Example of Error Back Propagation

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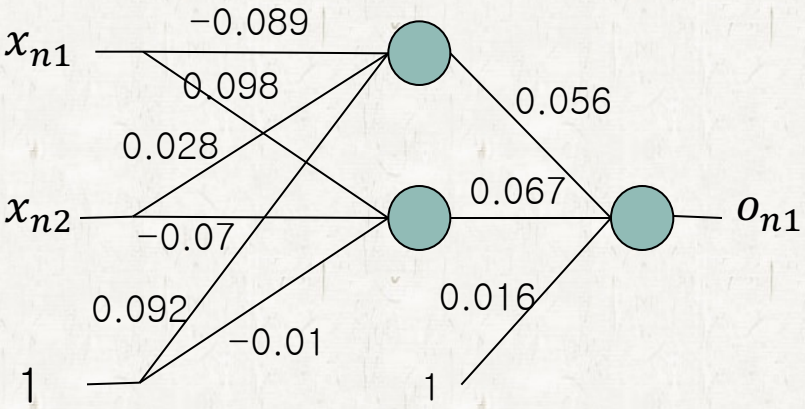
Example of Error Back Propagation (1)

- Example : XOR

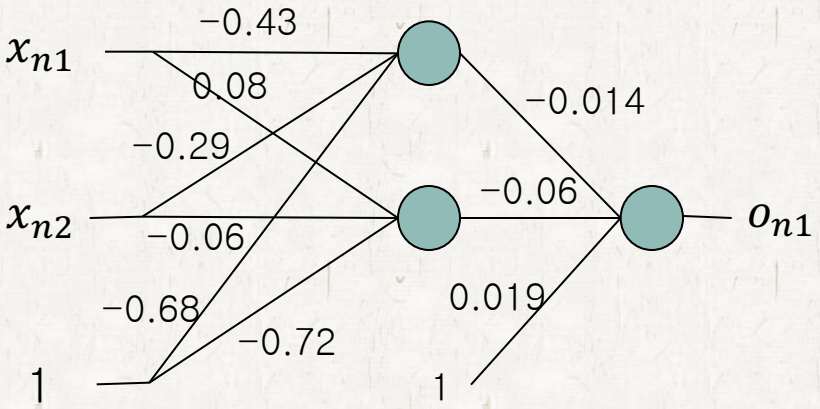
Iteration : 0

x_{n1}	x_{n2}	t_{n1}	o_{n1}
1	1	0	0.52
1	0	1	0.50
0	1	1	0.52
0	0	0	0.55



Iteration : 1000

x_{n1}	x_{n2}	t_{n1}	o_{n1}
1	1	0	0.50
1	0	1	0.48
0	1	1	0.50
0	0	0	0.52

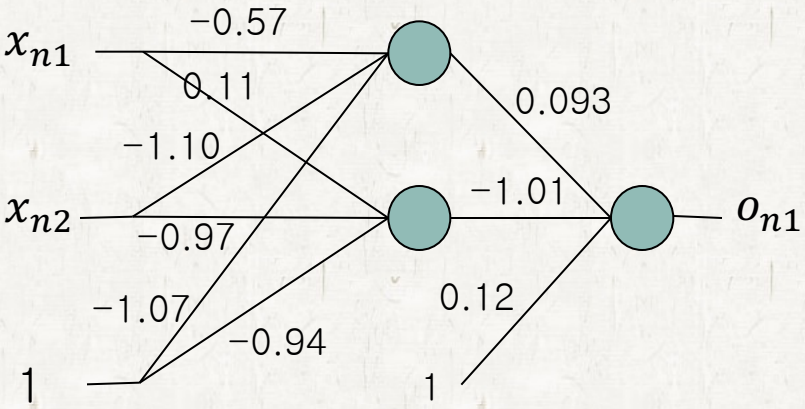


Example of Error Back Propagation (2)

- Example : XOR

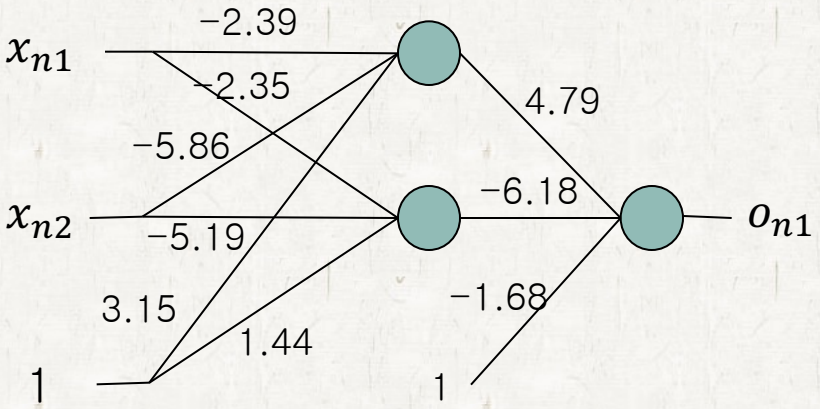
Iteration : 2000

x_{n1}	x_{n2}	t_{n1}	o_{n1}
1	1	0	0.53
1	0	1	0.48
0	1	1	0.50
0	0	0	0.48



Iteration : 3000

x_{n1}	x_{n2}	t_{n1}	o_{n1}
1	1	0	0.30
1	0	1	0.81
0	1	1	0.81
0	0	0	0.11

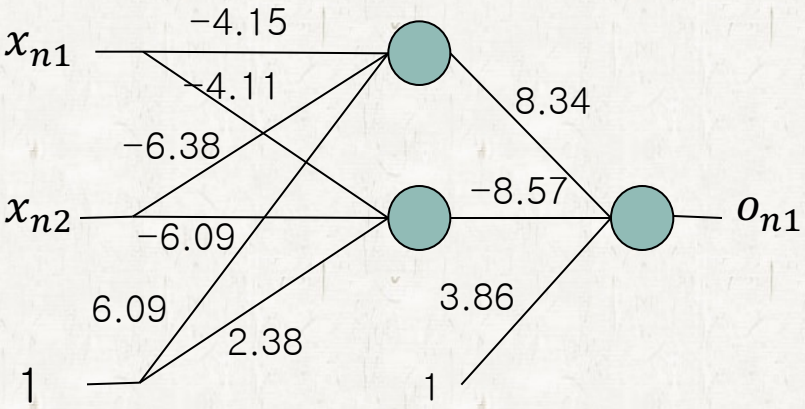


Example of Error Back Propagation (3)

- Example : XOR

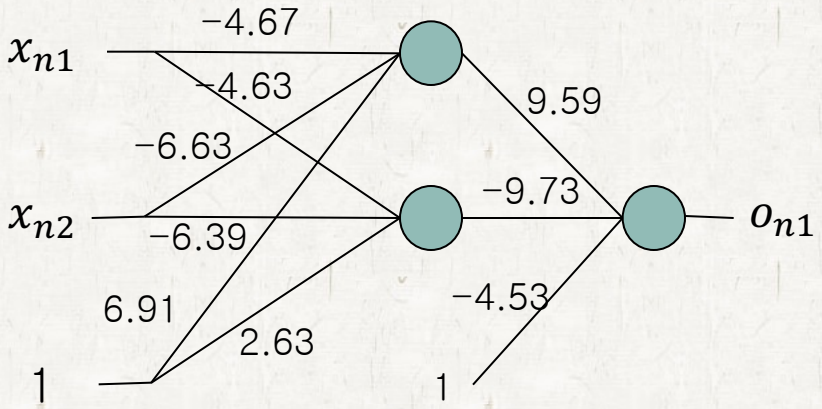
Iteration : 5000

x_{n1}	x_{n2}	t_{n1}	o_{n1}
1	1	0	0.05
1	0	1	0.96
0	1	1	0.96
0	0	0	0.03



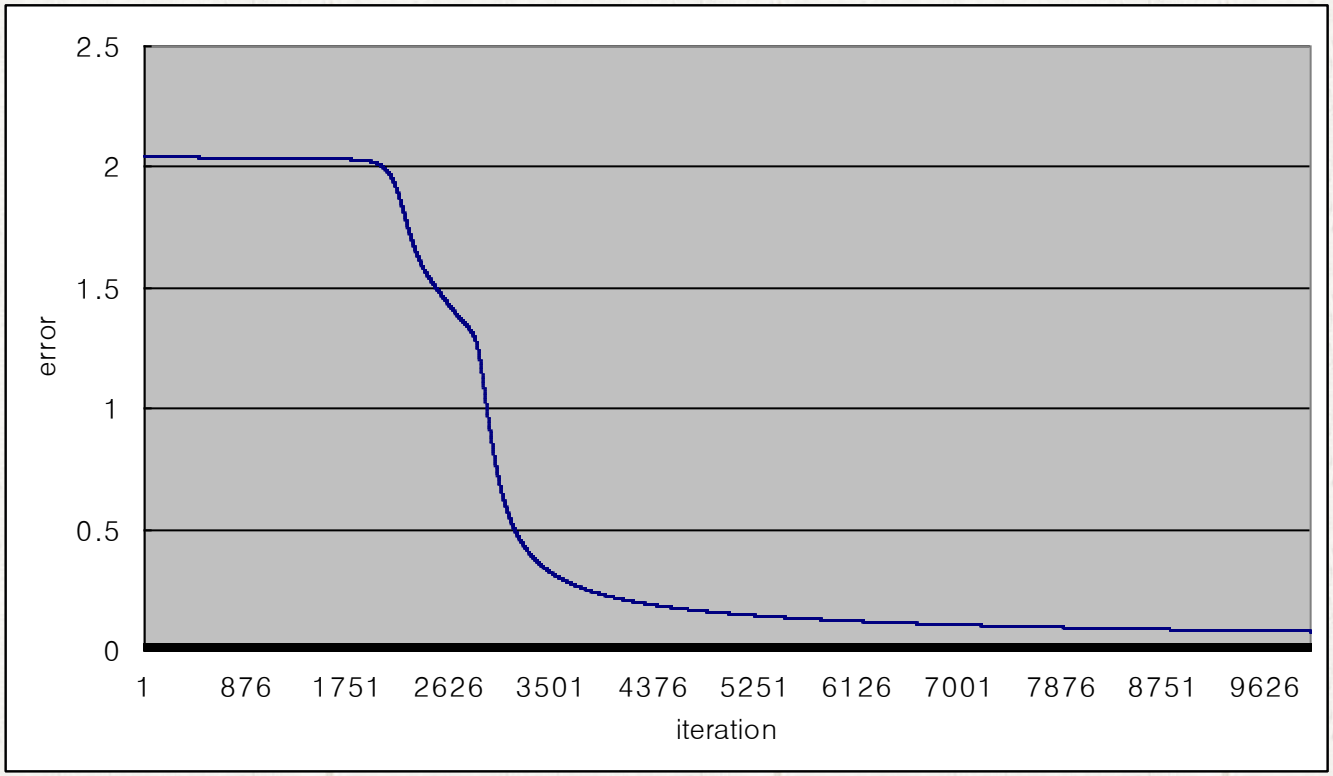
Iteration : 10000

x_{n1}	x_{n2}	t_{n1}	o_{n1}
1	1	0	0.02
1	0	1	0.98
0	1	1	0.98
0	0	0	0.02



Example of Error Back Propagation (4)

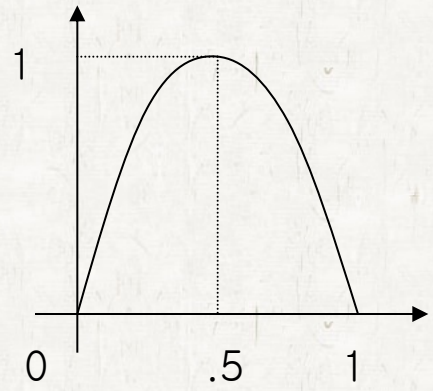
- Example : XOR
  - Error graph

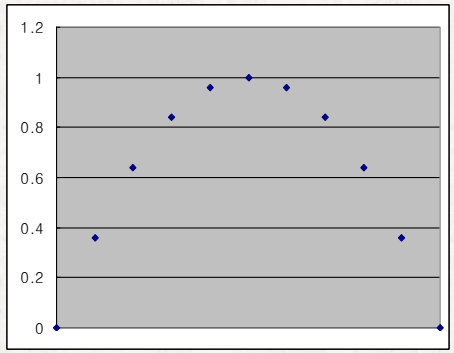


Example of Error Back Propagation (5)

- Example2 :
  - Hidden nodes : 4
  - Iteration : 500,000
  - Learning rate : 0.7

$$f(x) = 4x*(1-x)$$

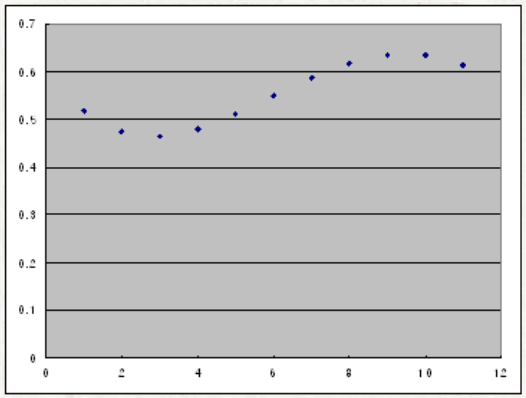
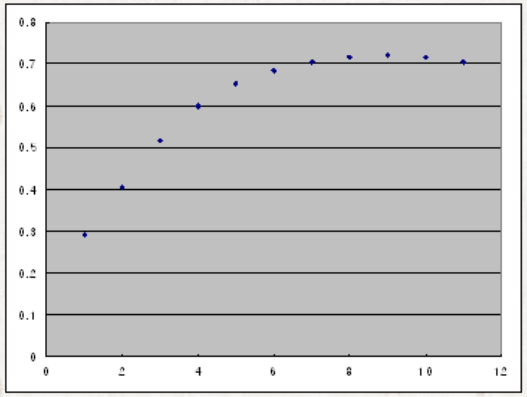
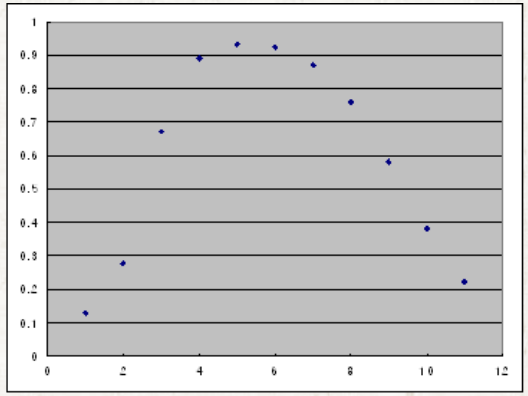
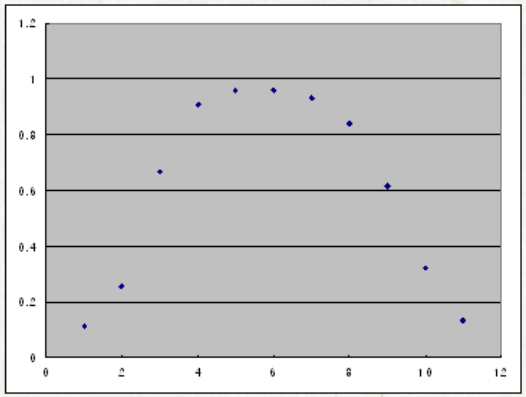
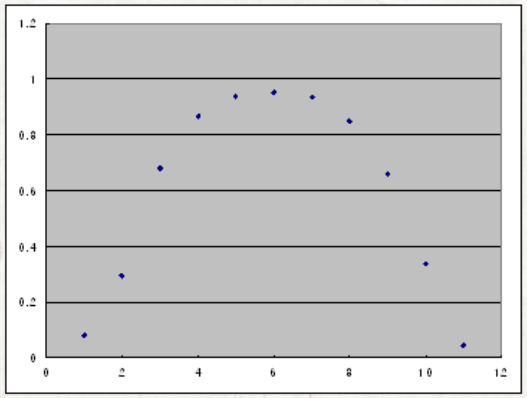
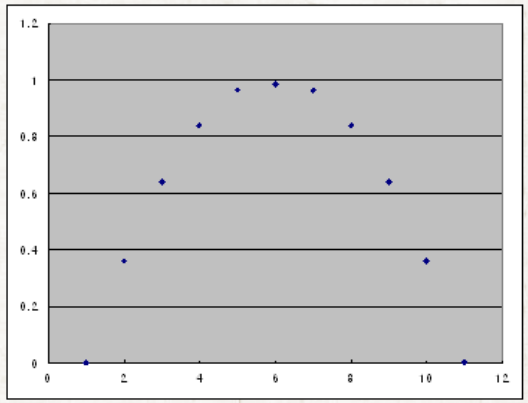




Input	Output
0.00	0.00
0.10	0.36
0.20	0.64
0.30	0.84
0.40	0.96
0.50	1.00
0.60	0.96
0.70	0.84
0.80	0.64
0.90	0.36
1.00	0.00

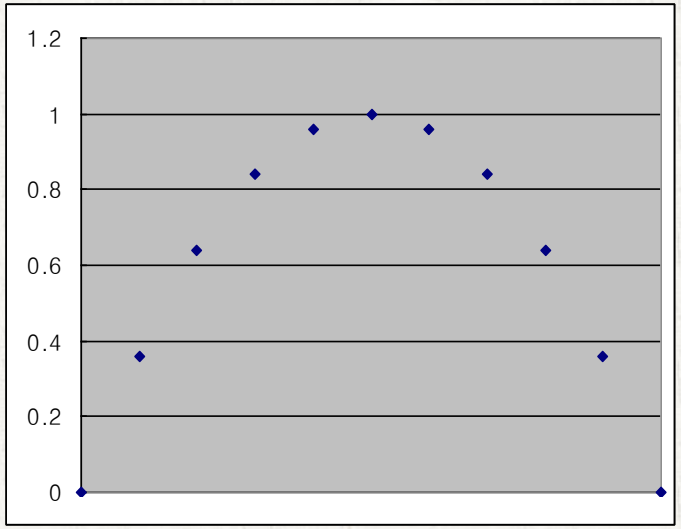
Example of Error Back Propagation (6)

- Example2

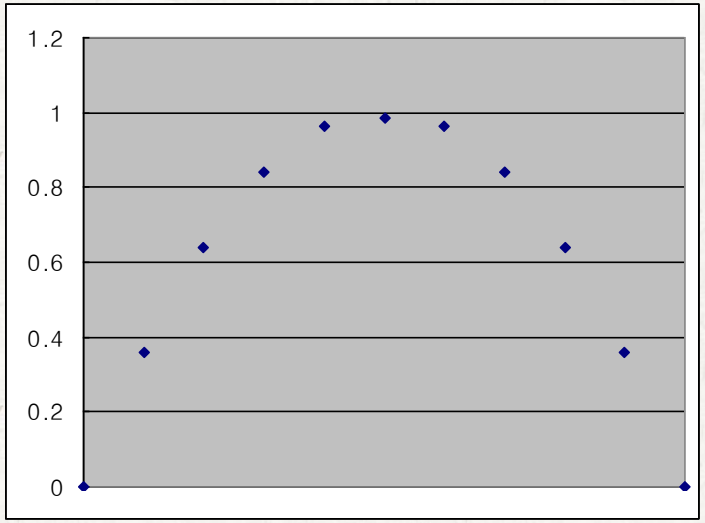







Generalization and Overfitting (1)

- We gave only 11 points
  - A NN learned only that 11 points



Training data

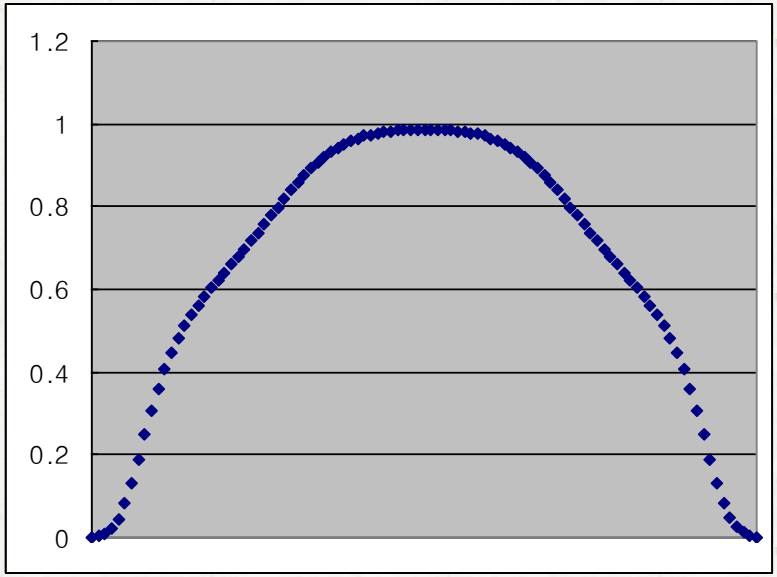


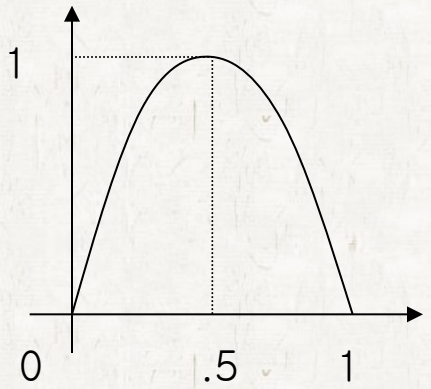
Training result

  - Can the NN answer to the un-learned points?

Generalization and Overfitting (2)

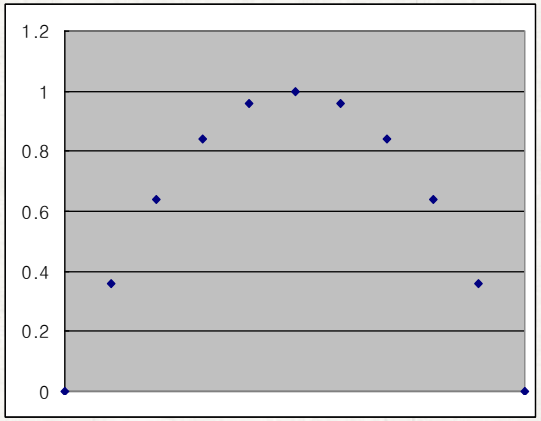
- Yes, NNs generalize what they have learned



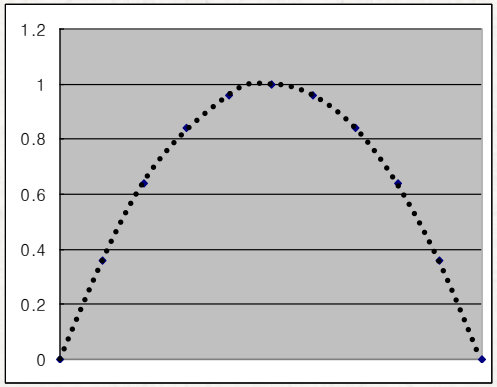


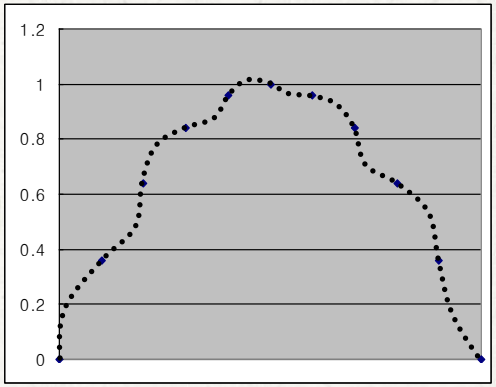
Generalization and Overfitting (3)

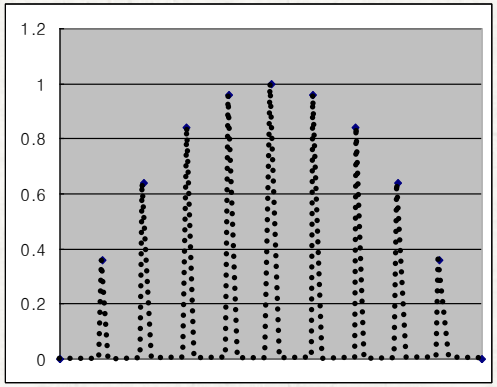
- Which one is better?



Training data

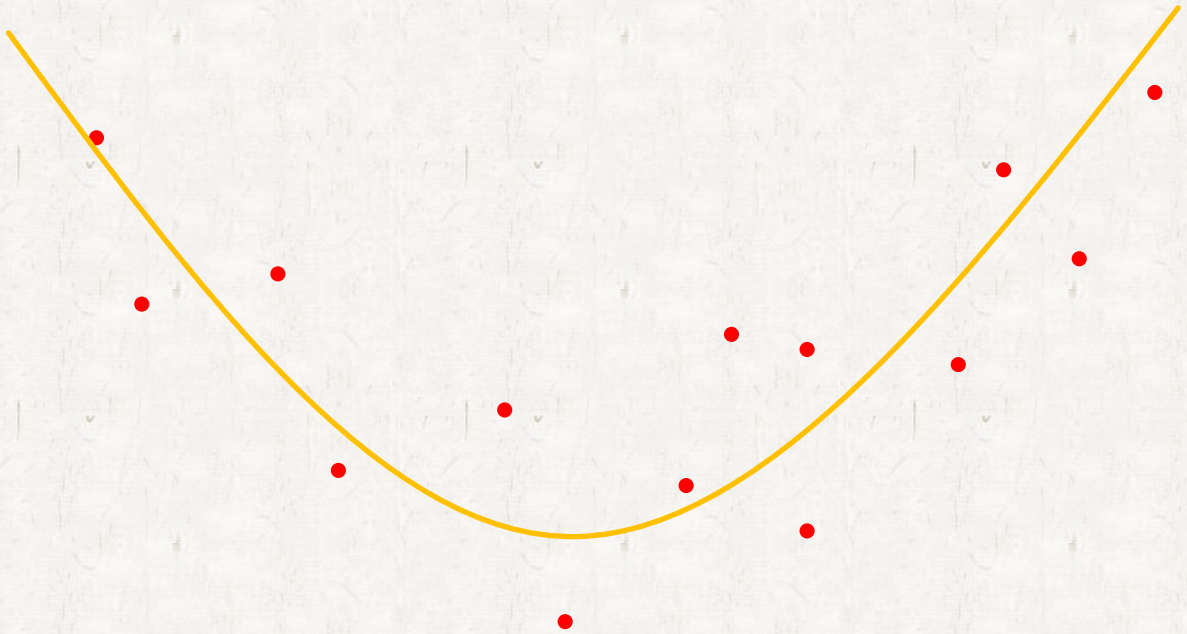






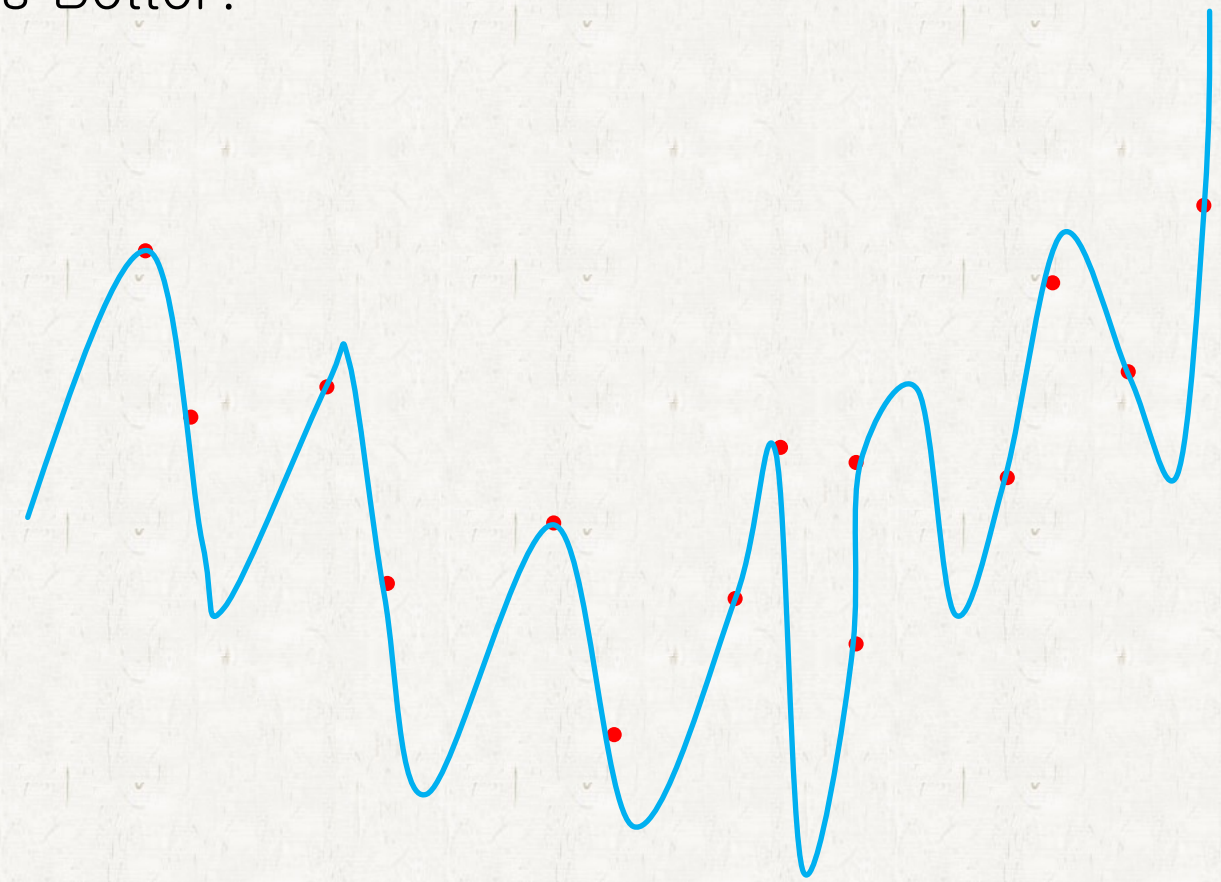
Generalization and Overfitting (4)

- Which is Better?



Generalization and Overfitting (5)

- Which is Better?



Generalization and Overfitting (6)

- To increase generalization accuracy
  - Find the optimal number of neurons
  - Find the optimal number of training iterations
  - Use regularization
  - Use more training data