

Exercise session: solving real-world problems and exam/interview questions

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Module 06-27818 and 27819:
Introduction to Neural Computation (Level 4/M)
Neural Computation (Level 3)

Outline of Topics

Neural networks for stock market index prediction

Examination questions

Interview questions

Let's look at the CA

- ▶ FTSE 100 stock index prediction using ANN

What is FTSE100 index

- ▶ FTSE100 index: Financial Times Stock Exchange 100 Index, is a share index of the 100 companies listed on the London Stock Exchange with the highest market capitalization
- ▶ A stock index: also known as stock market index is a measurement of the value of a section of the stock market
- ▶ FTSE 100 index: essentially a time series

$$\{x(t_0), x(t_1), \dots, x(t_{i-1}), x(t_i), x(t_{i+1}), \dots\}$$

Possible types of time series processing

- ▶ Predict future values of $x[t]$ ✓
 - ▶ Using the Past to Predict the Future:
 $y = x[t + 1] = ANN(\mathbf{x}, \mathbf{w})$, where the input $\mathbf{x} = \{x[t - 1], x[t - 2], \dots, x[t - n]\}$, and n is the maximum number of past observations
- ▶ Classify a series into one of a few classes:
 - ▶ Buy
 - ▶ Sell
 - ▶ Hold
- ▶ Transform one time series into another: oil prices \mapsto interest rates

Designing your ANN

- ▶ How to solve this nonlinear regression using neural networks.
- ▶ We need three things to define a neural network:
 - ▶ **Network topology:** to define how neurons are connected by weights: your inputs, e.g., how many previous days' index, i.e., n , how many layers, the number of hidden neurons
 - ▶ **Activation function:** to convert a neuron's weighted input to its output activation
 - ▶ **Learning process:** to update the weights

A few suggestions

- ▶ You can use my python implementation, or you can write your own
- ▶ You can even use any existing neural network simulators or libraries:
- ▶ For Java
 - ▶ [deeplearning4j](#)
 - ▶ [Neuroph](#)
- ▶ For Python
 - ▶ [scikilearn](#)
 - ▶ [Pybrain](#)
 - ▶ [Caffe](#)
 - ▶ [TensorFlow](#)
- ▶ For Matlab
 - ▶ [Neural Network Toolbox](#)
 - ▶ [NetLAB](#)

A few suggestions

- ▶ You can just use FTSE 100 index time series, e.g., low, high and adjusted closed
- ▶ To improve its accuracy, you can also include a few additional inputs:
 - ▶ Volume
 - ▶ Other stock index, e.g., Dow or S&P500
 - ▶ Other time series, e.g., oil price or gold price?
 - ▶ Do some preprocessing: [time series decomposition](#), etc.
 - ▶ Technical indicators

Technical analysis and Technical indicators

- ▶ Technical analysis: used by many practitioners in security analysis
- ▶ Usually thought as a pseudo-science, but at least Andrew Lo (Professor of Finance at MIT) does not think so ¹
- ▶ You can download Andrew Lo's book sample [The Evolution of Technical Analysis](#)
- ▶ Technical indicators: calculated based on the price and the volume of a security that measure trends, volatility and momentum, which are used
 - ▶ as secondary measure to the actual price movements and add additional information to the analysis of securities.
 - ▶ to confirm price movement and the quality of chart patterns, and to form buy and sell signals.

¹"Foundations of Technical Analysis: Computational Algorithms, Statistical Inference, and Empirical Implementation." Lo, Andrew W., Harry Mamaysky and Jiang Wang. Journal of Finance Vol. 55, No. 4 (2000): 17051765.

Warning: Trading (not investing) is a kind of legalised gambling.
DO NOT use your real money!

Exam: Perceptron

- ▶ Using labelled diagrams of each, describe how the McCulloch-Pitts Neuron represents the key features of Biological Neurons. (2014 Exam: Q1.2) (Answer: L2-13)
- ▶ Using a simple example, show that there are some logical functions that a single McCulloch-Pitts neuron cannot represent. (2014 Exam: Q1.3) (Answer: L3-8)

Exam: Gradient descent and Back-Propagation

- ▶ A large-scale bread producer has collected a large amount of data relating properties of their raw ingredients to the properties of their final product. Design and justify a Multi-Layer Perceptron (MLP) neural network that could predict future final product properties from their raw ingredient properties. (2014 Exam: Q2.1)
- ▶ Describe in detail how a gradient descent based approach could be used to train your network. (Detailed mathematical derivations are not required) (2014 Exam: Q2.2)

Exam: Gradient descent and Back-Propagation

- ▶ Explain in detail the approach you would follow to optimize the generalization ability of your trained network. (2014 Exam: Q2.3)
- ▶ Explain what the various symbols in following equation mean, and how it is relevant to understanding the performance of trained neural networks. (2014 Exam: Q3.1)

$$\begin{aligned}\text{Err}(x) &= \mathbb{E}[(t - \hat{f}(x))^2] \\ &= \mathbb{E}[\hat{f}(x) - f(x)]^2 + \mathbb{E}[\hat{f}(x)^2] - \mathbb{E}[\hat{f}(x)]^2 + \sigma^2\end{aligned}$$

Interview questions

21 Must-Know Data Science Interview Questions and Answers

- ▶ Q1. Explain what regularization is and why it is useful.
- ▶ Q2. Which data scientists do you admire most? which startups? [Click here to see the pictures](#)

Interview questions

Top 100 Data Science Interview Questions and Answers (General) for 2016

- ▶ Q3. Which technique is used to predict categorical responses?
- ▶ Q4. What is logistic regression? Or State an example when you have used logistic regression recently.
- ▶ Q26. What is gradient descent?
- ▶ Q17. Do gradient descent methods always converge to same point?
- ▶ Q33. Can you use machine learning for time series analysis?
- ▶ Q36. What is Regularization and what kind of problems does regularization solve?
- ▶ Q44. How can you overcome Overfitting?

Interview questions

What are the toughest neural networks and deep learning interview questions?

- ▶ By a startup ([Arimo](#)) CEO
 - ▶ Q1. Why do we use sigmoid for an output function? Why tanh? Why not cosine? Why any function in particular?
 - ▶ Q2. Explain backpropagation.
- ▶ By a ML Scientist at Microsoft Research:
 - ▶ Q1. Can they derive the back-propagation and weights update?
 - ▶ Q2. How to implement dropout?