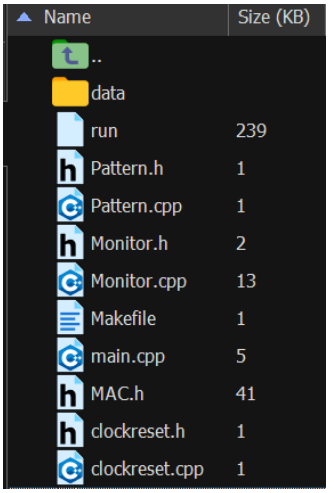
HW2 Implementation of AlexNet in SystemC

I. Code Structure

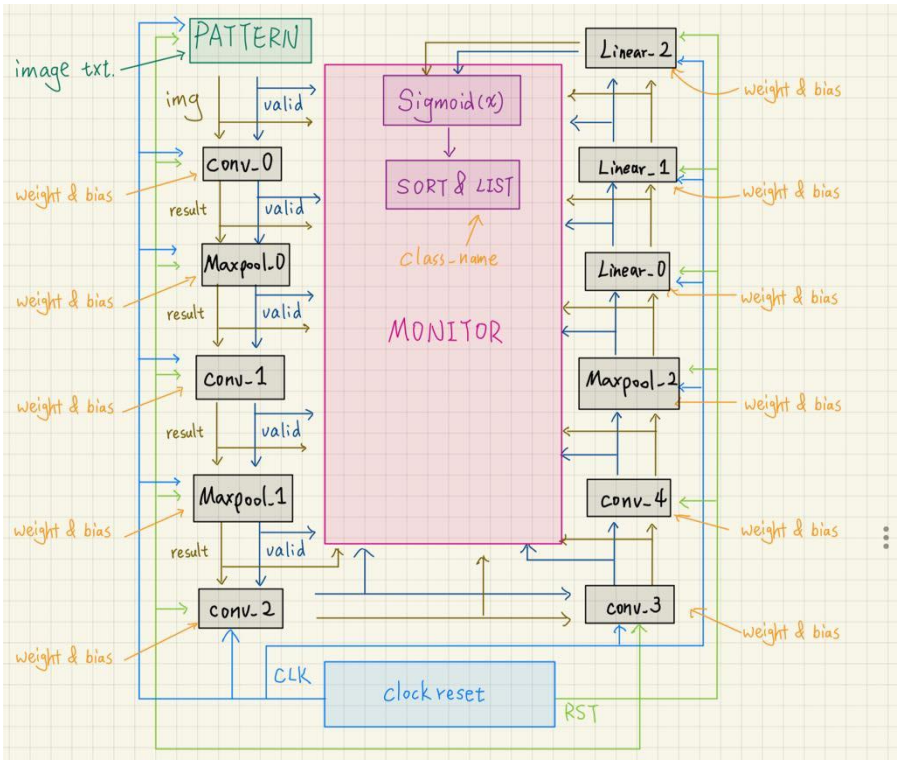
sc_signal, sc_buffer, and sc_fifo are sharing similar code structure.



data folder	Include weight, bias, and input image matrix
run	Executable files for SystemC program
Pattern.h	Declare the internal variable, input/output signal , functions, method.
Pattern.cpp	Implement the methods that will provide our AlexNet input image. It will read the text file (image) from data folder when rst signal is on. After turning off rst signal, Pattern will output 2 image in 2 following continuous cycles.
Monitor.h	Declare the input/output signal, functions and method for monitoring our AlexNet. Also, the output layer (Softmax layer and sorting) is implemented here. After getting the last linear layer (fc8), it will trigger the output layer and show the inference result according to the Softmax result and class name list.
Monitor.cpp	Implement the method for monitoring our AlexNet. Also, the output layer (Softmax layer and sorting) is implemented here. After getting the last linear layer (fc8), it will trigger the output layer and show the inference result according to the Softmax result and class name list.
Makefile	Makefile script for compile systemC program.
main.cpp	Declare the main function, create the module instances, mapping the signals. It includes all operation units, pattern module, clockreset modules, and monitor module.
MAC.h	Implement all operation units.
clockreset.h	Declare the clock module and reset modules.
clockreset.cpp	Implement the clock module and reset modules.

II. Design Architecture and Implementation

A. sc_signal, sc_buffer



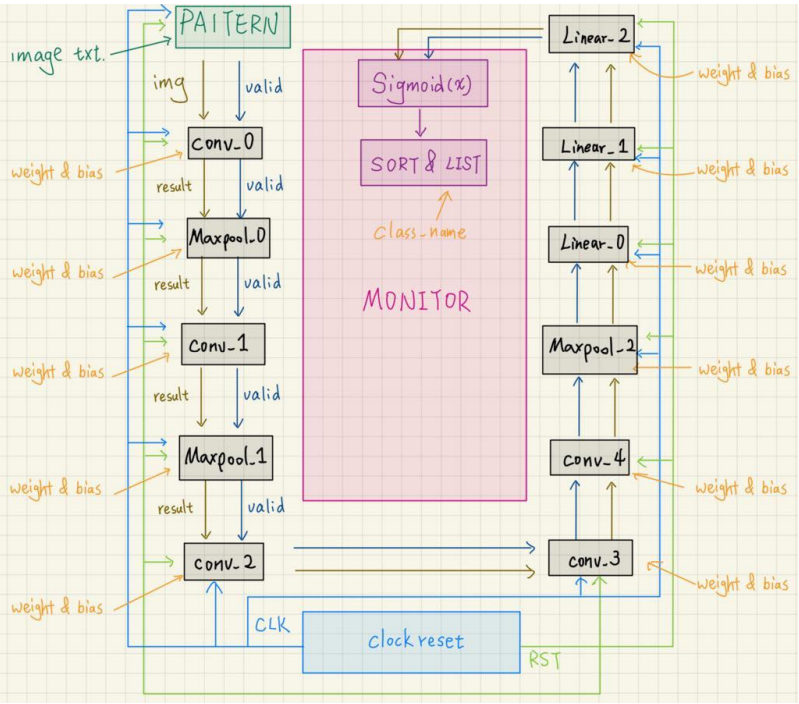
Fig(a) Architecture for sc_signal/sc_buffer solution

I implemented the design for sc_signal and sc_buffer with the same architecture since these two kinds of port are similar.

In the above Fig(a), brown ,dark blue, light blue, and light green lines are sc_signal/sc_buffer.

Orange and dark green parts are embedded in the layer which the orange/dark green arrows point at.

B. sc_fifo



Fig(b) Architecture for sc_fifo solution

In the above Fig(b), brown ,dark blue are implemented in sc_fifo. Other lines are the same as the setting in Fig(a). Orange and dark green parts are embedded in the layer which the orange/dark green arrows point at.

I remove most of lines that connect between operation layers and monitor since sc_fifo only allow one output port to connect with.

III. Observations and Optimization

A. sc_signal, sc_buffer

The main difference of wiring with sc_signal and sc_buffer is the trigger of updating value. The former, sc_signal, only updates the value when its input value changed, while sc_buffer always updates the value without checking input signal.

Besides, after using “write()” function to write the new value into both of these ports, the new value will be blocked and wait the next trigger event take

place. Then, we can use “read()” function to access the new value we just give to the ports.

B. sc_fifo

I still use Method to implement sc_fifo-wiring module. However, we have to know if fifo is empty. If not empty, we have to read out and release fifo space. If it is empty, we have to make sure the simulation will not be blocked. To do that, I use “nb_read()” . This function will return a bool term. If it is empty, it will return 0. Then, we will skip the empty process.s

IV. Demo Results

To run the simulation, Makefiles are placed in the folders (sc_signal, sc_buffer, sc_fifo). Just enter the folder and type “make”.

(a) sc_signal

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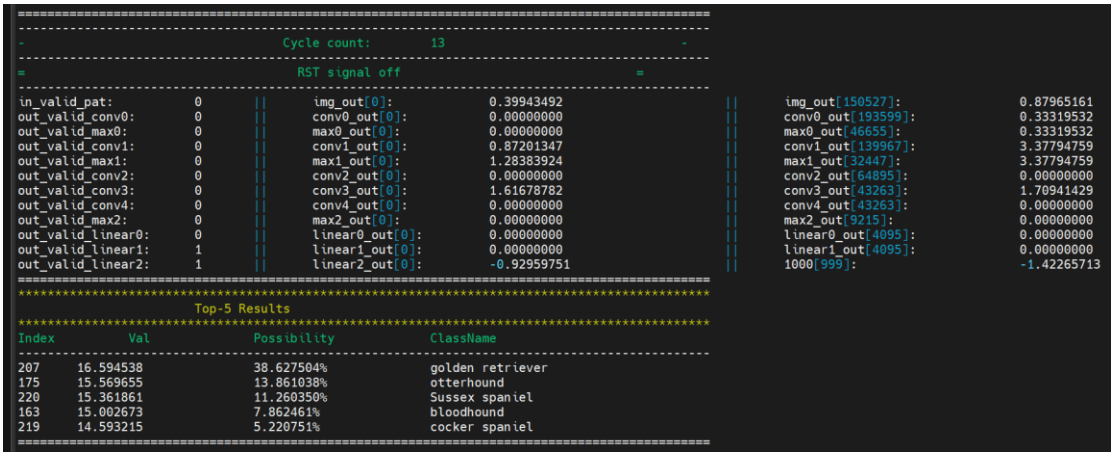
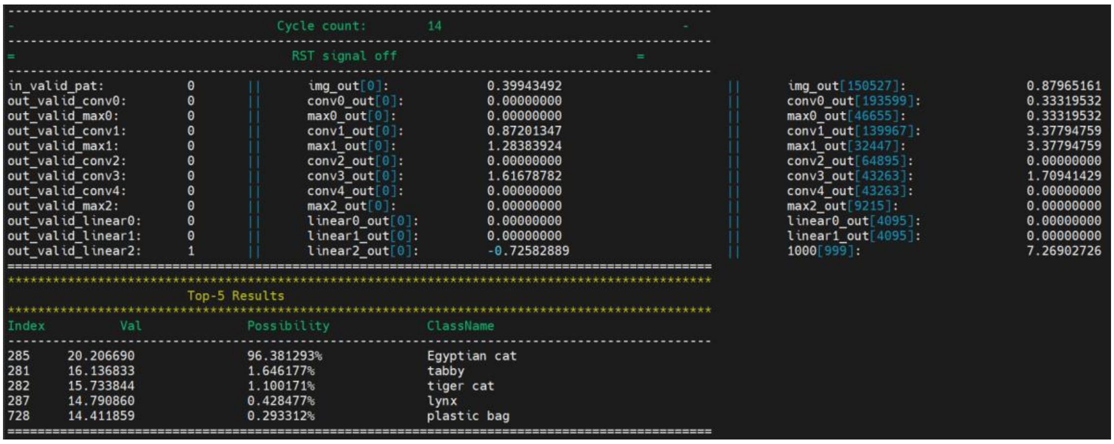
dog.txt for sc_signal



cat.txt for sc_signal


```
-                              Cycle count:        14                              -
=                                RST signal off                          =
in_valid_pat:           0    ||      img_out[0]:            0.39943492    ||    img_out[150527]:          0.87965161
out_valid_conv0:        0    ||      conv0_out[0]:          0.00000000    ||    conv0_out[193599]:        0.33319532
out_valid_max0:         0    ||      max0_out[0]:           0.00000000    ||    max0_out[46655]:          0.33319532
out_valid_conv1:        0    ||      conv1_out[0]:          0.87201347    ||    conv1_out[139967]:        3.37794759
out_valid_max1:         0    ||      max1_out[0]:           1.28383924    ||    max1_out[32447]:          3.37794759
out_valid_conv2:        0    ||      conv2_out[0]:          0.00000000    ||    conv2_out[64895]:         0.00000000
out_valid_conv3:        0    ||      conv3_out[0]:          1.61678782    ||    conv3_out[43263]:         1.70941429
out_valid_conv4:        0    ||      conv4_out[0]:          0.00000000    ||    conv4_out[43263]:         0.00000000
out_valid_max2:         0    ||      max2_out[0]:           0.00000000    ||    max2_out[9215]:           0.00000000
out_valid_linear0:      0    ||      linear0_out[0]:        0.00000000    ||    linear0_out[4095]:        0.00000000
out_valid_linear1:      0    ||      linear1_out[0]:        0.00000000    ||    linear1_out[4095]:        0.00000000
out_valid_linear2:      1    ||      linear2_out[0]:        -0.72582889   ||    1000[999]:                7.26902726
==========================================================================================
******************************************************************************************
                         Top-5 Results
******************************************************************************************
Index         Val                Possibility              ClassName
------------------------------------------------------------------------------------------
285     20.206690            96.381293%               Egyptian cat
281     16.136833            1.646177%                tabby
282     15.733844            1.100171%                tiger cat
287     14.790860            0.428477%                lynx
728     14.411859            0.293312%                plastic bag
==========================================================================================
```

(b)sc_buffer

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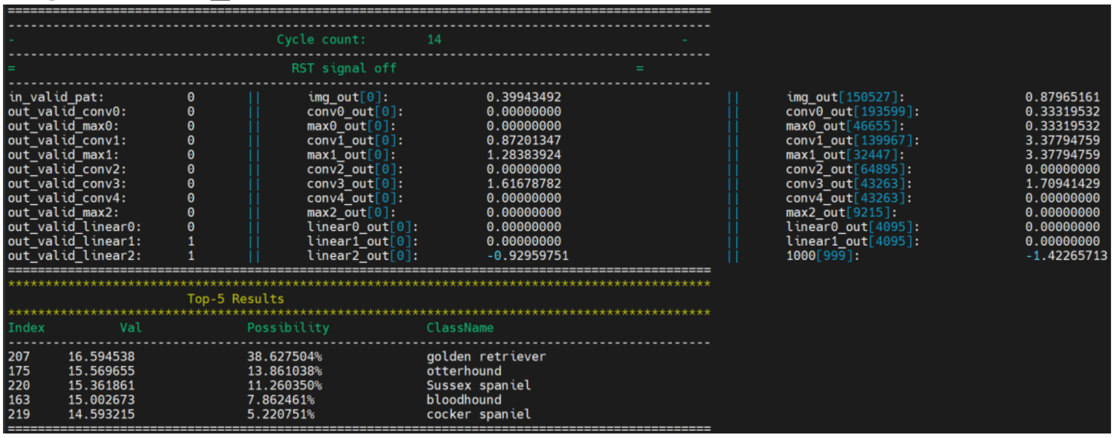
dog.txt for sc_buffer


```
-                              Cycle count:        14                              -
=                                RST signal off                          =
in_valid_pat:           0    ||      img_out[0]:            0.39943492    ||    img_out[150527]:          0.87965161
out_valid_conv0:        0    ||      conv0_out[0]:          0.00000000    ||    conv0_out[193599]:        0.33319532
out_valid_max0:         0    ||      max0_out[0]:           0.00000000    ||    max0_out[46655]:          0.33319532
out_valid_conv1:        0    ||      conv1_out[0]:          0.87201347    ||    conv1_out[139967]:        3.37794759
out_valid_max1:         0    ||      max1_out[0]:           1.28383924    ||    max1_out[32447]:          3.37794759
out_valid_conv2:        0    ||      conv2_out[0]:          0.00000000    ||    conv2_out[64895]:         0.00000000
out_valid_conv3:        0    ||      conv3_out[0]:          1.61678782    ||    conv3_out[43263]:         1.70941429
out_valid_conv4:        0    ||      conv4_out[0]:          0.00000000    ||    conv4_out[43263]:         0.00000000
out_valid_max2:         0    ||      max2_out[0]:           0.00000000    ||    max2_out[9215]:           0.00000000
out_valid_linear0:      0    ||      linear0_out[0]:        0.00000000    ||    linear0_out[4095]:        0.00000000
out_valid_linear1:      1    ||      linear1_out[0]:        0.00000000    ||    linear1_out[4095]:        0.00000000
out_valid_linear2:      1    ||      linear2_out[0]:        -0.92959751   ||    1000[999]:                -1.42265713
==========================================================================================
******************************************************************************************
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******************************************************************************************
Index         Val                Possibility              ClassName
------------------------------------------------------------------------------------------
207     16.594538            38.627504%               golden retriever
175     15.569655            13.861038%               otterhound
220     15.361861            11.260350%               Sussex spaniel
163     15.002673            7.862461%                bloodhound
219     14.593215            5.220751%                cocker spaniel
==========================================================================================
```
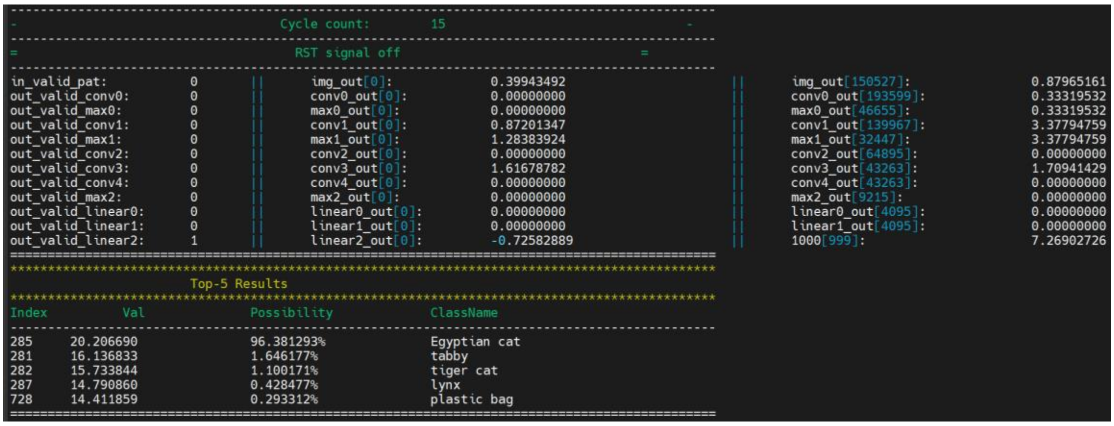

cat.txt for sc_buffer


```
-                              Cycle count:        15                              -
=                                RST signal off                          =
in_valid_pat:           0    ||      img_out[0]:            0.39943492    ||    img_out[150527]:          0.87965161
out_valid_conv0:        0    ||      conv0_out[0]:          0.00000000    ||    conv0_out[193599]:        0.33319532
out_valid_max0:         0    ||      max0_out[0]:           0.00000000    ||    max0_out[46655]:          0.33319532
out_valid_conv1:        0    ||      conv1_out[0]:          0.87201347    ||    conv1_out[139967]:        3.37794759
out_valid_max1:         0    ||      max1_out[0]:           1.28383924    ||    max1_out[32447]:          3.37794759
out_valid_conv2:        0    ||      conv2_out[0]:          0.00000000    ||    conv2_out[64895]:         0.00000000
out_valid_conv3:        0    ||      conv3_out[0]:          1.61678782    ||    conv3_out[43263]:         1.70941429
out_valid_conv4:        0    ||      conv4_out[0]:          0.00000000    ||    conv4_out[43263]:         0.00000000
out_valid_max2:         0    ||      max2_out[0]:           0.00000000    ||    max2_out[9215]:           0.00000000
out_valid_linear0:      0    ||      linear0_out[0]:        0.00000000    ||    linear0_out[4095]:        0.00000000
out_valid_linear1:      0    ||      linear1_out[0]:        0.00000000    ||    linear1_out[4095]:        0.00000000
out_valid_linear2:      1    ||      linear2_out[0]:        -0.72582889   ||    1000[999]:                7.26902726
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287     14.790860            0.428477%                lynx
728     14.411859            0.293312%                plastic bag
==========================================================================================
```

(c) sc_fifo

---

dog.txt for sc_fifo

```
--------------------------------------------------------------------------------------------------
-                                  Cycle count:        19                                        -
--------------------------------------------------------------------------------------------------
=                                    RST signal off                                              =
--------------------------------------------------------------------------------------------------
out_valid_linear2:      1       ||      linear2_out[0]:         -0.92959751
==================================================================================================
**************************************************************************************************
                         Top-5 Results
**************************************************************************************************
Index          Val              Possibility             ClassName
--------------------------------------------------------------------------------------------------
207      16.594538              38.627504%              golden retriever
175      15.569655              13.861038%              otterhound
220      15.361861              11.260350%              Sussex spaniel
163      15.002673              7.862461%               bloodhound
219      14.593215              5.220751%               cocker spaniel
```

cat.txt for sc_fifo

```
--------------------------------------------------------------------------------------------------
-                                  Cycle count:        20                                        -
--------------------------------------------------------------------------------------------------
=                                    RST signal off                                              =
--------------------------------------------------------------------------------------------------
out_valid_linear2:      1       ||      linear2_out[0]:         -0.72582889
==================================================================================================
**************************************************************************************************
                         Top-5 Results
**************************************************************************************************
Index          Val              Possibility             ClassName
--------------------------------------------------------------------------------------------------
285      20.206690              96.381293%              Egyptian cat
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287      14.790860              0.428477%               lynx
728      14.411859              0.293312%               plastic bag
```