

基于Duo开发板的Densenet图像分类

1.配置docker开发环境

docker安装

在windows环境下，可以安装Docker Desktop for Windows, [docker下载地址](#)

Install Docker Desktop on Windows

Welcome to Docker Desktop for Windows. This page contains information about Docker Desktop for Windows system requirements, download URL, instructions to install and update Docker Desktop for Windows.

Docker Desktop for Windows

For checksums, see [Release notes](#)

Docker Desktop terms

Commercial use of Docker Desktop in larger enterprises (more than 250 employees OR more than \$10 million USD in annual revenue) requires a paid subscription.

System requirements

You must meet the following requirements to successfully install Docker Desktop on Windows:

WSL 2 backend

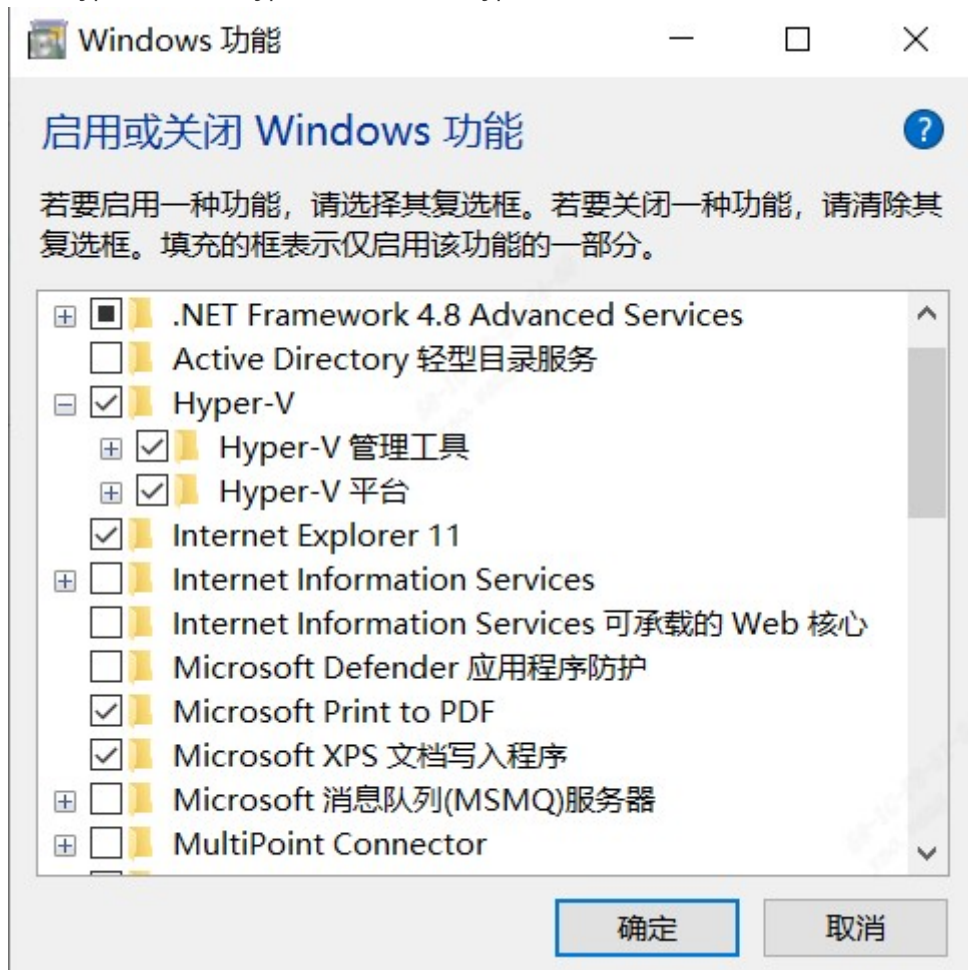
Hyper-V backend and Windows containers

在Windows下运行docker需要相关依赖，即如图中所示，需要使用WSL2后端或者Hyper-V后端作为运行依赖

Hyper-V后端的启用方式如下：

1. 控制面板 —— 程序 —— 启用或关闭Windows功能

2. 找到Hyper-V，勾选Hyper-V管理工具和Hyper-V平台，等待系统文件配置完成后重启电脑



然后即可安装下载好Docker Desktop for Windows，在安装指引中根据选择的后端进行相应的勾选
安装完成后，需要重启电脑，然后即可使用docker

拉取开发所需docker镜像

从docker hub获取镜像文件：

```
docker pull sophgo/tpuc_dev:v2.2
```

启动容器

```
docker run --privileged --name <container_name> -v /workspace -it  
sophgo/tpuc_dev:v2.2
```

其中，<container_name> 为自己定义的容器名

获取开发工具包

可以从下载站台中获取开发工具包 `tpu-mlir_XXXX.tar.gz`，XXXX 为版本号，如 `tpu-mlir_v1.2.89-g77a2268f-20230703`：

```
sftp://218.17.249.213
username: cvitek_mlir_2023
password: 7&2wd%cu5k
```

另外，也可以从github上下载，[下载地址](#)

拷贝开发工具包

新建一个终端，并将开发工具包从windows拷贝到docker容器中

```
docker cp <path>/tpu-mlir_xxxx.tar.gz <container_name>:/tpu-mlir_xxxx.tar.gz
```

其中，<path> 为windows系统中开发工具包所在的文件目录，<container_name> 为容器名

将工具包解压并添加环境变量

在docker容器中，解压工具包并添加环境变量

```
$ tar -zxvf tpu-mlir_xxxx.tar.gz
$ source ./tpu-mlir_xxxx/envsetup.sh
```

2.在docker中准备工作目录

建立 densenet121 工作目录，注意是与 tpu-mlir_xxxx 同级的目录，并将模型文件和图片文件都放入该目录下

```
$ mkdir densenet121 && cd densenet121
$ wget https://github.com/onnx/models/raw/main/vision/classification/densenet-121/model/densenet-12.tar.gz
$ tar -zxvf densenet-12.tar.gz
$ cp -rf $TPUC_ROOT/regression/dataset/ILSVRC2012 .
$ cp -rf $TPUC_ROOT/regression/image .
```

这里的 \$TPUC_ROOT 是环境变量，对应 tpu-mlir_xxxx 目录

将 densenet-12.tar.gz 解压后，会在当前目录生成 densenet-12 文件夹，该文件夹下包含有 densenet-12.onnx 模型文件

然后在当前目录下新建 work 目录

```
mkdir work && cd work
```

3.ONNX转MLIR

本例中，模型是RGB输入，mean 和 scale 分别为 123.675,116.28,103.53 和 0.0171,0.0175,0.0174

将onnx模型转换为mlir模型的命令如下：

```
$ model_transform.py \
--model_name densenet121 \
--model_def ../densenet-12/densenet-12.onnx \
--test_input ../image/cat.jpg \
--input_shapes [[1,3,224,224]] \
--resize_dims 256,256 \
--mean 123.675,116.28,103.53 \
--scale 0.0171,0.0175,0.0174 \
--pixel_format rgb \
--test_result densenet121_top_outputs.npz \
--mlir densenet121.mlir
```

运行成功示例：

```
[conv5_blk/bn_3_ReLU] SIMILAR [PASSED]
(1, 1024, 7, 7) float32
cosine_similarity = 1.000000
euclidean_similarity = 0.999999
sqnr_similarity = 121.799841
[pool5_1_GlobalAveragePool] CLOSE [PASSED]
(1, 1024, 1, 1) float32
close order = 5
[fc6_1_Conv] CLOSE [PASSED]
(1, 1000, 1, 1) float32
close order = 3
305 compared
305 passed
0 equal, 31 close, 274 similar
0 failed
0 not equal, 0 not similar
min_similarity = (0.9999997615814209, 0.9999987138564033, 117.36706733703613)
Target densenet121_top_outputs.npz
Reference densenet121_ref_outputs.npz
npz compare PASSED.
compare fc6_1_Conv: 100% 305/305 [00:02<00:00, 105.86it/s]
[Success]: npz_tool.py compare densenet121_top_outputs.npz densenet121_ref_outputs.npz --tolerance 0.99,0.99 --except -vv
```

转成mlir模型后，会生成一个 `densenet121.mlir` 文件，该文件即为mlir模型文件，还会生成一个 `densenet121_in_f32` 和一个 `densenet121_top_outputs.npz` 文件，该文件是后续转模型的输入文件

```
densenet121.mlir densenet121_opt.onnx.prototxt densenet121_top_f32_all_weight.npz final_opt.onnx
densenet121_in_f32.npz densenet121_origin.mlir densenet121_top_outputs.npz
```

4.MLIR转INT8模型

生成校准表

在转int8模型之前需要先生成校准表，这里用现有的100张来自ILSVRC2012的图片举例，执行calibration：

```
$ run_calibration.py densenet121.mlir \
--dataset ../ILSVRC2012 \
--input_num 100 \
-o densenet121_cali_table
```

运行成功示例：

```
input_num = 100, ref = 100
real input_num = 100
activation_collect_and_calc_th for op: fc6_1_Conv: 100% 306/306 [00:38<00:00, 7.92it/s]
[2048] threshold: fc6_1_Conv: 100% 306/306 [00:00<00:00, 1046.86it/s]
prepare data from 100
tune op: fc6_1_Conv: 100% 306/306 [00:58<00:00, 5.22it/s]
auto tune end, run time:58.822970151901245
```

运行完成后，会生成 `densenet121_cali_table` 文件，该文件用于后续编译int8模型

```
densenet121.mlir densenet121_in_f32.npz densenet121_origin.mlir densenet121_top_outputs.npz
densenet121_cali_table densenet121_opt.onnx.prototxt densenet121_top_f32_all_weight.npz final_opt.onnx
```

编译为int8模型

将mlir模型转换为int8模型的命令如下：

```
$ model_deploy.py \
  --mlir densenet121.mlir \
  --quantize INT8 \
  --calibration_table densenet121_cali_table \
  --chip cv180x \
  --test_input ../image/cat.jpg \
  --test_reference densenet121_top_outputs.npz \
  --compare_all \
  --fuse_preprocess \
  --model densenet121_cv180x_int8_fuse.cvimodel
```

编译成功示例：

```
[conv4_blk_1_Conv      ]      EQUAL [PASSED]
  (1, 512, 14, 14) float32
[concat_5_15_1_Concat  ]      EQUAL [PASSED]
  (1, 992, 7, 7) float32
[pool5_1_GlobalAveragePool]      EQUAL [PASSED]
  (1, 1024, 1, 1) float32
[fc6_1_Conv            ]      EQUAL [PASSED]
  (1, 1000, 1, 1) float32
[fc6_1_Conv_f32        ]      EQUAL [PASSED]
  (1, 1000, 1, 1) float32
11 compared
11 passed
  11 equal, 0 close, 0 similar
0 failed
  0 not equal, 0 not similar
min_similarity = (1.0, 1.0, inf)
Target      densenet121_cv180x_int8_sym_model_outputs.npz
Reference densenet121_cv180x_int8_sym_tpu_outputs.npz
npz compare PASSED.
compare fc6_1_Conv_f32: 100%|          | 11/11 [00:00<00:00, 109.05it/s]
[Success]: npz_tool.py compare densenet121_cv180x_int8_sym_model_outputs.npz densenet121_cv180x_int8_sym_tpu_outputs.npz
--tolerance 0.99,0.90 --except -vv
```

编译完成后，会生成 densenet121_cv180x_int8_fuse.cvimodel 文件

```
weight_map.csv          densenet121_opt.onnx.prototxt
densenet121.mlir        densenet121_origin.mlir
densenet121_cali_table  densenet121_top_f32_all_weight.npz
densenet121_cv180x_int8_fuse.cvimodel densenet121_top_outputs.npz
densenet121_cv180x_int8_sym_final.mlir densenet121_tpu_addressed_cv180x_int8_sym_weight.npz
densenet121_cv180x_int8_sym_tpu.mlir   densenet121_tpu_addressed_cv180x_int8_sym_weight_fix.npz
densenet121_in_f32.npz  final_opt.onnx
densenet121_in_ori.npz
```

5.在duo开发板上进行验证

连接duo开发板

根据前面的教程完成duo开发板与电脑的连接，并使用mobaxterm开启终端操作duo开发板

获取cvitek_tpu_sdk

可以从下载站台中获取开发工具包 cvitek_tpu_sdk_cv180x_musl_riscv64_rvv.tar.gz，注意需要选择 cv180x 的工具包，下载站台如下：

```
sftp://218.17.249.213
username: cvitek_mlir_2023
password: 7&2wd%cu5k
```

下载完成后，拷贝到docker中并在docker中进行解压

```
$ tar -zxvf cvitek_tpu_sdk_cv180x_musl_riscv64_rvv.tar.gz
```

解压完成后会生成 cvitek_tpu_sdk 文件夹

将开发工具包和模型文件拷贝到开发板上

在duo开发板的终端中，新建文件目录 /home/milkv/

```
$ mkdir /home/milkv && cd /home/milkv
```

在docker的终端中，将开发工具包和模型文件拷贝到开发板上

```
$ scp -r cvitek_tpu_sdk root@192.168.42.1:/home/milkv
$ scp /workspace/densenet121/work/densenet121_cv180x_int8_fuse.cvimodel
root@192.168.42.1:/home/milkv/cvitek_tpu_sdk
```

设置环境变量

在duo开发板的终端中，进行环境变量的设置

```
$ cd ./cvitek_tpu_sdk
$ source ./envs_tpu_sdk.sh
```

进行图像分类

在duo开发板中，对以下图像进行分类：



在duo开发板的终端中，输入如下命令，使用 `densenet121_cv180x_int8_fuse.cvimodel` 模型进行图像分类：

```
$ ./samples/bin/cvi_sample_classifier_fused_preprocess \  
./densenet121_cv180x_int8_fuse.cvimodel \  
./samples/data/cat.jpg \  
./samples/data/synset_words.txt
```

运行成功后会输出如下信息：

```
CVI_NN_RegisterModel succeeded  
CVI_NN_Forward succeeded  
-----  
10.750000, idx 282, n02123159 tiger cat  
8.937500, idx 285, n02124075 Egyptian cat  
8.500000, idx 281, n02123045 tabby, tabby cat  
7.593750, idx 287, n02127052 lynx, catamount  
6.250000, idx 263, n02113023 Pembroke, Pembroke Welsh corgi  
-----  
CVI_NN_CleanupModel succeeded
```