface HIAI_ModelManager_create at the JNI layer to create a model manager.

- Synchronous mode:

```
extern "C"  JNIEXPORT jint JNICALL
Java com huawei hiaidemo ModelManager loadModelSync(JNIEnv *env, jobject instance,
jstring jmodelName, jobject assetManager){
    ……
modelManager = HIA ModelManager create(NULL);
……
```

- Asynchronous mode:

```
extern "C"
JNIEXPORT jint JNICALL
Java com huawei hiaidemo ModelManager registerListenerJNI(JNIEnv *env, jobject obj,
                                                    jobject callbacks) {
    callbacksInstance = env->NewGlobalRef(callbacks);
    jclass objClass = env->GetObjectClass(callbacks);
    if (objClass) {
        callbacksClass = reinterpret cast<jclass>(env->NewGlobalRef(objClass));
        env->DeleteLocalRef(objClass);
    }
    listener.onLoadDone = onLoadDone;
    listener.onRunDone = onRunDone;
    listener.onUnloadDone = onUnloadDone;
    listener.onTimeout = onTimeout;
    listener.onError = onError;
    listener.onServiceDied = onServiceDied;
    modelManager = HIAI ModelManager create(&listener);
    return 0;
}
```

NewGlobalRef: used to obtain the ModelManagerListener object instance reference input at the application layer

GetObjectClass: used to obtain the input ModelManagerListener object type

DeleteLocalRef: used to release the object referenced by the application layer

The following describes how to call functions for the HIAI_ModelManagerListener object in asynchronous mode:

Use onLoadDone as an example.

```
void onLoadDone(void *userdata, int taskId) {
    LOGE("AYSNC JNI layer onLoadDone:", taskId);
    JNIEnv *env;
    jvm->AttachCurrentThread(&env, NULL);
    if (callbacksInstance != NULL) {
        jmethodID onValueReceived = env->GetMethodID(callbacksClass, "onStartDone",
"(I)V");
        env->CallVoidMethod(callbacksInstance, onValueReceived, taskId);
    }
}
```

The following code is used to obtain the JNIEnv pointer of the current thread from the local code:

```
JNIEnv *env;
jvm->AttachCurrentThread(&env, NULL);
```

GetMethodID: used to obtain the function interfaces in the ModelManagerListener class input at the application layer.

CallVoidMethod: used to call the onStartDone function.

5.3.3 Creating a Model Manager at the DDK Layer

The following is the function prototype used to create a model manager at the DDK layer.

```
HIAI_ModelManager* HIAI_ModelManager_create(HIAI_ModelManagerListener* listener);
```

A synchronous or an asynchronous model manager is created using input parameters. When the parameter is set to null, the synchronous model manager is created. When the input HIAI_ModelManagerListener is a non-empty instance pointer, the asynchronous model manager is created.

5.4 Loading a Model

You need to load a model before using it. The DDK supports single-model load and multi-model load. It also supports load of models from an SD card and the app source code directory **assets**.

5.4.1 Loading a Model at the Application Layer

- Synchronous mode:

  Invoke the loadModelSync function at the JNI layer to load the model in synchronous mode.

```
private class loadModelTask extends AsyncTask<Void, Void, Integer> {
       @Override
       protected Integer doInBackground(Void... voids) {
           int ret = ModelManager.loadModelSync("InceptionV3", mgr);
           return ret;
       }
```

- Asynchronous mode:

  Invoke the loadModelAsync function at the JNI layer to load the model in asynchronous mode.

```
   protected void onCreate(Bundle savedInstanceState) {
       super.onCreate(savedInstanceState);
       getSupportActionBar().hide();
       setContentView(R.layout.activity asynchronous classify);
       mgr = getResources().getAssets();
       int ret = ModelManager.registerListenerJNI(listener);
       Log.e(TAG, "onCreate: " + ret);
       ModelManager.loadModelAsync("InceptionV3", mgr);
       items = new ArrayList<>();
       mgr = getResources().getAssets();
       initView();
   }
```

5.4.2 Loading a Model at the JNI Layer

- Synchronous mode:

```
extern "C"
JNIEXPORT jint JNICALL
Java com huawei hiaidemo ModelManager loadModelSync(JNIEnv *env, jobject instance,
jstring jmodelName, jobject assetManager){
  ……
AAssetManager *mgr = AAssetManager fromJava(env, assetManager);
   LOGI("Attempting to load model...\n");
   LOGE("model name is %s", modelname);
   AAsset *asset = AAssetManager open(mgr, modelname, AASSET MODE BUFFER);
   if (nullptr == asset) {
```

```
        LOGE("AAsset is null...\n");
    }
    const void *data = AAsset_getBuffer(asset);
    if (nullptr == data) {
        LOGE("model buffer is null...\n");
    }
    off_t len = AAsset_getLength(asset);
    if (0 == len) {
        LOGE("model buffer length is 0...\n");
    }

    HIAI_ModelBuffer *modelBuffer = HIAI_ModelBuffer_create_from_buffer(modelName,
              (void *) data, len,   HIAI_DevPerf::HIAI_DEVPREF_HIGH);
    HIAI_ModelBuffer *modelBufferArray[] = {modelBuffer};

    int ret = HIAI_ModelManager_loadFromModelBuffers(modelManager, modelBufferArray, 1);
    LOGI("load model from assets ret = %d", ret);
    env->ReleaseStringUTFChars(jmodelName, modelName);
    getInputAndOutputFromModel(modelName)
    AAsset close(asset);
    return ret;
}
```

At the JNI layer, the AssetManager is obtained by using the following code:

```
AAssetManager *mgr = AAssetManager_fromJava(env, assetManager);
```

For details about the AssetManager APIs, visit the website for Android developers at https://developer.android.com/ndk/reference/asset__manager_8h.html.

Execute the following code:

```
AAsset* asset = AAssetManager_open(mgr, "InceptionV3.cambricon", AASSET_MODE_BUFFER);
```

The AAssetManager_open interface is used to read the **InceptionV3.cambricon** file in the **assets** directory of the app source code and returns **AAsset**.

Obtain the buffer address and size using the following functions:

```
void *data = (void *)AAsset_getBuffer(asset);

off_t len = AAsset_getLength(asset);
```

Invoke the DDK interface function HIAI_ModelBuffer_create_from_buffer to create the HIAI_ModelBuffer object and invoke HIAI_ModelManager_loadFromModelBuffers to load the model.

- Asynchronous mode:

```
extern "C"
JNIEXPORT void JNICALL
Java com huawei hiaidemo ModelManager loadModelAsync(JNIEnv *env, jobject instance,
          jstring jmodelName, jobject assetManager) {
……
    HIAI ModelBuffer *modelBuffer = HIAI ModelBuffer create from buffer(modelName,
          (void *) data, len, HIAI DevPerf::HIAI DEVPREF HIGH);
    HIAI ModelBuffer *modelBufferArray[] = {modelBuffer};
    int ret = HIAI ModelManager loadFromModelBuffers(modelManager, modelBufferArray, 1);
    LOGE("ASYNC JNI LAYER load model from assets ret = %d", ret);
    env->ReleaseStringUTFChars(jmodelName, modelName);
    AAsset close(asset);
}
```

The loading process is the same as that in synchronous mode. The only difference is that the input parameter is the asynchronous model management engine when the HIAI_ModelManager_loadFromModelBuffers interface function is invoked.

5.4.3 Loading a Model at the DDK Layer

The following is the interface function prototype used to load a model at the DDK layer:

```
int HIAI ModelManager loadFromModelBuffers(HIAI ModelManager* manager, HIAI ModelBuffer*
bufferArray[], int nBuffers);
```

manager: Specifies the object interface of the model management engine (synchronous or asynchronous).

bufferArray[]: HIAI_ModelBuffer. Single- and multi-model are both supported.

nBuffers: number of loaded models

5.5 Running a Model

5.5.1 Running a Model at the Application Layer

- Synchronous mode:

  Invoke the runModelSync function at the JNI layer to run the model in synchronous mode.

```
private class RunModelTask extends AsyncTask<Bitmap, Void, String[]> {
       @Override
       protected String[] doInBackground(Bitmap... bitmaps) {
          float[] buffer = getPixel(bitmaps[0], RESIZED_WIDTH, RESIZED_HEIGHT);
          initClassifiedImg = bitmaps[0];
          predictedClass = ModelManager.runModelSync("InceptionV3", buffer);
          return predictedClass;
       }
   ……
    }
```

  Use the getPixel function to obtain the model input from images, and then invoke the runModelSync function at the JNI layer to run the model in synchronous mode.

- Asynchronous mode:

  Invoke the runModelAsync function at the JNI layer to run the model in asynchronous mode.

```
protected void onActivityResult(int requestCode, int resultCode, Intent data) {
       super.onActivityResult(requestCode, resultCode, data);
       if (resultCode == RESULT OK && data != null) switch (requestCode) {
          case GALLERY REQUEST CODE:
             try {
                Bitmap bitmap;
                ContentResolver resolver = getContentResolver();
                Uri originalUri = data.getData();
                bitmap = MediaStore.Images.Media.getBitmap(resolver, originalUri);
                String[] proj = {MediaStore.Images.Media.DATA};
                Cursor cursor = managedQuery(originalUri, proj, null, null, null);
                cursor.moveToFirst();
                Bitmap rgba = bitmap.copy(Bitmap.Config.ARGB_8888, true);
                final Bitmap initClassifiedImg = Bitmap.createScaledBitmap(rgba,
RESIZED_WIDTH, RESIZED_HEIGHT, false);
```

```
                final float[] pixels = getPixel(initClassifiedImg, RESIZED_WIDTH,
RESIZED_HEIGHT);
                show = initClassifiedImg;
                ModelManager.runModelAsync("InceptionV3", pixels);
            } catch (IOException e) {
                Log.e(TAG, e.toString());
            }
            break;
……
    }
```

5.5.2 Running a Model at the JNI Layer

- Synchronous mode:

```
extern "C"
JNIEXPORT jobjectArray JNICALL
Java_com_huawei_hiaidemo_ModelManager_runModelSync(JNIEnv *env, jclass type, jstring
jmodelName, jfloatArray jbuf) {
    const char *modelName = env->GetStringUTFChars(jmodelName, 0);
    if (NULL == modelManager) {
        LOGE("please load model first");
        return NULL;
    }
    float *dataBuff = NULL;
    if (NULL != jbuf) {
        dataBuff = env->GetFloatArrayElements(jbuf, NULL);
    }
    inputtensor = HIAI_TensorBuffer_create(input_N, input_C, input_H, input_W);
    HIAI_TensorBuffer *inputtensorbuffer[] = {inputtensor};
    outputtensor = HIAI_TensorBuffer_create(output_N, output_C, output_H, output_W);
    HIAI_TensorBuffer *outputtensorbuffer[] = {outputtensor};
    float *inputbuffer = (float *) HIAI_TensorBuffer_getRawBuffer(inputtensor);
    int length = HIAI_TensorBuffer_getBufferSize(inputtensor);
    LOGE("SYNC JNI runModel modelname:%s", modelName);
    memcpy(inputbuffer, dataBuff, length);
    float time use;
    struct timeval tpstart, tpend;
    gettimeofday(&tpstart, NULL);
    int ret = HIAI ModelManager runModel(
           modelManager,
           inputtensorbuffer,
           1,
           outputtensorbuffer,
           1,
           1000,
           modelName);
    LOGE("run model ret: %d", ret);
    gettimeofday(&tpend, NULL);
……
```

Use the env->GetFloatArrayElements(jbuf, NULL) function to obtain the application-layer input data.

Invoke the HIAI_TensorBuffer_create(input_N, input_C, input_H, input_W) function to create the inputTensor.

Then, invoke the DDK interface function HIAI_TensorBuffer_getRawBuffer(inputtensor) to obtain the inputTensor address.

Invoke the HIAI_TensorBuffer_getBufferSize(inputtensor) function to obtain the inputTensor size.

Finally, use the memcpy function to copy the input dataBuff at the application layer to the inputTensor.

After the copy is complete, create the outputTensor.

After the inputTensor and outputTensor are ready, invoke the HiAI_ModelManager_runModel interface to run the model.

After the model is run, perform post-processing on the data generated after model running.

- Asynchronous mode:

```
extern "C"
JNIEXPORT void JNICALL
Java com huawei hiaidemo ModelManager runModelAsync(JNIEnv *env, jobject instance,
                              jstring jmodelName, jfloatArray jbuf) {
   ……
   int ret = HIAI ModelManager runModel(
          modelManager,
          inputtensorbuffer,
          1,
          outputtensorbuffer,
          1,
          1000,
          modelName);
   LOGE("ASYNC JNI layer runmodel ret: %d", ret);
   ……
}
```

The model running process in asynchronous mode is the same as that in synchronous mode. The only difference is that the input parameter is the asynchronous model management engine when the HIAI_ModelManager_runModel interface function is invoked.

The post-processing after the model is run in asynchronous mode is implemented through the callback function onRunDone.

5.5.3 Running a Model at the DDK Layer

The following is the interface function prototype for running a model at the DDK layer:

```
int HIAI_ModelManager_runModel(
       HIAI_ModelManager* manager,
       HIAI_TensorBuffer* input[],
       int nInput,
       HIAI_TensorBuffer* output[],
       int nOutput,
       int ulTimeout,
       const char* modelName);
```

manager: Specifies the object interface of the model management engine.

input[]: Specifies the model input. Multiple inputs are supported.

nInput: Specifies the number of inputs by a model.

output[]: Specifies the model output. Multiple outputs are supported.

nOutput: Specifies the number of outputs by a model.

ulTimeout: Specifies the timeout.

modelName: Specifies a model name.

5.6 Unloading a Model and Destroying a Model Manager

5.6.1 Unloading a Model and Destroying the Model Manager at the Application Layer

- Synchronous mode:

  Invoke the unloadModelSync function at the JNI layer to unload the model in synchronous mode.

```
protected void onDestroy() {
       super.onDestroy();
       int result = ModelManager.unloadModelSync();

       if (AI_OK == result) {
          Toast.makeText(this, "unload model success.", Toast.LENGTH_SHORT).show();
       } else {
          Toast.makeText(this, "unload model fail.", Toast.LENGTH_SHORT).show();
       }
   }
```

- Asynchronous mode:

  Invoke the unloadModelAsync function at the JNI layer to unload the model in asynchronous mode.

```
protected void onDestroy() {
       super.onDestroy();
       ModelManager.unloadModelAsync();
   }
```

  The model manager in asynchronous mode is unloaded through the callback function.

5.6.2 Unloading a Model and Destroying the Model Manager at the JNI Layer

- Synchronous mode:

```
extern "C"
JNIEXPORT jint JNICALL
Java com huawei hiaidemo ModelManager unloadModelSync(JNIEnv *env, jobject instance) {
   if (NULL == modelManager) {
       LOGE("please load model first.");
       return -1;
   } else {
       if (modelBuffer != NULL) {
          HIAI ModelBuffer destroy(modelBuffer);
          modelBuffer = NULL;
       }
       int ret = HIAI ModelManager unloadModel(modelManager);

       LOGE("JNI unload model ret:%d", ret);
       HIAI ModelManager destroy(modelManager);
       modelManager = NULL;
       return ret;
   }
```

```
}
```

- Asynchronous mode:

```
void onUnloadDone(void *userdata, int taskStamp) {
    LOGE("JNI layer onUnloadDone:", taskStamp);
    JNIEnv *env;
    jvm->AttachCurrentThread(&env, NULL);
    if (callbacksInstance != NULL) {
        jmethodID onValueReceived = env->GetMethodID(callbacksClass, "onStopDone", "(I)V");
        env->CallVoidMethod(callbacksInstance, onValueReceived, taskStamp);
    }
    HIAI ModelManager destroy(modelManager);
    modelManager = NULL;
    listener.onRunDone = NULL;
    listener.onUnloadDone = NULL;
    listener.onTimeout = NULL;
    listener.onServiceDied = NULL;
    listener.onError = NULL;
    listener.onLoadDone = NULL;
}
extern "C"
JNIEXPORT void JNICALL
Java com huawei hiaidemo ModelManager unloadModelAsync(JNIEnv *env, jobject instance) {
    if (NULL == modelManager) {
        LOGE("please load model first");
        return;
    } else {
        if (modelBuffer != NULL) {
            HIAI ModelBuffer destroy(modelBuffer);
            modelBuffer = NULL;
        }
        int ret = HIAI ModelManager unloadModel(modelManager);
        LOGE("ASYNC JNI layer unLoadModel ret:%d", ret);
    }
}
```

The model is unloaded using the unloadModelAsync function, while the model manager is destroyed using the callback function onUnloadDone.

5.6.3 Unloading a Model and Destroying the Model Manager at the DDK Layer

The following is the interface function prototype for unloading a model at the DDK layer:

```
int HIAI_ModelManager_unloadModel(HIAI_ModelManager* manager);
```

The following is the interface function prototype for destroying the model manager at the DDK layer:

```
void HIAI_ModelManager_destroy(HIAI_ModelManager* manager);
```

manager: Specifies the object interface of the model management engine.