Deep learning
Introduction

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Course Information

1. Course name : Deep learning
2. The objective of deep learning is moving Machine Learning closer to one of its original goals: Artificial Intelligence.
3. Instructor : Hamid Beigy
   Email : beigy@sharif.edu
4. Course Website:
   http://ce.sharif.edu/courses/98-99/1/ce718-1/
5. Lectures: Sat-Mon (10:30-12:00)
6. TAs : | Fariba Lotfi   Email: flotfi@ce.sharif.edu
         | Farzad Beizaee   Email:
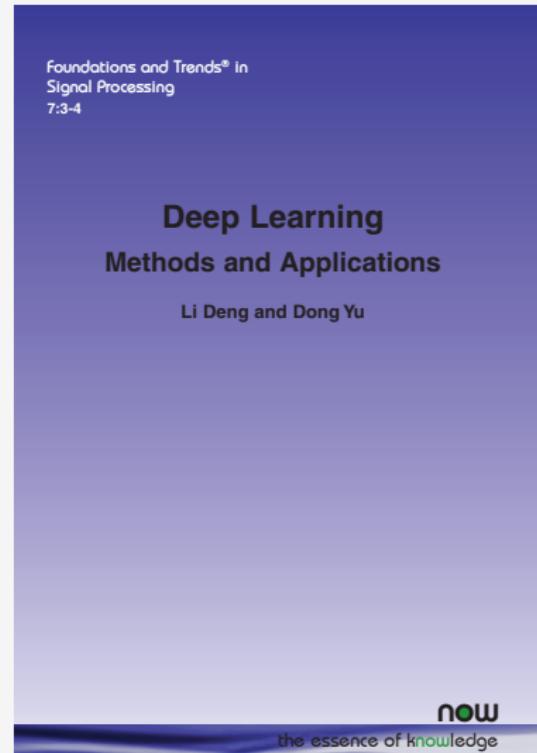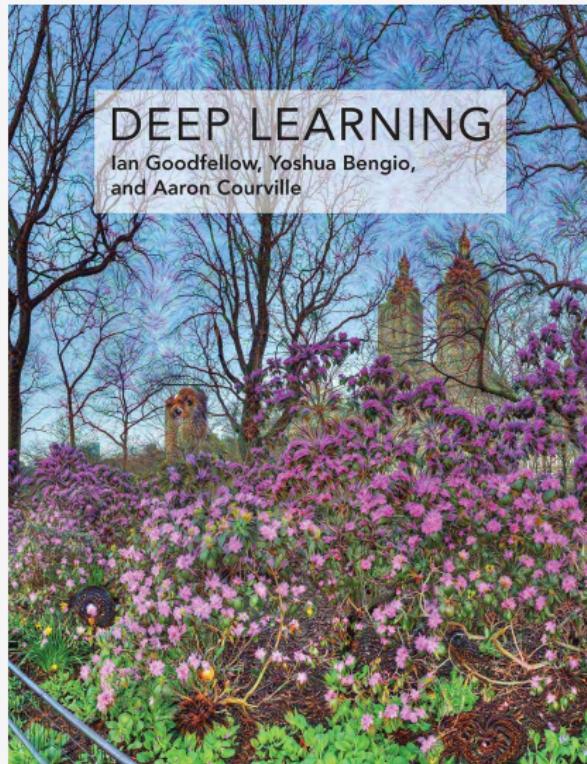
Course evaluation

- Evaluation:

Mid-term exam	30%	1397/8/11
Final exam	30%	
Practical Assignments	30%	
Quiz	10%	
Paper	10%	

Main reference

References I

📄 Deng, L., and Yu, D.
Deep learning: Methods and applications.
Foundations and Trends in Signal Processing 7, 3–4 (2013), 197–387.

📄 Goodfellow, I., Bengio, Y., and Courville, A.
Deep Learning.
MIT Press, 2016.

Relevant journals I

1. IEEE Trans on Pattern Analysis and Machine Intelligence
2. Journal of Machine Learning Research
3. Pattern Recognition
4. Machine Learning
5. Neural Networks
6. Neural Computation
7. Neurocomputing
8. IEEE Trans. on Neural Networks and Learning Systems
9. Annuals of Statistics
10. Journal of the American Statistical Association
11. Pattern Recognition Letters
12. Artificial Intelligence

Relevant journals II

13 Data Mining and Knowledge Discovery

14 IEEE Transaction on Cybernetics (SMC-B)

15 IEEE Transaction on Knowledge and Data Engineering

16 Knowledge and Information Systems

Relevant conferences

1. Neural Information Processing Systems (NIPS)
2. International Conference on Machine Learning (ICML)
3. European Conference on Machine Learning (ECML)
4. Asian Conference on Machine Learning (ACML)
5. Conference on Learning Theory (COLT)
6. Algorithmic Learning Theory (ALT)
7. Conference on Uncertainty in Artificial Intelligence (UAI)
8. Practice of Knowledge Discovery in Databases (PKDD)
9. International Joint Conference on Artificial Intelligence (IJCAI)
10. IEEE International Conference on Data Mining series (ICDM)

Relevant packages and datasets

1. Packages:
   - Keras https://keras.io
   - TensorFlow http://www.tensorflow.org/
   - Cafe http://caffe.berkeleyvision.org
   - PyTorch https://pytorch.org

2. Datasets:
   - UCI Machine Learning Repository
     http://archive.ics.uci.edu/ml/
   - MNIST: handwritten digits http://yann.lecun.com/exdb/mnist/
   - 20 newsgroups http://qwone.com/~jason/20Newsgroups/

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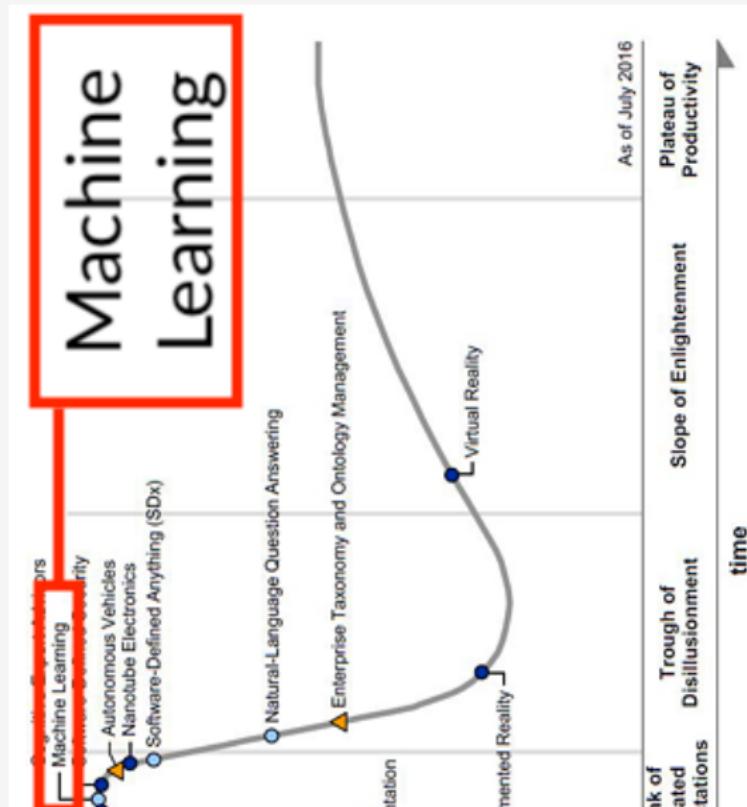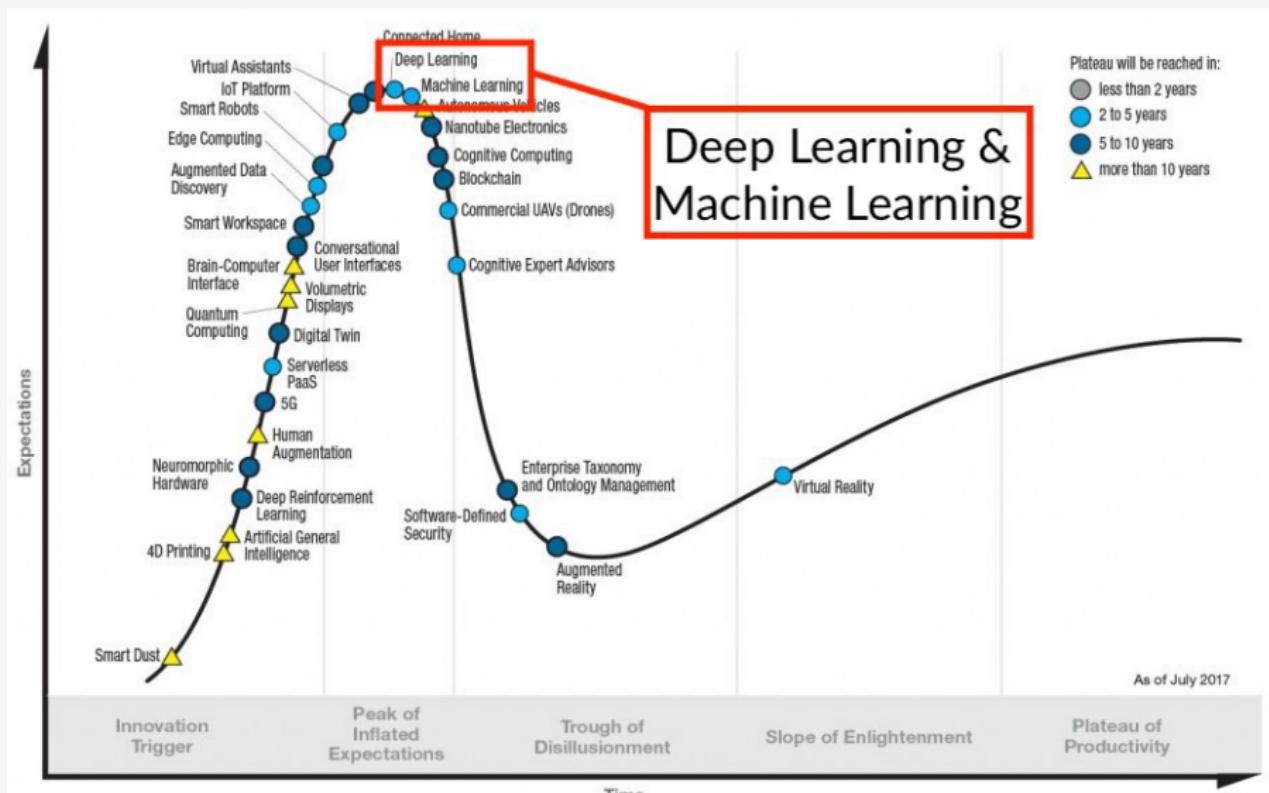
Gartner Hyper-Cycle of Emerging Technologies (2016)
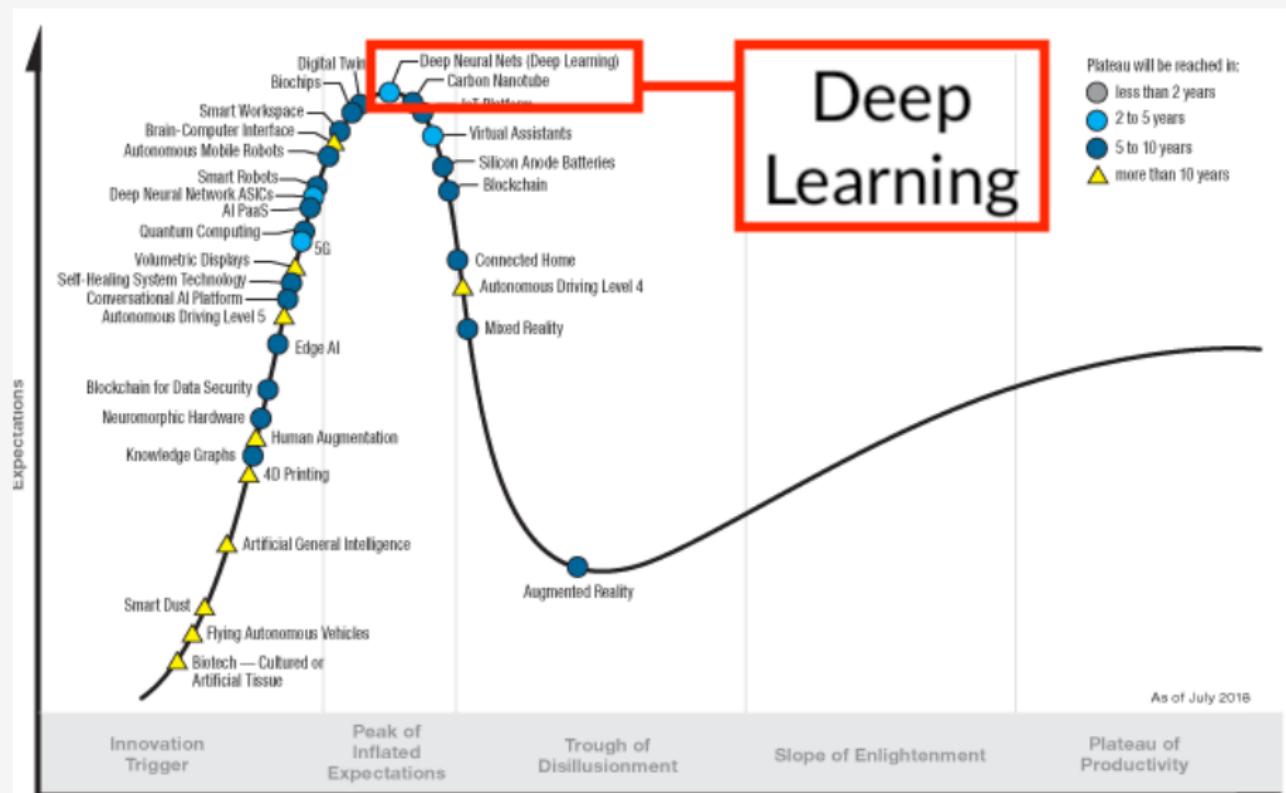
Gartner Hyper-Cycle of Emerging Technologies (2017)
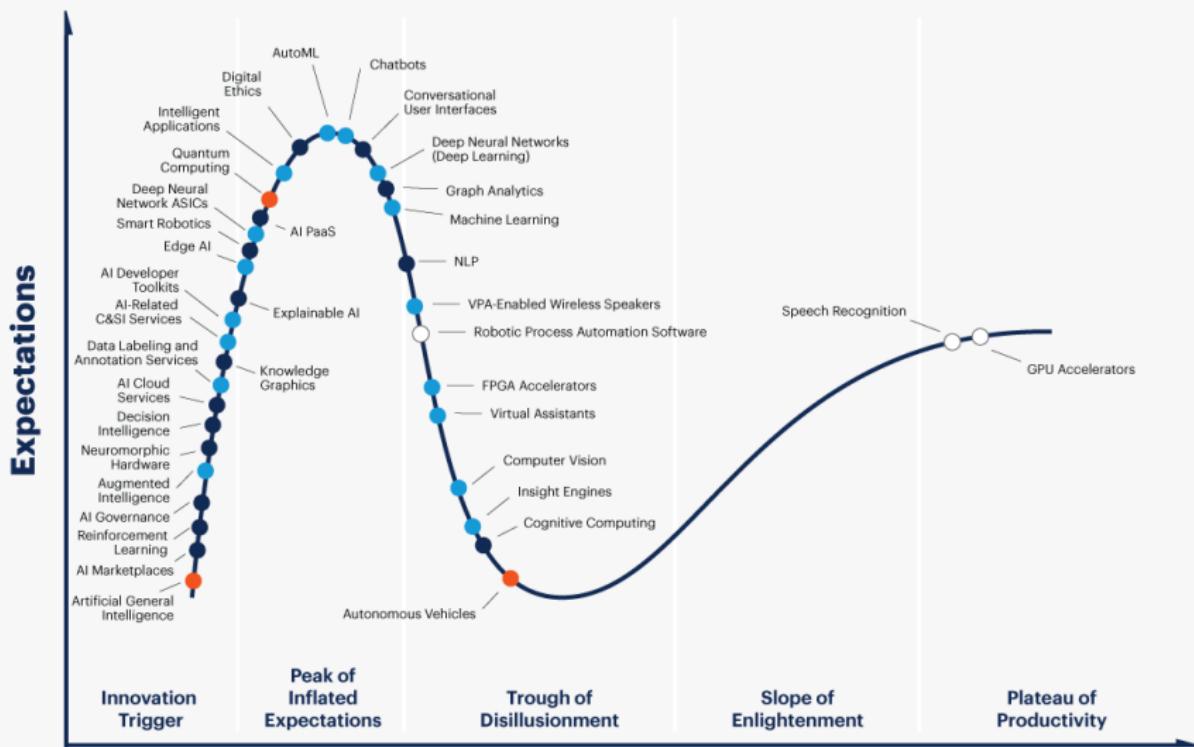
Gartner Hyper-Cycle of Emerging Technologies (2018)

Gartner Hyper-Cycle of Emerging Technologies (2019)

What is deep learning?

Deep learning has various closely related definitions or high-level descriptions.
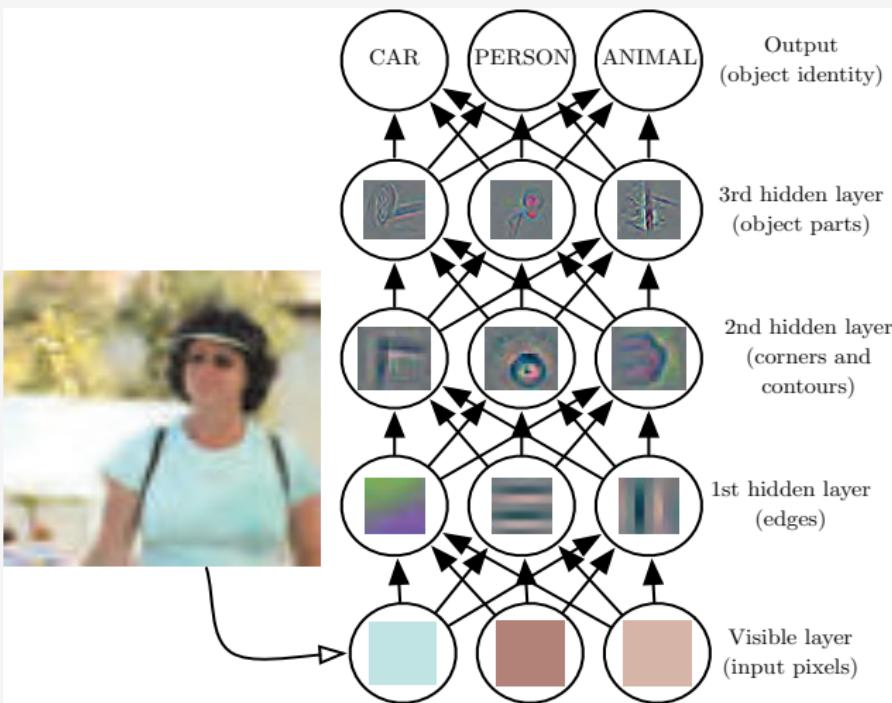

Definition (Deep learning)

A sub-field of machine learning that is based on

- learning several levels of representations, corresponding to a hierarchy of features or factors or concepts,
- where
    - higher-level concepts are defined from lower-level ones, and
    - the same lower- level concepts can help to define many higher-level concepts.

An Example
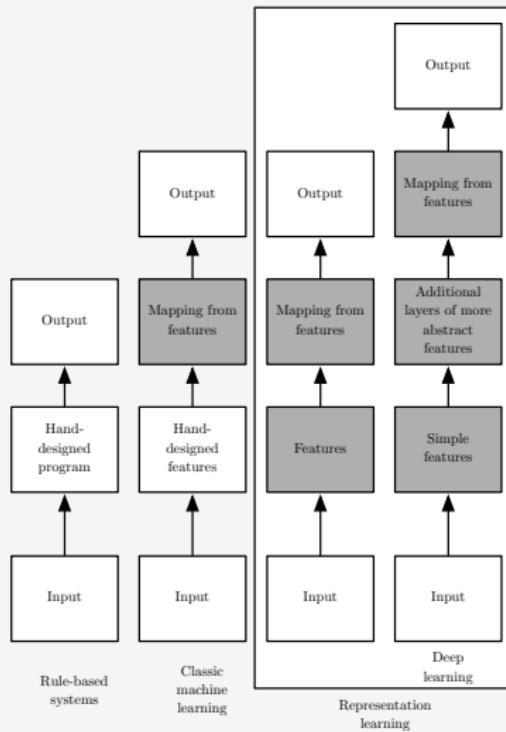
What is deep learning?

Definition (Deep learning)

- Deep learning is part of a broader family of machine learning methods based on learning representations.

- An observation (e.g., an image) can be represented in many ways (e.g., a vector of pixels), but some representations make it easier to learn tasks of interest (e.g., is this the image of a human face?) from examples, and research in this area attempts to define what makes better representations and how to learn them.

An Example

What is deep learning?

Common among the various high-level descriptions of deep learning are two key aspects:

1. Models consisting of multiple layers/stages of nonlinear information processing

2. Methods for supervised or unsupervised learning of feature representation at successively higher, more abstract layers.

Deep learning is in the intersections among the research areas of

1. Neural networks

2. Artificial intelligence

3. Graphical modeling

4. Optimization

5. Pattern recognition

6. Signal processing.

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Success stories[1]

1 Finding nearest images

Nearest Images

- day + night =
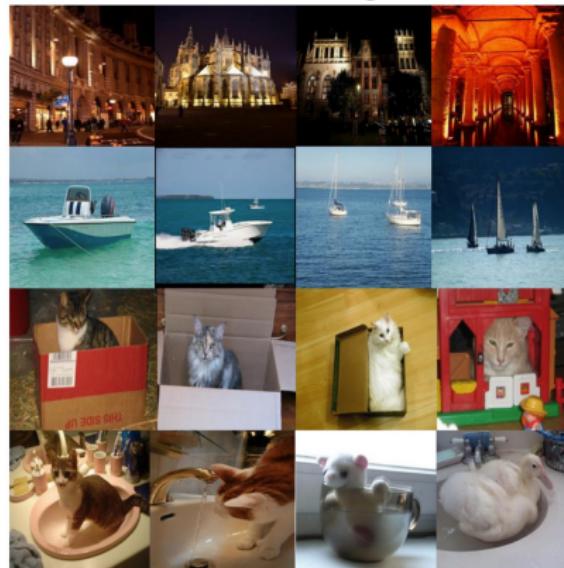
- flying + sailing =

- bowl + box =

- box + bowl =

[1]This slide is taken from Prof. Ghodsi's slides.
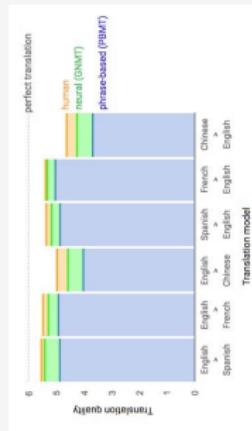
Success stories

1 **Word2vec** , Mikolov, 2013.
   king man + woman = queen
2 Google neural machine translation[2]

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[2]Borrowed from

https://blog.statsbot.co/deep-learning-achievements-4c563e034257
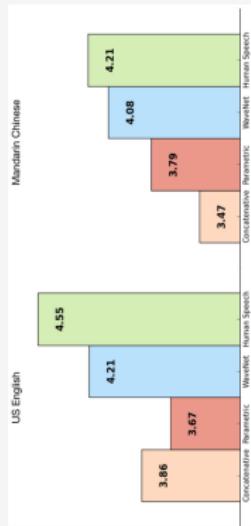
Success stories

1 Wavenet : Generating voice [3]

2 Lip Reading

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[3]Borrowed from
https://blog.statsbot.co/deep-learning-achievements-4c563e034257

Success stories

1. **LeNet-5**
   LeNet-5 is designed for handwritten and machine-printed character recognition
   Live demo : http://yann.lecun.com/exdb/lenet/index.html

2. **Sentiment Trees**
   Predicting the sentiment of movie reviews.
   Live demo :
   http://nlp.stanford.edu:8080/sentiment/rntnDemo.html

Success stories of Deep RL

1. TD-Gammon
2. DQN in Atari
3. Deep RL in Robotics
4. Alpha Go and Alpha Zero
5. Dota2 (Video Game)

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Outline of course

1. Introduction
2. Review of machine learning and history of deep learning
3. Multi-layer perceptrons and Backpropagation (MLP)
4. Optimization and Regularization
5. Convolutional networks (CNN)
6. Recurrent networks (RNN)
7. Sum-Product networks (SPN)
8. Dual learning
9. Deep reinforcement learning (Deep RL)
10. Representation learning
11. Deep generative models
12. Applications
    - Text mining and natural language processing
    - Computer vision
13. Advanced topics

Reading

Please read chapter 1 of Deep Learning Book.