MLIC Final Project

SystemC Implementation of a NoC for Siamese Neural Network

Lecture : Machine Learning Intelligent Chip Design

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Outline

- Introduction
- DNN Model
- NoC Architecture
- Simulation Result

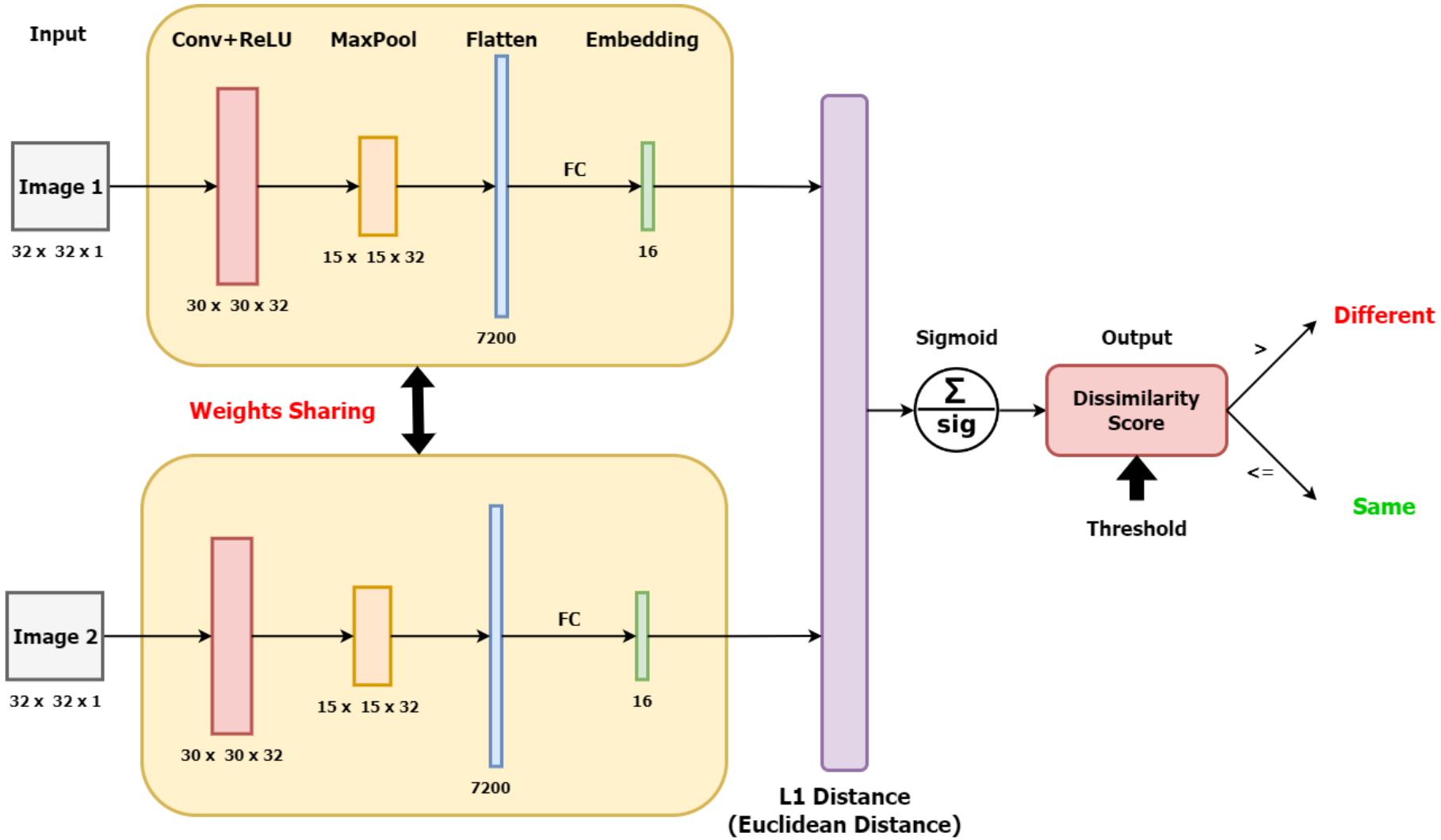
Introduction

Siamese Network

- Compare the similarity between two different inputs
- Few-shot learning
- Applications:
  - Signature verification
  - Human face verification
  - …

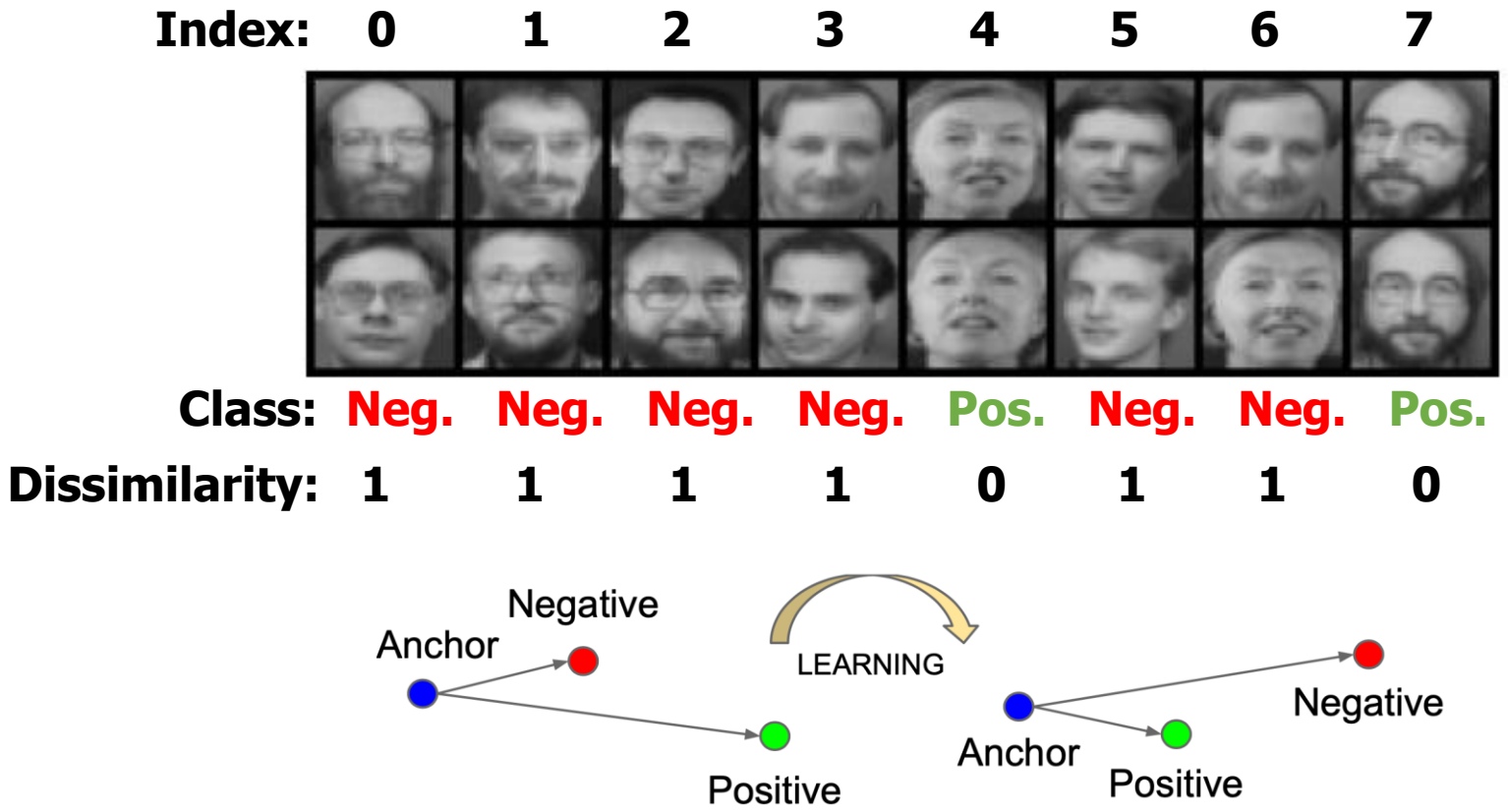
Are these two faces the same?

Siamese Network



Model Training

- **Dataset**
  - AT&T Database of Faces
  - EMNIST
- **DataLoader**
  - Batch size: 8
  - Resize: 32 x 32 x 1
- **Loss Function**
  - Contrastive loss
  - $L = \frac{1}{2N}\left(\sum_{n=1}^{N} y_n {d_n}^2 + (1-y_n)\max(margin - d_n, 0)^2\right)$



* Pos. : Positive sample
Neg. : Negative sample

Model Architecture

Layer No.	Type	Input Size	Stride	#Kernels	Output Size	#Weights	#Biases	#Params.
1	Conv2d	32 x 32 x 1	1	3 x 3 x 32	30 x 30 x 32	288	32	340
2	ReLU	30 x 30 x 32			30 x 30 x 32			
3	MaxPool2d	30 x 30 x 32	2	2 x 2	15 x 15 x 32			
4	Flatten	15 x 15 x 32			7200 x 1			
5	Fully Connect	7200 x 1			16 x 1	115,200	16	115,216
6	Sigmoid	16 x 1			16 x 1			
7	L1 Distance	16 x 1			1			
8	Sigmoid	1						
Total Parameters		115,556						

Input Data & NN Weights

Image	Size	#Pixels
1	32 x 32 x 1	1024
2	32 x 32 x 1	1024

Layer No.	Type	#Weights	#Biases	#Params.
1	Conv2d	288	32	320
2	ReLU			
3	MaxPool2d			
4	Flatten			
5	Fully Connect	115,200	16	115,216
Total Parameters		115,536		

Index	Data
0	Image1 Pixel 1
1	Image1 Pixel 2
⋮	⋮
1023	Image1 Pixel 1024
1024	Image2 Pixel 1
2047	Image2 Pixel 1024
2048	Conv2d Weight 1
117,583	Fully Connect Bias 16

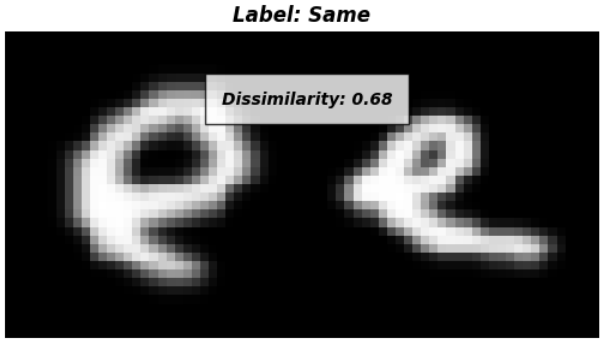
ROM

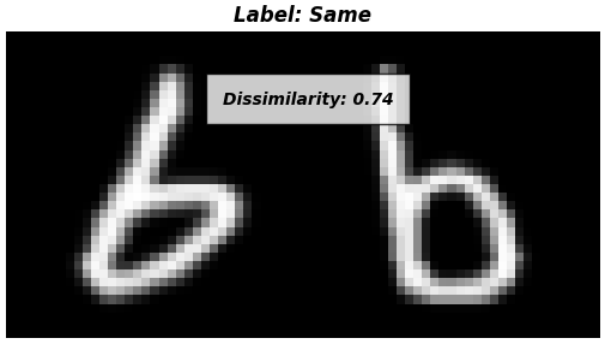
Training Result

■ Character Verification (EMNIST)

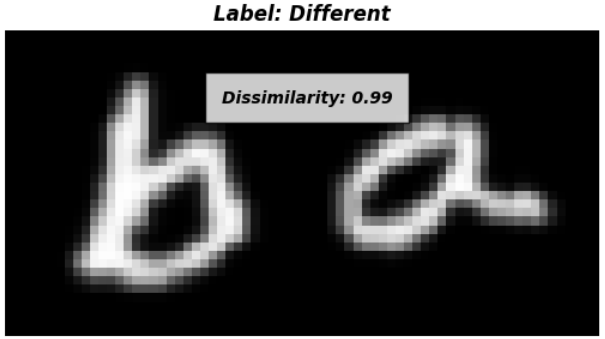
- Test Samples: 50
- Test Accuracy: 96%

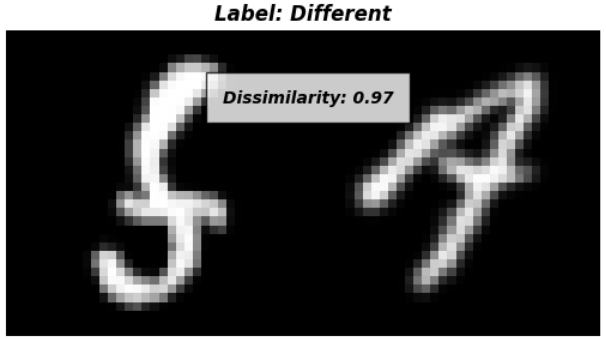
Pos.

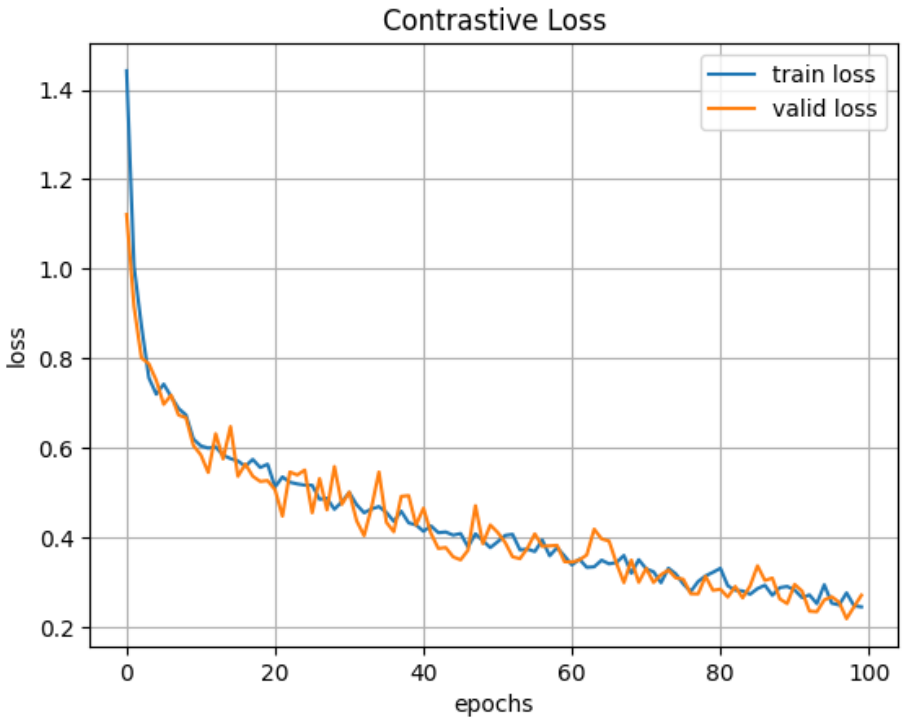




Neg.





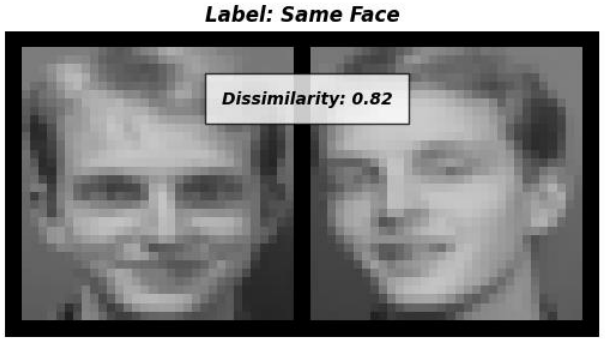


Training Result

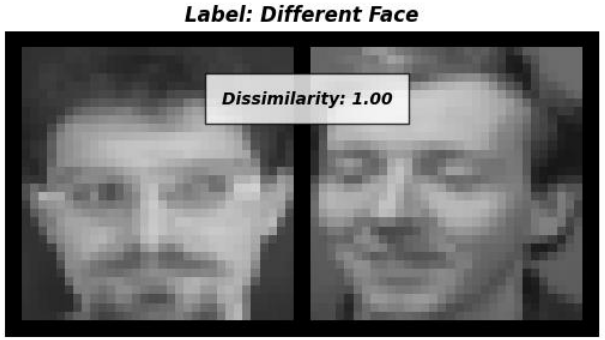
■ Human Face Verification (AT&T)

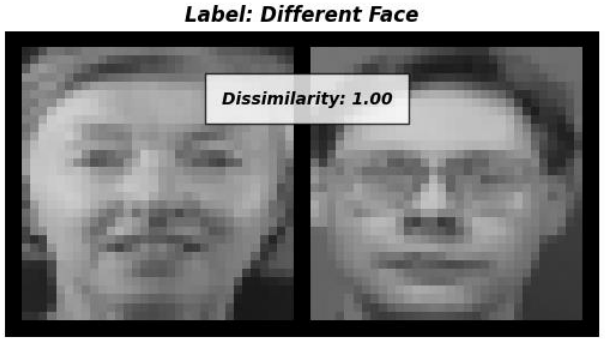
- Test Samples: 50
- Test Accuracy: 94%

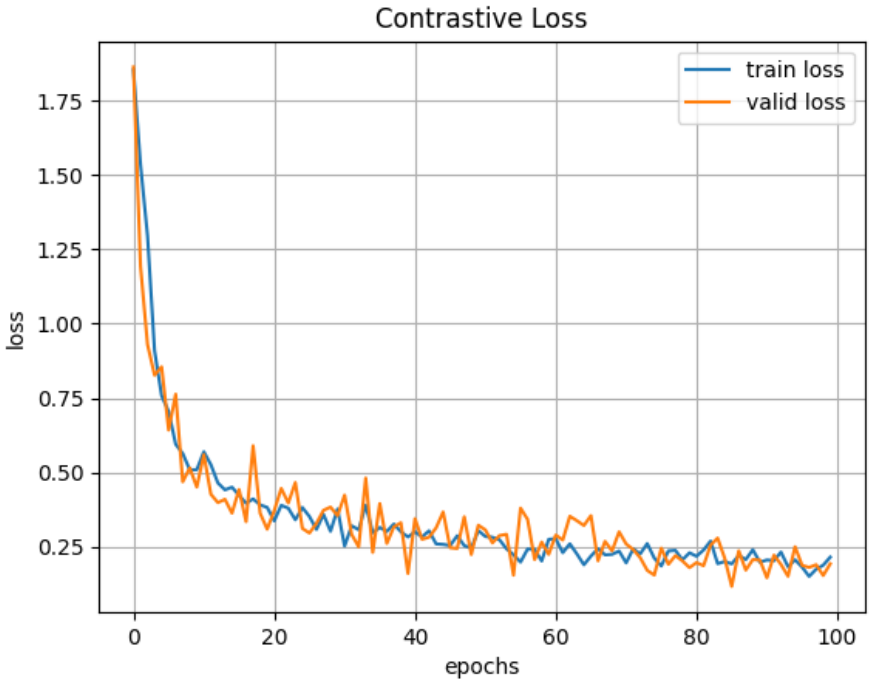
Pos.



Neg.



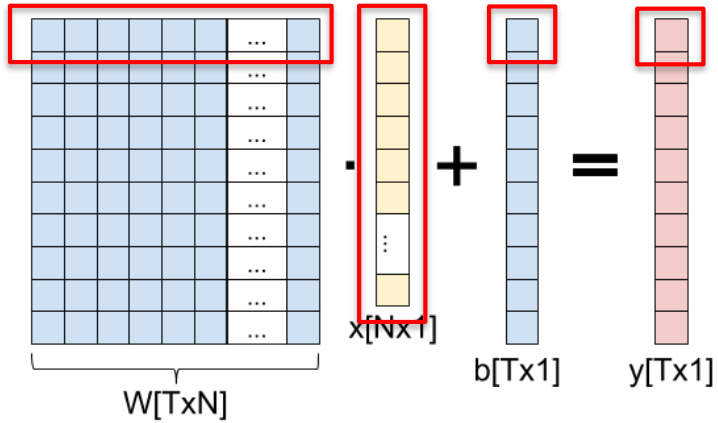




NoC Architecture

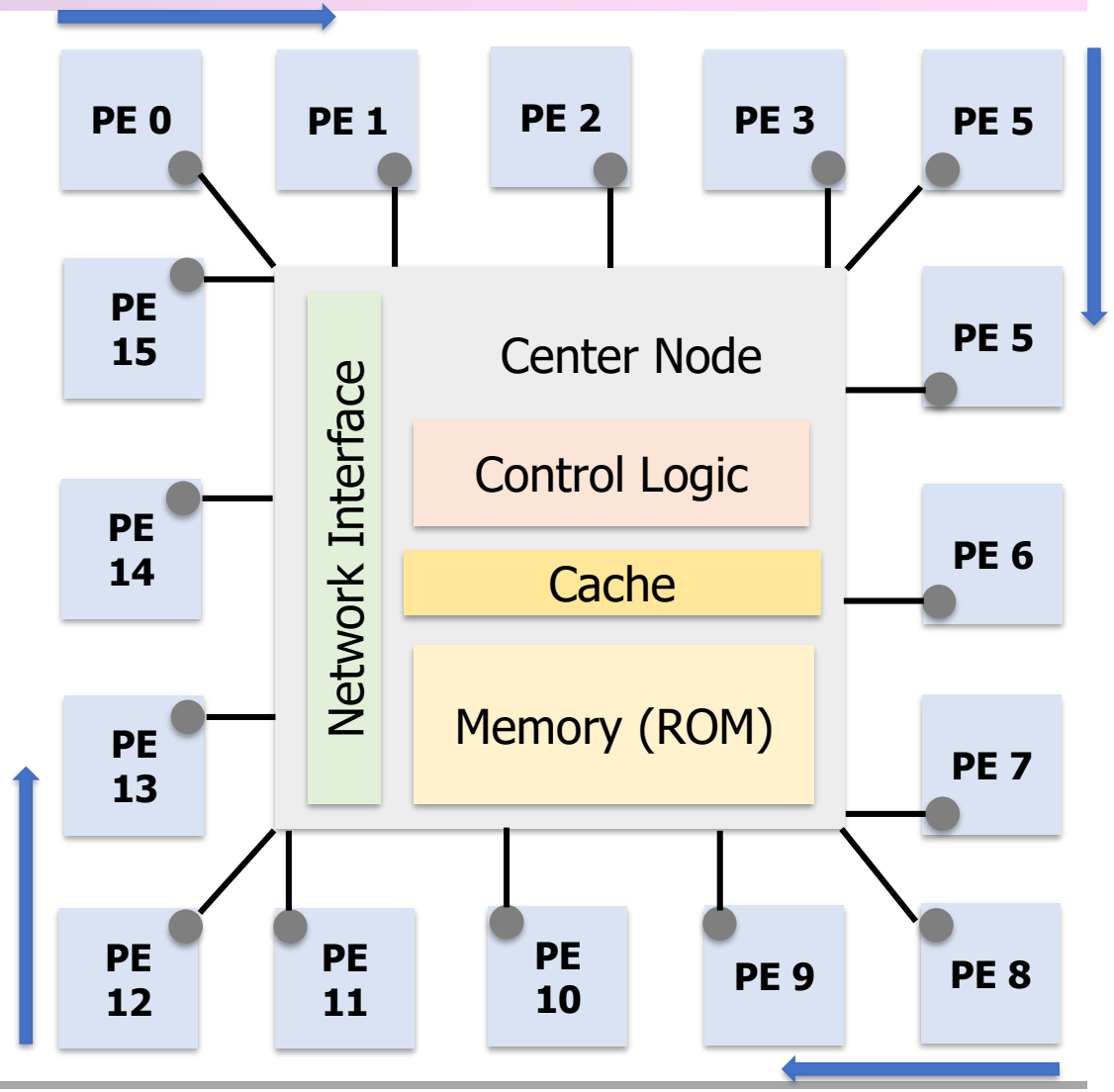
Processing Element

- Fully Connected



Topology

- STAR



Simulation Result

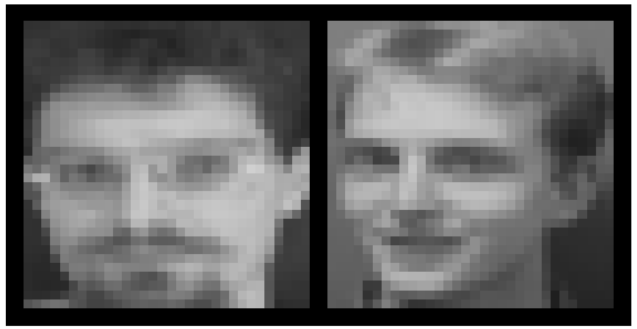
PyTorch

Label: Same Face, Dissimilarity: 0.54

SystemC

```
Starting Simulation...
Result:
Result:
Dissimilarity: 0.535529
Predict: Same
```

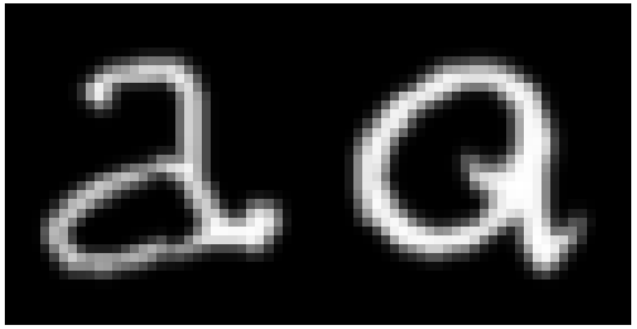
Label: Different Face, Dissimilarity: 1.00



```
Starting Simulation...
Result:
Result:
Dissimilarity: 0.997747
Predict: Different
```

PyTorch

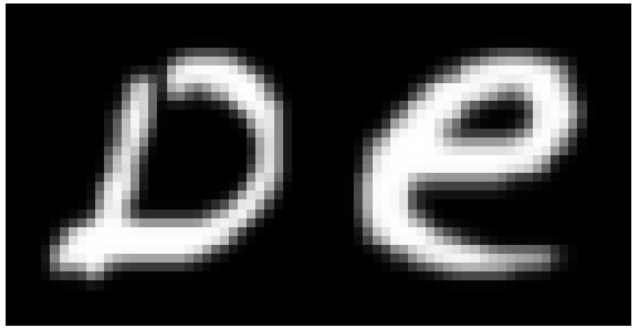
Label: Same, Dissimilarity: 0.77



SystemC

```
Starting Simulation...
Result:
Result:
Dissimilarity: 0.768814
Predict: Same
```

Label: Different, Dissimilarity: 0.99



```
Starting Simulation...
Result:
Result:
Dissimilarity: 0.994181
Predict: Different
```

Thanks !