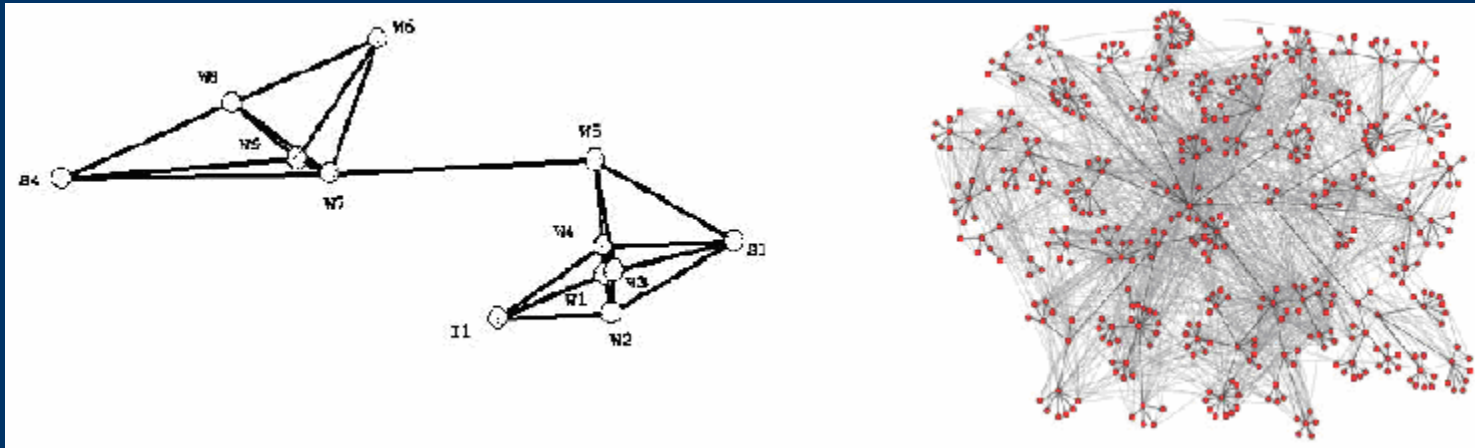


Applied social network theory: a brief excursion



Neil Ernst

<http://neilernst.net/blog>



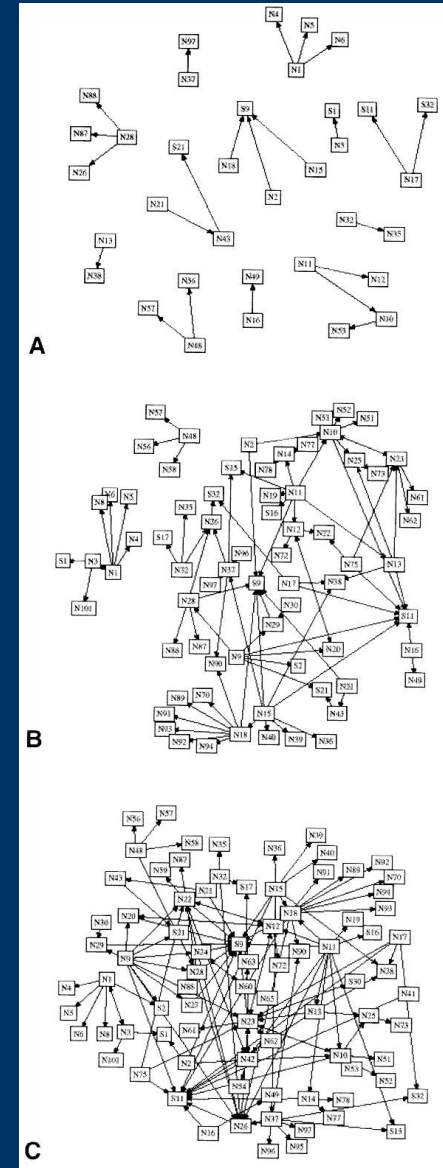
Overview

- Scholarly applications
 - Epidemiology
 - Software architecture
 - Visualization design
 - Image Processing
- Future applications
 - Network standards
 - Mobile Social networks



Epidemiology

- Use social network theory to understand transmission of syphilis
- Teens in Atlanta with multiple simultaneous partners
- High degree of centrality among participants (e.g. 1 component with all but 4 members)
- Unlikely that investigation reached edge of the network
- Infection was not a factor in sexual connection



Epidemiology (2)

- Traditional epidemic modeling fails to capture complexity and size of this case
- Traditional techniques can ignore bridges
- Hard to delineate precise causal chain
- Questions:
 - What connotation does node placement have in network visualization?
 - What role does network evolution play? Can seemingly unimportant edge nodes grow in importance?

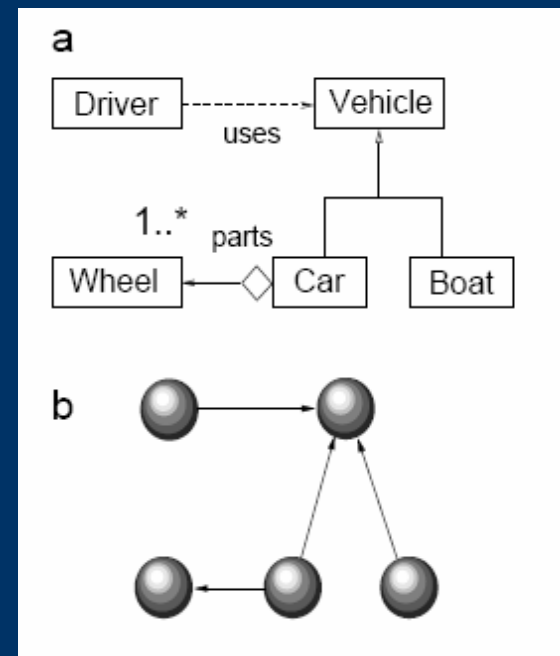


SOME RIGHTS RESERVED

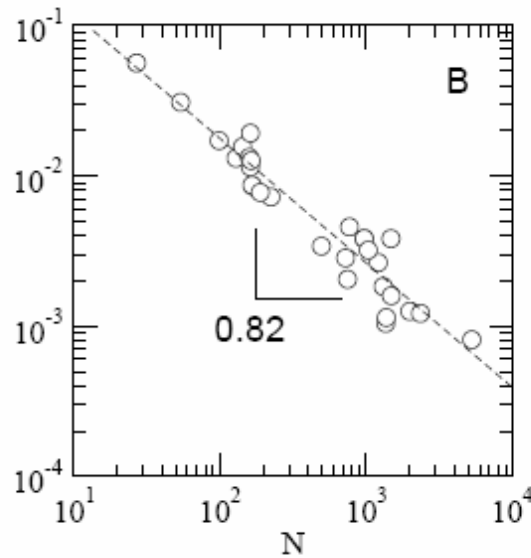
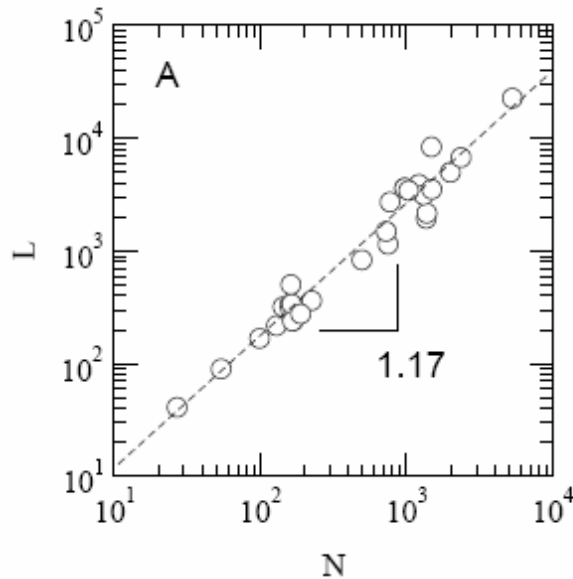
Attribution-NonCommercial-ShareAlike2.5

Software architecture

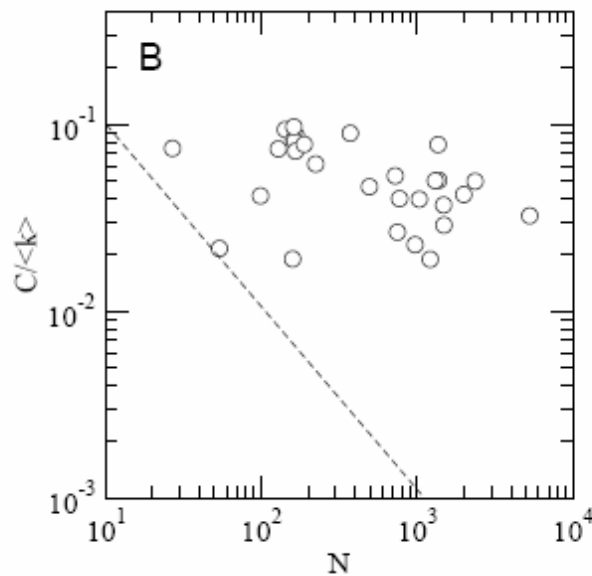
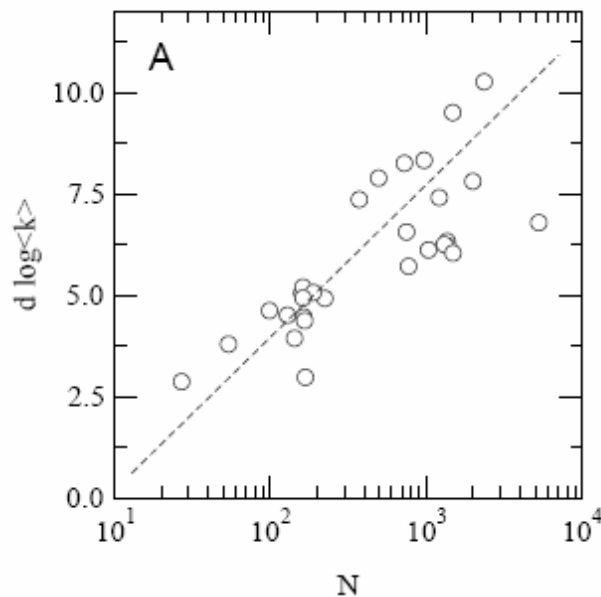
- Software graphs are similar to other network systems
- Software components are well-connected in spite of low connections per class.



Software architecture (2)



A: Links scale linearly with system size
B: Possible links decay with system size



A: Average path length follows small-world properties
B: Clustering metric diverges from behaviour of random model (more clustered)

Software architecture (3)

- Software evolution: Change in degree, mean path length, and clustering over time for one system
- Different systems share similar characteristics
- Modularity introduces hierarchy (as indicated by value of C)
- Possible to assess change cost by calculating the transitive closure of a node at some point in the hierarchy
- Cost scales with system size
- Does this suggest a model for software evolution?

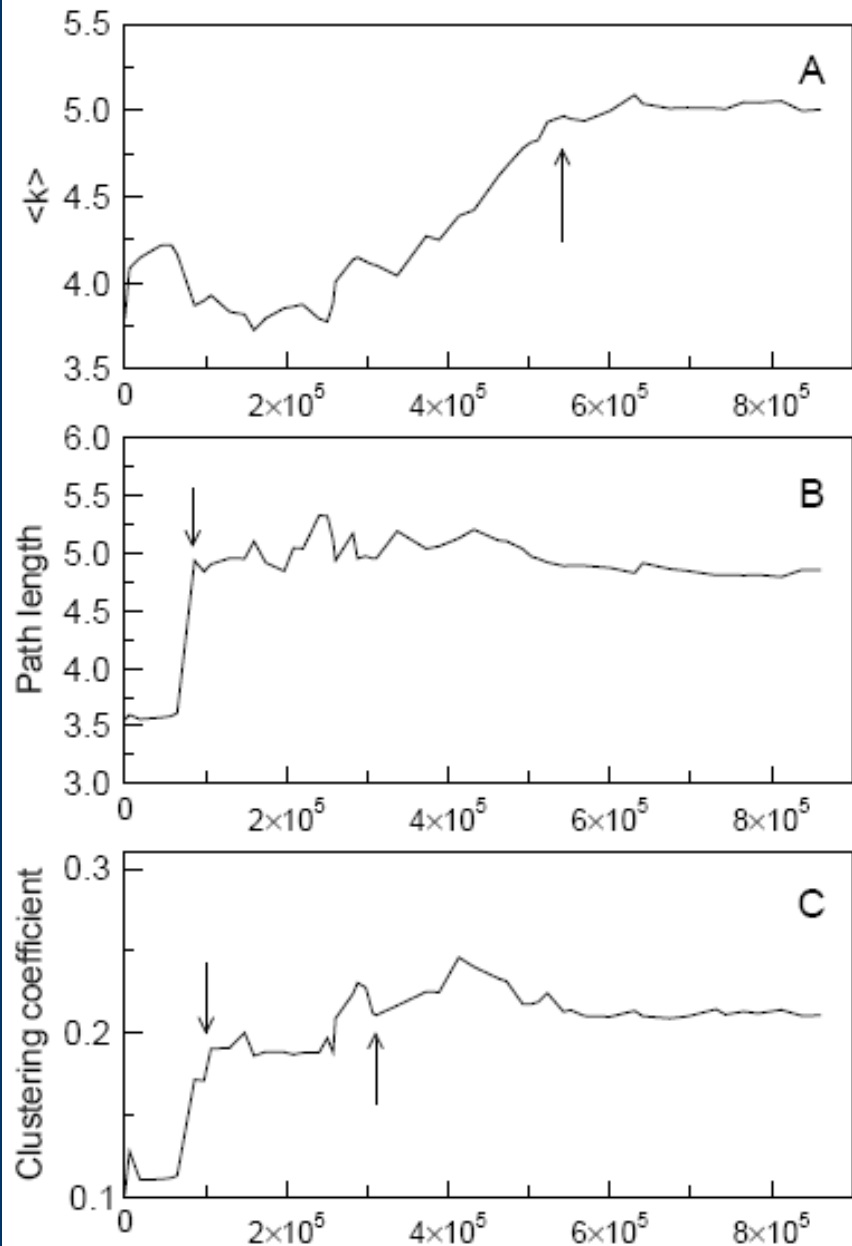


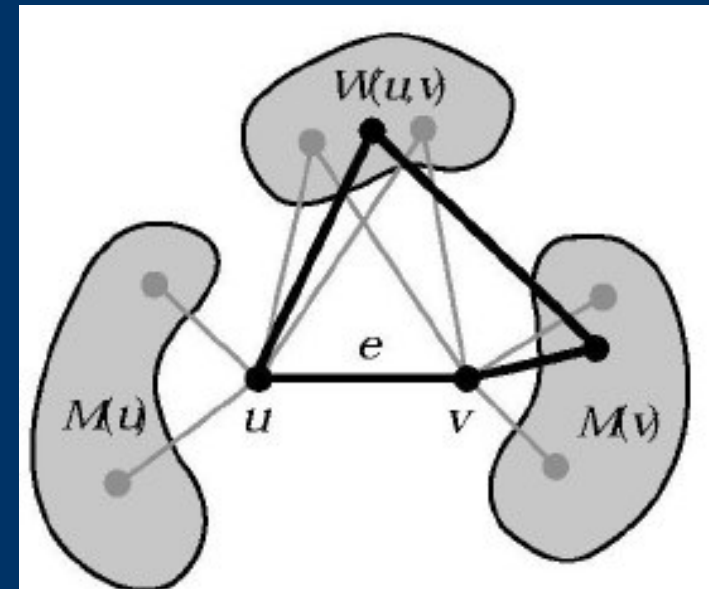
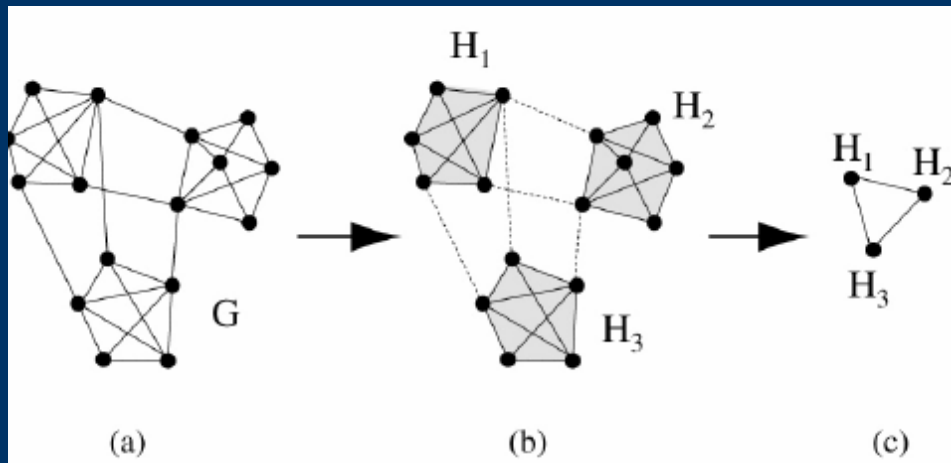
Fig. 6. Evolution of some quantities of interest (ProRally 2002) Time is displayed in minutes. (A) Evolution of mean degree. (B) Evolution of mean path length. (C) Evolution of clustering coefficient.

Multi-scale visualization

- Proposes using small-world characteristics to filter nodes in a visualization tool
- Visual info-seeking: “Overview first, zoom and filter, details on demand”
- Assume recursive small-world property



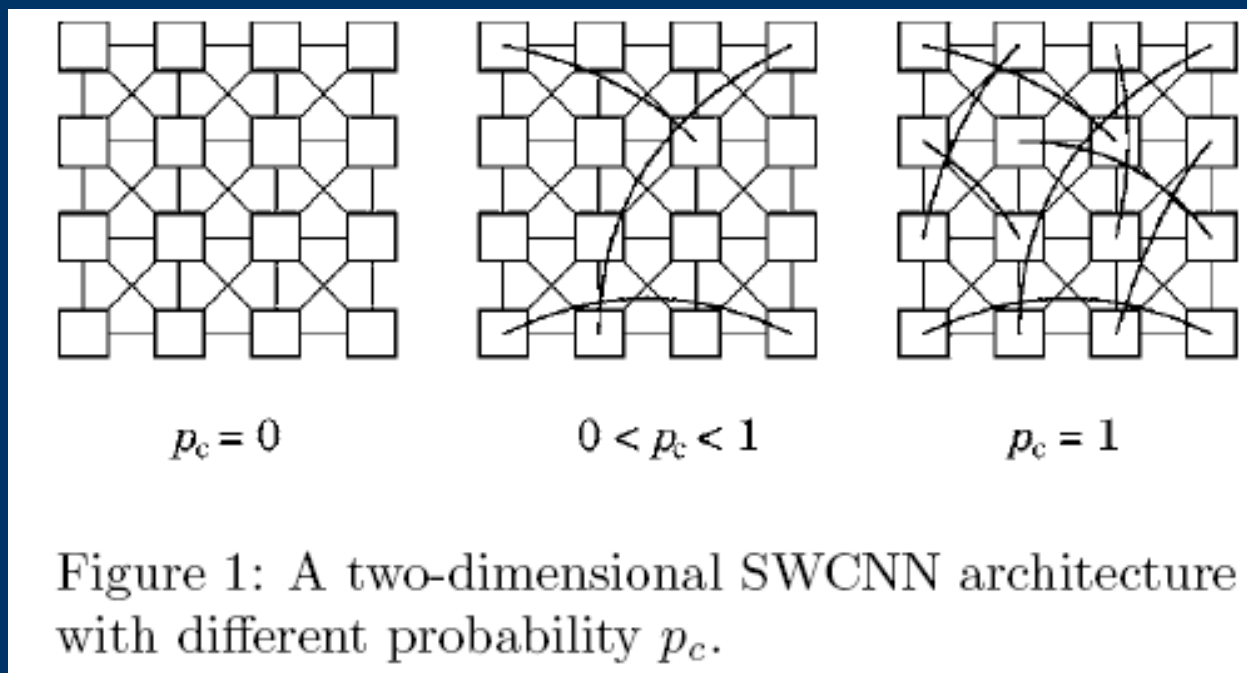
Edge strength

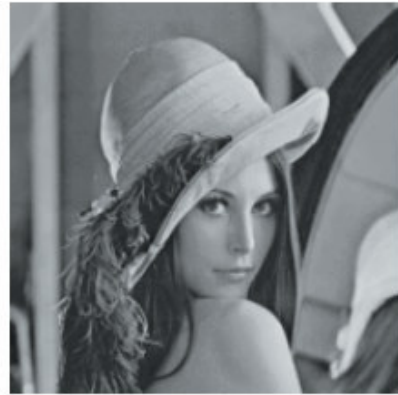


$$MQ(C; G) = \frac{1}{p} \sum_{i=1}^n s(C_i, C_i) - \frac{1}{p(p-1)/2} \sum_{i < j} s(C_i, C_j).$$

Image processing

- Modify a cellular neural network to add small-world properties
 - Add random couplings to CNN





(a)



(b)



(c)



(d)



(e)



(f)

$$A = \begin{Bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{Bmatrix}$$

$$B = \begin{Bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{Bmatrix}$$



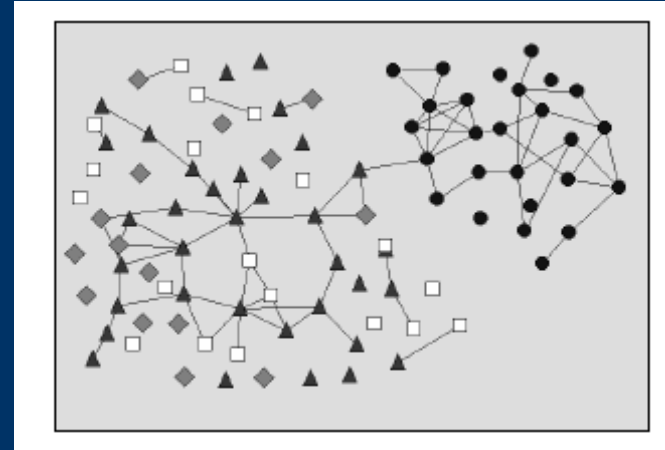
Reality mining: mobile social networks

- Study of 100 undergrad/faculty cell-phone users
- Use Bluetooth to detect proximity, and thence social networks and patterns
- HMM used to derive difference btw *office, home, elsewhere*
- Validate with surveys and diaries
- Can begin to infer who will be seen, when and where with DBNs



Reality mining (2)

- Circles indicate biz students, triangles senior CS students, squares incoming students, pluses faculty
- Friendship inferred from Gaussian mixture model and survey data
- Relationship between proximity and friendship



XDI: Open Social Networks

- Proposed web standard
- Long-term trusted links
- Stated goals:
 1. To create an Internet-wide system that enables more efficient and effective knowledge sharing between people across institutional, geographic, and social boundaries.
 2. To establish a form of persistent online identity that supports the public commons and the values of civil society.
 3. To enhance the ability of citizens to form relationships and self-organize around shared interests in communities of practice to better engage in the process of democratic governance.
- 1. Properties
 - **Persistent Identity.** As federated network identity
 - **Enhancements to Online Community Infrastructure.**
 - (a) *interoperability protocols*
 - (b) *the pre-processing and post-processing of e-mail communications*
 - (c) *receive specially tagged automated introductions*
 - (d) *automated forwarding of relevant media*
 - (e) *the generation of ad hoc social networks*
 - (f) *implement reputation mechanisms*
 - **Matching Technologies.**
 - **Brokering Services**
 - *a brokered introduction.*
 - *context specific introduction protocols*



References

- Richard Rothenberg, *et al.*, 1998. “Using Social Network and Ethnographic Tools to Evaluate Syphilis Transmission”, *Sexually Transmitted Diseases* **25**(3) pp. 154-160.
- S. Valverde and Sole, R.V., 2006. “Hierarchical Small Worlds in Software Architecture”, *IEEE Transactions on Software Engineering*, in press.
- Peter Grindrod, 2002. “Range-dependent random graphs and their application to modeling large small-world Proteome datasets”, *Phys. Rev. E* **66**, 066702, Vol. 6.
- Kazuya Tsuruta *et al.*, 2003. “Small-World Cellular Neural Networks for Image Processing Applications”, *Proceedings of European Conference on Circuit Theory and Design*, pp. 225-228.
- D . Auber, *et al.*, 2003. “Multiscale visualization of small world networks”. In *IEEE Symposium on Information Visualisation*, pp. 75-81.



- Counter-espionage
- Epidemiology
- Tools
 - Visualization
 - Draft standards
- Long-term trusted links
- Bioinformatics <http://prola.aps.org/abstract/PRE/v66/i6/e066702>
- Image processing <http://www-akio2.ee.tokushima-u.ac.jp/USHIDA/nishio/Pub-Data/CONF/C143.pdf>
- Graph visualization
<http://csdl2.computer.org/persagen/DLAbsToc.jsp?resourcePath=/dl/proceedings/&toc=comp/proceedings/infovis/2003/2055/00/2055toc.xml&DOI=10.1109/INFVIS.2003.1249011>



Bioinformatics

