Interactive Visualization of the Stock Market Graph

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Overview

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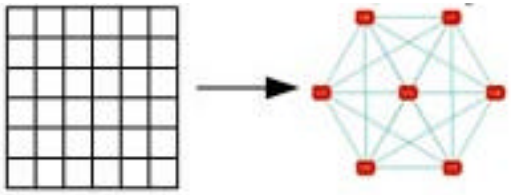
Stock Market Data

- Huge amounts of accessible data on a daily basis
- Consists of a variety of fields such as price, volume, change
- Stock price interactions form a complex system
- Want to understand these interactions of the subsystems

Constructing the Market Graph

1. From a dataset, compute the correlation matrix

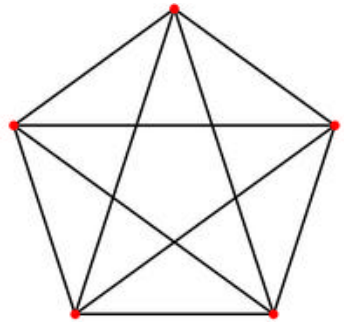


2. Convert correlation matrix to a graph, where
   - Vertices represent stocks
   - Edges represents a relationships between two stocks

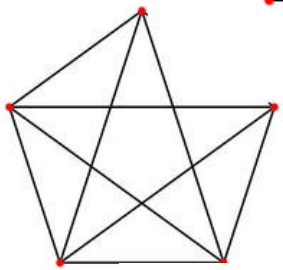
correlation(stock1,stock2) > THRESHOLD

What Are We Visualizing?

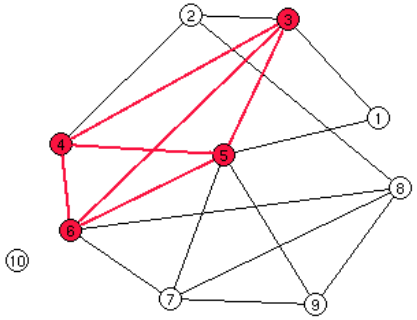
- Find clusters/groups of stocks that exhibit certain trading patterns



- Maximum Cliques
  - Highly positively/negatively correlated subsets of stocks
- Independent Sets
  - Completely diversified stocks



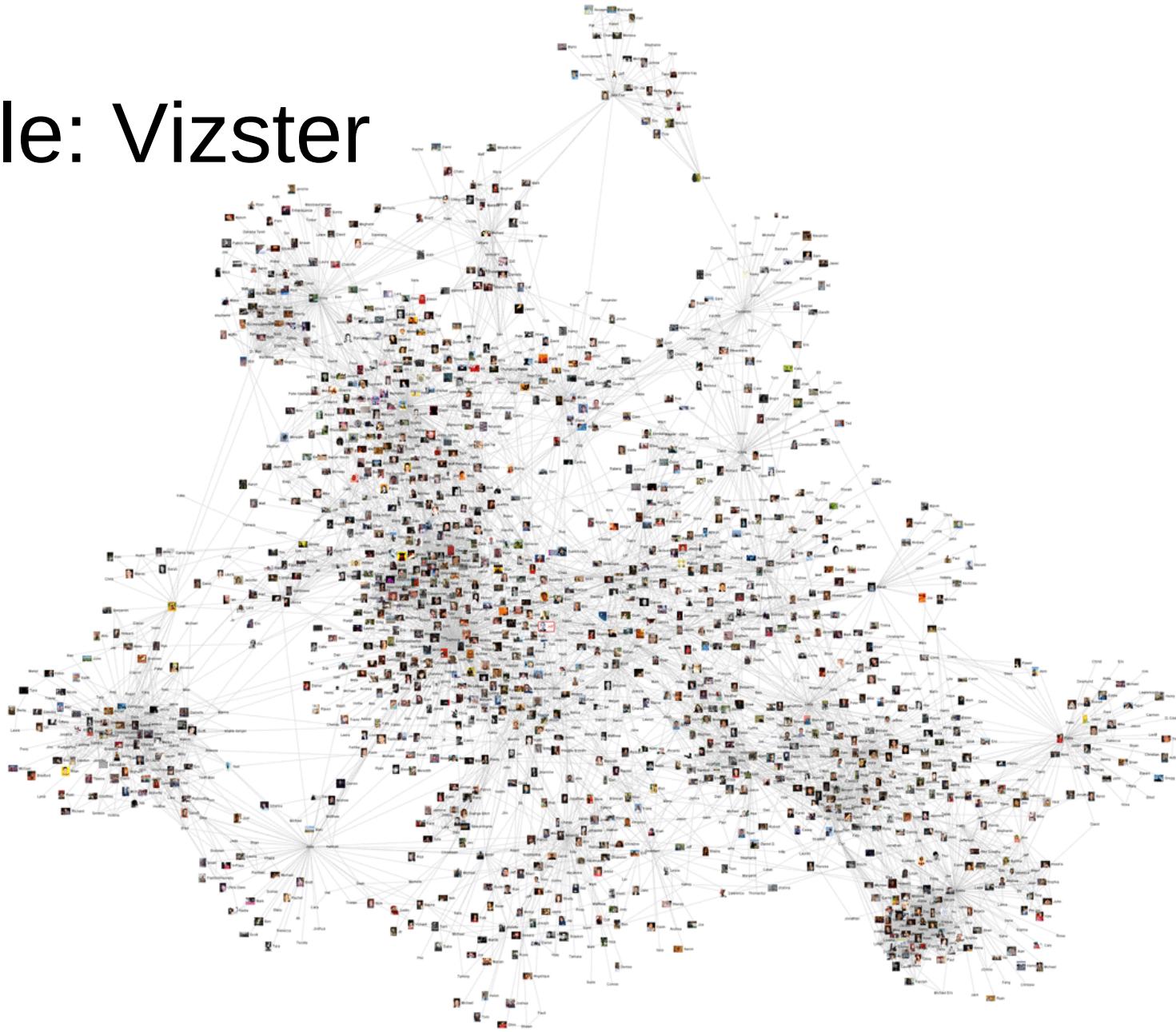
- Quasi-Cliques/Independent Sets
  - Generalizations → allow for near matches
- Clusters ? Cliques/IS interchangeably



Existing Approaches to Visualizing Graph Structures

1. Determine target structures (i.e. clusters) *a priori* and use a standard layout algorithm to show the results
2. Use a layout algorithm optimized to visually differentiate target structures
3. Our approach: combine the two
   - Find target structures first, but include additional nodes and edges for context
   - Then use force-directed layout algorithm to effectively visualize the results

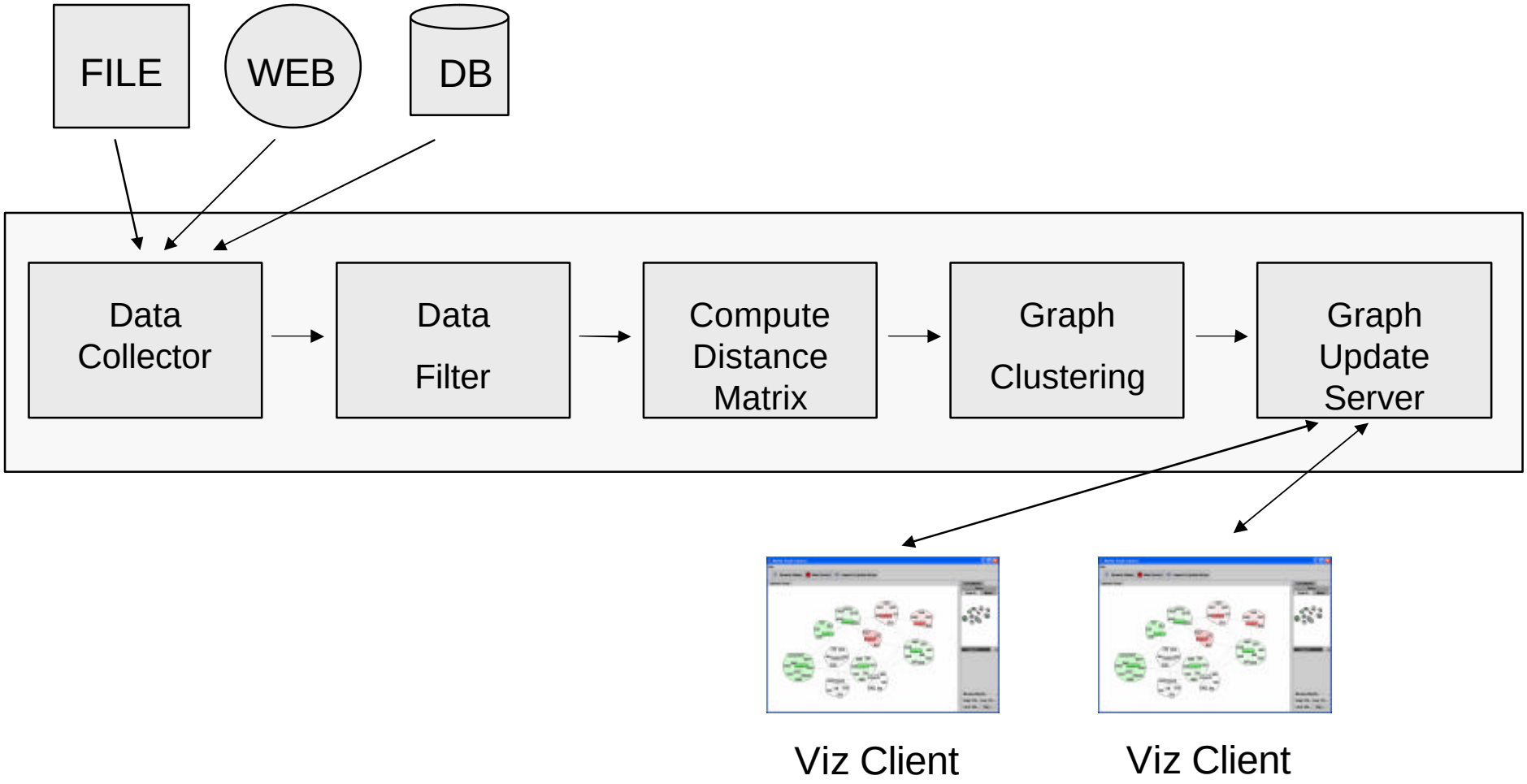
Example: Vizster



Motivation: Usage Scenarios

- Portfolio management (static)
- Real-time market analysis (dynamic)
- Exploratory analysis of trading data to gain new insights, spot patterns/trends, etc (static)

Motivation: Visualizing Results from a Real-time Data-mining Pipeline



Visualization Goals

1. Visualize different graph structures representing various *patterns* and *trends*
   - (quasi-)cliques and (quasi-)independent sets
   - positively and negatively correlations
2. Represent inter-cluster relationships
3. Dynamic graph capabilities
4. Interaction for efficient data exploration
5. Information integration

Force-Directed Graph Layout Model

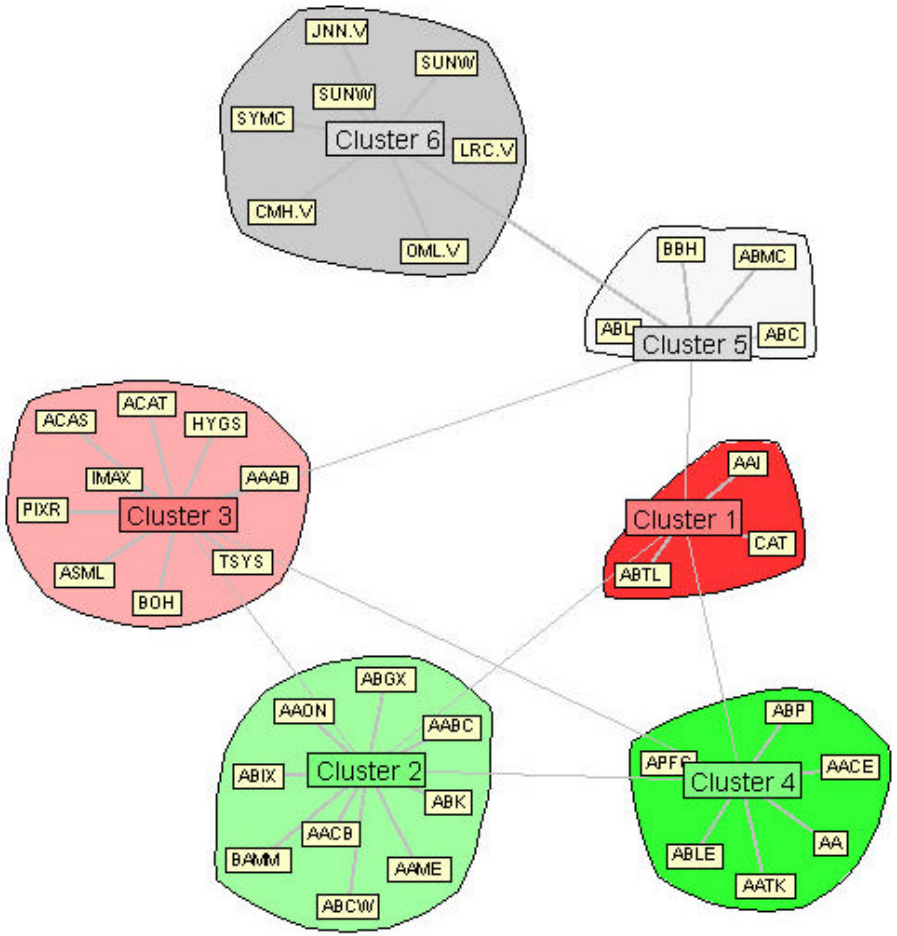
- Create “summaries” of the graph using the clusters and their induced subgraphs
- Force model: spring-embedded layout
- Spring lengths and tensions parameterized to optimize layout
  - Highly related clusters should be close
  - Independent clusters and minimally related clusters should be further apart

F.D. Model Parameterizations

- Edge Length
  - Cluster-Cluster edges (CC)
    - # intra-cluster edges (shows “connectedness” of clusters)
  - Cluster-Member edges (CM)
    - Quasi-cliques → # intra-cluster edges (“clique contribution”)
    - Cliques: cluster sizes (more space to larger clusters)
- Tension
  - CM edges use constant “tight” tension
  - CC edge tension proportional to # of inter-cluster links

Differentiating cluster types

- Correlation Metrics: positive negative, independent
  - Color encoded
- Cluster types: (quasi-) Cliques and (quasi-) Independent sets
  - Transparency-encoding for cluster summary
  - Individual members edge length encodes “clique contribution”



Interaction & Information Integration

- Interaction Features
  - Geometric pan/zoom
  - Display/hide cluster outlines
  - Symbol search for quick navigation
  - Overview display for global context
- Node context menus provide stock quotes and news:
  - Stock news from various sources integrated via RSS feeds
  - Online quote details and Google search for provided by opening an external web browser

Dynamic graph capabilities

- Receive remote graph updates via socket connection to a “graph update server”
- Nodes/edges can be added, removed or replaced
- Event-based architecture allows for automatic processing of new updates
- Force-model allows for efficient incremental layouts when new nodes/edges placed “intelligently”

Future Work & Improvements

- Handle overlapping clusters
- Encode other variables
  - i.e. node size could encode trade volume
- Ability to view underlying edge weights
- Ability to optionally view complete underlying graph
  - especially the intra-cluster edges

Future Work & Improvements (2)

- Interactively adding/removing nodes and edges
- Semantic zoom
- Focus+Context
- Other clustering methods besides partitioning via (quasi-)cliques and independent sets

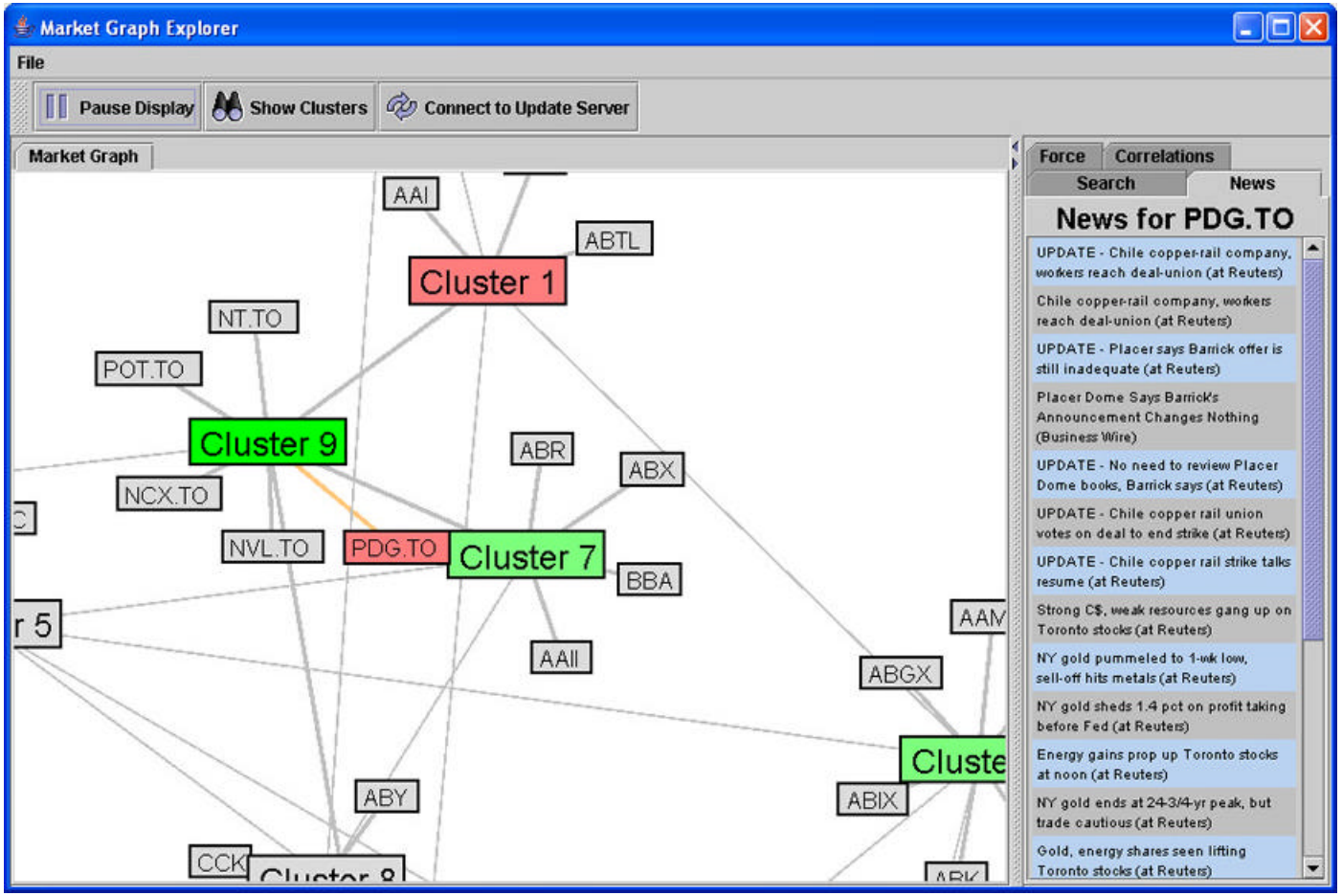
Conclusion

- Implemented basic Visualization tool for exploring the market graph
- Visualizes different cluster types and their attributes
- User interaction for pan/zoom, on-demand details (quotes, news, web search)
- Dynamic graph capability to support a real-time data processing pipeline

References

1. Jeffrey Heer and Danah Boyd. Vizster: **Visualizing online social networks**. *InfoVis 2005 IEEE Symposium on Information Visualization*, 2005.
2. Jeffrey Heer, Stuart K. Card, and James A. Landay. **prefuse: a toolkit for interactive information visualization**. In *CHI '05: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 421–430, New York, NY, USA, 2005. ACM Press.
3. Frank van Ham and Jarke J. van Wijk. **Interactive visualization of small world graphs**. In *Proceedings of the IEEE Symposium on Information Visualization*, pages 199–206, Washington, DC, USA, 2004. IEEE Computer Society.
4. Vladimir Boginski, Sergiy Butenko, and Panos M. Pardalos. **Mining market data**: A network approach.

DEMO


Market Graph Explorer
File
Pause Display
Show Clusters
Connect to Update Server
Market Graph
AAI
ABTL
Cluster 1
NT.TO
POT.TO
Cluster 9
ABR
ABX
NCX.TO
NVL.TO
PDG.TO
Cluster 7
BBA
AAII
ABGX
ABIX
ABY
CCK
Force
Correlations
Search
News
News for PDG.TO
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NY gold sheds 1.4 pct on profit taking before Fed (at Reuters)
Energy gains prop up Toronto stocks at noon (at Reuters)
NY gold ends at 24-3/4-yr peak, but trade cautious (at Reuters)
Gold, energy shares seen lifting Toronto stocks (at Reuters)

THE END!

Construct a Similarity Matrix

- Currently, our similarity measure is

$$C_{ij} = \frac{\langle R_i R_j \rangle - \langle R_i \rangle \langle R_j \rangle}{\sqrt{\langle R_i^2 - \langle R_i \rangle^2 \rangle \langle R_j^2 - \langle R_j \rangle^2 \rangle}},$$

where:

$$R_i(t) = \ln P_i(t) / P_i(t-1)$$