HW1 AlexNet with SystemC

Machine learning Chip Design

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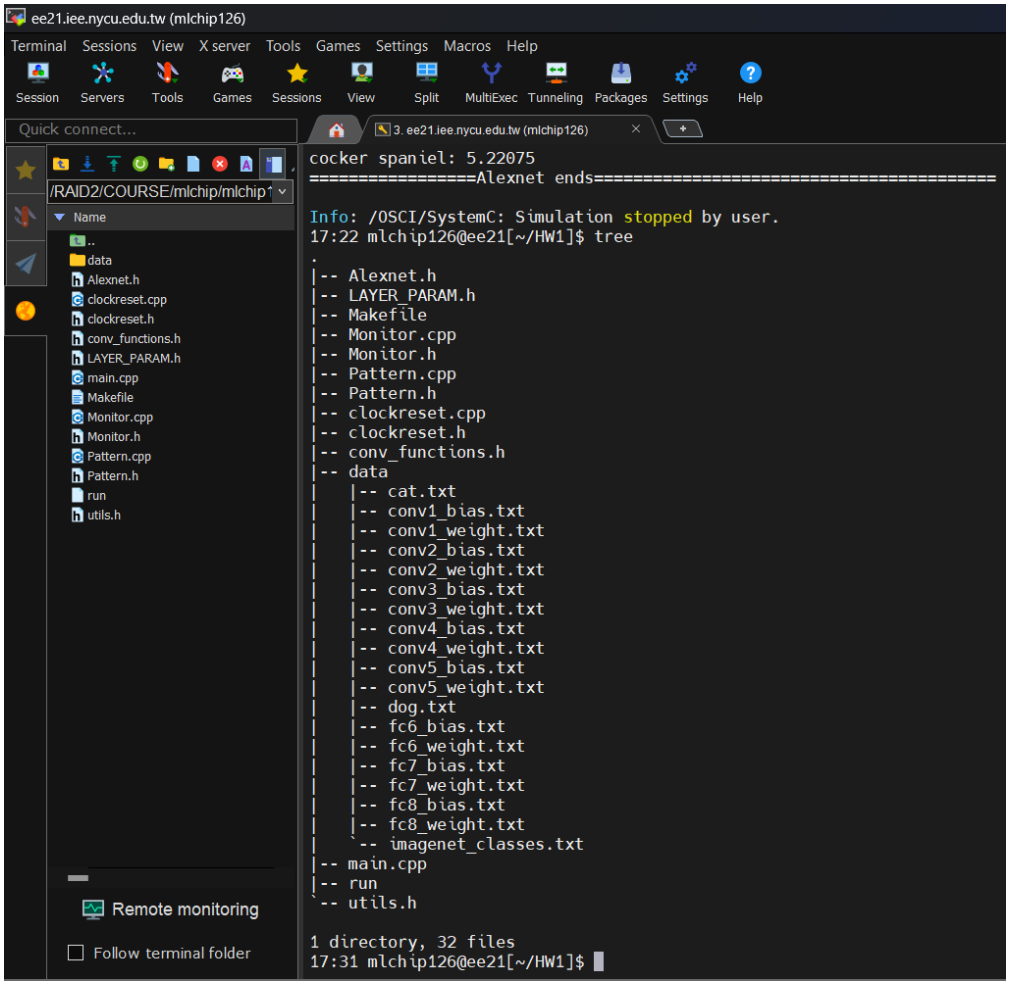
File structure

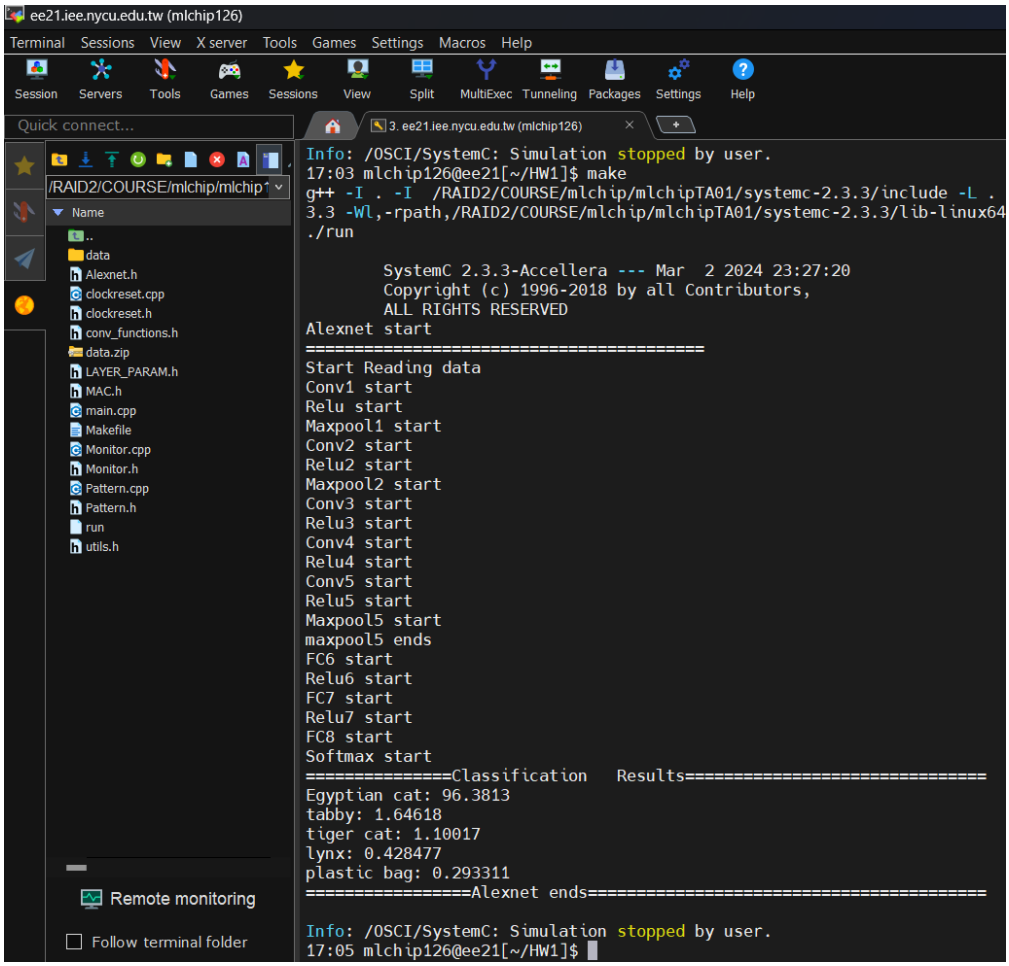


Pytorch AlexNet model

```python
class Net(nn.Module):
    def __init__(self):
        super(Net, self).__init__()
        # The convolution model of pytorch, used to compare results
        self.conv1 = nn.Conv2d(3, 64, 11, 4, 2) # (in_channels,out_channels,kernel_size,stride,padding)
        self.conv2 = nn.Conv2d(64, 192, 5, 1, 2)
        self.conv3 = nn.Conv2d(192, 384, 3, 1, 1)
        self.conv4 = nn.Conv2d(384, 256, 3, 1, 1)
        self.conv5 = nn.Conv2d(256, 256, 3, 1, 1)
        self.fc6 = nn.Linear(256*6*6, 4096)
        self.fc7 = nn.Linear(4096, 4096)
        self.fc8 = nn.Linear(4096, 1000)
        self.inter_value = {}

    def forward(self, x):
        x = self.conv1(x)
        self.inter_value['conv1'] = x
        x = F.relu(x)
        self.inter_value['relu1'] = x
        x = F.max_pool2d(F.relu(self.conv1(x)), (3, 3), 2)
        self.inter_value['layer1'] = x
        x = F.max_pool2d(F.relu(self.conv2(x)), (3, 3), 2)
        self.inter_value['layer2'] = x
        x = F.relu(self.conv3(x))
        self.inter_value['layer3'] = x
        x = F.relu(self.conv4(x))
        self.inter_value['layer4'] = x
        x = F.max_pool2d(F.relu(self.conv5(x)), (3, 3), 2)
        # 256 x 6 x 6
        self.inter_value['layer5'] = x

        x = torch.flatten(x)
        self.inter_value['layer_flat'] = x

        x = F.relu(self.fc6(x))
        self.inter_value['layer6'] = x
        x = F.relu(self.fc7(x))
        self.inter_value['layer7'] = x
        x = self.fc8(x)
        self.inter_value['layer8'] = x
        return x
```

- First uses the pytorch alexnet model to generate the output feature maps of every layer as golden, so that cross-validation can be performed when coding out SystemC code.

Results


ee21.iee.nycu.edu.tw (mlchip126)
Terminal Sessions View X server Tools Games Settings Macros Help
Session Servers Tools Games Sessions View Split MultiExec Tunneling Packages Settings Help
Quick connect...
3. ee21.iee.nycu.edu.tw (mlchip126)
/RAID2/COURSE/mlchip/mlchip
Name
..
data
Alexnet.h
clockreset.cpp
clockreset.h
conv_functions.h
data.zip
LAYER_PARAM.h
MAC.h
main.cpp
Makefile
Monitor.cpp
Monitor.h
Pattern.cpp
Pattern.h
run
utils.h
Remote monitoring
Follow terminal folder
Info: /OSCI/SystemC: Simulation stopped by user.
17:03 mlchip126@ee21[~/HW1]$ make
g++ -I . -I /RAID2/COURSE/mlchip/mlchipTA01/systemc-2.3.3/include -L .
3.3 -Wl,-rpath,/RAID2/COURSE/mlchip/mlchipTA01/systemc-2.3.3/lib-linux64
./run
SystemC 2.3.3-Accellera --- Mar 2 2024 23:27:20
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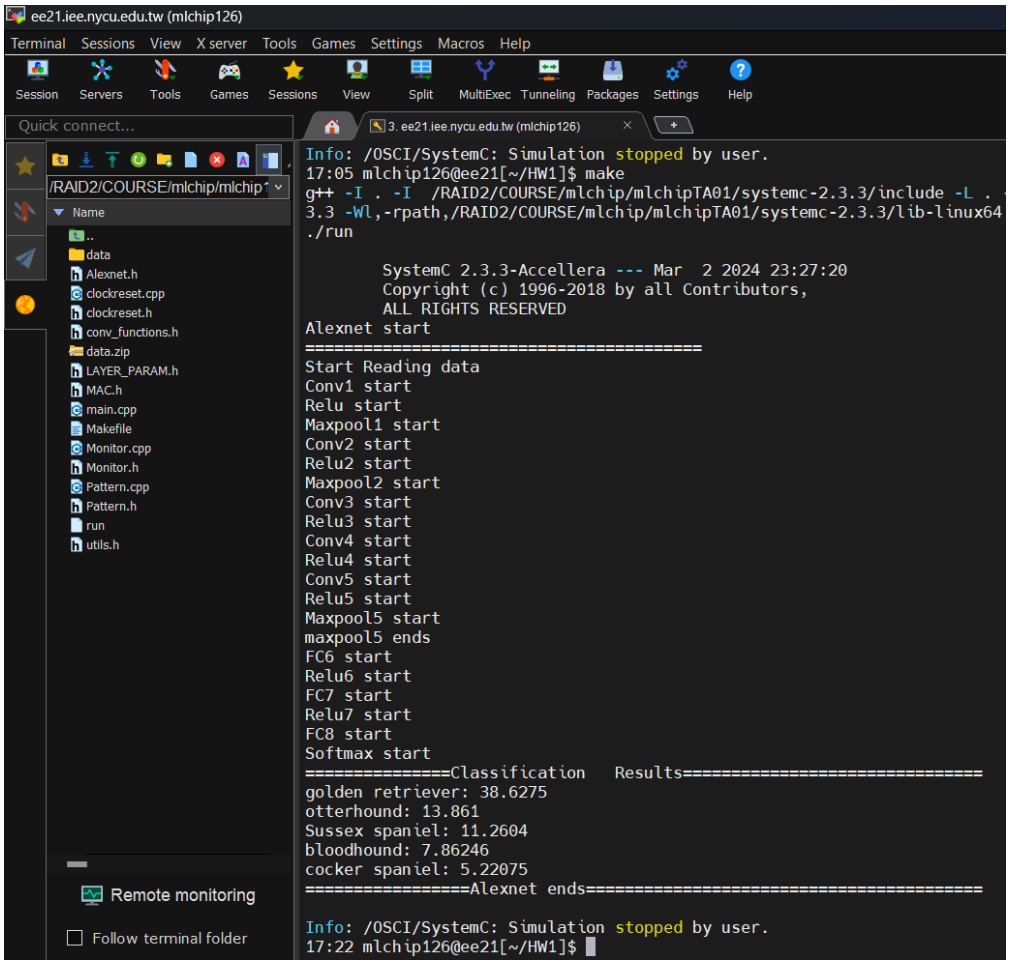
ALL RIGHTS RESERVED
Alexnet start
Start Reading data
Conv1 start
Relu start
Maxpool1 start
Conv2 start
Relu2 start
Maxpool2 start
Conv3 start
Relu3 start
Conv4 start
Relu4 start
Conv5 start
Relu5 start
Maxpool5 start
maxpool5 ends
FC6 start
Relu6 start
FC7 start
Relu7 start
FC8 start
Softmax start
==========Classification Results==========
Egyptian cat: 96.3813
tabby: 1.64618
tiger cat: 1.10017
lynx: 0.428477
plastic bag: 0.293311
==========Alexnet ends==========
Info: /OSCI/SystemC: Simulation stopped by user.
17:05 mlchip126@ee21[~/HW1]$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Session Servers Tools Games Sessions View Split MultiExec Tunneling Packages Settings Help
Quick connect...
3. ee21.iee.nycu.edu.tw (mlchip126)
/RAID2/COURSE/mlchip/mlchip1
Name
..
data
Alexnet.h
clockreset.cpp
clockreset.h
conv_functions.h
data.zip
LAYER_PARAM.h
MAC.h
main.cpp
Makefile
Monitor.cpp
Monitor.h
Pattern.cpp
Pattern.h
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Remote monitoring
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3.3 -Wl,-rpath,/RAID2/COURSE/mlchip/mlchipTA01/systemc-2.3.3/lib-linux64
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SystemC 2.3.3-Accellera --- Mar 2 2024 23:27:20
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Alexnet start
Start Reading data
Conv1 start
Relu start
Maxpool1 start
Conv2 start
Relu2 start
Maxpool2 start
Conv3 start
Relu3 start
Conv4 start
Relu4 start
Conv5 start
Relu5 start
Maxpool5 start
maxpool5 ends
FC6 start
Relu6 start
FC7 start
Relu7 start
FC8 start
Softmax start
==========Classification Results==========
golden retriever: 38.6275
otterhound: 13.861
Sussex spaniel: 11.2604
bloodhound: 7.86246
cocker spaniel: 5.22075
==========Alexnet ends==========
Info: /OSCI/SystemC: Simulation stopped by user.
17:22 mlchip126@ee21[~/HW1]$

Problem faced

- I dont have prior knowledege of Neural Network, thus the main focus of this HW seems to focus on understanding and implementing the AlexNet model from scratch, not understanding the SystemC model.
- At first we do not know the parameters info of each layer, we must try it out first in pytorch model so that correct layer parameters can be found. One of the most annoying part of this HW is the first convolution layer and the average pooling layer. In order to get the correct result for the first layer, one must first pad the image from 224x224 to 227x227 which is an assymetrical zero-padding, this is annoying as xxx. We do not have this info when first implementing the AlexNet python model, which results in a hell lot of time. Then the adaptive average pooling 2d layer should be removed for getting the correct inference value, it seems like the average layer does not do anything when doing the inferences.

Comment

- I think I still dont understand systemC at all after this HW, I dont think it is an appropriate topic for learning SystemC, since SystemC is a Transaction level hardware description language, which introduce lots of hazard when implementing AlexNet.

References

- [Lab1 MAC exercise and handouts]
- MIT Introduction to Deep Learning | 6.S191
- MIT 6.S191: Convolutional Neural Networks
- Pytorch Torchvision AlexNet model