Social Networks

• A social network is a graph structure where
  – vertices are people or groups and
  – edges are relations between these people or groups
  – Vertices and edges usually carry attributes
    • Name, size, age, count, etc.
Facebook Network Dec. 2010


LinkedIn Profession Network

http://inmaps.linkedinlabs.com/network
InfoVis Co-authoring
(K. Börner et al. 04)

Generally, after loading...
Readability Experiment

Controlled Experiment:
Node Link Diagrams vs. Adjacency Matrices

- **The Tasks:**
  - Tasks related to the overview
    - Number of vertices
    - Number of arcs
  - Tasks related to graph elements
    - Finding an element (a vertex, a link)
    - Finding the most connected vertex (a central actor, a pivot, a hub)
    - Finding a common neighbor
    - Finding a path
  - Random graphs (3 sizes and 3 densities)
  - 2 representations: Node-Link and Matrix

- **Results:**
  - Node-link diagrams are preferable for small sparse graphs (20 vertices)
  - Matrices are more readable wrt dense graphs and medium/large graphs (> 20 vertices) wrt the selected tasks, except path finding

References:
Matrix vs. NodeLink

+  
  • Usable without reordering  
  • No node overlapping  
  • Fast navigation  
  • Fast manipulation  
  • More readable for some tasks  
  • Readable for dense graphs

-  
  • Less familiar  
  • Use more space  
  • Weak for path following tasks  

+  
  • Familiar  
  • Compact  
  • More readable for path following  
  • More effective for small graphs  
  • More effective for sparse graphs

-  
  • Useless without layout  
  • Node overlapping  
  • Edge crossing  
  • Not readable for dense graphs  
  • Manipulation requires layout computation

Explore  
Communicate
Visual Patterns with Ordered Matrices

The Reorderable Matrix

- Introduced by Bertin 67 as a representation for relational data
- Table or Network
- The value table provides details
- The reordered table provides details AND overall structure in the same representation

Problems:
- How to compute a good ordering?
  - Row and column permutations
- how to assess its quality?
Reordering the Matrix

- Interactive or Automated
- Naïve approach:
  - Define an objective function (e.g. favor diagonal placement and dense clusters)
  - Try all permutations and retain the one that maximizes it
  - Problem: for a $n \times m$ table, there are $n! \times m!$ configurations
- Four families of methods to reorder a matrix:
  1. Robinsonian
  2. Dimension reduction
  3. Graph linearization methods
  4. Heuristics

Reordering methods

- Lot’s of methods !
  - Table-based ordering methods
  - Graph linearization
  - Mixed approach

Hierarchical clustering of microarray data

Exploring social networks with matrices
Mixed approach

• Place actors with similar connection patterns next to each other

\[ \text{Add information to the adjacency matrix} \]

Participatory Design

• What Social Science researchers
  – Use? (representations, software)
  – Analyze? (datasets)
  – Do? (tasks, exploration process)
  – Want? (goal)

\[ \text{Henry and Fekete, IHM'06} \]
\[ \text{Henry and Fekete, InfoVis'06} \]

[http://insitu.lri.fr/~nhenry/MatrixExplorer](http://insitu.lri.fr/~nhenry/MatrixExplorer)
Breakthrough in Social Network Visualization:
Improving Matrices

Several representations:

1. **Combined**
   - MatrixExplorer
     (Henry & Fekete, InfoVis’06)

2. **Augmented**
   - MatLink
     (Henry & Fekete, Interact’07, Best Paper)
   - GeneaQuilts
     (Bezerianos et al., InfoVis’10)

3. **Hybrid**
   - NodeTrix
     (Henry et al., InfoVis’07)
   - CoCoNutTrix
     (Isenberg et al., CG&A’09)

4. **Multiscale**
   - ZAME
     (Elmqvist et al., PacificVis’08)

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**MatrixExplorer** [Henry & Fekete06]
Combined representation

- Matrices to explore
- Node-Link diagrams to present findings
**MatLink** [Henry&Fekete07]

Augmented representation

- Augmenting matrices with interactive links
- Solving the path-related tasks problem for matrices

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**MatLink significantly improves matrices**

- Controlled experiment
  - 3 vis. x 6 datasets x 5 tasks

Matrix, Node-Link, MatLink

**Data:** From almost-trees
  To complete-graphs
  Including small-world networks

**Tasks:**
1. CommonNeighbour,
2. ShortestPath,
3. MostConnected,
4. ArticulationPoint,
5. LargestClique
NodeTrix [Henry et al.07]

Hybrid representation

- Designed for small-world networks
  - Globally sparse
  - Locally dense

- Visualizing dense sub-graphs as matrices
- Interact to create, edit and remove the matrices

Video
NodeTrix: the NetVis Nirvana?

- Can you see every node?
- Can you count each node’s degree?
- Can follow every link from its source to its destination?
- Can you identify clusters and outliers?

- Node Labels
- Link Labels (excentric labels?!) 
- … even cluster labels
- Node Attributes
- Link Attributes
- … even clusters attributes
- Directed Graph (links width?!) 

... But... beware the graphics overload!

Visual Patterns

Infovis Coauthorship (133 actors)
ZAME: Interactive Large-Scale Graph Visualization [Elmqvist et al. 08]

Visualize very large networks:
- Larger than $10^7$ vertices and edges
- Reorder
- Create a pyramid
- Aggregate attributes
- Visualize using enhanced glyphs
Breakthrough in Social Network Visualization: Improving Matrices

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Other Related Res

- Van Ham et al. 2004-2005 have shown techniques to navigate in large matrices
- Brandes & Nick 2011 have visualized temporal networks (friendship evolution)
- Dinkla et al. 2012 have introduced Compressed Adjacency Matrices
PhD defense

Connections, Changes, and Cubes: Unfolding Dynamic Networks for Visual Exploration

• Benjamin Bach
• 9 May 2014

Advisors:
Jean-Daniel Fekete
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Jury:
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Jarke J. van Wijk
Tim Dwyer
Silvia Miksch
Guy Melançon

Boyandin et al., 2012
Maray Friedrich and Eades, 2001
TempoVis Ahn et al, 2011

2.5D visualization Dwyer, 2004
Gaertler & Wagner, 2005
**Timeline**

- **Parallel Edge Splatting** Burch et al., 2011
- **Massive Parallel Sequence Views** Willems et al., 2012
- **GraphDice** Bezerianos et al., 2010
- Reda et al., 2012

**Ego Network Representations**

- **1.5D Visualization** Shi et al., 2011
- **Dynamic Ego Networks** Farrugia et al., 2011

**Temporal Aggregation**

- **Collberg et al. 2003**
- **Gestalt Lines** Brandes & Nick, 2011
Unfolding Dynamic Networks
Central Model

Interactivity

Nodes

'05  '06  '07

'08  '09  '10
Ceci n'est pas une visualisation 3D
Cubix: [http://aviz.fr/cubix](http://aviz.fr/cubix)

Visualizing Dynamic Networks with Matrix Cubes

submitted to CHI2014

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**Conclusion**

- Visualization of Social Network has been greatly improved in the last years
- Novel representations are denser and more expressive
  - Though they require a little training
- Huge and dense networks can be visualized
  - Relations between clients, suppliers, employees
  - Aggregated over long periods of time
- They need integration in complete systems (commercial or not)
Challenges

- Moving from research prototypes to product
- Study what is a good order
  - What structures can we see?
  - What algorithm will reveal what structure?
  - How to characterize data to fit with algorithms?
- Scalability
- Multivariate networks (several attributes on the vertices and edges)
- Dynamic networks

Conclusion

- Exploring complex data is possible with novel visualizations
  - To make sense of datasets, check for quality, etc.
- It requires a bit of time to understand the visual mapping
  - About 10mn to 1h
- It also requires a bit of time to learn the interactions
- Visualization Literacy is necessary to realize how much you will gain from investing this time
References

• Frank van Ham, Hans-Jörg Schulz, Joan Morris DiMicco: Honeycomb: Visual Analysis of Large Scale Social Networks. INTERACT (2) 2009: 439–442