Artificial Intelligence

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Group Project

- Submission
  - Each group only needs to submit one video by one group member via blackboard
  - Include your group information either in readme file or in the video
  - 1-4 members/group
- Deadline
  - Thur. Nov. 7 23:59pm
  - 50% per day for late submission
- Demonstration day
  - At least one group member should attend the demonstration on Nov. 12
  - The presentation order will be announced Nov. 12 morning time via blackboard
  - TA will display your movie by generating a long video including all submissions
    - TA may contact you between Nov. 8 and Nov. 11 under the case your file does not work well
    - Please check your email frequently to guarantee not to miss the important email

Learning Outcomes of Lecture 08

- Realize the basic character of artificial neural networks
- Understand the rationale of artificial neuro design
- Master the learning procedure of perceptron
- Understand the gradient descent
- Understand the motivation of multilayer perceptron
- Master the structure of multilayer perceptron
- Realize the difficulty of learning in multilayer perceptron
- Master the backpropagation method

Agenda

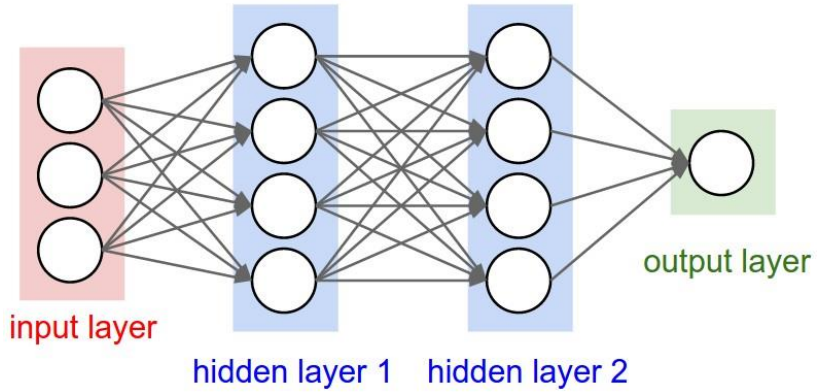
- Deep learning
- Deep belief networks
  - Restricted Boltzmann Machine
- Recurrent neural networks
  - Long short-term memory
- Convolutional neural networks
  - Case study
- Generative adversarial nets
  - Application in computational creativity

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Deep Learning

- Deep Learning
  - A class of machine learning algorithms
  - Allows computational models that are composed of multiple processing layers
  - to learn representations of data with multiple levels of abstraction

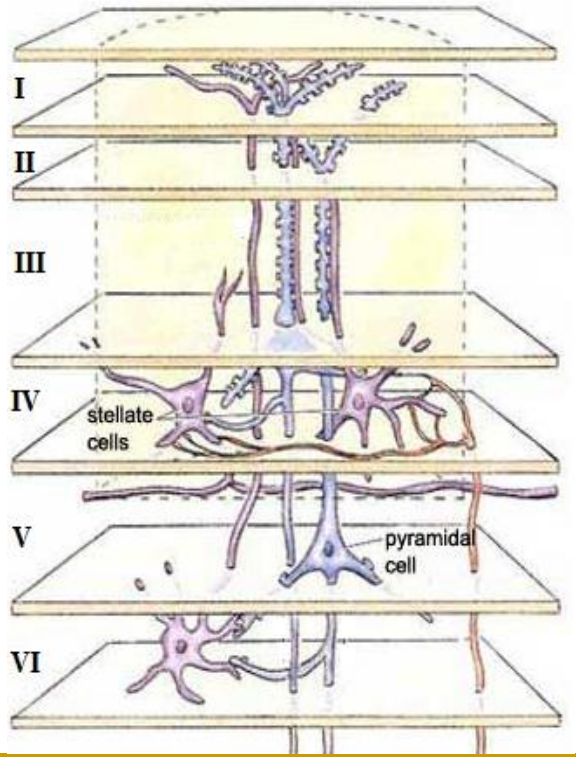


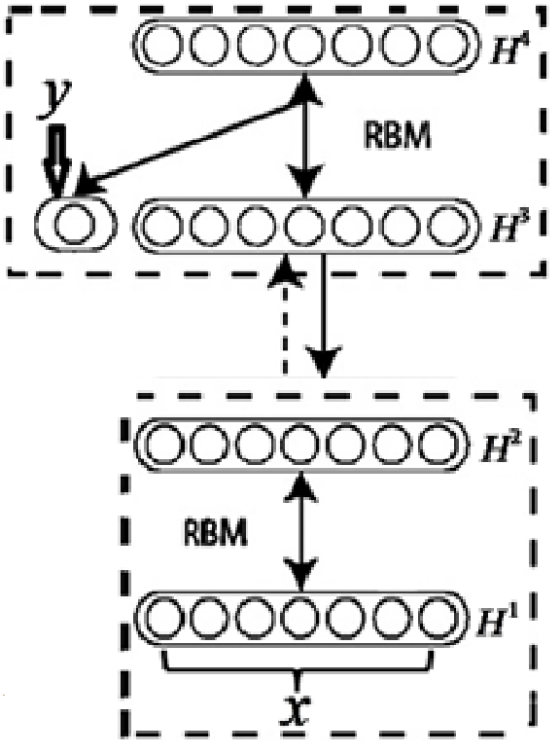
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Deep Belief Networks

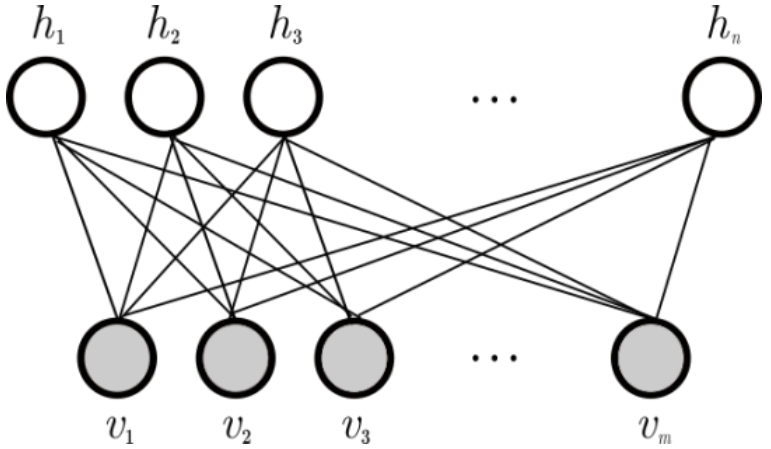
- Human visual cortex
  - Multiplayer structure
- Deep belief networks
  - A set of Restricted Boltzmann machines (RBMs)





Restricted Boltzmann Machine

- Basic structure of RBM



$$P(h_j = 1|v) = \sigma\left(b_j + \sum_{i=1}^{m} w_{i,j} v_i\right) \text{ and } P(v_i = 1|h) = \sigma\left(a_i + \sum_{j=1}^{n} w_{i,j} h_j\right)$$

- Restriction
  - No connection between the nodes from same group

Characters of DBFs

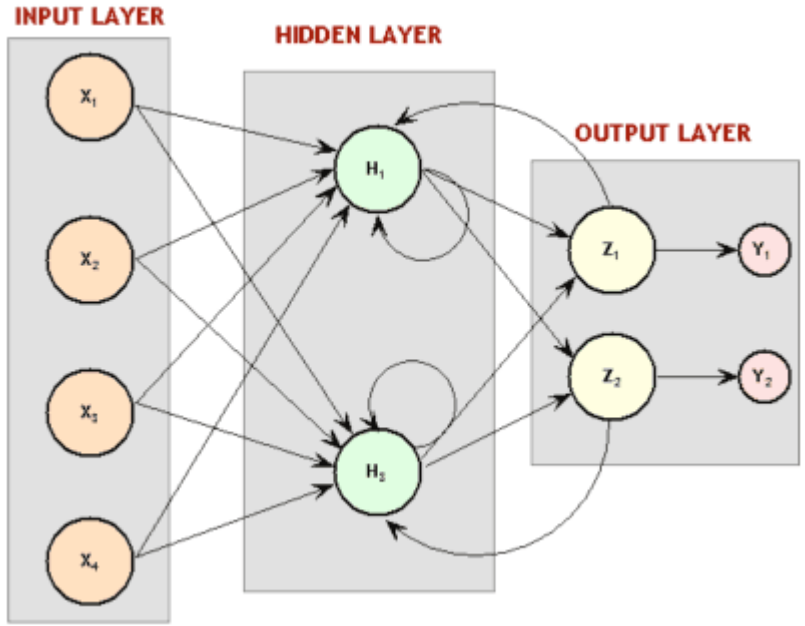
- Two stages of learning
  - Unsupervised learning using RBMs
  - Fine-tune the whole deep network using supervised learning
  - Preserve both the distribution of the data and the categorial information
  - Increase the generalization of the model
- Pair-wise reconstruction
  - Abstract the information layer by layer from visible layer to hidden layer
  - Construct the hidden layer from the visible layer
  - Provide a good initial state of the neural networks learning
- Limitations
  - Better learning for temporal data
  - Better learning for spatial data
- Reference reading
  - Reference_RBM

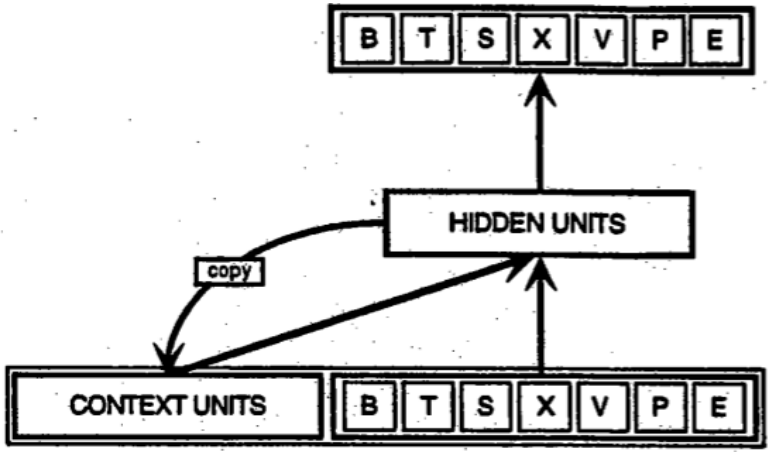
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Typical Recurrent Neural Networks

- A recurrent neural network is a type of artificial neural networks
  - where connections between units form a directed cycle
  - Use internal memory to process sequences
  - The order of the input will influence the outputs



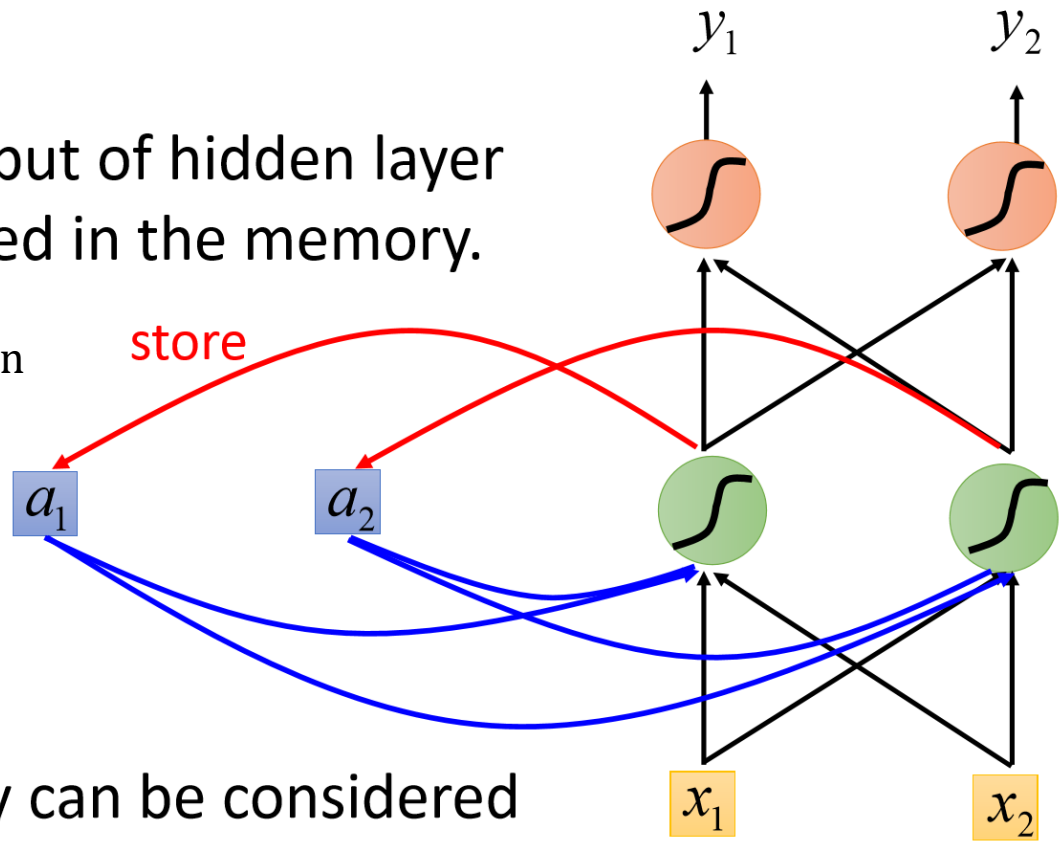


Example of Recurrent Neural Networks

- Input: (1,1); (1,1);(2,2)
- Output:

The output of hidden layer are stored in the memory.

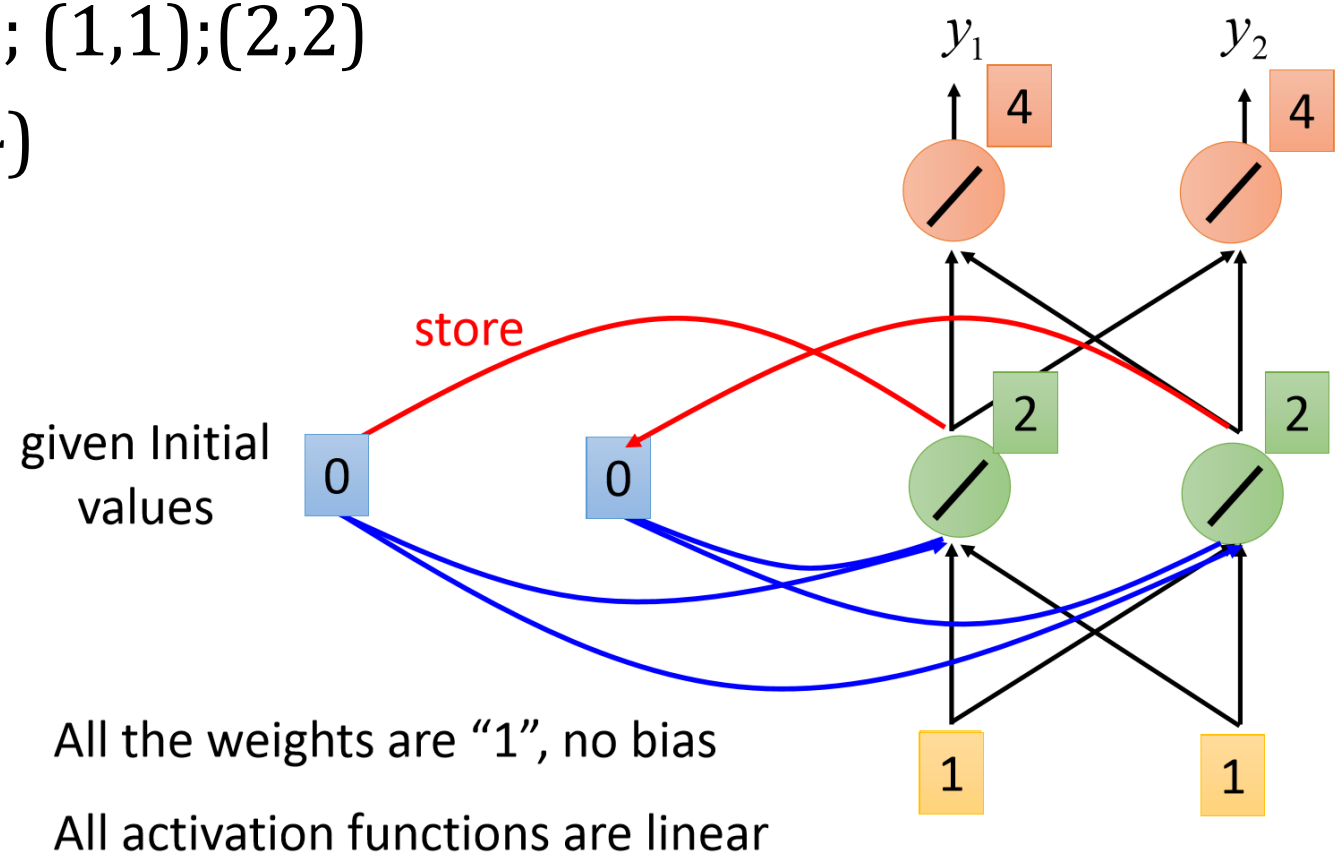
- No linear activation function
- Only linear combination
- All weights are set to 1
- No bias



Memory can be considered as another input.

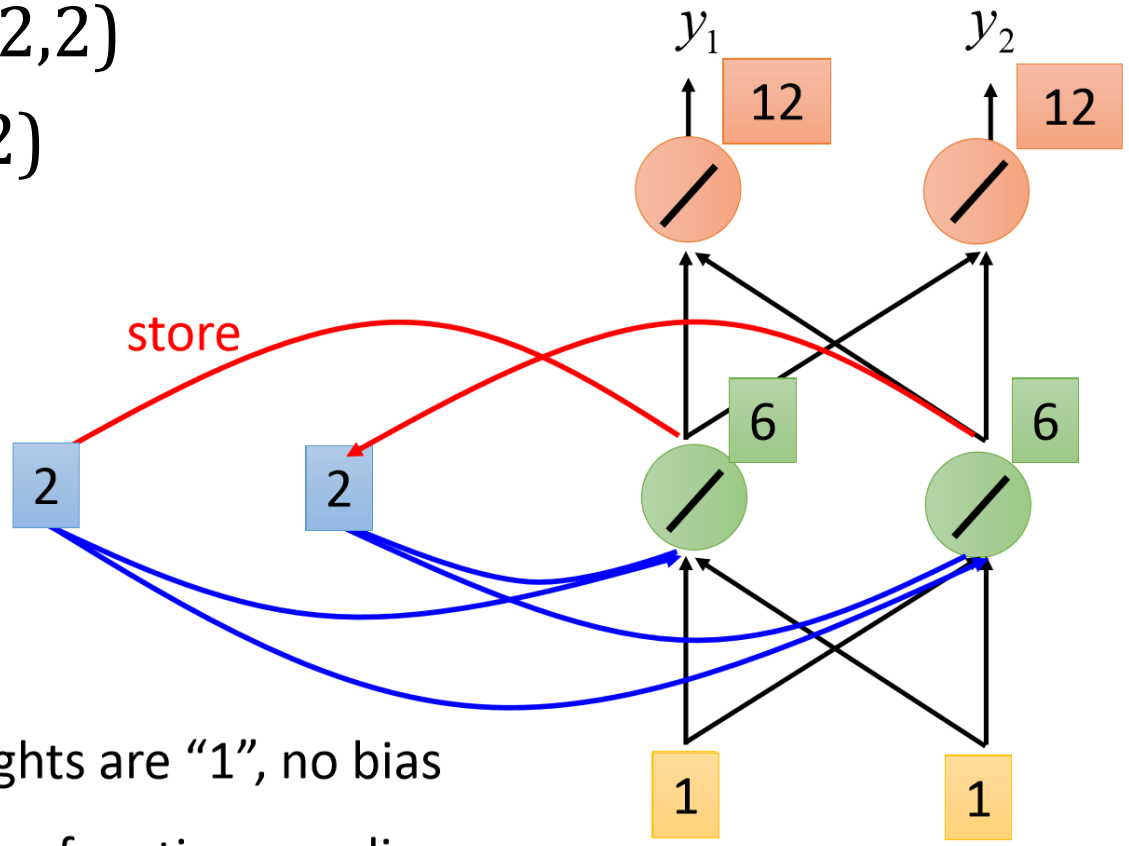
Example of recurrent neural networks

- Input: (1,1); (1,1);(2,2)
- Output:(4,4)



Example of recurrent neural networks

- Input: (1,1); (1,1);(2,2)
- Output:(4,4);(12,12)

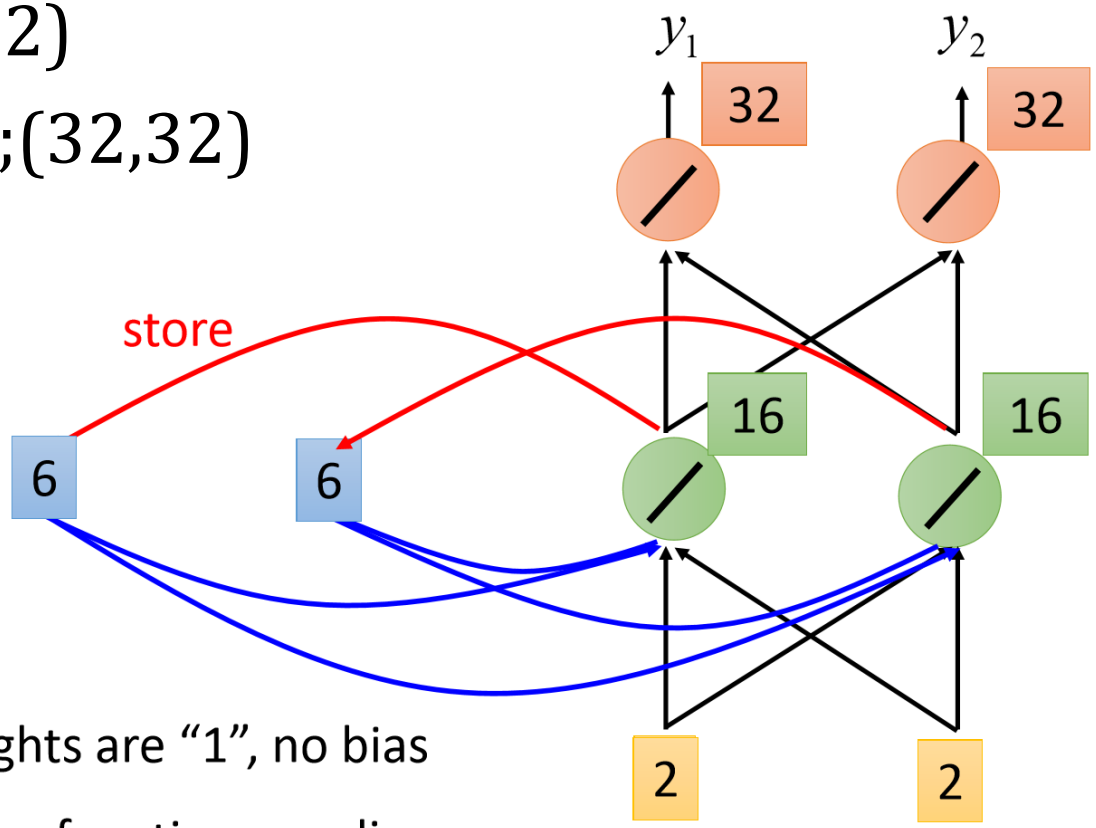


All the weights are “1”, no bias

All activation functions are linear

Example of recurrent neural networks

- Input: (1,1); (1,1);(2,2)
- Output:(4,4);(12,12);(32,32)

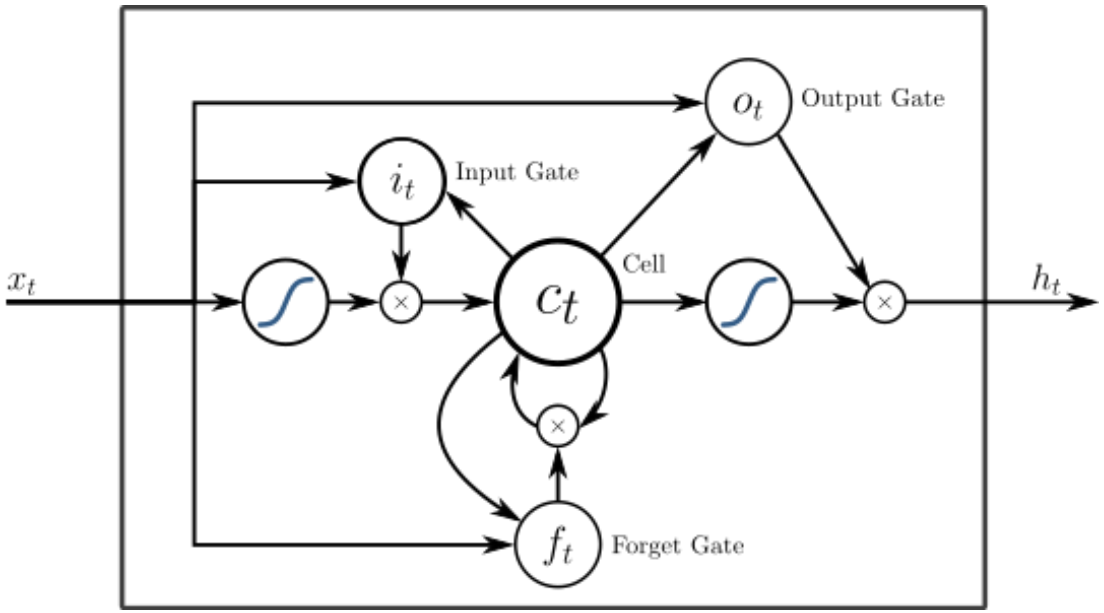


All the weights are “1”, no bias

All activation functions are linear

Long Short-Term Memory

- Basic structure of LSTM
  - A kind of recurrent neural networks
  - With the basic unit composed of a cell with an input gate, output gate and a forget gate



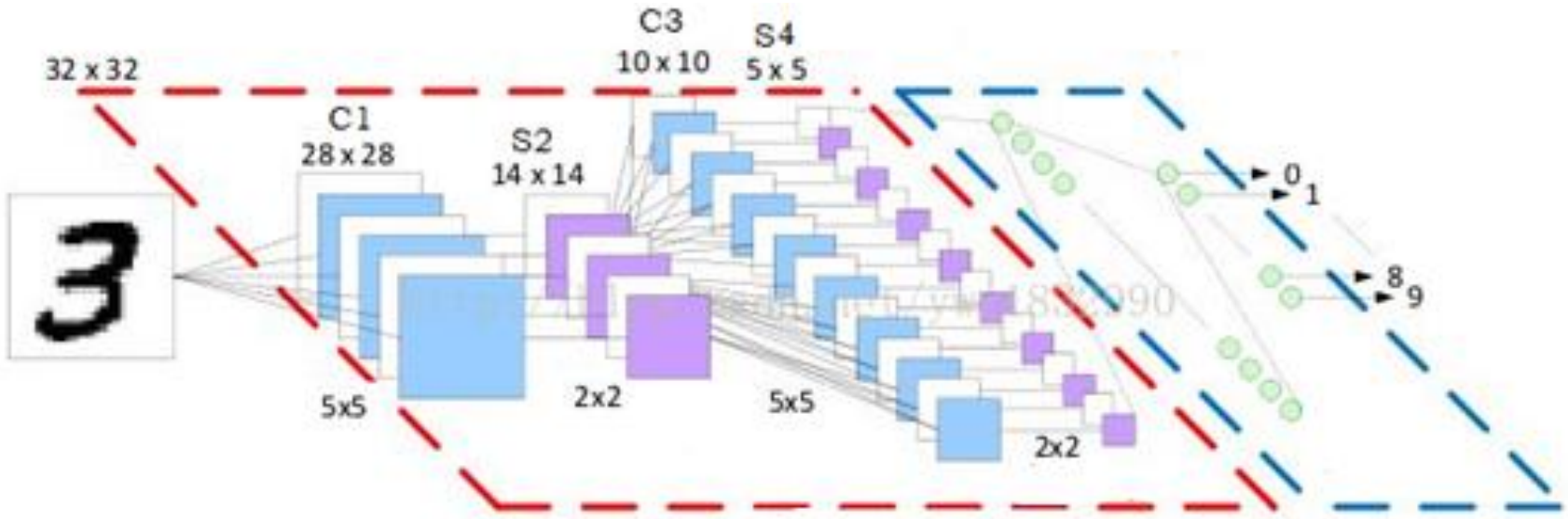
- Reference reading
  - Reference_LSTM

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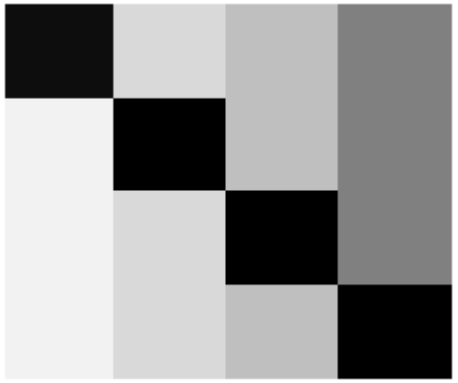
Convolutional Neural Networks

- Basic structure
  - Convolutional layer
  - Pooling layer



Motivation of the design

- Characteristics of image data
  - Natural second-order tensor
  - Distortion of spatial information
- Characteristics of visual cortex
  - The information delivered in the form of matrix
  - No evidence for the unfold processing
- Reference reading
  - Reference_CNN

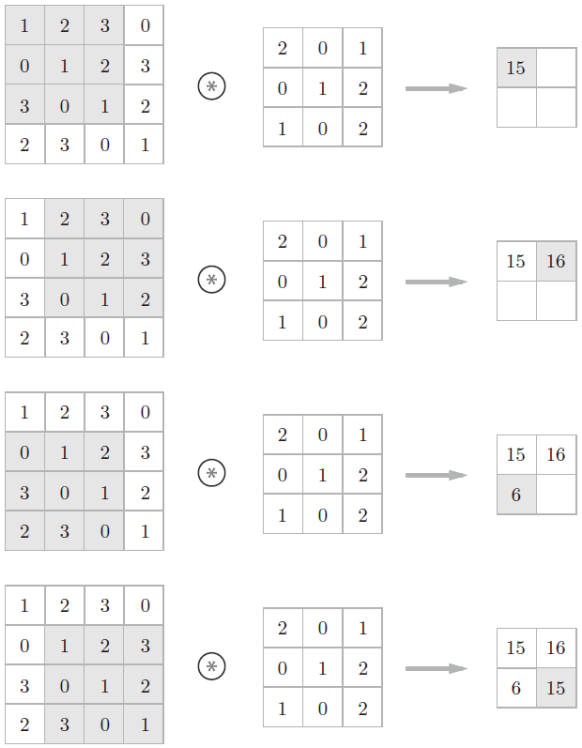






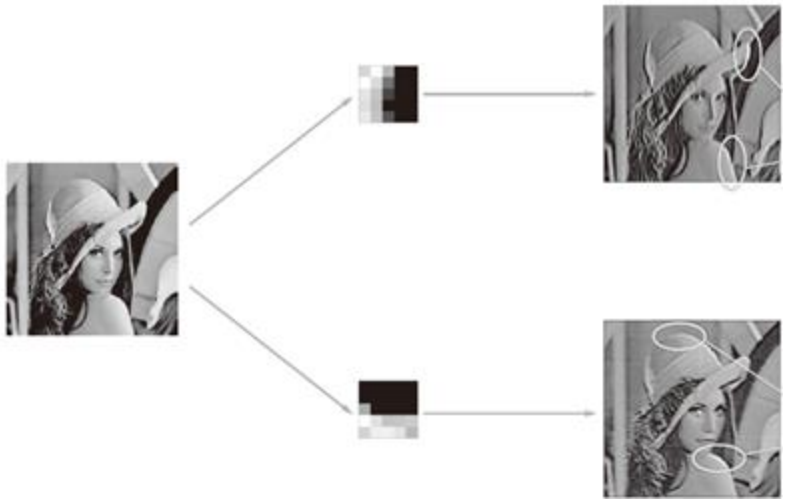
Convolution and Pooling

Convolution

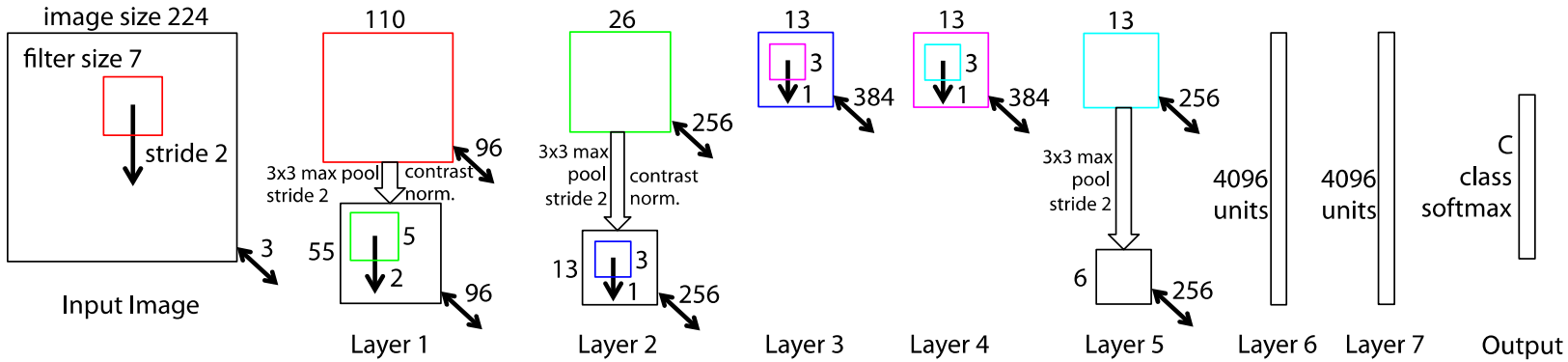


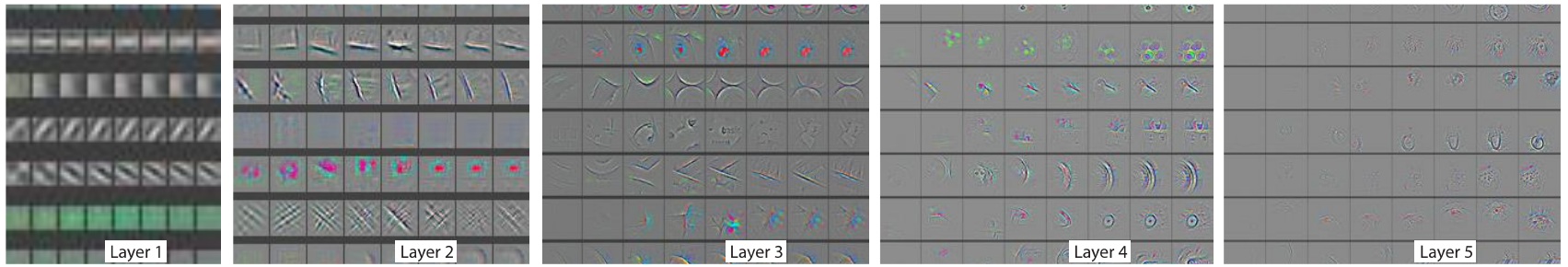
Pooling

Maximal: 16 Average: 13



Visualize the activity within Convolutional Neural Networks



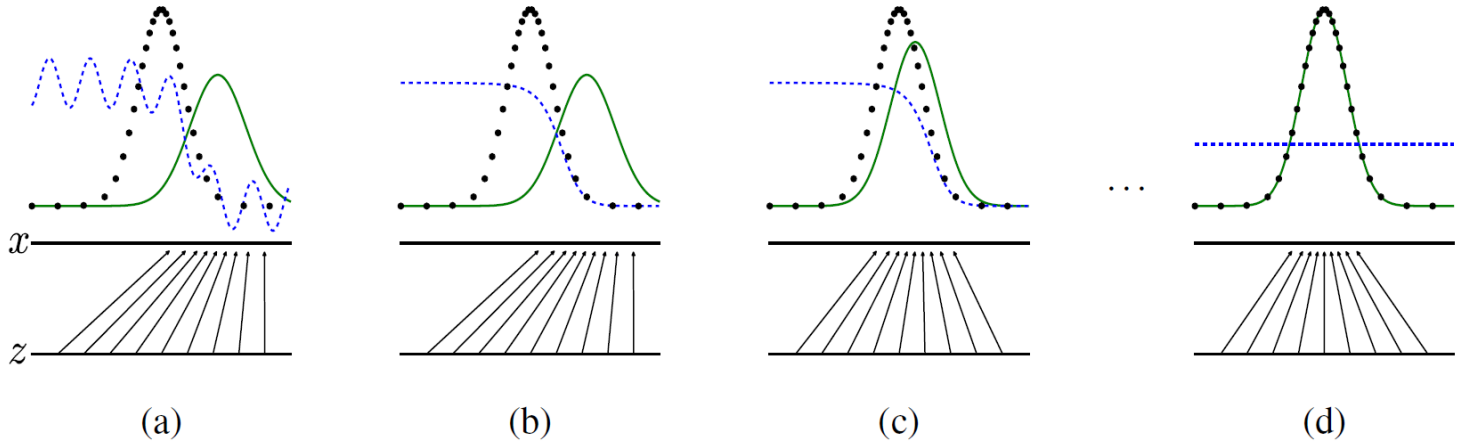


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Generative adversarial nets

- A generative model G
  - Captures the data distribution
- A discriminative model D
  - Estimates the probability that a sample came from the training data rather than G
- G and D contest with each other in a game
- Reference reading
  - Reference_GAN



Application of GANs

