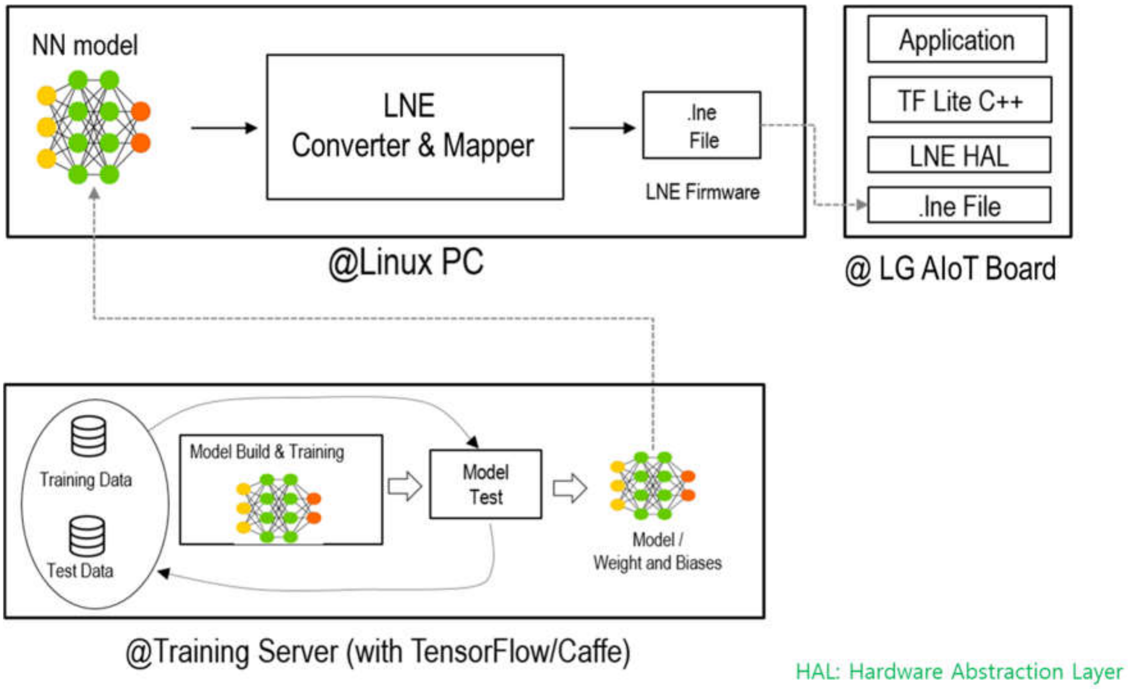
The process of executing inferencing application with LNE on LG AIoT board is as follows.

- Step 1 : Creating neural network model and training it with data
- Step 2 : Converting the neural network model to format acceptable by the LNE(.lne)
- Step 3 : Download .lne to LG AIoT board
- Step 4 : Executing inferencing application with LNE using .lne, then validating the network model

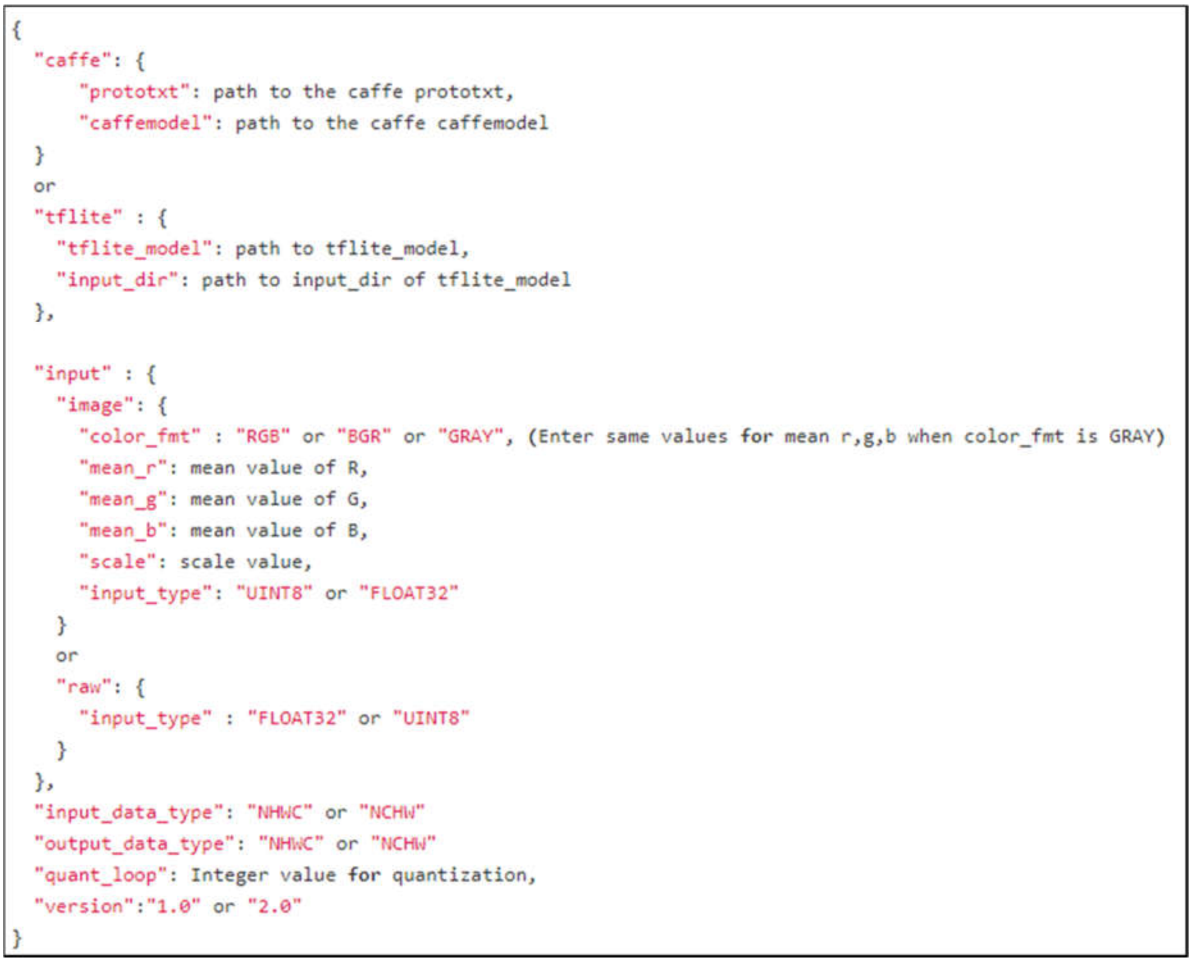


In this document, we are going to show how "LNE Converter & Mapper", that converts neural networks into a format acceptable to LNE, works.

[Prerequisites]

1. Creating neural network model and training it with data using with Caffe or Tensorflow Lite
   - ✓ Caffe - *.prototxt, *.caffemodel
   - ✓ Tflite - *.tflite
2. Prepare input data to be used for quantization
   - ✓ Caffe – LMDB (*.prototxt)
   - ✓ Tensorflow Lite – Image directory

3. Fill "lne.json" with neural network information



```
{
  "caffe": {
      "prototxt": path to the caffe prototxt,
      "caffemodel": path to the caffe caffemodel
  }
  or
  "tflite" : {
    "tflite_model": path to tflite_model,
    "input_dir": path to input_dir of tflite_model
  },

  "input" : {
    "image": {
      "color_fmt" : "RGB" or "BGR" or "GRAY", (Enter same values for mean r,g,b when color_fmt is GRAY)
      "mean_r": mean value of R,
      "mean_g": mean value of G,
      "mean_b": mean value of B,
      "scale": scale value,
      "input_type": "UINT8" or "FLOAT32"
    }
    or
    "raw": {
      "input_type" : "FLOAT32" or "UINT8"
    }
  },
  "input_data_type": "NHWC" or "NCHW"
  "output_data_type": "NHWC" or "NCHW"
  "quant_loop": Integer value for quantization,
  "version":"1.0" or "2.0"
}
```

Figure 2. json format used by LNE Converter & Optimizer

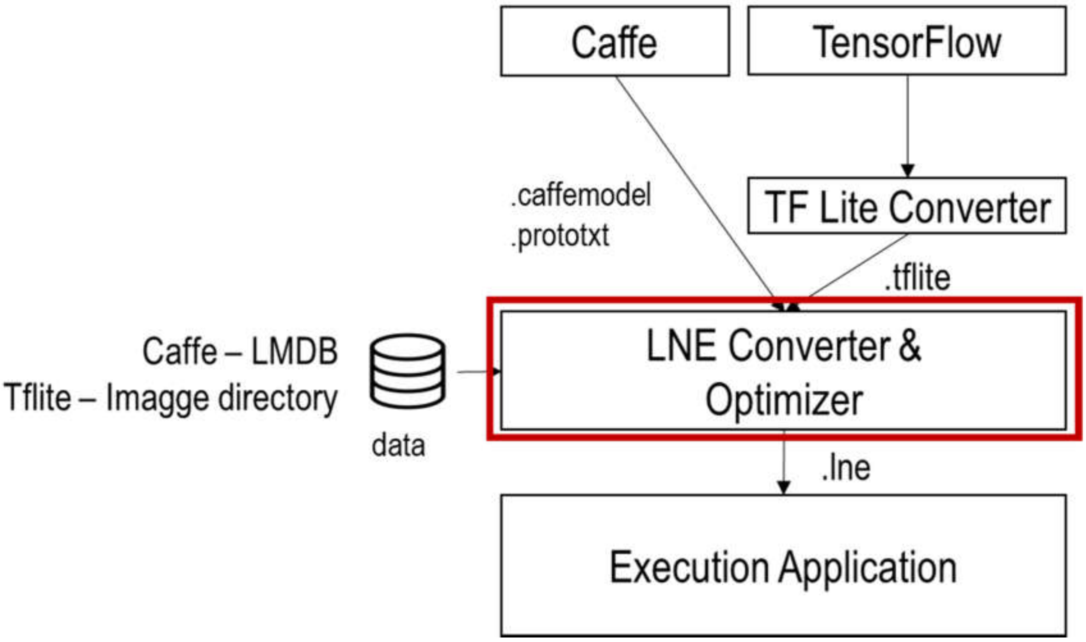


Figure 1. Network model conversion

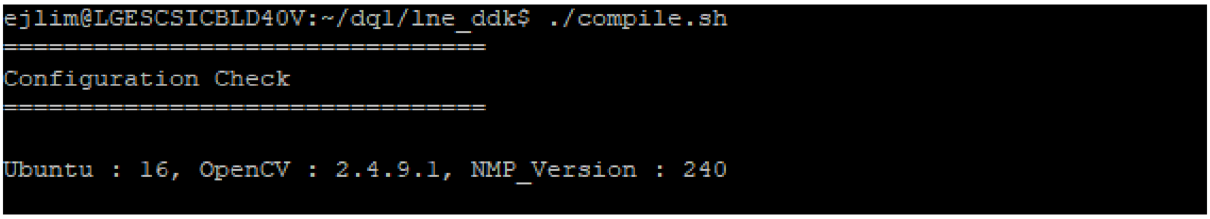
LNE Converter and Optimizer can be performed using “compile.sh” script provided in LG AI SDK.

```
$ ./compile.sh
```

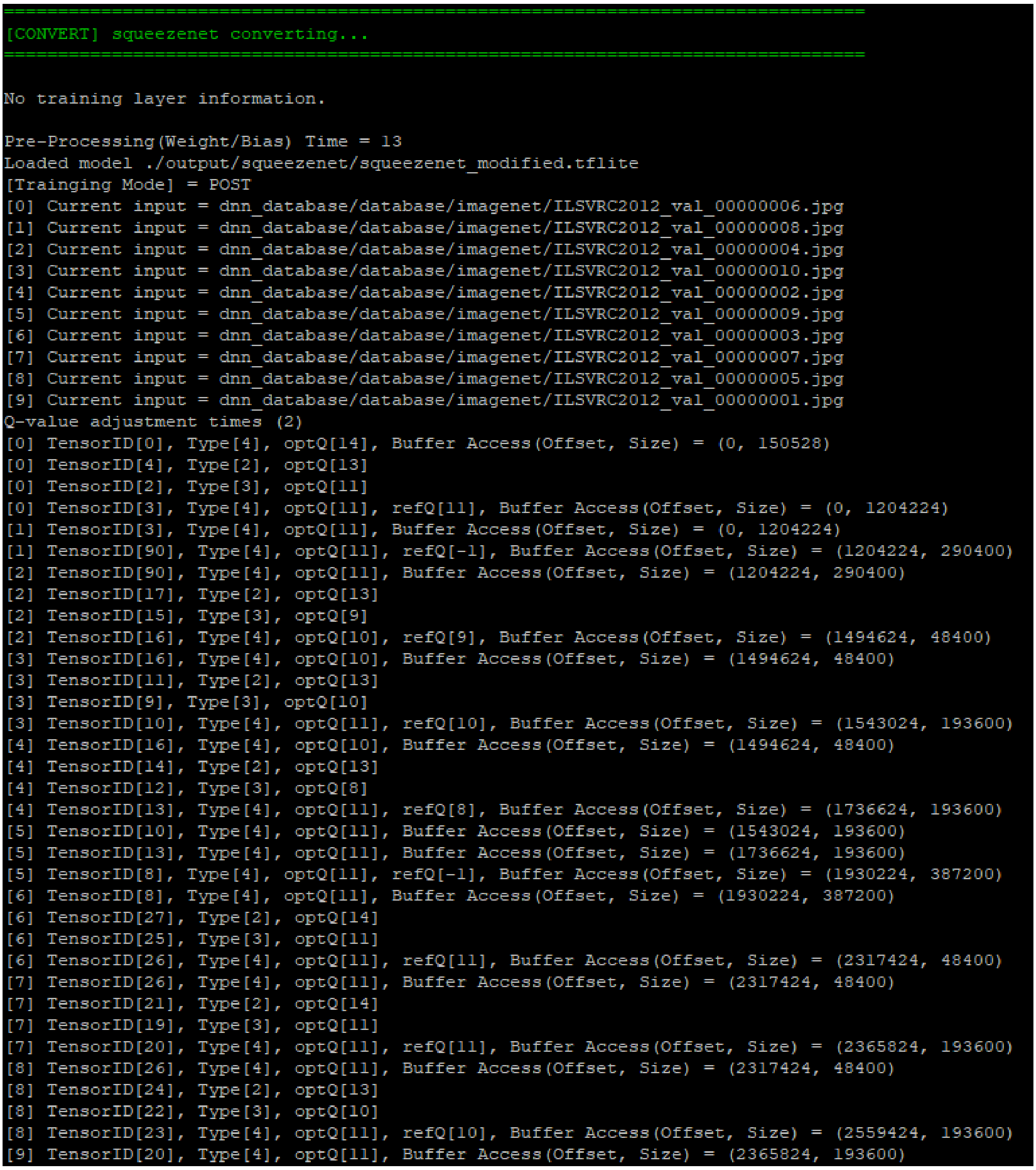
Note) The script parses the lne.json file to get a trained model and other values.

Therefore, lne.json modification is required before the script execution.

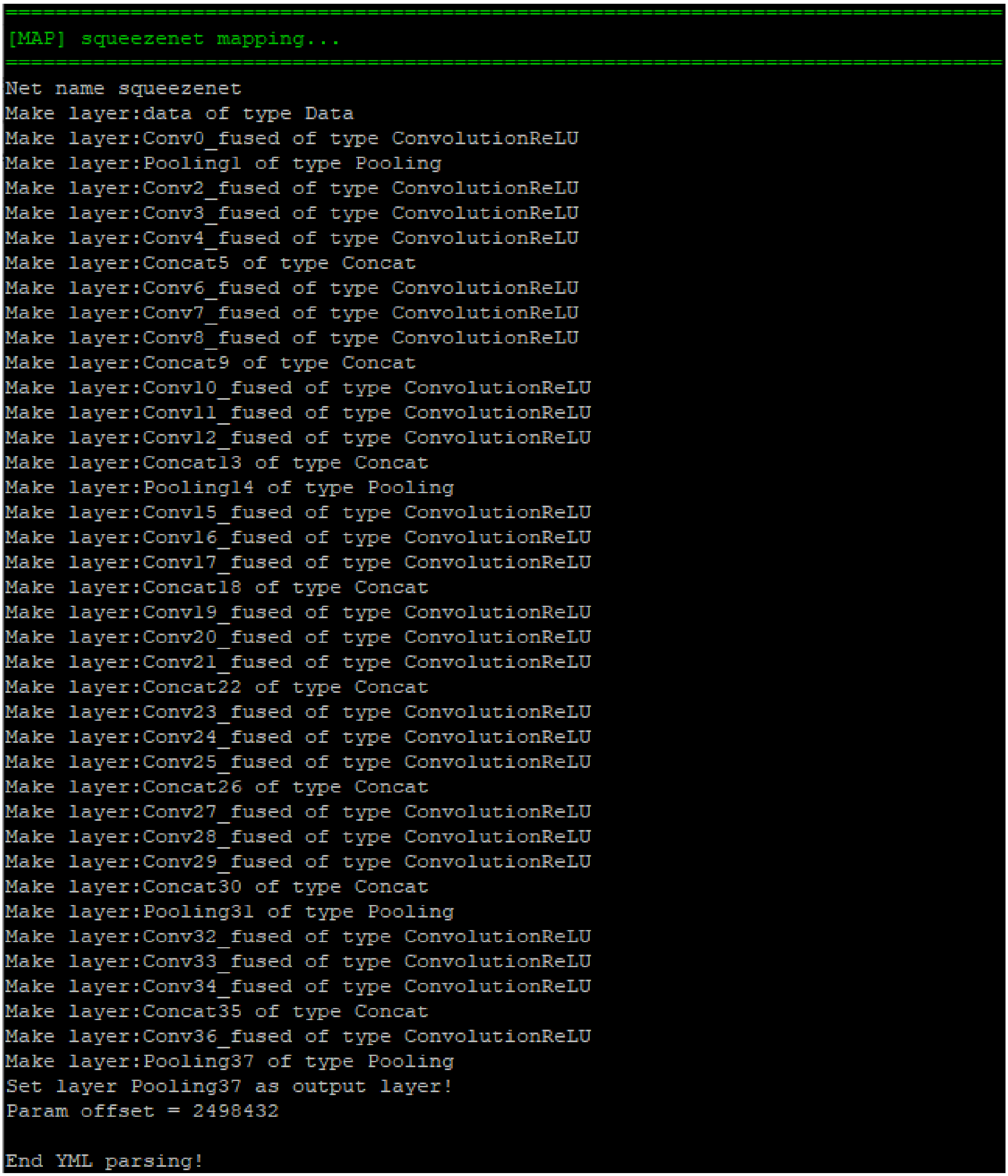
When you run the shell script, you can check the operation of the LNE Converter & Optimizer through the screen below.



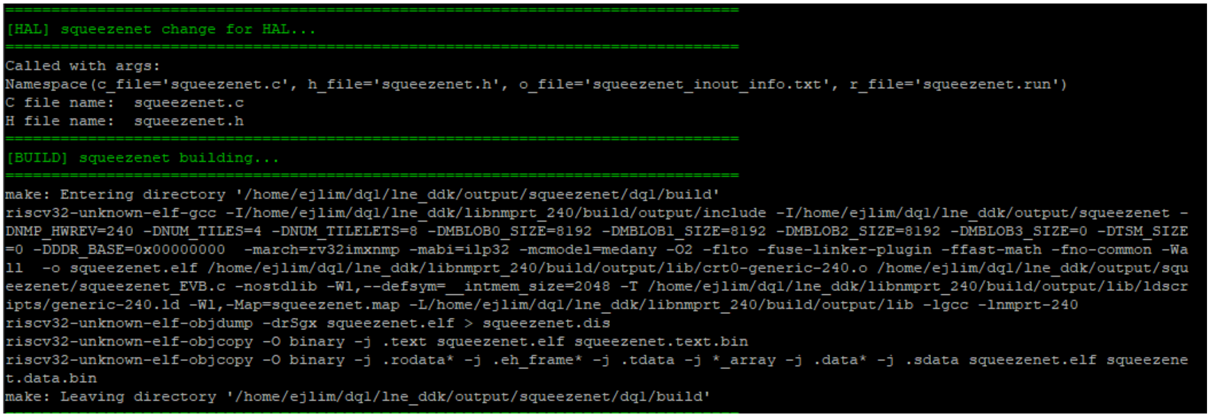
```
ejlim@LGESCSICBLD40V:~/dql/lne_ddk$ ./compile.sh
================================
Configuration Check
================================

Ubuntu : 16, OpenCV : 2.4.9.1, NMP_Version : 240
```



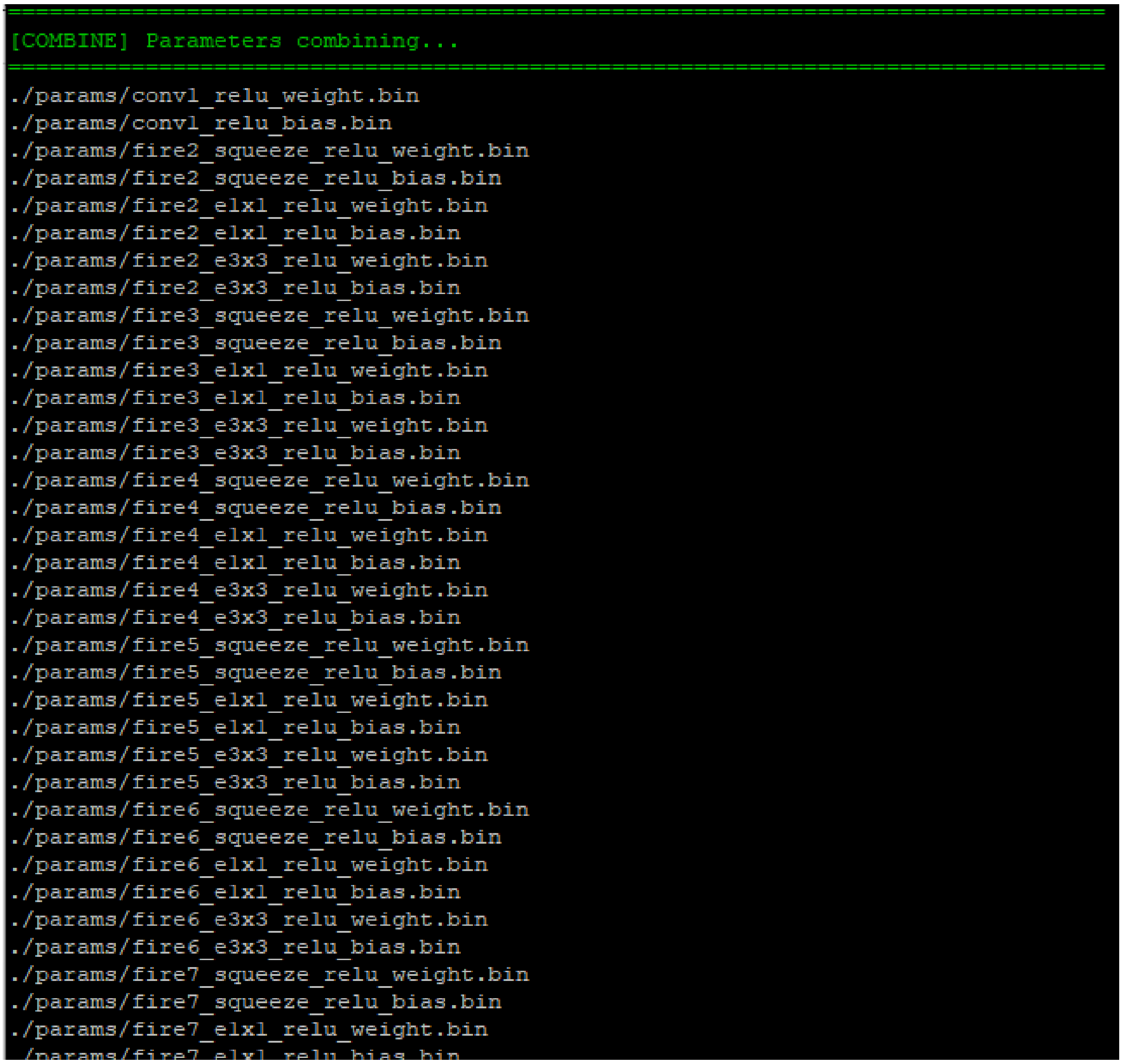
```
================================================================================
[CONVERT] squeezenet converting...
================================================================================

No training layer information.

Pre-Processing(Weight/Bias) Time = 13
Loaded model ./output/squeezenet/squeezenet_modified.tflite
[Trainging Mode] = POST
[0] Current input = dnn_database/database/imagenet/ILSVRC2012_val_00000006.jpg
[1] Current input = dnn_database/database/imagenet/ILSVRC2012_val_00000008.jpg
[2] Current input = dnn_database/database/imagenet/ILSVRC2012_val_00000004.jpg
[3] Current input = dnn_database/database/imagenet/ILSVRC2012_val_00000010.jpg
[4] Current input = dnn_database/database/imagenet/ILSVRC2012_val_00000002.jpg
[5] Current input = dnn_database/database/imagenet/ILSVRC2012_val_00000009.jpg
[6] Current input = dnn_database/database/imagenet/ILSVRC2012_val_00000003.jpg
[7] Current input = dnn_database/database/imagenet/ILSVRC2012_val_00000007.jpg
[8] Current input = dnn_database/database/imagenet/ILSVRC2012_val_00000005.jpg
[9] Current input = dnn_database/database/imagenet/ILSVRC2012_val_00000001.jpg
Q-value adjustment times (2)
[0] TensorID[0], Type[4], optQ[14], Buffer Access(Offset, Size) = (0, 150528)
[0] TensorID[4], Type[2], optQ[13]
[0] TensorID[2], Type[3], optQ[11]
[0] TensorID[3], Type[4], optQ[11], refQ[11], Buffer Access(Offset, Size) = (0, 1204224)
[1] TensorID[3], Type[4], optQ[11], Buffer Access(Offset, Size) = (0, 1204224)
[1] TensorID[90], Type[4], optQ[11], refQ[-1], Buffer Access(Offset, Size) = (1204224, 290400)
[2] TensorID[90], Type[4], optQ[11], Buffer Access(Offset, Size) = (1204224, 290400)
[2] TensorID[17], Type[2], optQ[13]
[2] TensorID[15], Type[3], optQ[9]
[2] TensorID[16], Type[4], optQ[10], refQ[9], Buffer Access(Offset, Size) = (1494624, 48400)
[3] TensorID[16], Type[4], optQ[10], Buffer Access(Offset, Size) = (1494624, 48400)
[3] TensorID[11], Type[2], optQ[13]
[3] TensorID[9], Type[3], optQ[10]
[3] TensorID[10], Type[4], optQ[11], refQ[10], Buffer Access(Offset, Size) = (1543024, 193600)
[4] TensorID[16], Type[4], optQ[10], Buffer Access(Offset, Size) = (1494624, 48400)
[4] TensorID[14], Type[2], optQ[13]
[4] TensorID[12], Type[3], optQ[8]
[4] TensorID[13], Type[4], optQ[11], refQ[8], Buffer Access(Offset, Size) = (1736624, 193600)
[5] TensorID[10], Type[4], optQ[11], Buffer Access(Offset, Size) = (1543024, 193600)
[5] TensorID[13], Type[4], optQ[11], Buffer Access(Offset, Size) = (1736624, 193600)
[5] TensorID[8], Type[4], optQ[11], refQ[-1], Buffer Access(Offset, Size) = (1930224, 387200)
[6] TensorID[8], Type[4], optQ[11], Buffer Access(Offset, Size) = (1930224, 387200)
[6] TensorID[27], Type[2], optQ[14]
[6] TensorID[25], Type[3], optQ[11]
[6] TensorID[26], Type[4], optQ[11], refQ[11], Buffer Access(Offset, Size) = (2317424, 48400)
[7] TensorID[26], Type[4], optQ[11], Buffer Access(Offset, Size) = (2317424, 48400)
[7] TensorID[21], Type[2], optQ[14]
[7] TensorID[19], Type[3], optQ[11]
[7] TensorID[20], Type[4], optQ[11], refQ[11], Buffer Access(Offset, Size) = (2365824, 193600)
[8] TensorID[26], Type[4], optQ[11], Buffer Access(Offset, Size) = (2317424, 48400)
[8] TensorID[24], Type[2], optQ[13]
[8] TensorID[22], Type[3], optQ[10]
[8] TensorID[23], Type[4], optQ[11], refQ[10], Buffer Access(Offset, Size) = (2559424, 193600)
[9] TensorID[20], Type[4], optQ[11], Buffer Access(Offset, Size) = (2365824, 193600)
```



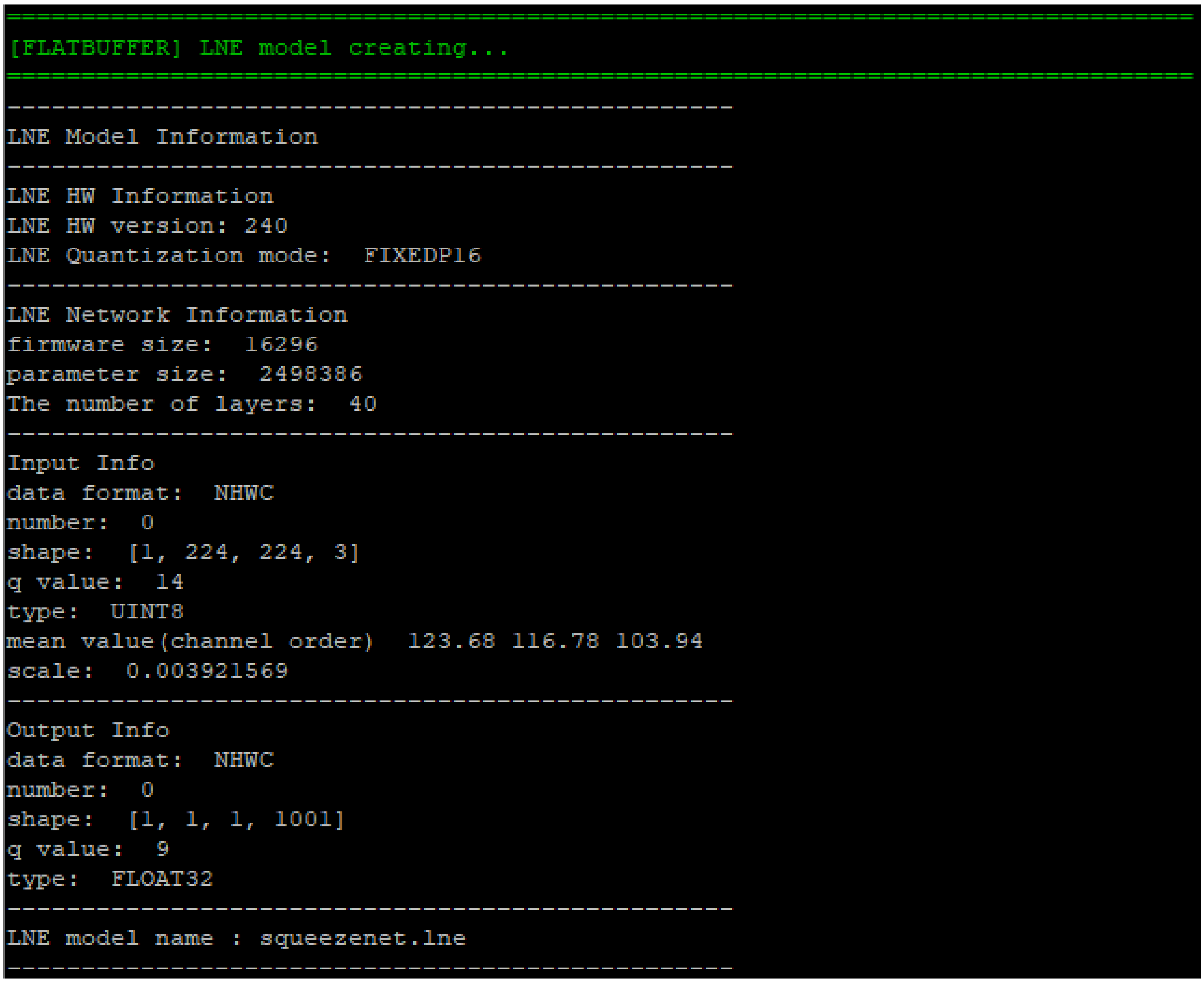
```
==========================================================================
[MAP] squeezenet mapping...
==========================================================================
Net name squeezenet
Make layer:data of type Data
Make layer:Conv0_fused of type ConvolutionReLU
Make layer:Pooling1 of type Pooling
Make layer:Conv2_fused of type ConvolutionReLU
Make layer:Conv3_fused of type ConvolutionReLU
Make layer:Conv4_fused of type ConvolutionReLU
Make layer:Concat5 of type Concat
Make layer:Conv6_fused of type ConvolutionReLU
Make layer:Conv7_fused of type ConvolutionReLU
Make layer:Conv8_fused of type ConvolutionReLU
Make layer:Concat9 of type Concat
Make layer:Conv10_fused of type ConvolutionReLU
Make layer:Conv11_fused of type ConvolutionReLU
Make layer:Conv12_fused of type ConvolutionReLU
Make layer:Concat13 of type Concat
Make layer:Pooling14 of type Pooling
Make layer:Conv15_fused of type ConvolutionReLU
Make layer:Conv16_fused of type ConvolutionReLU
Make layer:Conv17_fused of type ConvolutionReLU
Make layer:Concat18 of type Concat
Make layer:Conv19_fused of type ConvolutionReLU
Make layer:Conv20_fused of type ConvolutionReLU
Make layer:Conv21_fused of type ConvolutionReLU
Make layer:Concat22 of type Concat
Make layer:Conv23_fused of type ConvolutionReLU
Make layer:Conv24_fused of type ConvolutionReLU
Make layer:Conv25_fused of type ConvolutionReLU
Make layer:Concat26 of type Concat
Make layer:Conv27_fused of type ConvolutionReLU
Make layer:Conv28_fused of type ConvolutionReLU
Make layer:Conv29_fused of type ConvolutionReLU
Make layer:Concat30 of type Concat
Make layer:Pooling31 of type Pooling
Make layer:Conv32_fused of type ConvolutionReLU
Make layer:Conv33_fused of type ConvolutionReLU
Make layer:Conv34_fused of type ConvolutionReLU
Make layer:Concat35 of type Concat
Make layer:Conv36_fused of type ConvolutionReLU
Make layer:Pooling37 of type Pooling
Set layer Pooling37 as output layer!
Param offset = 2498432

End YML parsing!
```



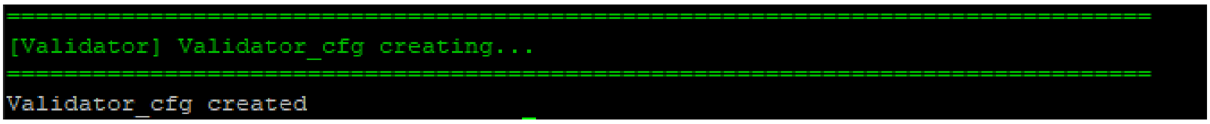
```
==========================================================================
[HAL] squeezenet change for HAL...
==========================================================================
Called with args:
Namespace(c_file='squeezenet.c', h_file='squeezenet.h', o_file='squeezenet_inout_info.txt', r_file='squeezenet.run')
C file name:  squeezenet.c
H file name:  squeezenet.h
==========================================================================
[BUILD] squeezenet building...
==========================================================================
make: Entering directory '/home/ejlim/dql/lne_ddk/output/squeezenet/dql/build'
riscv32-unknown-elf-gcc -I/home/ejlim/dql/lne_ddk/libnmprt_240/build/output/include -I/home/ejlim/dql/lne_ddk/output/squeezenet -
DNMP_HWREV=240 -DNUM_TILES=4 -DNUM_TILELETS=8 -DMBLOB0_SIZE=8192 -DMBLOB1_SIZE=8192 -DMBLOB2_SIZE=8192 -DMBLOB3_SIZE=0 -DTSM_SIZE
=0 -DDDR_BASE=0x00000000  -march=rv32imxnmp -mabi=ilp32 -mcmodel=medany -O2 -flto -fuse-linker-plugin -ffast-math -fno-common -Wa
ll  -o squeezenet.elf /home/ejlim/dql/lne_ddk/libnmprt_240/build/output/lib/crt0-generic-240.o /home/ejlim/dql/lne_ddk/output/squ
eezenet/squeezenet_EVB.c -nostdlib -Wl,--defsym=__intmem_size=2048 -T /home/ejlim/dql/lne_ddk/libnmprt_240/build/output/lib/ldscr
ipts/generic-240.ld -Wl,-Map=squeezenet.map -L/home/ejlim/dql/lne_ddk/libnmprt_240/build/output/lib -lgcc -lnmprt-240
riscv32-unknown-elf-objdump -drSgx squeezenet.elf > squeezenet.dis
riscv32-unknown-elf-objcopy -O binary -j .text squeezenet.elf squeezenet.text.bin
riscv32-unknown-elf-objcopy -O binary -j .rodata* -j .eh_frame* -j .tdata -j *_array -j .data* -j .sdata squeezenet.elf squeezene
t.data.bin
make: Leaving directory '/home/ejlim/dql/lne_ddk/output/squeezenet/dql/build'
==========================================================================
```



```
================================================================================
[COMBINE] Parameters combining...
================================================================================
./params/conv1_relu_weight.bin
./params/conv1_relu_bias.bin
./params/fire2_squeeze_relu_weight.bin
./params/fire2_squeeze_relu_bias.bin
./params/fire2_e1x1_relu_weight.bin
./params/fire2_e1x1_relu_bias.bin
./params/fire2_e3x3_relu_weight.bin
./params/fire2_e3x3_relu_bias.bin
./params/fire3_squeeze_relu_weight.bin
./params/fire3_squeeze_relu_bias.bin
./params/fire3_e1x1_relu_weight.bin
./params/fire3_e1x1_relu_bias.bin
./params/fire3_e3x3_relu_weight.bin
./params/fire3_e3x3_relu_bias.bin
./params/fire4_squeeze_relu_weight.bin
./params/fire4_squeeze_relu_bias.bin
./params/fire4_e1x1_relu_weight.bin
./params/fire4_e1x1_relu_bias.bin
./params/fire4_e3x3_relu_weight.bin
./params/fire4_e3x3_relu_bias.bin
./params/fire5_squeeze_relu_weight.bin
./params/fire5_squeeze_relu_bias.bin
./params/fire5_e1x1_relu_weight.bin
./params/fire5_e1x1_relu_bias.bin
./params/fire5_e3x3_relu_weight.bin
./params/fire5_e3x3_relu_bias.bin
./params/fire6_squeeze_relu_weight.bin
./params/fire6_squeeze_relu_bias.bin
./params/fire6_e1x1_relu_weight.bin
./params/fire6_e1x1_relu_bias.bin
./params/fire6_e3x3_relu_weight.bin
./params/fire6_e3x3_relu_bias.bin
./params/fire7_squeeze_relu_weight.bin
./params/fire7_squeeze_relu_bias.bin
./params/fire7_e1x1_relu_weight.bin
./params/fire7_e1x1_relu_bias.bin
```



```
================================================================================
[FLATBUFFER] LNE model creating...
================================================================================
-------------------------------------------------
LNE Model Information
-------------------------------------------------
LNE HW Information
LNE HW version: 240
LNE Quantization mode:  FIXEDP16
-------------------------------------------------
LNE Network Information
firmware size:  16296
parameter size:  2498386
The number of layers:  40
-------------------------------------------------
Input Info
data format:  NHWC
number:  0
shape:  [1, 224, 224, 3]
q value:  14
type:  UINT8
mean value(channel order)  123.68 116.78 103.94
scale:  0.003921569
-------------------------------------------------
Output Info
data format:  NHWC
number:  0
shape:  [1, 1, 1, 1001]
q value:  9
type:  FLOAT32
-------------------------------------------------
LNE model name : squeezenet.lne
-------------------------------------------------
```



```
============================================================================
[Validator] Validator_cfg creating...
============================================================================
Validator_cfg created
```