Using Centrality to Predict Movement of Stock Prices

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Goals

The purpose of this paper is to use various centrality measures to predict movement of stock prices. It has been shown that a social network can be created by knowing only membership within groups [1]. Here a network is created using the words found in annual regulatory 10-K reports filed with the US Securities and Exchange Commission during 2012. The method was correct in predicting up to 81

Background

Securities and Exchange Commission (SEC)

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The Electronic Data Gathering, Analysis, and Retrieval system (EDGAR)

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10-K report

Leinweber, D. *Nerds on Wall Street: Math, machines, and wired markets.* (2009)

The number of filings by companies increase when they expect to do poorly.

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Breiger, R. L. *The duality of persons and groups.* (1997)

Individuals come together within groups based on shared interests, and the connection between them can be measured.

Methods

$$\text{A} = \text{Word by Company Matrix} \qquad \begin{array}{c} \\ w_1 \\ w_2 \\ w_3 \end{array} \begin{array}{c} \begin{array}{cc} AA & X \end{array} \\ \begin{bmatrix} 1 & 0 \\ 0 & 3 \\ 2 & 4 \end{bmatrix} \end{array}$$

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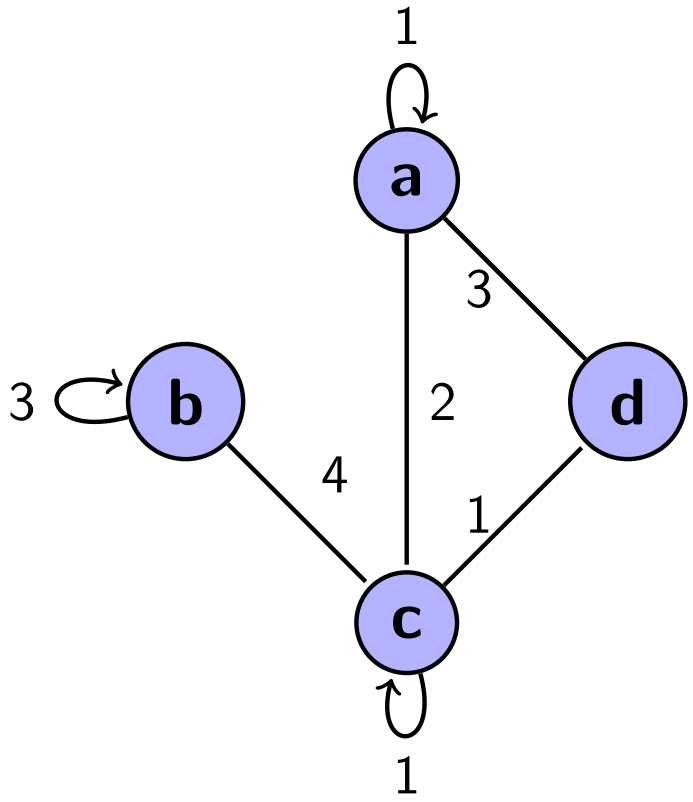
$$\mathrm{A}^T = \text{Company by Word Matrix} \qquad \begin{array}{c} \\ AA \\ X \end{array} \begin{array}{c} \begin{array}{ccc} w_1 & w_2 & w_3 \end{array} \\ \begin{bmatrix} 1 & 0 & 2 \\ 0 & 3 & 4 \end{bmatrix} \end{array}$$

$$A \cdot A^T = \text{Non-Directional Word by Word Matrix}$$

$$\begin{array}{c} \\ w_1 \\ w_2 \\ w_3 \end{array} \begin{array}{c} \begin{array}{ccc} w_1 & w_2 & w_3 \end{array} \\ \begin{bmatrix} 20 & 0 & 2 \\ 0 & 9 & 12 \\ 2 & 12 & 20 \end{bmatrix} \end{array}$$

$$
\begin{array}{c} \\ a \\ b \\ c \\ d \end{array}
\begin{array}{c}
\begin{array}{cccc} a & b & c & d \end{array} \\
\left[\begin{array}{cccc}
1 & 0 & 2 & 3 \\
0 & 3 & 4 & 0 \\
2 & 4 & 1 & 1 \\
3 & 0 & 1 & 0
\end{array}\right]
\end{array}
$$



Degree Centrality

For all nodes, degree centrality is the number of ties a node has compared to all the other nodes in the graph.

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Let u be a node in a graph G of n nodes,

the degree centrality of u is equal to $\frac{u}{n-1}$

Eigenvector Centrality

Let u be a node in a graph G of n nodes,

$$\text{Eigenvector Centrality of } u = \frac{1}{\lambda} \sum_{v \in M(u)} v$$

where λ is the principle eigenvalue.

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λ is typically calculated using Power Iteration where:

$b_{k+1} = \frac{Ab_k}{||Ab_k||}$ assuming it converges

Making the Prediction

Calculate the centralities for the initial (2012) corpus.

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Calculate the individual centralizes for new filings (2013).

Results

Degree Centrality:

Predicted Up: 81% Predicted Down: 66% out of 830 ending up and 1592 ending down

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Predicted Up: 81% Predicted Down: 66% out of 830 ending up and 1592 ending down

Eigenvector Centrality:

Predicted Up 66% Predicted Down 67% out of 831 ending up and 1594 ending down

References

Breiger, R. L. (1974). The Duality of Persons and Groups. *Social Forces*, 53, 2, 181-190.

Leinweber, D. (2009). Nerds on Wall Street: Math, machines, and wired markets. Hoboken, N.J: John Wiley & Sons.

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