Universität Zürich[UZH]

Blockchain & Distributed Ledger Technologies

UZH Blockchain Center

A07: Analysis of Financial Networks

Network Science '21: Assignment 7

Prof. Dr Claudio J. Tessone, Dr Carlo Campajola

Blockchain & Distributed Ledger Technologies Group

Objectives

1. Learn how to filter a correlation matrix
2. Generate Minimum Spanning Trees from correlations
3. Compare correlation backbones at different time horizons

A07.1 - The Marčenko-Pastur law

Task: *For the 97 most capitalized stocks in the NY Stock Exchange, filter the correlation matrix of returns at the 1 hour and 1 minute timescales using Marčenko-Pastur law*

For each of the provided correlation matrices (for 1 hour and 1 minute returns):

- compute the eigenvalues and eigenvectors
- plot the histogram of eigenvalues and superimpose the Marčenko-Pastur law with parameter
  - for hourly returns, $Q = 3.6289$
  - for minute returns, $Q = 200.8969$
- compute the denoised correlations (see lecture)

A07.1 Hints

- eigenvalues and vectors are obtained through `numpy.linalg.eig()`
- in the Marčenko-Pastur equation, $\sigma = 1$ since we have correlations
- the denoised correlation matrix $\overline{\Upsilon}$ may have diagonal $\overline{\Upsilon}_{ii} \neq 1$:
  - define the diagonal matrix D s.t. $D_{ii} = \frac{1}{\sqrt{\overline{\Upsilon}_{ii}}}$
  - rescale $\overline{\Upsilon}$ to have unit diagonal by doing

$$\tilde{\Upsilon} = D\overline{\Upsilon}D$$

  - Eigenvectors of $\tilde{\Upsilon}$ are rescaled by D themselves

A07.2 - Correlation MSTs

Task: *Build MSTs from denoised correlations and analyze them*

- make a scatterplot of the 1 hour vs 1 minute denoised correlations (1 data point per pair of stocks)
- from the denoised correlation matrices, build the Minimum Spanning Tree (see lecture)
- assign the correct ticker ('AAPL', 'AMZN', ...) as an attribute to the nodes and calculate the degrees
- make a scatterplot of the 1 hour vs 1 minute MST degrees of stocks (1 data point per stock)

A07.2 Hints

- To build the MST, use `networkx.minimum_spanning_tree` on the **weighted undirected** graph that is generated by the matrix with entries d_{ij} (see lecture)
- Assign a 'ticker' attribute to nodes by using `networkx.set_node_attributes(G, values=tickers, name='ticker')`
- WARNING: make sure the order of nodes is the same in the two degree lists (e.g. 'AAPL' is item 0, 'AMZN' is item 1 etc. for both the 1 minute and 1 hour returns), otherwise you'll get the wrong scatterplot

A07.3 - Conclusions

***Task:** finish the analysis by drawing conclusions*

Answer the following questions (for both timescales):

1. Is there a 'market mode'?
2. Which is the stock that has the strongest relation with the market?
3. Which are the 5 stocks with highest degree on the MST?
4. Is the degree distribution of MSTs qualitatively the same at 1 minute and 1 hour?

A07.3 Hints

- a stock's relation to the market mode is given by the corresponding element of the eigenvector of the largest eigenvalue
- notice that eigenvector components can be negative: take the maximum in absolute value

A07.3 Datasets provided

- Correlation matrices corresponding to the 1 hour and 1 minute correlations of log-returns in open market hours, for the 97 most capitalized stocks on the NY Stock Exchange in September 2014.
- Source: NYSE Consolidated Trades dataset, accessed through UZH's Wharton Research Data Services platform
- Rows and columns are sorted according to the `stocknames.txt` file list, containing stock tickers (trading codes)

Universität Zürich[UZH]

Blockchain & Distributed Ledger Technologies

UZH Blockchain Center

Prof. Dr Claudio J. Tessone, Dr Carlo Campajola

Blockchain & Distributed Ledger Technologies Group

tessone@ifi.uzh.ch

http://www.blockchain.uzh.ch