

Homework #4 Report

資工 110

B063040061

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Problem :

以 SystemC code 實作 CNN Lenet-5 的模型，給定已訓練好的類神經網路的權重結果，做 MNIST 手寫辨識數字辨認。

Input 為 28x28 的手寫數字圖片，並 scale 255 到 1 (input/255)，第一次 convolution 為六個 5x5 kernel，得到 6 層 24x24 不同權重的圖片，並做 max pooling 成 6 層 12x12 圖片，第二次 convolution 為 16 個 5x5 深度 6 的 kernel，得到 16 層 8x8 不同特徵的圖片，並做第二次 max pooling 成 16 層 4x4 的圖片，總共有 256 個 data 為全連接類神經網路的 input，第一層神經網路 layer 為 128 的神經元，激勵函數為 ReLu，第二層神經網路為 84 個神經元，激勵函數也是 ReLu，最後一層為 output layer 總共 10 個輸出，原先要做分類的激勵函數，但在這邊不做，直接輸出數值，其中最高數值的結果就是辨認後的數字結果。

除了善用 RAM 與 ROM 存取與取得 Data 外，同時實作兩種小數點類型，float 與 sc_fixed，透過 run_mode.h 控制 macro。

Source Code :

main.cpp, Monitor.cpp, Monitor.h, clockreset.h, clockreset.cpp,
RAM.cpp, RAM.h, ROM.cpp, ROM.h, Lenet.cpp, Lenet.h, run_mode.h

Simulation Result :

Terminal :

float type :

input_1

數字 7

sc_fixed type :

```
B063040061 ZEUS /home/B063040061/Desktop/B063040061_HW4% ./test
SystemC 2.3.1-Accellera --- Jun 22 2017 17:44:29
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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_1.txt

Output # 0 : -5.692679 Label : -5.692680
Output # 1 : -0.288591 Label : -0.288590
Output # 2 : 1.907344 Label : 1.907344
Output # 3 : 0.751245 Label : 0.751244
Output # 4 : -7.023232 Label : -7.023230
Output # 5 : -3.161095 Label : -3.161095
Output # 6 : -12.820799 Label : -12.820796
Output # 7 : 11.970234 Label : 11.970235
Output # 8 : -0.548813 Label : -0.548812
Output # 9 : -1.591035 Label : -1.591035

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.
```

```
B063040061 ZEUS /home/B063040061/Desktop/B063040061_HW4% ./test
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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_1.txt

Output # 0 : -5.746094 Label : -5.692680
Output # 1 : -0.285156 Label : -0.288590
Output # 2 : 1.937500 Label : 1.907344
Output # 3 : 0.753906 Label : 0.751244
Output # 4 : -7.097656 Label : -7.023230
Output # 5 : -3.246094 Label : -3.161095
Output # 6 : -12.992188 Label : -12.820796
Output # 7 : 12.019531 Label : 11.970235
Output # 8 : -0.468750 Label : -0.548812
Output # 9 : -1.679688 Label : -1.591035

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.
```

float type :

input_2

數字 2

sc_fixed type :

```

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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_2.txt

Output # 0 : 1.883513 Label : 1.883511
Output # 1 : 5.204262 Label : 5.204263
Output # 2 : 11.776731 Label : 11.776729
Output # 3 : -2.710082 Label : -2.710081
Output # 4 : -8.719761 Label : -8.719760
Output # 5 : -10.605380 Label : -10.605376
Output # 6 : -3.290086 Label : -3.290083
Output # 7 : -4.403935 Label : -4.403935
Output # 8 : -0.877534 Label : -0.877534
Output # 9 : -12.395869 Label : -12.395868

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.

```

```

B063040061 ZEUS /home/B063040061/Desktop/B063040061_HW4% ./test

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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_2.txt

Output # 0 : 1.972656 Label : 1.883511
Output # 1 : 5.238281 Label : 5.204263
Output # 2 : 11.878906 Label : 11.776729
Output # 3 : -2.761719 Label : -2.710081
Output # 4 : -8.742188 Label : -8.719760
Output # 5 : -10.675781 Label : -10.605376
Output # 6 : -3.328125 Label : -3.290083
Output # 7 : -4.441406 Label : -4.403935
Output # 8 : -0.929688 Label : -0.877534
Output # 9 : -12.492188 Label : -12.395868

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.

```

float type :

input_3

數字 1

sc_fixed type :

```

B063040061 ZEUS /home/B063040061/Desktop/B063040061_HW4% ./test

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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_3.txt

Output # 0 : -2.304688 Label : -2.327977
Output # 1 : 7.644531 Label : 7.517640
Output # 2 : -1.250000 Label : -1.210088
Output # 3 : -4.277344 Label : -4.182842
Output # 4 : 0.082031 Label : 0.081699
Output # 5 : -5.144531 Label : -5.105879
Output # 6 : -1.910156 Label : -2.000495
Output # 7 : -0.234375 Label : -0.150937
Output # 8 : -0.707031 Label : -0.760908
Output # 9 : -3.089844 Label : -2.999766

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.

```

```

B063040061 ZEUS /home/B063040061/Desktop/B063040061_HW4% ./test

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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_3.txt

Output # 0 : -2.327977 Label : -2.327977
Output # 1 : 7.517642 Label : 7.517640
Output # 2 : -1.210088 Label : -1.210088
Output # 3 : -4.182841 Label : -4.182842
Output # 4 : 0.081698 Label : 0.081699
Output # 5 : -5.105879 Label : -5.105879
Output # 6 : -2.000496 Label : -2.000495
Output # 7 : -0.150937 Label : -0.150937
Output # 8 : -0.760909 Label : -0.760908
Output # 9 : -2.999767 Label : -2.999766

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.

```

float type :

input_4

數字 0

sc_fixed type :

```

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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_4.txt

Output # 0 : 10.857318 Label : 10.857318
Output # 1 : -4.916886 Label : -4.916887
Output # 2 : -1.645170 Label : -1.645169
Output # 3 : -3.324846 Label : -3.324847
Output # 4 : -5.333570 Label : -5.333570
Output # 5 : -0.875547 Label : -0.875546
Output # 6 : 3.338291 Label : 3.338293
Output # 7 : -3.206848 Label : -3.206848
Output # 8 : -3.664100 Label : -3.664099
Output # 9 : -0.118884 Label : -0.118883

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.

```

```

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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_4.txt

Output # 0 : 10.976562 Label : 10.857318
Output # 1 : -5.011719 Label : -4.916887
Output # 2 : -1.574219 Label : -1.645169
Output # 3 : -3.339844 Label : -3.324847
Output # 4 : -5.503906 Label : -5.333570
Output # 5 : -0.898438 Label : -0.875546
Output # 6 : 3.289062 Label : 3.338293
Output # 7 : -3.269531 Label : -3.206848
Output # 8 : -3.621094 Label : -3.664099
Output # 9 : -0.175781 Label : -0.118883

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.

```

float type :

input_5

數字 4

sc_fixed type :

```
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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_5.txt

Output # 0 : -5.327168 Label : -5.327168
Output # 1 : -2.725101 Label : -2.725101
Output # 2 : -4.887796 Label : -4.887795
Output # 3 : -4.522934 Label : -4.522934
Output # 4 : 10.841787 Label : 10.841791
Output # 5 : -4.217877 Label : -4.217876
Output # 6 : -1.268859 Label : -1.268860
Output # 7 : -3.602647 Label : -3.602647
Output # 8 : -3.273474 Label : -3.273473
Output # 9 : 3.877691 Label : 3.877691

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.
```

```
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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_5.txt

Output # 0 : -5.429688 Label : -5.327168
Output # 1 : -2.750000 Label : -2.725101
Output # 2 : -4.929688 Label : -4.887795
Output # 3 : -4.613281 Label : -4.522934
Output # 4 : 11.003906 Label : 10.841791
Output # 5 : -4.261719 Label : -4.217876
Output # 6 : -1.328125 Label : -1.268860
Output # 7 : -3.621094 Label : -3.602647
Output # 8 : -3.296875 Label : -3.273473
Output # 9 : 3.890625 Label : 3.877691

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.
```

float type :

input_6

數字 9

sc_fixed type :

```
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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_6.txt

Output # 0 : -4.155002 Label : -4.155001
Output # 1 : -3.685336 Label : -3.685337
Output # 2 : -4.951273 Label : -4.951273
Output # 3 : -1.510458 Label : -1.510458
Output # 4 : 1.080713 Label : 1.080713
Output # 5 : -0.137100 Label : -0.137101
Output # 6 : -7.223796 Label : -7.223797
Output # 7 : -1.383158 Label : -1.383158
Output # 8 : 0.894924 Label : 0.894923
Output # 9 : 7.178139 Label : 7.178138

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.
```

```
B063040061 ZEUS /home/B063040061/Desktop/B063040061_HW4% ./test

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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_6.txt

Output # 0 : -4.273438 Label : -4.155001
Output # 1 : -3.679688 Label : -3.685337
Output # 2 : -4.988281 Label : -4.951273
Output # 3 : -1.507812 Label : -1.510458
Output # 4 : 1.140625 Label : 1.080713
Output # 5 : -0.152344 Label : -0.137101
Output # 6 : -7.394531 Label : -7.223797
Output # 7 : -1.406250 Label : -1.383158
Output # 8 : 0.867188 Label : 0.894923
Output # 9 : 7.257812 Label : 7.178138

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.
```

float type :

input_7

數字 5

sc_fixed type :

```
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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_7.txt

Output # 0 : -6.083923 Label : -6.083921
Output # 1 : -7.429938 Label : -7.429938
Output # 2 : -5.149819 Label : -5.149817
Output # 3 : -2.606214 Label : -2.606215
Output # 4 : -5.594572 Label : -5.594570
Output # 5 : 9.824126 Label : 9.824126
Output # 6 : 1.315442 Label : 1.315440
Output # 7 : -4.608023 Label : -4.608022
Output # 8 : 1.697768 Label : 1.697766
Output # 9 : 0.610571 Label : 0.610572

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.
```

```
B063040061 ZEUS /home/B063040061/Desktop/B063040061_HW4% ./test

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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_7.txt

Output # 0 : -6.152344 Label : -6.083921
Output # 1 : -7.585938 Label : -7.429938
Output # 2 : -5.160156 Label : -5.149817
Output # 3 : -2.687500 Label : -2.606215
Output # 4 : -5.656250 Label : -5.594570
Output # 5 : 9.878906 Label : 9.824126
Output # 6 : 1.347656 Label : 1.315440
Output # 7 : -4.667969 Label : -4.608022
Output # 8 : 1.722656 Label : 1.697766
Output # 9 : 0.660156 Label : 0.610572

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.
```

float type : input_8 數字 6 sc_fixed type :

```
B063040061 ZEUS /home/B063040061/Desktop/B063040061_HW4% ./test

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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_8.txt

Output # 0 :    3.861394    Label :    3.861394
Output # 1 :   -4.694177    Label :   -4.694178
Output # 2 :   -4.684811    Label :   -4.684812
Output # 3 :   -3.411602    Label :   -3.411603
Output # 4 :   -4.133462    Label :   -4.133463
Output # 5 :    3.112758    Label :    3.112759
Output # 6 :   10.723673    Label :   10.723674
Output # 7 :   -4.971688    Label :   -4.971688
Output # 8 :    0.177012    Label :    0.177012
Output # 9 :   -1.925642    Label :   -1.925641

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.
```

```
B063040061 ZEUS /home/B063040061/Desktop/B063040061_HW4% ./test

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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_8.txt

Output # 0 :    3.917969    Label :    3.861394
Output # 1 :   -4.753906    Label :   -4.694178
Output # 2 :   -4.683594    Label :   -4.684812
Output # 3 :   -3.437500    Label :   -3.411603
Output # 4 :   -4.214844    Label :   -4.133463
Output # 5 :    3.144531    Label :    3.112759
Output # 6 :   10.785156    Label :   10.723674
Output # 7 :   -4.953125    Label :   -4.971688
Output # 8 :    0.222656    Label :    0.177012
Output # 9 :   -1.984375    Label :   -1.925641

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.
```

float type : input_9 數字 3 sc_fixed type :

```
B063040061 ZEUS /home/B063040061/Desktop/B063040061_HW4% ./test

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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_9.txt

Output # 0 :   -5.225960    Label :   -5.225956
Output # 1 :   -1.254550    Label :   -1.254549
Output # 2 :    -0.619967    Label :   -0.619967
Output # 3 :    6.112026    Label :    6.112026
Output # 4 :   -6.522448    Label :   -6.522448
Output # 5 :    0.407647    Label :    0.407647
Output # 6 :   -5.123464    Label :   -5.123464
Output # 7 :   -4.786591    Label :   -4.786593
Output # 8 :    1.669284    Label :    1.669284
Output # 9 :   -4.366187    Label :   -4.366186

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.
```

```
B063040061 ZEUS /home/B063040061/Desktop/B063040061_HW4% ./test

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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_9.txt

Output # 0 :   -5.343750    Label :   -5.225956
Output # 1 :   -1.207031    Label :   -1.254549
Output # 2 :    -0.683594    Label :   -0.619967
Output # 3 :    6.203125    Label :    6.112026
Output # 4 :   -6.507812    Label :   -6.522448
Output # 5 :    0.457031    Label :    0.407647
Output # 6 :   -5.292969    Label :   -5.123464
Output # 7 :   -4.851562    Label :   -4.786593
Output # 8 :    1.585938    Label :    1.669284
Output # 9 :   -4.484375    Label :   -4.366186

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.
```

float type : input_10 數字 8 sc_fixed type :

```
B063040061 ZEUS /home/B063040061/Desktop/B063040061_HW4% ./test

SystemC 2.3.1-Accellera --- Jun 22 2017 17:44:29
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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_10.txt

Output # 0 :   -6.667819    Label :   -6.667818
Output # 1 :   -2.805802    Label :   -2.805802
Output # 2 :   -3.585072    Label :   -3.585072
Output # 3 :    0.436139    Label :    0.436139
Output # 4 :   -2.577520    Label :   -2.577520
Output # 5 :    0.812739    Label :    0.812739
Output # 6 :    0.602996    Label :    0.602996
Output # 7 :   -4.287213    Label :   -4.287211
Output # 8 :    9.967606    Label :    9.967606
Output # 9 :   -2.928843    Label :   -2.928842

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.
```

```
B063040061 ZEUS /home/B063040061/Desktop/B063040061_HW4% ./test

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Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_10.txt

Output # 0 :   -6.843750    Label :   -6.667818
Output # 1 :   -2.941406    Label :   -2.805802
Output # 2 :   -3.664062    Label :   -3.585072
Output # 3 :    0.429688    Label :    0.436139
Output # 4 :   -2.554688    Label :   -2.577520
Output # 5 :    0.933594    Label :    0.812739
Output # 6 :    0.640625    Label :    0.602996
Output # 7 :   -4.304688    Label :   -4.287211
Output # 8 :   10.093750    Label :    9.967606
Output # 9 :   -2.921875    Label :   -2.928842

Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.
```

Platform Architecture : (PA 中無法使用 sc_fixed , 僅能使用 float type)

Input_1

ans : 7

```
Console
Loading label : Answer/lenet_output_1.txt
Loading weights...
47154 loaded weights.
Output # 0 : -5.692679 Label : -5.692680
Output # 1 : -0.288591 Label : -0.288590
Output # 2 : 1.907344 Label : 1.907344
Output # 3 : 0.751245 Label : 0.751244
Output # 4 : -7.023232 Label : -7.023230
Output # 5 : -3.161095 Label : -3.161095
Output # 6 : -12.820799 Label : -12.820796
Output # 7 : 11.970234 Label : 11.970235
Output # 8 : -0.548813 Label : -0.548812
Output # 9 : -1.591035 Label : -1.591035
SystemC: simulation stopped by user.
[New SystemC Thread 0x1eeec0 "HARDWARE.i_Reset.do_it"]
[SystemC Thread 0x1eeec0 "HARDWARE.i_Reset.do_it" exited]
[Inferior 1 (process 14509) exited normally]
```



Input_2

ans : 2

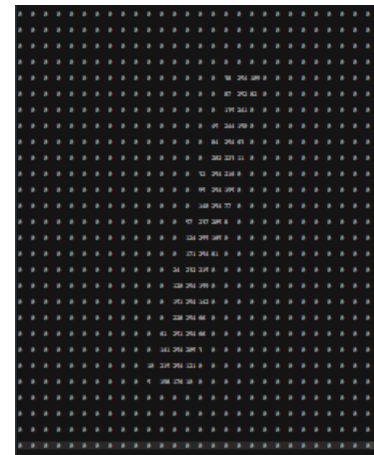
```
Console
Loading label : Answer/lenet_output_2.txt
Loading weights...
47154 loaded weights.
Output # 0 : 1.883513 Label : 1.883511
Output # 1 : 5.204262 Label : 5.204263
Output # 2 : 11.776731 Label : 11.776729
Output # 3 : -2.710082 Label : -2.710081
Output # 4 : -8.719761 Label : -8.719760
Output # 5 : -10.605380 Label : -10.605376
Output # 6 : -3.290086 Label : -3.290083
Output # 7 : -4.403935 Label : -4.403935
Output # 8 : -0.877534 Label : -0.877534
Output # 9 : -12.395869 Label : -12.395868
SystemC: simulation stopped by user.
[New SystemC Thread 0x1a5cec0 "HARDWARE.i_Reset.do_it"]
[SystemC Thread 0x1a5cec0 "HARDWARE.i_Reset.do_it" exited]
[Inferior 1 (process 14815) exited normally]
```



Input_3

ans : 1

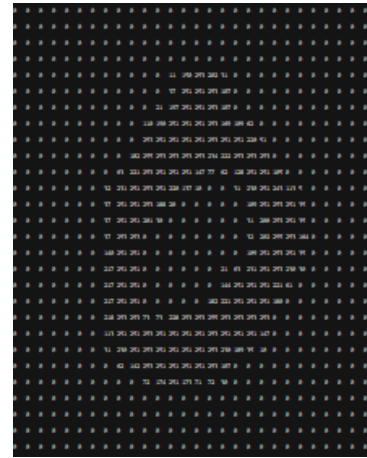
```
Console
Loading label : Answer/lenet_output_3.txt
Loading weights...
47154 loaded weights.
Output # 0 : -2.327977 Label : -2.327977
Output # 1 : 7.517642 Label : 7.517640
Output # 2 : -1.210088 Label : -1.210088
Output # 3 : -4.182841 Label : -4.182842
Output # 4 : 0.081698 Label : 0.081699
Output # 5 : -5.105879 Label : -5.105879
Output # 6 : -2.000496 Label : -2.000495
Output # 7 : -0.150937 Label : -0.150937
Output # 8 : -0.760909 Label : -0.760908
Output # 9 : -2.999767 Label : -2.999766
SystemC: simulation stopped by user.
[New SystemC Thread 0x1098ec0 "HARDWARE.i_Reset.do_it"]
[SystemC Thread 0x1098ec0 "HARDWARE.i_Reset.do_it" exited]
```



Input_4

ans : 0

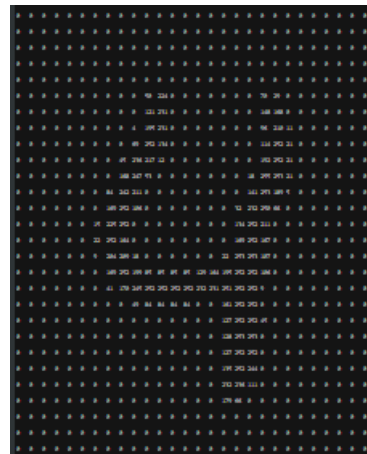
```
Console
Loading label : Answer/lenet_output_4.txt
Loading weights...
47154 loaded weights.
Output # 0 : 10.857318 Label : 10.857318
Output # 1 : -4.916886 Label : -4.916887
Output # 2 : -1.645170 Label : -1.645169
Output # 3 : -3.324846 Label : -3.324847
Output # 4 : -5.333570 Label : -5.333570
Output # 5 : -0.875547 Label : -0.875546
Output # 6 : 3.338291 Label : 3.338293
Output # 7 : -3.206848 Label : -3.206848
Output # 8 : -3.664100 Label : -3.664099
Output # 9 : -0.118884 Label : -0.118883
SystemC: simulation stopped by user.
[New SystemC Thread 0x2eb5ec0 "HARDWARE.i_Reset.do_it"]
[SystemC Thread 0x2eb5ec0 "HARDWARE.i_Reset.do_it" exited]
```



Input_5

ans : 4

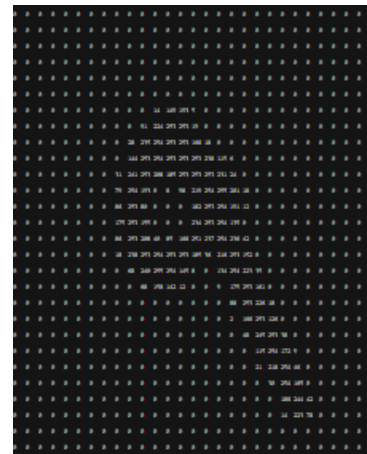
```
Console
Loading label : Answer/lenet_output_5.txt
Loading weights...
47154 loaded weights.
Output # 0 : -5.327168 Label : -5.327168
Output # 1 : -2.725101 Label : -2.725101
Output # 2 : -4.887796 Label : -4.887795
Output # 3 : -4.522934 Label : -4.522934
Output # 4 : 10.841787 Label : 10.841791
Output # 5 : -4.217877 Label : -4.217876
Output # 6 : -1.268859 Label : -1.268860
Output # 7 : -3.602647 Label : -3.602647
Output # 8 : -3.273474 Label : -3.273473
Output # 9 : 3.877691 Label : 3.877691
SystemC: simulation stopped by user.
[New SystemC Thread 0xfd7ec0 "HARDWARE.i_Reset.do_it"]
[SystemC Thread 0xfd7ec0 "HARDWARE.i_Reset.do_it" exited]
```



Input_6

ans : 9

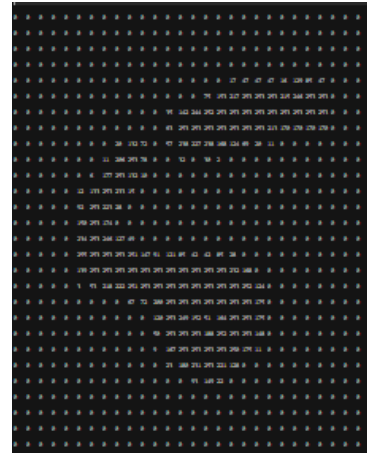
```
Console
Loading label : Answer/lenet_output_6.txt
Loading weights...
47154 loaded weights.
Output # 0 : -4.155002 Label : -4.155001
Output # 1 : -3.685336 Label : -3.685337
Output # 2 : -4.951273 Label : -4.951273
Output # 3 : -1.510458 Label : -1.510458
Output # 4 : 1.080713 Label : 1.080713
Output # 5 : -0.137100 Label : -0.137101
Output # 6 : -7.223796 Label : -7.223797
Output # 7 : -1.383158 Label : -1.383158
Output # 8 : 0.894924 Label : 0.894923
Output # 9 : 7.178139 Label : 7.178138
SystemC: simulation stopped by user.
[New SystemC Thread 0x2134ec0 "HARDWARE.i_Reset.do_it"]
[SystemC Thread 0x2134ec0 "HARDWARE.i_Reset.do_it" exited]
```



Input_7

ans : 5

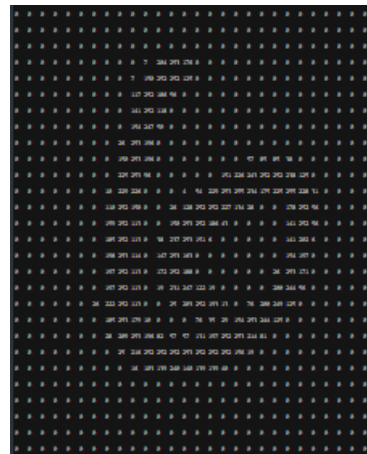
```
Console
Loading label : Answer/lenet_output_7.txt
Loading weights...
47154 loaded weights.
Output # 0 : -6.083923 Label : -6.083921
Output # 1 : -7.429938 Label : -7.429938
Output # 2 : -5.149819 Label : -5.149817
Output # 3 : -2.606214 Label : -2.606215
Output # 4 : -5.594572 Label : -5.594570
Output # 5 : 9.824126 Label : 9.824126
Output # 6 : 1.315442 Label : 1.315440
Output # 7 : -4.608023 Label : -4.608022
Output # 8 : 1.697768 Label : 1.697766
Output # 9 : 0.610571 Label : 0.610572
SystemC: simulation stopped by user.
[New SystemC Thread 0x2dc1ec0 "HARDWARE.i_Reset.do_it"]
[SystemC Thread 0x2dc1ec0 "HARDWARE.i_Reset.do_it" exited]
```



Input_8

ans : 6

```
Console
Loading label : Answer/lenet_output_8.txt
Loading weights...
47154 loaded weights.
Output # 0 : 3.861394 Label : 3.861394
Output # 1 : -4.694177 Label : -4.694178
Output # 2 : -4.684811 Label : -4.684812
Output # 3 : -3.411602 Label : -3.411603
Output # 4 : -4.133462 Label : -4.133463
Output # 5 : 3.112758 Label : 3.112759
Output # 6 : 10.723673 Label : 10.723674
Output # 7 : -4.971688 Label : -4.971688
Output # 8 : 0.177012 Label : 0.177012
Output # 9 : -1.925642 Label : -1.925641
SystemC: simulation stopped by user.
[New SystemC Thread 0x26a4ec0 "HARDWARE.i_Reset.do_it"]
[SystemC Thread 0x26a4ec0 "HARDWARE.i_Reset.do_it" exited]
```



Input_9

ans : 3

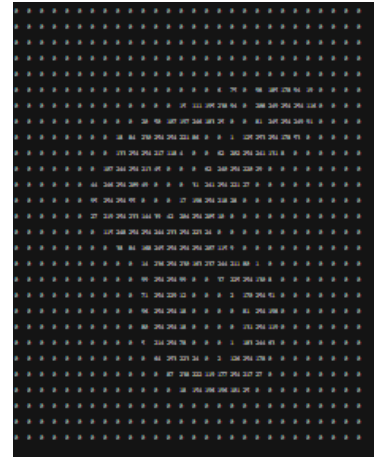
```
Console
Loading label : Answer/lenet_output_9.txt
Loading weights...
47154 loaded weights.
Output # 0 : -5.225960 Label : -5.225956
Output # 1 : -1.254550 Label : -1.254549
Output # 2 : -0.619967 Label : -0.619967
Output # 3 : 6.112026 Label : 6.112026
Output # 4 : -6.522448 Label : -6.522448
Output # 5 : 0.407647 Label : 0.407647
Output # 6 : -5.123464 Label : -5.123464
Output # 7 : -4.786591 Label : -4.786593
Output # 8 : 1.669284 Label : 1.669284
Output # 9 : -4.366187 Label : -4.366186
SystemC: simulation stopped by user.
[New SystemC Thread 0x1b67ec0 "HARDWARE.i_Reset.do_it"]
[SystemC Thread 0x1b67ec0 "HARDWARE.i_Reset.do_it" exited]
```



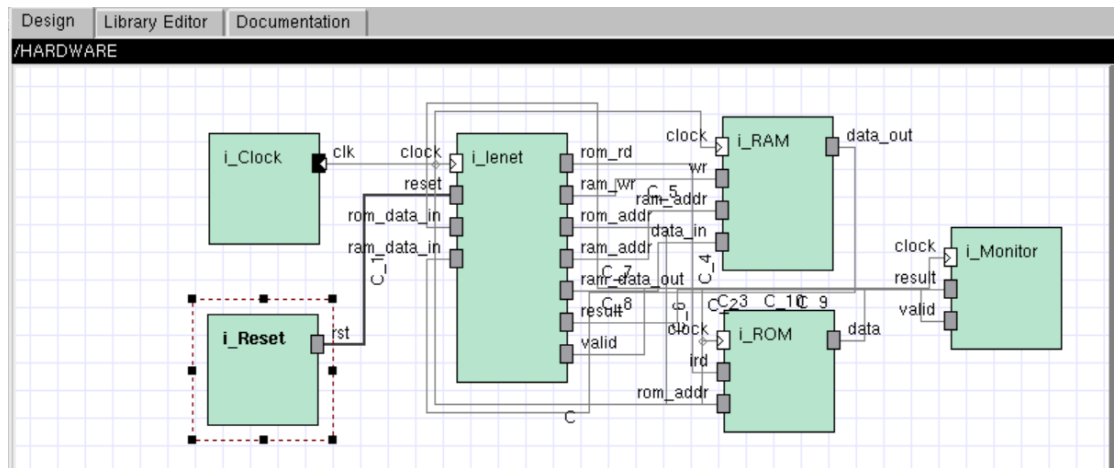
Input_10

ans : 8

```
Console
Loading label : Answer/lenet_output_10.txt
Loading weights...
47154 loaded weights.
Output # 0 : -6.667819 Label : -6.667818
Output # 1 : -2.805802 Label : -2.805802
Output # 2 : -3.585072 Label : -3.585072
Output # 3 : 0.436139 Label : 0.436139
Output # 4 : -2.577520 Label : -2.577520
Output # 5 : 0.812739 Label : 0.812739
Output # 6 : 0.602996 Label : 0.602996
Output # 7 : -4.287213 Label : -4.287211
Output # 8 : 9.967606 Label : 9.967606
Output # 9 : -2.928843 Label : -2.928842
SystemC: simulation stopped by user.
[New SystemC Thread 0x1c1eec0 "HARDWARE.i_Reset.do_it"]
[SystemC Thread 0x1c1eec0 "HARDWARE.i_Reset.do_it" exited]
```



Design :



遇到的問題與解法：

這次作業為期末 project，雖然看似就是機器學習運用 CNN 辨識 MNIST 手寫數字，但我之前都是只了解原理，在 python 中 call function，並沒有實際一個一個 data 去做過運算，這次的 project 除了讓我對 systemC 更理解以外，也讓我對 CNN 的實際 data 運算有更深入的了解。

這次的運算量相較前幾次作業大很多，所以在 debug 上有很多細節要去注意，我剛開始得到錯誤的側資的大部分原因都是因為從 ram 或 rom 中存取 data 有問題，例如忘記要等一個 cycle 才取的到值，或是同時做了存入與取出的動作導致衝突等等，需要再多加細心撰寫。

這次要寫兩種 TYPE 可以切換 float 與 sc_fixed，從結果可以發現 float 的運算會比 sc_fixed 的數值更準一些，猜測是因為 sc_fixed 會有一些捨去的小數點所導致，若從 sc_fixed 的宣告參數中去做調整會接近正確數值一些。如下圖如果改成 sc_fixed<25,9>就會更準確一點。


```
B063040061 ZEUS /home/B063040061/Desktop/B063040061_HW4% make
g++ -I . -I /usr/systemc/include -L . -L /usr/systemc/lib-linux
p -lsystemc -lm -DSC_INCLUDE_FX
B063040061 ZEUS /home/B063040061/Desktop/B063040061_HW4% ./test
```

```
SystemC 2.3.1-Accellera --- Jun 22 2017 17:44:29
Copyright (c) 1996-2014 by all Contributors,
ALL RIGHTS RESERVED
```

```
Loading weights...
47154 loaded weights.
Loading label : Answer/lenet_output_1.txt
```

Output # 0 :	-5.692581	Label :	-5.692680
Output # 1 :	-0.288971	Label :	-0.288590
Output # 2 :	1.907166	Label :	1.907344
Output # 3 :	0.751129	Label :	0.751244
Output # 4 :	-7.022995	Label :	-7.023230
Output # 5 :	-3.160904	Label :	-3.161095
Output # 6 :	-12.820648	Label :	-12.820796
Output # 7 :	11.970490	Label :	11.970235
Output # 8 :	-0.548874	Label :	-0.548812
Output # 9 :	-1.590881	Label :	-1.591035

```
Info: /OSCI/SystemC: Simulation stopped by user.
10 output received.
```

```
run_mode.h x run_mode.h x
1 #define MODE 2
2 //1 for floating , 2 for fixed
3
4 #define NUM 1
5
6
7
8
9
10
11
12 #define QUO(x) #x
13 #define QUOTE(x) QUO(x)
14 #define CONC(x,y,z) x ## y.z
15 #define CONCAT(x,y) QUOTE(CONC(x,y,txt))
16
17 #if MODE == 1
18 #define TYPE float
19 #elif MODE == 2
20 #define TYPE sc_fixed<25,9,SC_RND,SC_SAT>
21 #endif
22
23 #define INPUT_FILE CONCAT(Pattern/input,NUM)
24 #define LABEL_FILE CONCAT(Answer/lenet_output_,NUM)
25
```