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# Toolkit-based Visualization

# Introduction

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VTK is obviously only one of the many toolkits and libraries that can be used for visualizing data and information.

Most of these toolkits are java-based, even though many are nowadays JavaScript/web-based (see next chapter).

The next slides will provide an overview of some of these toolkits.

An extensive list can be found on the InfoVis Wiki:

[http://www.infovis-wiki.net/index.php?title=Toolkit\\_Links](http://www.infovis-wiki.net/index.php?title=Toolkit_Links)

# ParaView

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ParaView is a VTK-based software package that makes using VTK easier in that it does not involve programming. The user can select objects from the menu to build the visualization pipeline interactively and make changes to the settings of those filters.

ParaView is designed to run in parallel which is where many of the parallel features in VTK's design come from.

# VisIt

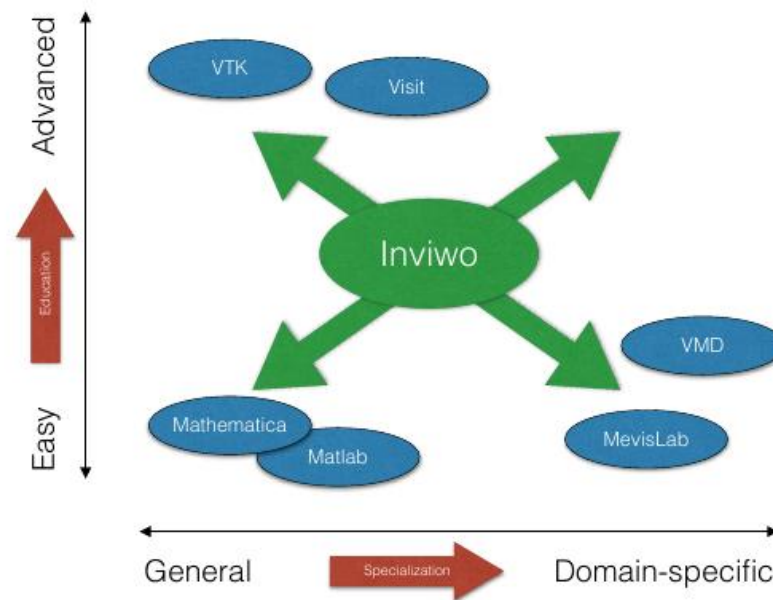
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Similar to ParaView, VisIt is another open source visualization tool. It is designed to be scalable to support large-scale data sets and is also based on VTK.

It utilizes a client-server model, where the server is parallelized. This design enables the capability to run the server on a supercomputer with the client displaying the results.

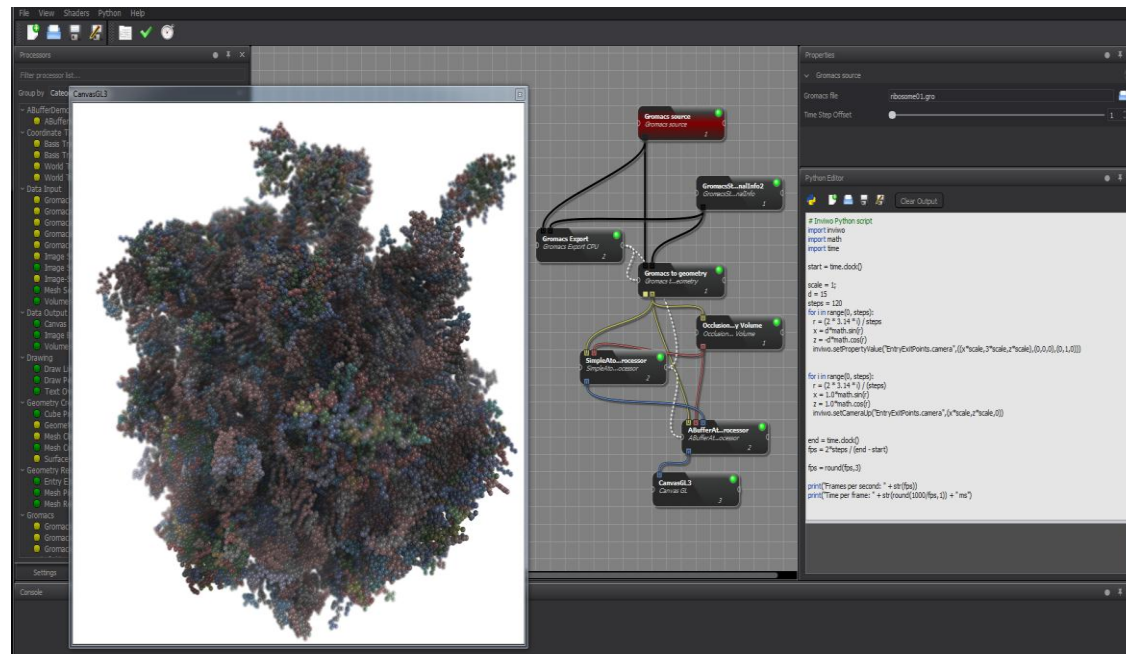
# Inviwo

Inviwo is a relatively new software package that provides yet another user interface to VTK in which the user can drag and drop filters and make connections among them to define the visualization pipeline.



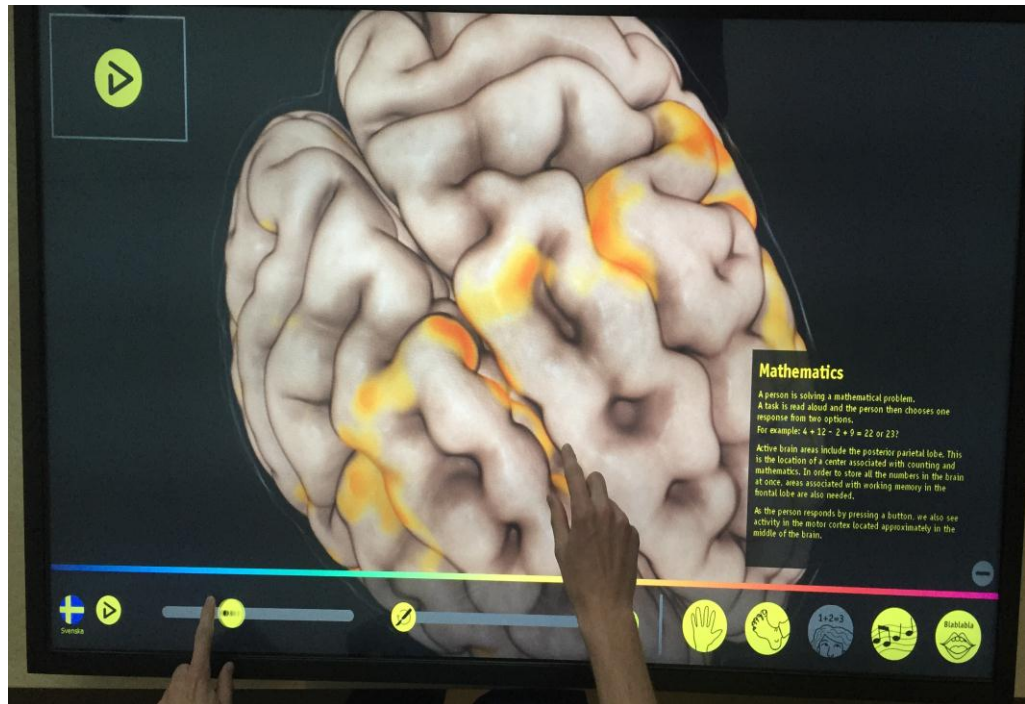
# Inviwo

Molecular visualization functionality implemented inside an Inviwo module. Various operations are performed inside processors and the result from each processor flows between connected ports in an top-down topology structure.



# Inviwo

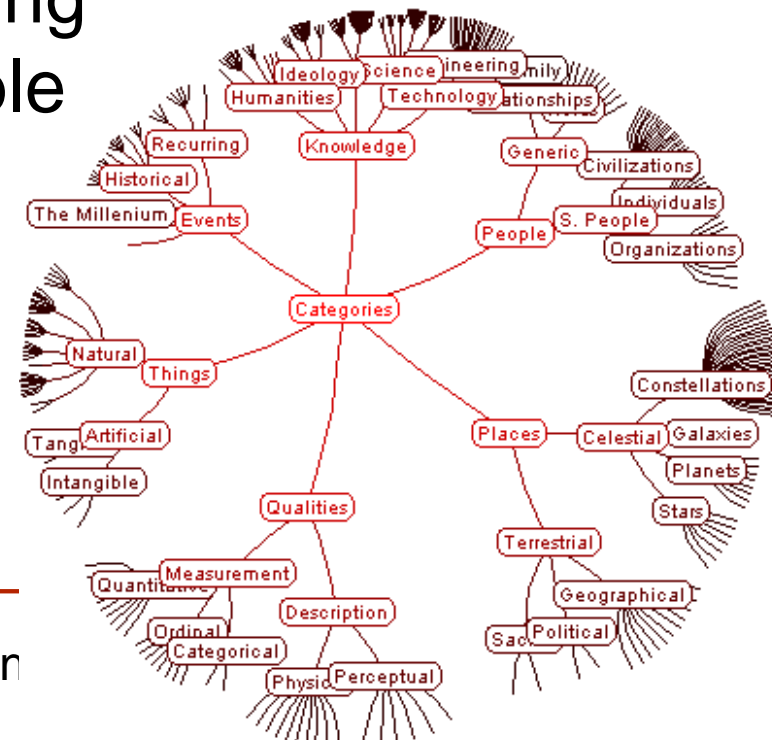
Application designed for public exhibition, utilizing Inviwo for as the visualization pipeline. The application allows users to explore the brain structure (MRI) and learn about brain activity (fMRI).



# the prefuse toolkit

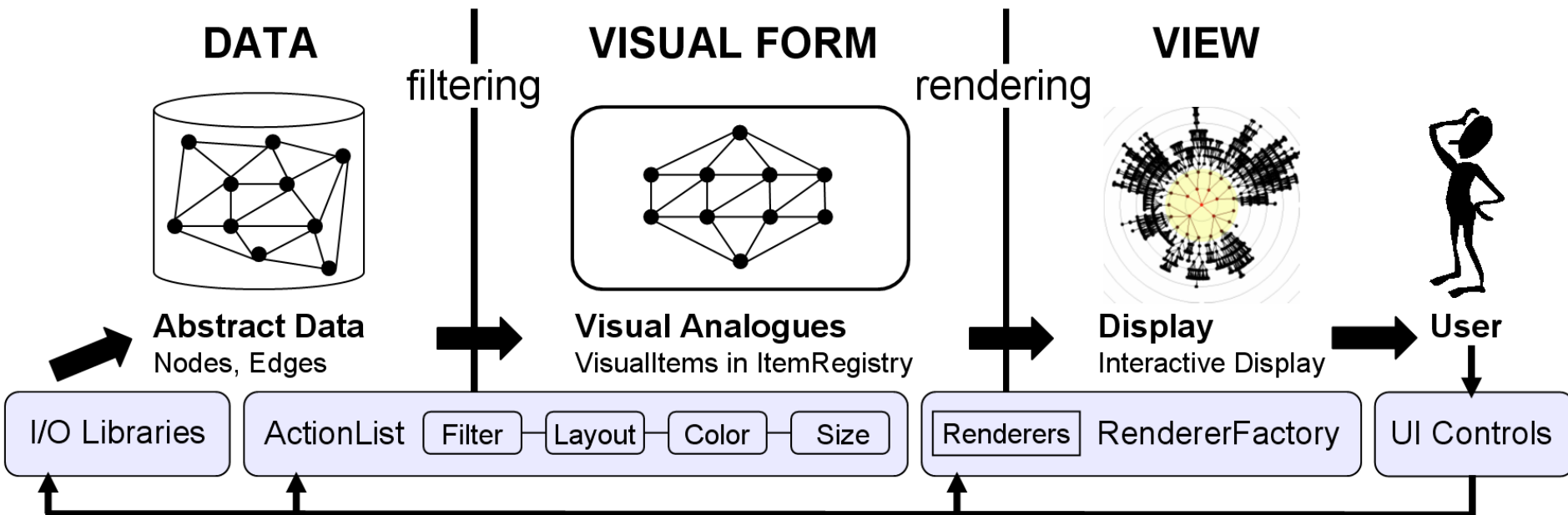
a java user interface toolkit for constructing  
interactive information visualization applications  
supports visualization, animation, and interaction

- application building by stringing together fine-grained, reusable components
- layers of indirection between source data, visualized data, and rendering





# system architecture



## toolkit features

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Data structures and I/O libraries

Multiple visualizations, multiple views

Application design through composable modules

A library of provided layout and distortion techniques

Animation and time-based processing

Graphics transforms, including panning and zooming

A full force simulator for physics-based interfaces

Interactor components for common interactions

Integrated color maps and search functionality

Event logging to support visualization evaluation

# prefuse

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Interactive demos, videos, and research papers available at:

<http://prefuse.sourceforge.net>

<http://github.com/prefuse/Prefuse>

# InfoVis Toolkit (ivtk)

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The InfoVis Toolkit is an Interactive Graphics Toolkit written in Java to ease the development of Information Visualization applications and components.

The main characteristics of the InfoVis Toolkit are:

**Unified data structure:** The base data structure is a table of columns. Columns contain objects of homogeneous types, such as integers or strings. Trees and Graphs are derived from Tables.

**Small memory footprint:** Using homogeneous columns instead of compound types improves dramatically the memory required to store large tables, trees or graphs, and generally the time to manage them.

# InfoVis Toolkit (ivtk)

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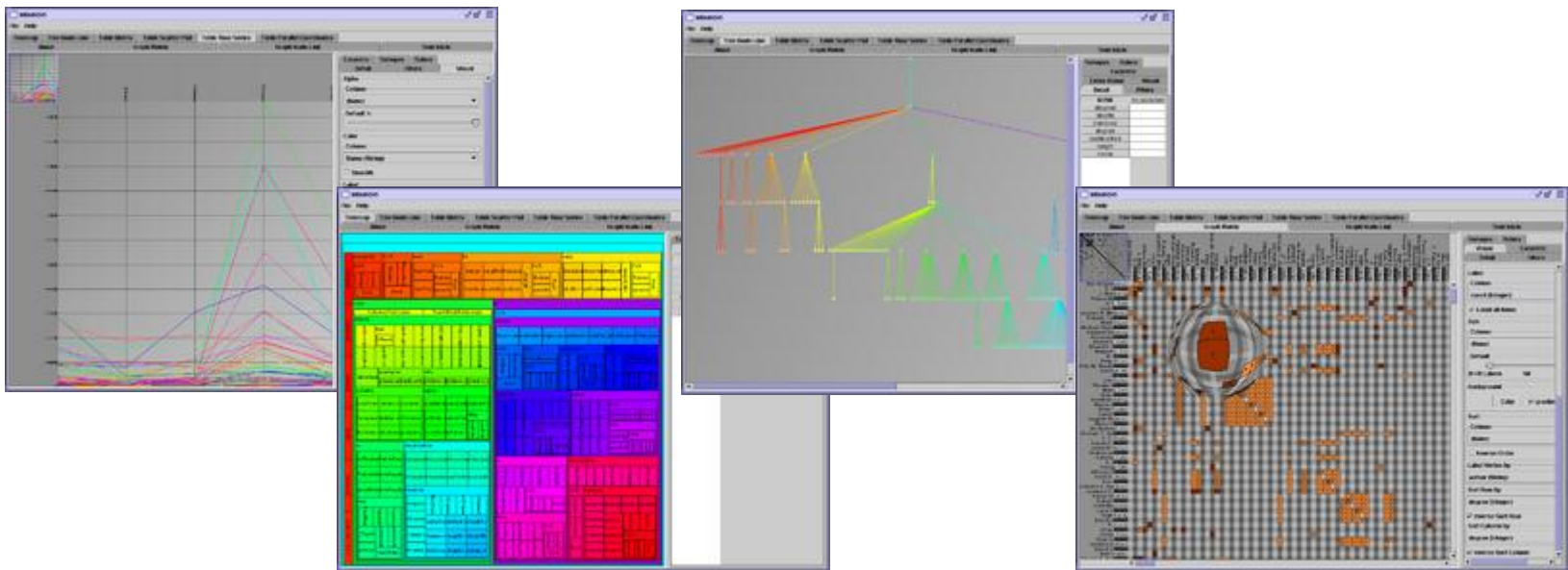
**Unified set of interactive components:** Interactive filtering (a.k.a. dynamic queries) can be performed with the same control objects and components regardless of the data structure, simplifying the reuse of existing components and the design of generic ones.

**Fast:** The InfoVis Toolkit can use accelerated graphics provided by Agile2D, an implementation of Java2D based on the OpenGL API for hardware accelerated graphics. On machine with hardware acceleration, some visualizations redisplay 100 times faster than with the standard Java2D implementation.

**Extensible:** The InfoVis Toolkit is meant to incorporate new information visualization techniques and is distributed with the full sources and with a very liberal license. It could be a base for student projects, research projects or commercial products.

# InfoVis Toolkit (ivtk)

The InfoVis Toolkit, as of version 0.9, implements nine (9) types of visualization: Scatter Plots, Time Series, Parallel Coordinates and Matrices for tables; Node-Link diagrams, Icicle trees and Treemaps for trees; Adjacency Matrices and Node-Link diagrams for graphs. Node-Link visualizations provides several variants (8 for graphs and 4 for trees).



# Tulip

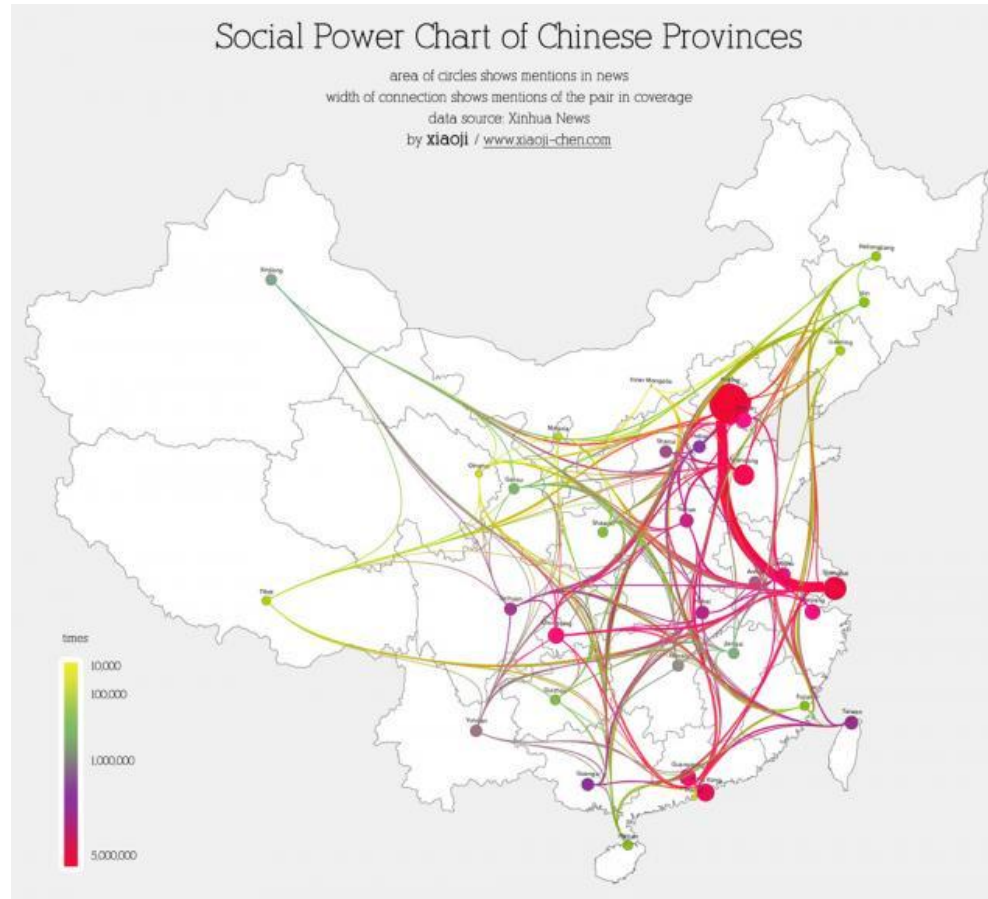
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Tulip is an information visualization framework dedicated to the analysis and visualization of relational data. Tulip aims to provide the developer with a complete library, supporting the design of interactive information visualization applications for relational data that can be tailored to the problems he or she is addressing.

Written in C++ the framework enables the development of algorithms, visual encodings, interaction techniques, data models, and domain-specific visualizations. One of the goal of Tulip is to facilitates the reuse of components and allows the developers to focus on programming their application. This development pipeline makes the framework efficient for research prototyping as well as the development of end-user applications.

# Tulip

## Social Power Chart of Chinese Provinces





# Tulip

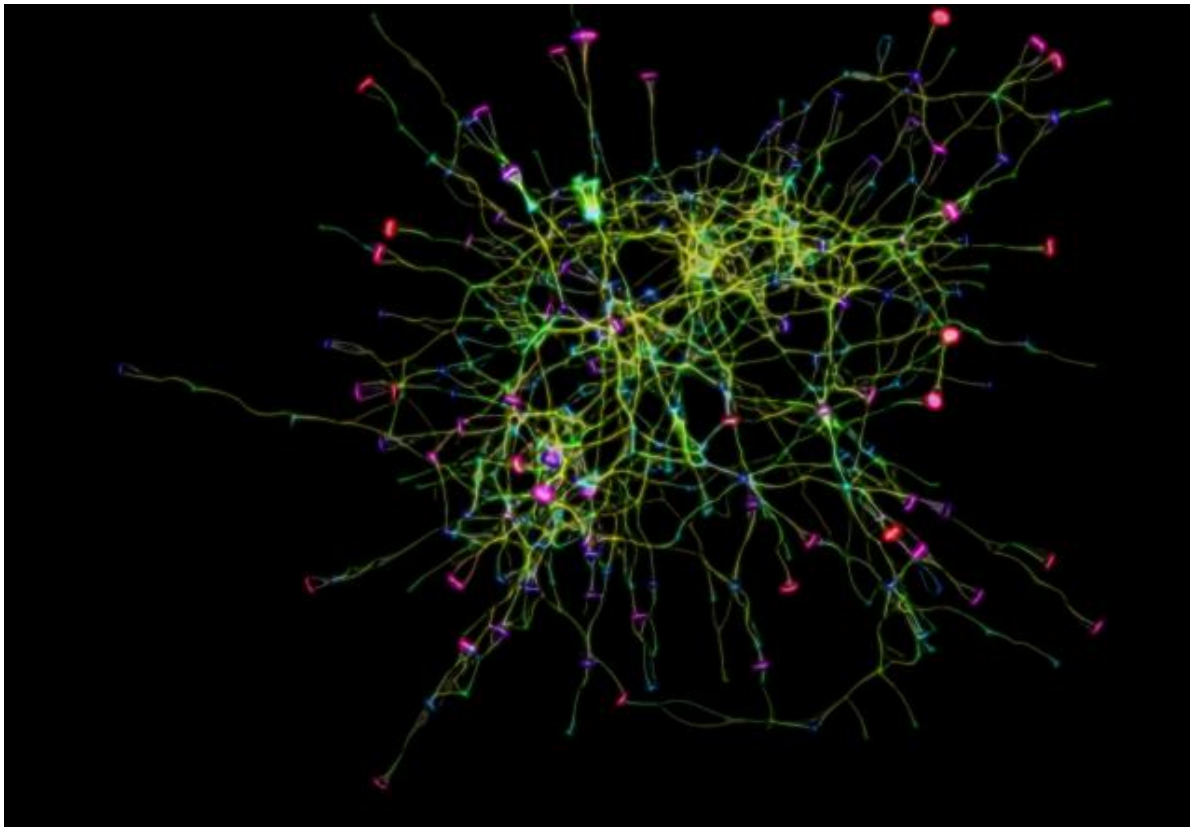
## World Air Traffic Maps 1990



# Tulip

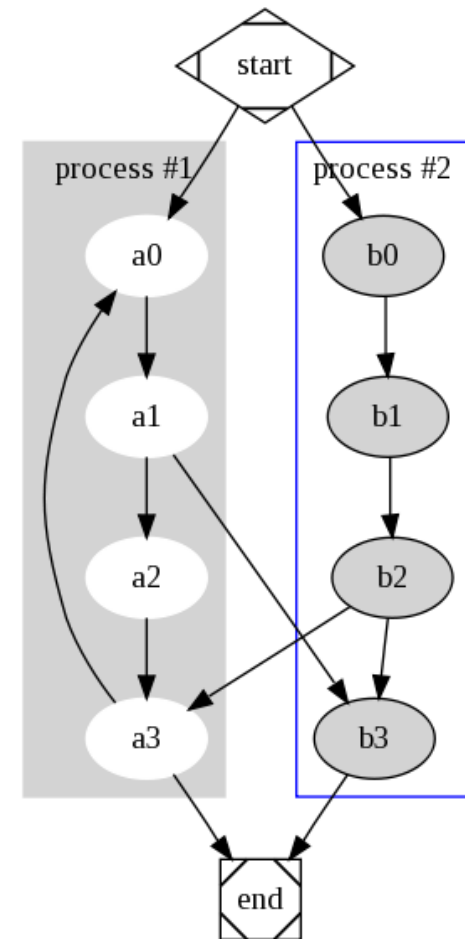
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A nice image of a subset of the IMDB Dataset (4.000 actors with 40.000 edges)



# GraphViz

The Graphviz layout programs take descriptions of graphs in a simple text language, and make diagrams in useful formats, such as images and SVG for web pages; PDF or Postscript for inclusion in other documents; or display in an interactive graph browser. Graphviz has many useful features for concrete diagrams, such as options for colors, fonts, tabular node layouts, line styles, hyperlinks, and custom shapes.



# Walrus - Graph Visualization Tool

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Walrus is a tool for interactively visualizing large directed graphs in three-dimensional space. It is technically possible to display graphs containing a million nodes or more, but visual clutter, occlusion, and other factors can diminish the effectiveness of Walrus as the number of nodes, or the degree of their connectivity, increases. Thus, in practice, Walrus is best suited to visualizing moderately sized graphs that are nearly trees. A graph with a few hundred thousand nodes and only a slightly greater number of links is likely to be comfortable to work with.

Walrus computes its layout based on a user-supplied spanning tree. Because the specifics of the supplied spanning tree greatly affect the resulting display, it is crucial that the user supply a spanning tree that is both meaningful for the underlying data and appropriate for the desired insight. The prominence and orderliness that Walrus gives to the links in the spanning tree, in contrast to all other links, means that an arbitrarily chosen spanning tree may create a misleading or ineffective visualization. Ideally, the input graphs should be inherently hierarchical.

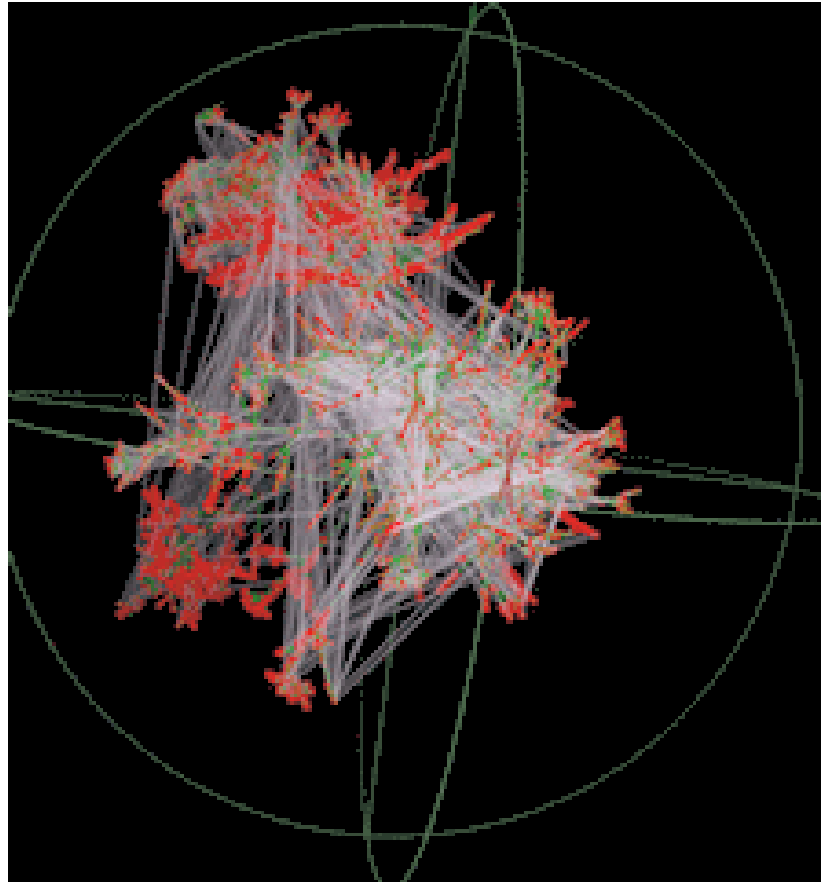
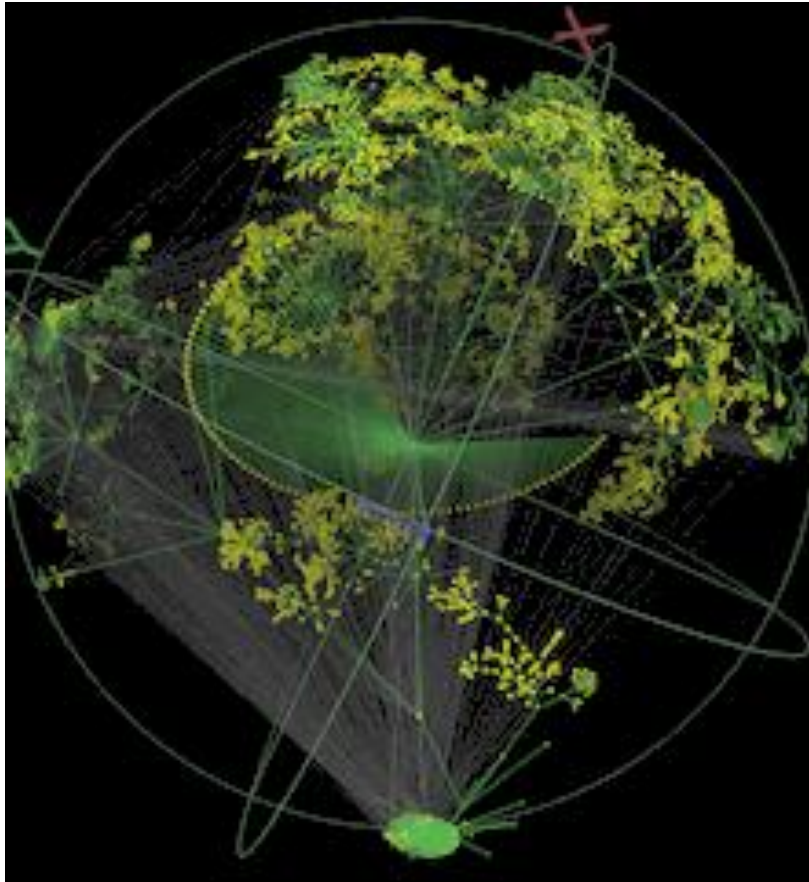
# Walrus - Graph Visualization Tool

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Walrus uses 3D hyperbolic geometry to display graphs under a fisheye-like distortion. At any moment, the amount of magnification, and thus the level of visible detail, varies across the display. This allows the user to examine the fine details of a small area while always having a view of the whole graph available as a frame of reference. Graphs are rendered inside a sphere that contains the Euclidean projection of 3D hyperbolic space. Points within the sphere are magnified according to their radial distance from the center. Objects near the center are magnified, while those near the boundary are shrunk. The amount of magnification decreases continuously and at an accelerated rate from the center to the boundary, until objects are reduced to zero size at the latter, which represents infinity. By bringing different parts of a graph to the magnified central region, the user can examine every part of the graph in detail.

# Walrus - Graph Visualization Tool

3D hyperbolic browser



# Gephi

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Gephi is a visualization and exploration software for all kinds of graphs and networks. Gephi is open-source and free.

**Exploratory Data Analysis:** intuition-oriented analysis by networks manipulations in real time.

**Link Analysis:** revealing the underlying structures of associations between objects.

**Social Network Analysis:** easy creation of social data connectors to map community organizations and small-world networks.

**Biological Network analysis:** representing patterns of biological data.

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# Gephi

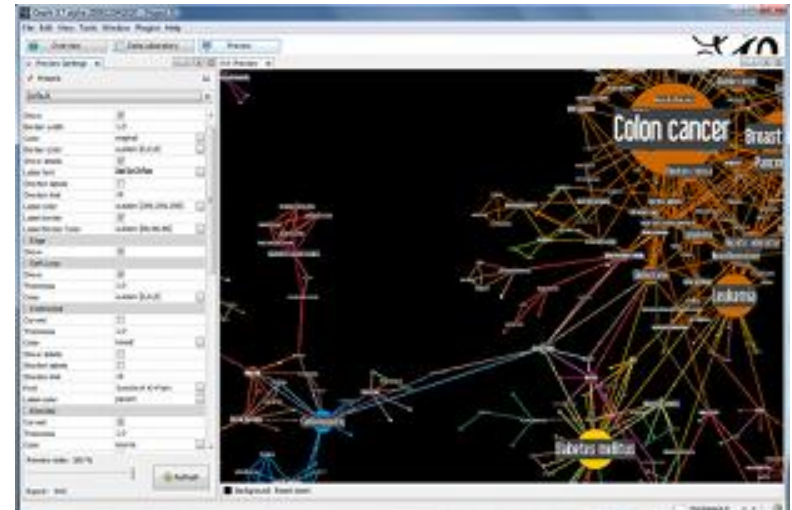
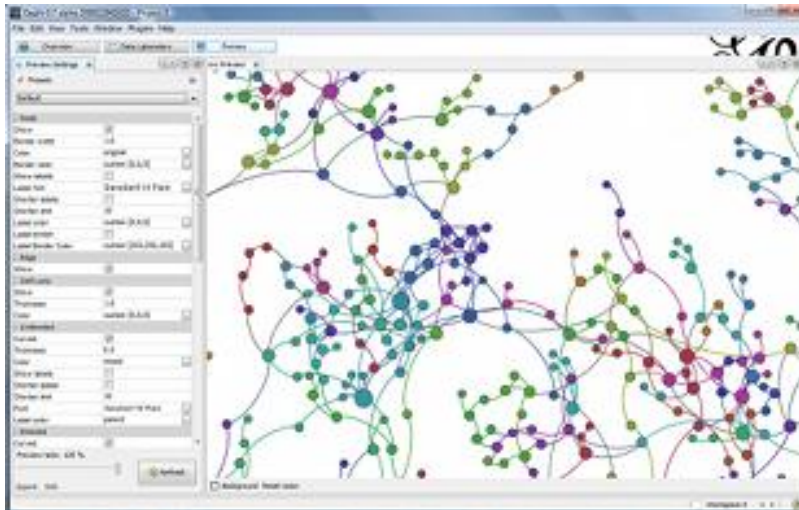
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Gephi is a tool for data analysts and scientists keen to explore and understand graphs. Like Photoshop™ but for graph data, the user interacts with the representation, manipulate the structures, shapes and colors to reveal hidden patterns. The goal is to help data analysts to make hypothesis, intuitively discover patterns, isolate structure singularities or faults during data sourcing. It is a complementary tool to traditional statistics, as visual thinking with interactive interfaces is now recognized to facilitate reasoning. This is a software for Exploratory Data Analysis, a paradigm appeared in the Visual Analytics field of research.



# Gephi

Gephi requires no programming to achieve results like shown below.



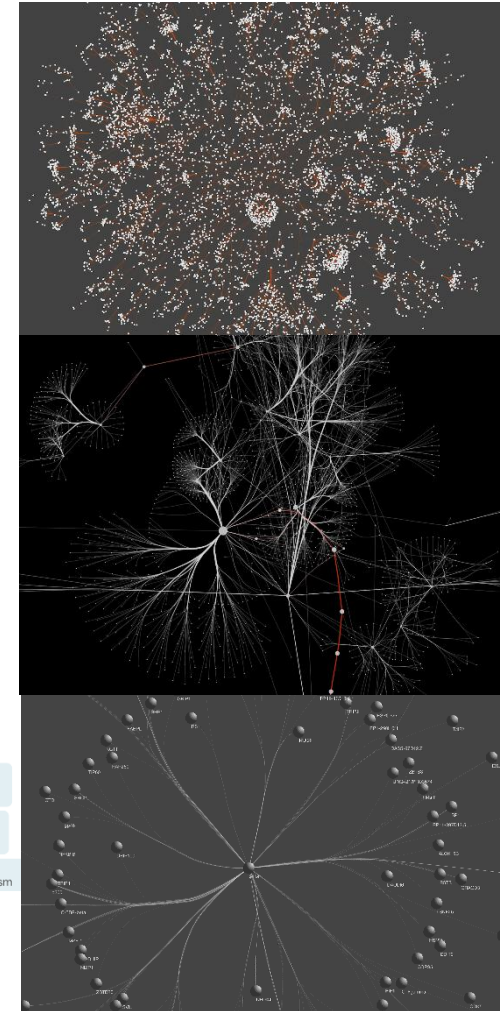
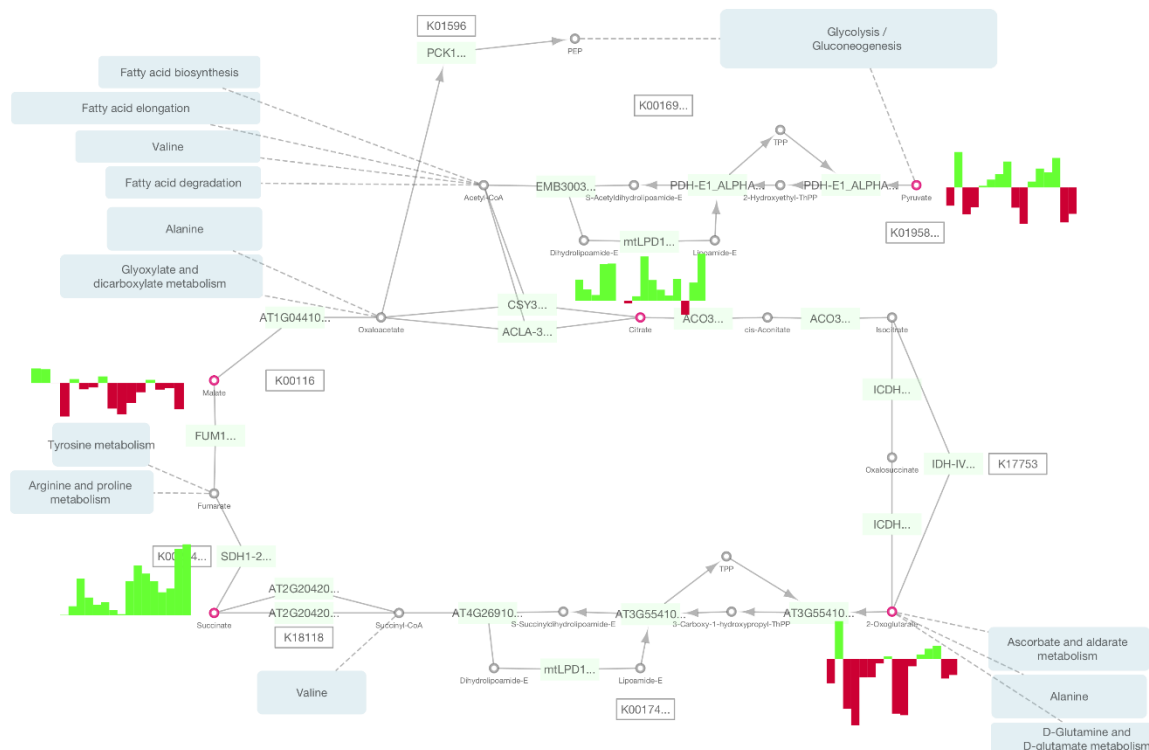
# Cytoscape

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**Cytoscape** is an open source software platform for visualizing molecular interaction networks and biological pathways and integrating these networks with annotations, gene expression profiles and other state data. Although Cytoscape was originally designed for biological research, now it is a general platform for complex network analysis and visualization. Cytoscape core distribution provides a basic set of features for data integration, analysis, and visualization.

# Cytoscape

## Examples



## Community Board [secvis.org](http://secvis.org)

There is even an entire community devoted to security visualization and the visual analytics challenges resulting from it:

<http://secviz.org/>

There you can find further tutorials, courses, and examples for security visualization, most of which are based on toolkits and techniques we discussed in class.