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

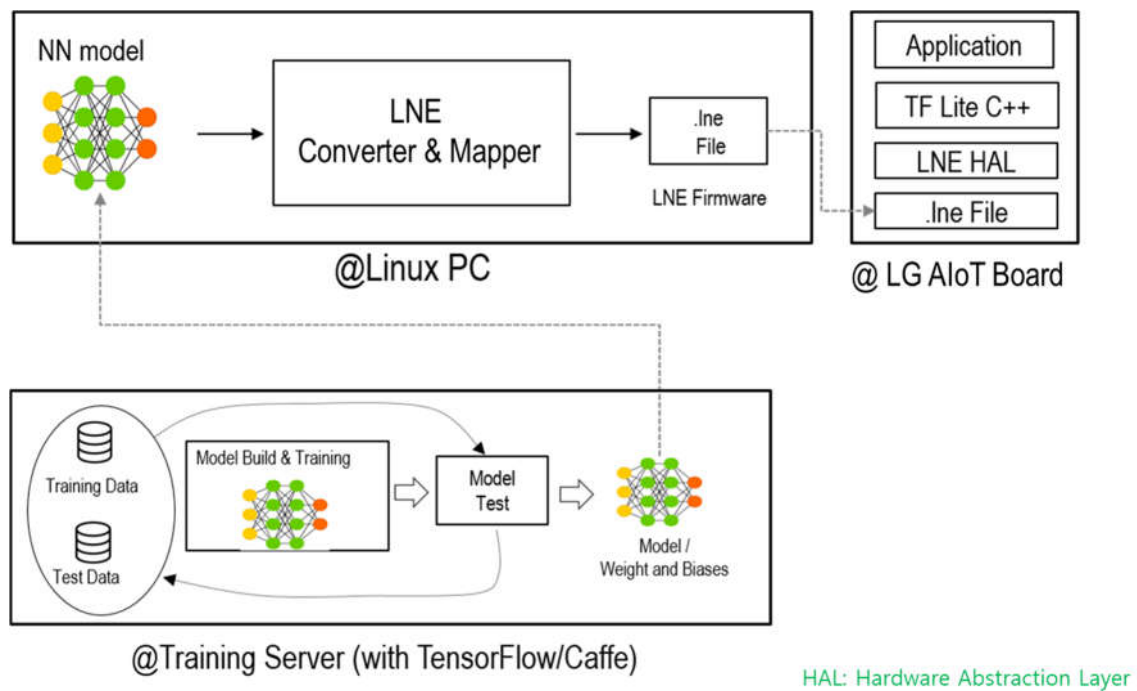- Step 4 : Executing inferencing application with LNE using .lne, then validating the network model

Figure 1. Executing inferencing application on LG AIoT board

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

```json
{
  "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"
}
```

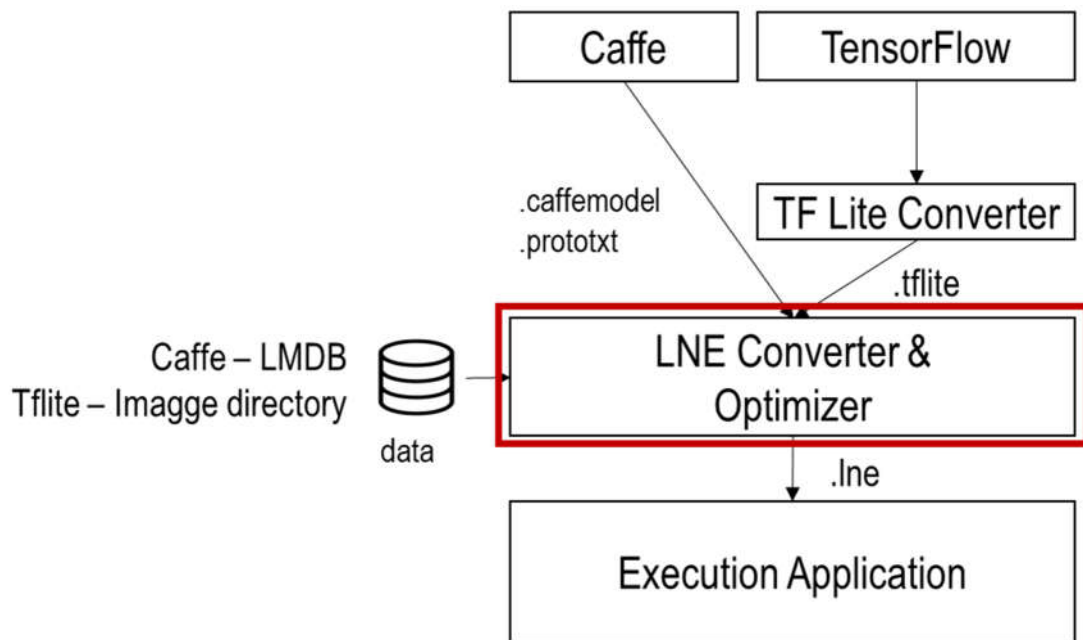**Figure 2. json format used by LNE Converter & Optimizer**

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
```