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Rockchip Trouble Shooting RKNN-Toolkit EN

(Technology Department, Graphic Display Platform Center)

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福州瑞芯微电子股份有限公司

Fuzhou Rockchips Electronics Co., Ltd

Revision History

Version no.	Author	Revision Date	Revision description	Auditor
V0.9	HPC	2019-04-01	Initial version release	Randall
V1.0	HPC	2019-07-18	Add some questions.	Randall
V1.1	HPC	2019-08-22	Add some convolution acceleration tips	Randall

Content

1. RKNN-Toolkit usage related questions

1.1. Why does channel_mean_value of rknn.config function have 4 values? If it is rgb image, does it still have 4 values?

channel-mean-value of rknn.config: used to set the preprocessing command line parameter. It includes four values (M0 M1 M2 S0). The first three values are mean value parameters and the last value is Scale parameter. If the input data have three channels (Cin0, Cin1, Cin2), the output data will be (Cout0,Cout1, Cout2) after preprocessing. The calculating process is as below:

Cout0 = (Cin0 - M0)/S0

Cout1 = (Cin1 - M1)/S0

Cout2 = (Cin2 - M2)/S0

For example, if need to formulate the input data into [-1, 1], you can set this parameter as (128 128 128 128);

If need to formulate the input data into [0, 1], you can set this parameter as (0 0 0 255).

1.2. When the input image is gray picture with single channel, how to set rknn.config interface?

Please refer to the answer of 1.1, when the input image is single channel, only "Cout0 = (Cin0 - M0)/S0" is used, so you can set as (M0, 0, 0, S0), while the values of M1 and M2 are not used.

1.3. How to set scale parameter of rknn.config function? That is to compress the input range into a certain scope, e.g. from (0-255) to (0-1).

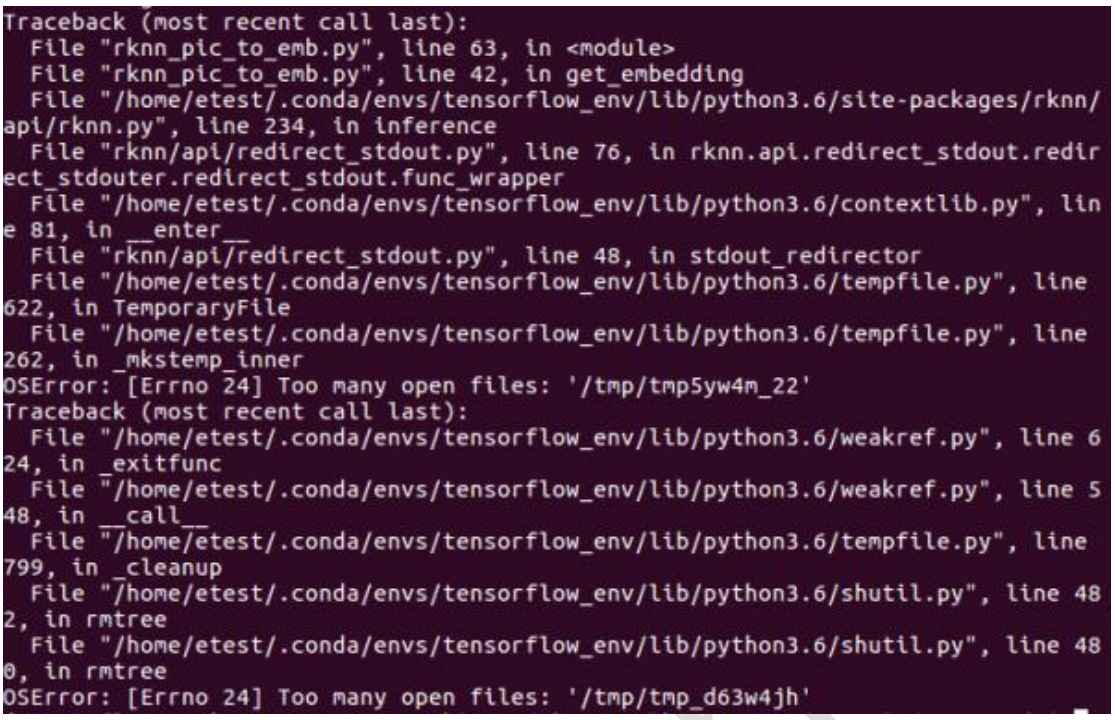
Refer to the answer of 1.1.

1.4. How to set "channel_mean_value" when input channel large than 3?

You don't need to set channel_mean_value or reorder_channel. The default value of mean will set to 0, scale will set to 1.

1.5. rknn.Inference() interface error or stuck happened after multiple invoke

If the error log is similar as below:



```
Traceback (most recent call last):
  File "rknn_pic_to_emb.py", line 63, in <module>
  File "rknn_pic_to_emb.py", line 42, in get_embedding
  File "/home/etest/.conda/envs/tensorflow_env/lib/python3.6/site-packages/rknn/
api/rknn.py", line 234, in inference
  File "rknn/api/redirect_stdout.py", line 76, in rknn.api.redirect_stdout.redir
ect_stdouter.redirect_stdout.func_wrapper
  File "/home/etest/.conda/envs/tensorflow_env/lib/python3.6/contextlib.py", lin
e 81, in __enter__
  File "rknn/api/redirect_stdout.py", line 48, in stdout_redirector
  File "/home/etest/.conda/envs/tensorflow_env/lib/python3.6/tempfile.py", line
622, in TemporaryFile
  File "/home/etest/.conda/envs/tensorflow_env/lib/python3.6/tempfile.py", line
262, in _mkstemp_inner
OSError: [Errno 24] Too many open files: '/tmp/tmp5yw4m_22'
Traceback (most recent call last):
  File "/home/etest/.conda/envs/tensorflow_env/lib/python3.6/weakref.py", line 6
24, in _exitfunc
  File "/home/etest/.conda/envs/tensorflow_env/lib/python3.6/weakref.py", line 5
48, in __call__
  File "/home/etest/.conda/envs/tensorflow_env/lib/python3.6/tempfile.py", line
799, in _cleanup
  File "/home/etest/.conda/envs/tensorflow_env/lib/python3.6/shutil.py", line 48
2, in rmtree
  File "/home/etest/.conda/envs/tensorflow_env/lib/python3.6/shutil.py", line 48
0, in rmtree
OSError: [Errno 24] Too many open files: '/tmp/tmp_d63w4jh'
```

Please update RKNN Toolkit to 0.9.9 or higher version.

1.6.rknn.inference() inferring speed slow issue

This issue has two kinds of phenomenon:

1) The speed of forward inferring test is slow, and some picture may take over 0.5s while testing mobilenet-ssd.

2) The time difference between model rknn.inference and rknn.eval_perf() is relatively big, such as:

Theoretical computing time(single picture)	1.79ms	8.23ms	7.485ms	30.55ms
Actual computing time(single picture)	21.37ms	39.82ms	33.12ms	76.13ms

There are two reasons for the issue of slow measured frame rate:

1. Using the method of pc + adb to upload picture is quite slow, as it has high frame rate requirement for network such as 1.79ms theoretically.
2. RKNN Toolkit 0.9.8 and previous versions have BUG, which is already fixed in 0.9.9.

For more real measured frame rate, you can directly use c/c++ api to test on the board.

1.7. The first inference of RKNN Toolkit 0.9.9 version is very slow

RKNN Toolkit 0.9.9 version postpones the model loading to the first inference, so the first inference is relatively slow. This issue will be fixed in next version.

1.8. Fail to enable pre_compile=true when using RKNN Toolkit to convert model on the development board

Arm64 version RKNN Toolkit doesn't support pre_compile so far, if need to open pre_compile, suggest to use x86 version RKNN Toolkit to do the conversion.

1.9. Returned outputs of YOLO forward test is [array1 , array2], the length is [10140 , 40560], what is the meaning of the returned value?

The outputs returned by rknn.inference is a list of numpy ndarray, the size and quantity of each model output data are different, users need to look up the corresponding output and analytic rule of models by themselves.

1.10. RKNN Toolkit supported quantization method

RKNN supports two kinds of quantization mechanisms:

- **Quantization-aware training**

  Refer to Tensorflow quantization-aware training (https://github.com/tensorflow/tensorflow/tree/master/tensorflow/contrib/quantize), which requires user should have some re-training experience of fine tune. Use rknn.build (do_quantization=False) after the quantized model is loaded through RKNN Toolkit, and now RKNN Toolkit will use the own quantization parameter of the model, so there is no loss on the quantization accuracy.

- **Post training quantization**

  When use this method, user loads the well-trained float point model, and RKNN Toolkit will do the quantization according to the dataset provided by user. Dataset should try to cover as many input type of model as possible. To make example simple, generally put only one picture. Suggest to put more.

Currently RKNN Toolkit supports three kinds of quantization methods:

✓ asymmetric_quantized-u8（default）

This is the quantization method supported by tensorflow, which is also recommended by

Google. According to the description in the article of Quantizing deep convolutional networks for efficient inference: A whitepaper, the accuracy loss of this quantization method is the smallest for most networks.

Its calculation formula is as follows:

$$quant = round\left(\frac{float\_num}{scale}\right) + zero\_point$$
$$quant = cast\_to\_bw$$

Where 'quant' represents the quantized number; 'float_num' represents float; data type of 'scalse' if float32; data type of 'zero-points' is int32, it represents the corresponding quantized value when the real number is 0. Finally saturate 'quant' to [range_min, range_max].

$$range\_\max = 255$$
$$range\_\min = 0$$

Currently only supports the inverse quantization of u8, the calculation formula is as follows:

$$float\_num = scale(quant - zero\_point)$$

✓ dynamic_fixed_point-8

For some models, the quantization accuracy of dynamic_fixed_point-8 is higher than asymmetric_quantized-u8.

Its calculation formula is as follows:

$$quant = round(\text{float}\_num * 2^{fl})$$
$$quant = cast\_to\_bw$$

Where 'quant' represents the quantized number; 'float_num' represents float; 'fl' is the number of digits shifted to the left. Finally saturate 'quant' to [range_min, range_max].

$$range\_\max = 2^{bw-1} - 1$$
$$range\_\min = -(2^{bw-1} - 1)$$

If 'bw' equals 8, the range is [-127, 127].

✓ dynamic_fixed_point-16

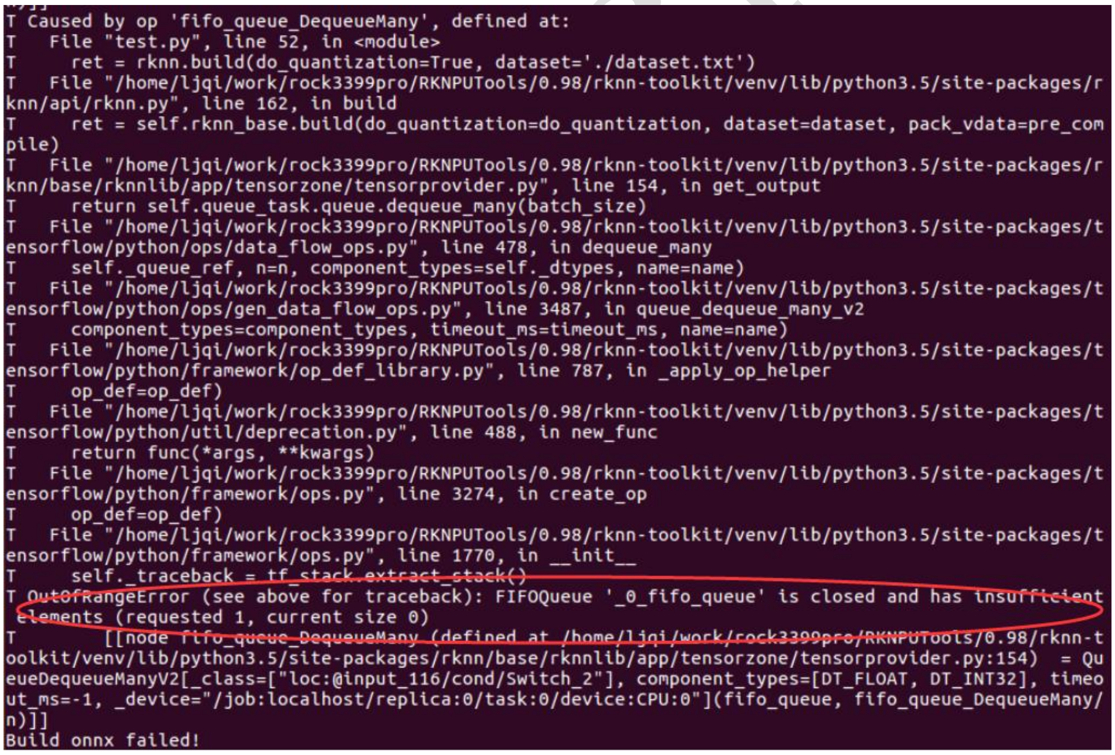
The quantization formula of dynamic_fixed_point-16 is the same as dynamic_fixed_point-8, except bw=16. For RK3399pro/RK1808, there is 300Gops int16 computing unit inside NPU, for some quantized to 8 bit network with relatively high accuracy loss, you can consider to use this quantization method.

1.11. If do_quantization is False during model conversion, will it do quantization? What is the quantization accuracy? (because the model is nearly half the size after conversion)

There are two scenarios. When the loaded model is the quantized model, do_quantization=False will use the quantization parameter of the model, for more details please refer to the answer of 1.9. When the loaded model is the non-quantized model, do_quantization=False will not do quantization, but will convert the weight from float32 to float16, which will not cause accuracy loss.

1.12. When structure RKNN model(invoking build interface), set do_quantization=False can build successfully, but set True will fail to build

The error log is as below:



```
n)]]
T Caused by op 'fifo_queue_DequeueMany', defined at:
T   File "test.py", line 52, in <module>
T     ret = rknn.build(do_quantization=True, dataset='./dataset.txt')
T   File "/home/ljqi/work/rock3399pro/RKNPUTools/0.98/rknn-toolkit/venv/lib/python3.5/site-packages/r
knn/api/rknn.py", line 162, in build
T     ret = self.rknn_base.build(do_quantization=do_quantization, dataset=dataset, pack_vdata=pre_com
pile)
T   File "/home/ljqi/work/rock3399pro/RKNPUTools/0.98/rknn-toolkit/venv/lib/python3.5/site-packages/r
knn/base/rknnlib/app/tensorzone/tensorprovider.py", line 154, in get_output
T     return self.queue_task.queue.dequeue_many(batch_size)
T   File "/home/ljqi/work/rock3399pro/RKNPUTools/0.98/rknn-toolkit/venv/lib/python3.5/site-packages/t
ensorflow/python/ops/data_flow_ops.py", line 478, in dequeue_many
T     self._queue_ref, n=n, component_types=self._dtypes, name=name)
T   File "/home/ljqi/work/rock3399pro/RKNPUTools/0.98/rknn-toolkit/venv/lib/python3.5/site-packages/t
ensorflow/python/ops/gen_data_flow_ops.py", line 3487, in queue_dequeue_many_v2
T     component_types=component_types, timeout_ms=timeout_ms, name=name)
T   File "/home/ljqi/work/rock3399pro/RKNPUTools/0.98/rknn-toolkit/venv/lib/python3.5/site-packages/t
ensorflow/python/framework/op_def_library.py", line 787, in _apply_op_helper
T     op_def=op_def)
T   File "/home/ljqi/work/rock3399pro/RKNPUTools/0.98/rknn-toolkit/venv/lib/python3.5/site-packages/t
ensorflow/python/util/deprecation.py", line 488, in new_func
T     return func(*args, **kwargs)
T   File "/home/ljqi/work/rock3399pro/RKNPUTools/0.98/rknn-toolkit/venv/lib/python3.5/site-packages/t
ensorflow/python/framework/ops.py", line 3274, in create_op
T     op_def=op_def)
T   File "/home/ljqi/work/rock3399pro/RKNPUTools/0.98/rknn-toolkit/venv/lib/python3.5/site-packages/t
ensorflow/python/framework/ops.py", line 1770, in __init__
T     self._traceback = tf_stack.extract_stack()
T OutOfRangeError (see above for traceback): FIFOQueue '_0_fifo_queue' is closed and has insufficient
 elements (requested 1, current size 0)
T         [[node fifo_queue_DequeueMany (defined at /home/ljqi/work/rock3399pro/RKNPUTools/0.98/rknn-t
oolkit/venv/lib/python3.5/site-packages/rknn/base/rknnlib/app/tensorzone/tensorprovider.py:154)  = Qu
eueDequeueManyV2[_class=["loc:@input_116/cond/Switch_2"], component_types=[DT_FLOAT, DT_INT32], timeo
ut_ms=-1, _device="/job:localhost/replica:0/task:0/device:CPU:0"](fifo_queue, fifo_queue_DequeueMany/
n)]]
Build onnx failed!
```

It is because there is no data in dataset.txt, or the data format is not supported. Recommend to use jpg or npy.

1.13. "undefined symbol: PyFPE_jbuf" error occurs when install RKNN-Toolkit

The reason of the error is Python environment is not clean, for example, numpy is installed in two different paths. You can re-build a clean Python environment and try again.

1.14. “Permission Denied” error occurs when install RKNN-Toolkit on Toybrick

The reason is there is no root authority. Need to add ‘--user’ option for installation.

1.15. Does RKNN support model conversion with multiple inputs?

Currently it doesn’t support model conversion with multiple inputs. This function is under evaluating.

1.16. What is the role of dataset during RKNN quantization? Why does quantization need to relate to dataset?

During RKNN quantization, need to find appropriate quantization parameters, such as scale or zero point. These quantization parameters should be selected according to the inference of the actual input.

1.17. Does rknn.inference() support multiple pictures input at the same time? Or support batch input?

Currently it doesn’t support multiple pictures input at the same time.

1.18. When will it support to convert pytorch and mxnet model directly to rknn?

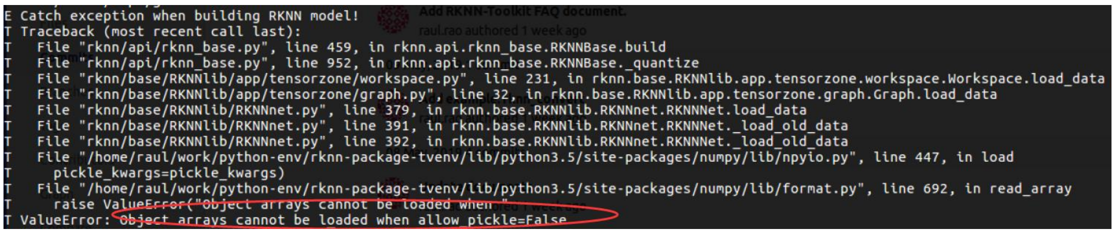
The function of converting Pytorch directly to rknn is under developing. There is no plan for mxnet so far.

1.19. Pre-compile model generated by RKNN-Toolkit-V0.9.9 can not run on RK3399Pro which NPU driver version is 0.9.6.

Pre-compiled model generated by RKNN-Toolkit-v1.0.0 can not run on device installed old driver (NPU driver version < 0.9.6), and pre-compiled model generated by old RKNN-Toolkit (version < 1.0.0) can not run on device installed new NPU driver (NPU drvier version == 0.9.6). We can call get_sdk_version interface to fetch driver version.

1.20. When I load model, the numpy module raises error: Object arrays cannot be loaded when allow pickle=False.

The error message is as follows：



```
E Catch exception when building RKNN model!
T Traceback (most recent call last):
T   File "rknn/api/rknn_base.py", line 459, in rknn.api.rknn_base.RKNNBase.build
T   File "rknn/api/rknn_base.py", line 952, in rknn.api.rknn_base.RKNNBase._quantize
T   File "rknn/base/RKNNlib/app/tensorzone/workspace.py", line 231, in rknn.base.RKNNlib.app.tensorzone.workspace.Workspace.load_data
T   File "rknn/base/RKNNlib/app/tensorzone/graph.py", line 32, in rknn.base.RKNNlib.app.tensorzone.graph.Graph.load_data
T   File "rknn/base/RKNNlib/RKNNnet.py", line 379, in rknn.base.RKNNlib.RKNNnet.RKNNnet.load_data
T   File "rknn/base/RKNNlib/RKNNnet.py", line 391, in rknn.base.RKNNlib.RKNNnet.RKNNnet._load_old_data
T   File "rknn/base/RKNNlib/RKNNnet.py", line 392, in rknn.base.RKNNlib.RKNNnet.RKNNnet._load_old_data
T   File "/home/raul/work/python-env/rknn-package-tvenv/lib/python3.5/site-packages/numpy/lib/npyio.py", line 447, in load
T     pickle_kwargs=pickle_kwargs)
T   File "/home/raul/work/python-env/rknn-package-tvenv/lib/python3.5/site-packages/numpy/lib/format.py", line 692, in read_array
T     raise ValueError("Object arrays cannot be loaded when "
T ValueError: Object arrays cannot be loaded when allow_pickle=False
```

This error is caused by the change in the default value of the allow_pickle parameter of the load file interface after numpy is upgraded to 1.16.3. There are two solutions: one is to reduce the numpy version to version 1.16.2 or lower; the other is to update RKNN-Toolkit to version 1.0.0 or later.

1.21. When I call rknn_init(), it raises error:RKNN_ERR_MODEL_INVALID.

The error message is as follows：

```
E RKNNAPI: rknn_init,    msg_load_ack fail, ack = 1, expect 0!
E Catch exception when init runtime!
T Traceback (most recent call last):
T     File "rknn/api/rknn_base.py", line 646, in rknn.api.rknn_base.RKNNBase.init_runtime
T     File "rknn/api/rknn_runtime.py", line 378, in
rknn.api.rknn_runtime.RKNNRuntime.build_graph
T Exception: RKNN init failed. error code: RKNN_ERR_MODEL_INVALID
```

Please make sure that the system version of the device is up to date.

1.22. When I call rknn_init(), it raises error:RKNN_ERR_DEVICE_UNAVAILABLE.

The error message is as follows：

```
E RKNNAPI: rknn_init, driver open fail! ret = -9!

E Catch exception when init runtime!

T Traceback (most recent call last):

T File "rknn/api/rknn_base.py", line 617, in rknn.api.rknn_base.RKNNBase.init_runtime

T File "rknn/api/rknn_runtime.py", line 378, in rknn.api.rknn_runtime.RKNNRuntime.build_graph

T Exception: RKNN init failed. error code: RKNN_ERR_DEVICE_UNAVAILABLE
```

Please check it out as follows:

1) Make sure that the RKNN Toolkit and the firmware of devices have been upgraded to the latest version.

2) Make sure the "adb devices" command can get the device, and the target and device_id settings of rknn.init_runtime() are correct.

3) If you use RKNN Toolkit 1.1.0 and above, make sure rknn.list_devices() can get the devices list.

4) If you are using a compute stick or NTB mode for the RK1808 EVB version, make sure you have called update_rk1808_usb_rule.sh (contained in the RKNN Toolkit distribution) to get read and write access to the USB device.

5) If you are running the AARCH64 version of the RKNN Toolkit directly on the RK3399/RK3399Pro, make sure the system firmware has been upgraded to the latest version.

1.23. When calling rknn.build() with pre_compile=True, it raises an error, it can be successful if it is not set.

The error message is as follows:

```
E Catch exception when building RKNN model!
T Traceback (most recent call last):
T     File "rknn/api/rknn_base.py", line 515, in rknn.api.rknn_base.RKNNBase.build
T     File "rknn/api/rknn_base.py", line 439, in rknn.api.rknn_base.RKNNBase._build
T     File "rknn/base/ovxconfiggenerator.py", line 187, in
rknn.base.ovxconfiggenerator.generate_vx_config_from_files
T     File "rknn/base/RKNNlib/app/exporter/ovxlib_case/casegenerator.py", line 380, in
rknn.base.RKNNlib.app.exporter.ovxlib_case.casegenerator.CaseGenerator.generate
T     File "rknn/base/RKNNlib/app/exporter/ovxlib_case/casegenerator.py", line 352, in
rknn.base.RKNNlib.app.exporter.ovxlib_case.casegenerator.CaseGenerator._gen_special_case
T     File "rknn/base/RKNNlib/app/exporter/ovxlib_case/casegenerator.py", line 330, in
rknn.base.RKNNlib.app.exporter.ovxlib_case.casegenerator.CaseGenerator._gen_nb_file
T AttributeError: 'CaseGenerator' object has no attribute 'nbg_graph_file_path'
```

Please confirm:

1) The system is equipped with the gcc compiler toolchain

2) The name of the model only contains "letters", "numbers", "_".

2. Questions related with quantization accuracy

2.1. The accuracy doesn't match with original model after quantization, how to debug?

- **Firstly make sure the accuracy of float type is similar to test result of original platform:**
  1. Make rknn.build(do_quantization=False) when the quantized model is loaded by RKNN Toolkit.
  2. Refer to 1.1 to set **channel_mean_value** parameter, which should be same as the parameter used for training model.
  3. Make sure the sequence of the input image channel must be R,G,B while testing. (Whatever the sequence of the image channel is used for training, it must be input by R,G,B while using RKNN to do testing)
  4. Set **reorder_channel** parameter in **rknn.config** function, '0 1 2' stands for RBG, '2 1 0' stands for BGR, and it must be consistent with the sequence of the image channel used for training.
- **Accuracy test after quantization**

(1) Use multiple pictures to do quantization, to ensure the stability of quantization accuracy.

Set batch_size parameter in rknn.config (recommend to set batch_size = 200) and provide more than 200 images path in dataset.txt for quantization.

If the display memory is not enough, you can set batch_size =1, epochs=200 instead of batch_size = 200 for quantization.

(2) Accuracy comparison, try to use relatively big data set to do testing. Compare the accuracy of top-1, top-5 for classifying network, compare mAP, Recall of data set for checking network, and so on.

2.2. How to dump the output of each layer of network

Currently PC simulator supports to dump out data of each layer of network. Need to set an environment variable before executing inference script. The command is as below:

```
export NN_LAYER_DUMP=1
python xxx.py
```

After execution, tensor data file of each layer of network will be generated in current directory, and then you can compare with data of other framework layer by layer.

Note, some layers may be combined, for example, conv+bn+scale may be combined into one conv, in this case, need to compare with output of scale layer of the original model.

3. Common issues of Caffe model conversion

3.1. “ Deprecated caffe input usage ” error occurs during model conversion

It means this model is old version of caffe mode. Need to change input layer into below format.

```
layer {
   name: "data"
   type: "Input"
   top: "data"
   input_param {
      shape {
         dim: 1
         dim: 3
         dim: 224
         dim: 224
      }
   }
}
```

3.2. “Message type "caffe.PoolingParameter" has no field named "round_mode"”error occurs during model conversion

round_mode field of Pool layer cannot be recognized, you can change it to ceil_model. For example, if originally it is round_mode: CEIL, then you can delete (ceil_mode is True by default) or change to ceil_mode:True.

3.3. “ValueError("'%s' is not a valid scope name" % name)” error occurs during caffe or other model conversion

The detailed error log is as below:

```
T         raise ValueError("'%s' is not a valid scope name" % name)
T    ValueError: '_plus0_17' is not a valid scope name
```

In this case, it is because layer name '_plusxxx' is not allowed to use _ at the beginning. Need to follow the naming rule of tensorflow:

[A-Za-z0-9.][A-Za-z0-9_.\\-/]* (for scopes at the root)

[A-Za-z0-9_.\\-/]* (for other scopes)

3.4. "Invalid tensor id(1), tensor(@mbox_conf_flatten_188:out0)" error occurs when Caffe version SSD conversion fails

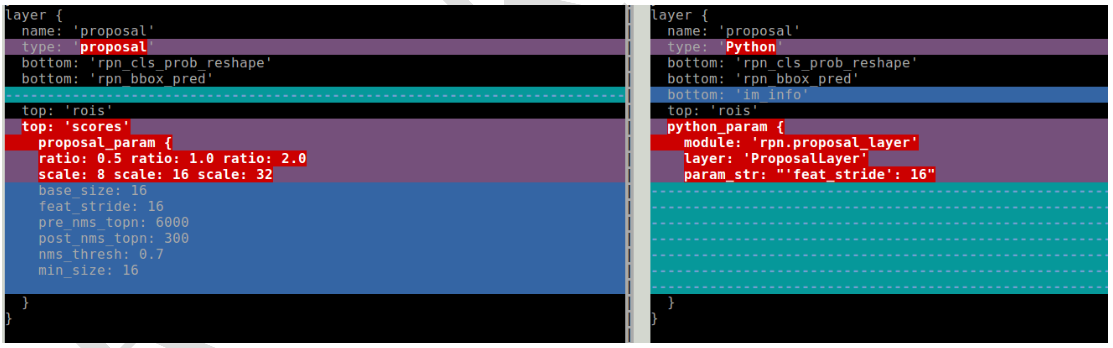
Not support detectionoutput layer, you can delete and then change to CPU.

3.5. There should be three output tensor after Caffe version SSD model deletes detectionoutput, but actually only return two tensor by RKNN inference

The missing tensor is priori box. It is the same during training and inference stage, and for all inputs. In order to improve performance, RKNN-Toolkit optimized the relative layer in the model. If want to get the tensor of priori box, you can save the tensor of priori box, or use Caffe to do inference once in training stage.

3.6. "ValueError: Invalid tensor id(1), tensor(@rpn_bbox_pred_18:out0)" error occurs during py-faster-rcnn model conversion

Comparing with official code, need to change 'proposal' layer of prototxt as below:



```
layer {
  name: 'proposal'
  type: 'proposal'
  bottom: 'rpn_cls_prob_reshape'
  bottom: 'rpn_bbox_pred'

  top: 'rois'
  top: 'scores'
    proposal_param {
    ratio: 0.5 ratio: 1.0 ratio: 2.0
    scale: 8 scale: 16 scale: 32
    base_size: 16
    feat_stride: 16
    pre_nms_topn: 6000
    post_nms_topn: 300
    nms_thresh: 0.7
    min_size: 16

  }
}
```

```
layer {
  name: 'proposal'
  type: 'Python'
  bottom: 'rpn_cls_prob_reshape'
  bottom: 'rpn_bbox_pred'
  bottom: 'im_info'
  top: 'rois'
  python_param {
    module: 'rpn.proposal_layer'
    layer: 'ProposalLayer'
    param_str: "'feat_stride': 16"
  }
}
```

layer {

  name: 'proposal'

  type: 'proposal'

  bottom: 'rpn_cls_prob_reshape'

  bottom: 'rpn_bbox_pred'

  top: 'rois'

  top: 'scores'

    proposal_param {

    ratio: 0.5 ratio: 1.0 ratio: 2.0

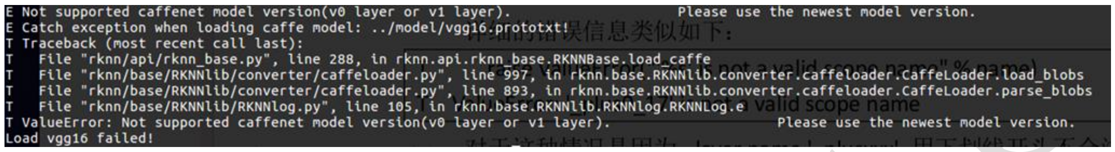
    scale: 8 scale: 16 scale: 32

    base_size: 16

    feat_stride: 16

```
        pre_nms_topn: 6000
        post_nms_topn: 300
        nms_thresh: 0.7
        min_size: 16
    }
}
```

3.7. “E Not supported caffenet model version(v0 layer or v1 layer)” error occurs during model conversion



```
E Not supported caffenet model version(v0 layer or v1 layer).                    Please use the newest model version.
E Catch exception when loading caffe model: ../model/vgg16.prototxt!
T Traceback (most recent call last):
T   File "rknn/api/rknn_base.py", line 288, in rknn.api.rknn_base.RKNNBase.load_caffe
T   File "rknn/base/RKNNlib/converter/caffeloader.py", line 997, in rknn.base.RKNNlib.converter.caffeloader.CaffeLoader.load_blobs
T   File "rknn/base/RKNNlib/converter/caffeloader.py", line 893, in rknn.base.RKNNlib.converter.caffeloader.CaffeLoader.parse_blobs
T   File "rknn/base/RKNNlib/RKNNlog.py", line 105, in rknn.base.RKNNlib.RKNNlog.RKNNLog.e
T ValueError: Not supported caffenet model version(v0 layer or v1 layer).                    Please use the newest model version.
Load vgg16 failed!
```

The main reason is that the version of the caffe model is too old and needs to be updated. The update method is as follows (take VGG16 as an example):

1) Download Caffe source code from https://github.com/BVLC/caffe.git

2) Compile Caffe

3) Convert the model to a new format

```
./build_release/tools/upgrade_net_proto_text vgg16_old/vgg16.prototxt vgg16_new/vgg16.prototxt
./build_release/tools/upgrade_net_proto_binary vgg16_old/vgg16.caffemodel vgg16_new/vgg16.caffemodel
```

4. Common issues of Tensorflow model conversion

4.1. “AttributeError: ‘NoneType’ object has no attribute op” error occurs during Google official ssd_mobilenet_v2 model conversion

One possible reason is that input node is not correct. You can modify as below:

```
rknn.load_tensorflow(tf_pb='./ssd_mobilenet_v2_coco_2018_03_29/frozen_inference_graph.pb',
                     inputs=['FeatureExtractor/MobilenetV2/MobilenetV2/input'],
                     outputs=['concat', 'concat_1'],
                     input_size_list=[[INPUT_SIZE, INPUT_SIZE, 3]])
```

4.2. “Cannot convert value dtype ([‘resource’, ‘u1’]) to a Tensorflow Dtype” error occurs during SSD_Resnet50_v1_FPN_640x640 model conversion

Need to update RKNN Toolkit to version 0.9.8 or higher.

4.3. On RKNN-Toolkit-V1.0.0， is the output shape of RKNN model converted from TensorFlow changed?

Versions prior to 1.0.0 will convert output shape from "NHWC" to "NCHW". Starting from this version, the shape of the output will be consistent with the original model, and no longer convert from "NHWC" to "NCHW". Please pay attention to the location of the channel when performing post processing.

5. Common issues of Pytorch model conversion

Currently RKNN Toolkit indirectly supports pytorch through ONNX, so need to convert pytorch to ONNX first. If issue occurs during conversion, please update RKNN Toolkit to the latest version first.

5.1. “assert(tsr.op_type == 'Constant')” error occurs during conversion

This issue is introduced after pytorch 0.4.5 version. In your model, if there is something like “x = x.view(x.size(0), -1)”, need to change to “x = x.view(int(x.size(0)), -1)”.

6. RKNN convolution acceleration tips

6.1. How to design a convolutional neural network to achieve optimal performance on RKNN

Here are some suggestions from us：

1. Optimal Kernel Size is 3x3

Convolution cores can support a large range of kernel sizes. The minimum supported kernel size is [1] and maximum is [11 * stride - 1].

The NN Engine performs most optimally when the Convolution kernel size is 3x3, under which the highest MAC utilization can be achieved.

Non-square kernels are also supported, but with some computation overhead.

2. Fused Operations Reduce Overhead

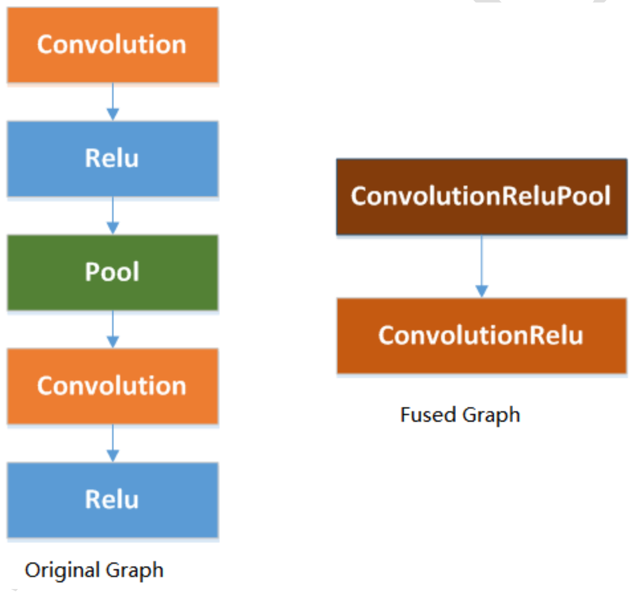
The Convolution core can fuse ReLU and MAX Pooling operations on the fly to further reduce computation and bandwidth overhead. A ReLU layer following a Convolution layer will always be fused, while MAX pooling layer fusion has the following restrictions, Max pooling must

- have a pool size of 3x3 or 2x2, and stride of 2

- 2x2 pooling must have an even input size and no padding

- 3x3 pooling must have odd input size which is not one and no padding

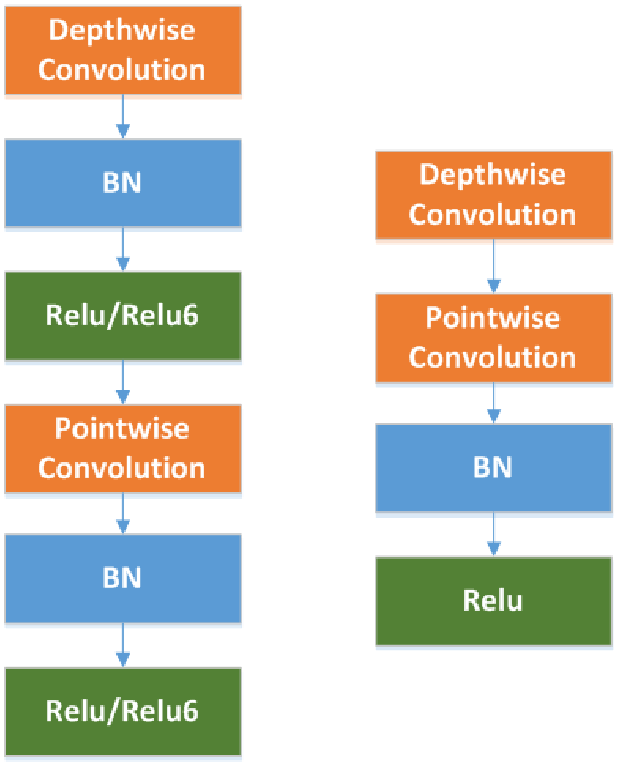
- Horizontal input size must be less than 64 (8-bit mode) or 32 (16-bit mode) if pool size is 3x3



3. Depthwise Convolutions

Both regular 2D and Depthwise convolutions are supported, while 2D convolutions perform more optimally. Since Depthiwise Convolution-specific structure makes it less friendly to quantized model. We recommend using 2D convolution whenever possible when designing your network.

If you must use a Depthwise convolution, we recommend following the rules below that can improve the accuracy of the quantized model:



- Change the activation function RELU6 to RELU.
- Remove the BN layer and activation layer of the Depthwise convolution layer.
- In training, for the Depthwise convolutional layer, L2 regularization of its weight.

4. Output channel number setting

We recommend setting the number of convolution output channels to be a multiple of the number of convolution kernels in the NPU to ensure that all convolution kernels are better utilized for higher hardware utilization.

5. Take advantage of Hardware's Sparse Matrix Support

Modern Neural-Networks are known to be over parameterized and have much redundancy in their design. Pruning a network to be sparse has been proven to reduce computation overhead while maintaining accuracy.

RKNN hardware is designed to support sparse matrix operations efficiently by skipping computations and memory fetches on zero values. The sparsity level can be fine grain down to individual weights. Designing a sparse network to take advantage of this technology could further improve performance on RKNN.