Discovery group: Data mining for pattern and link discovery

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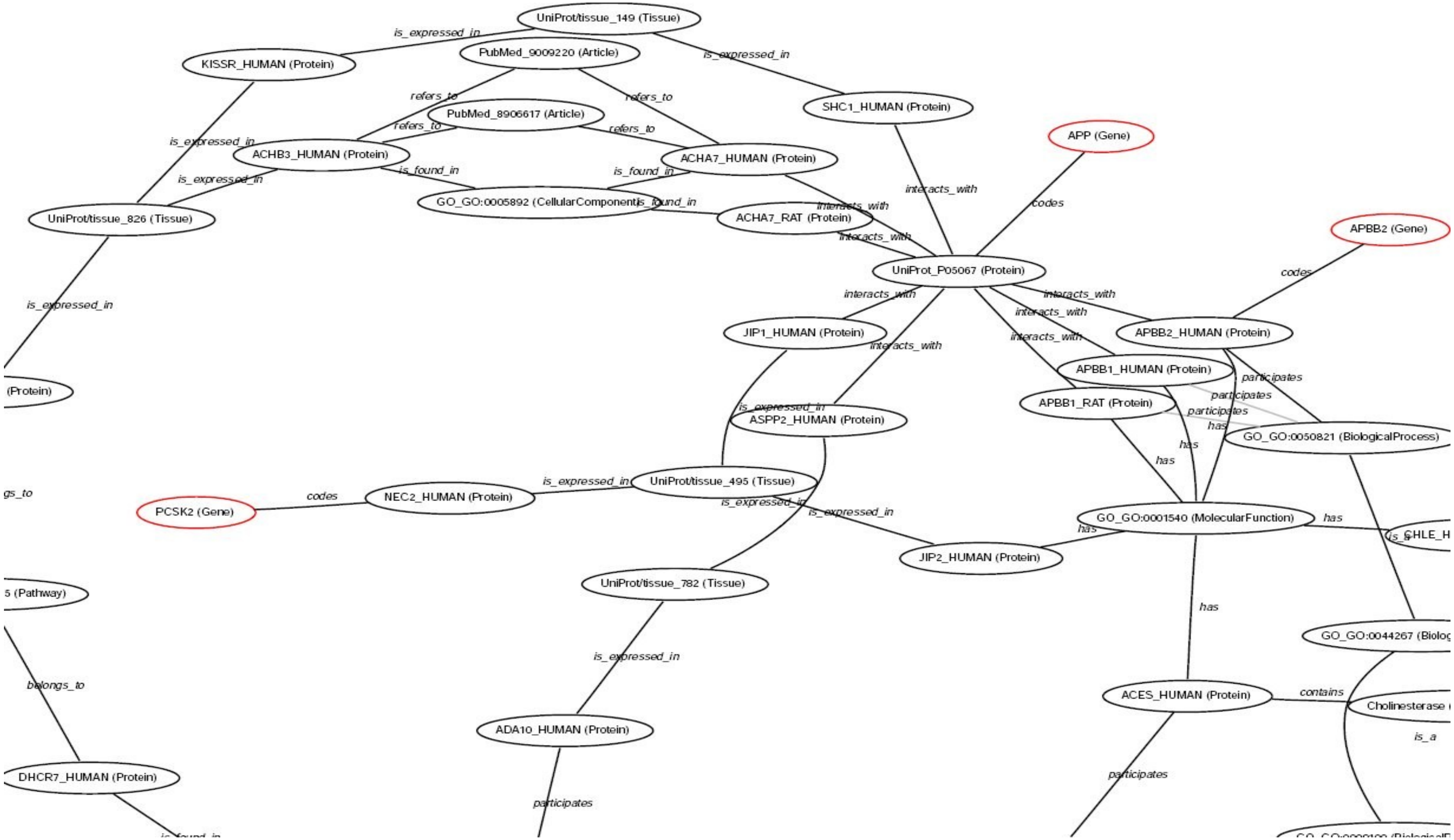
Structured and heterogeneous data



Mission

We develop novel methods and tools for pattern and link discovery

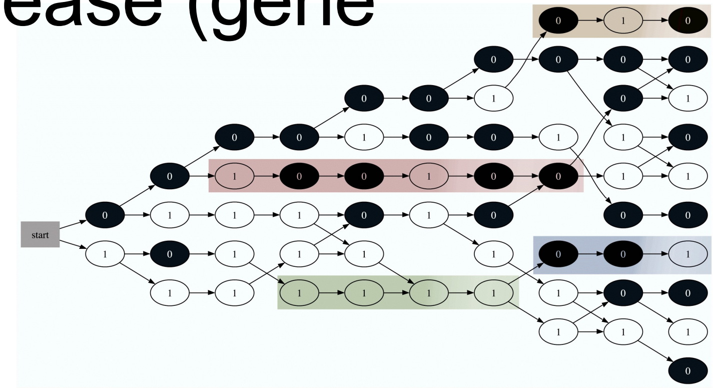
- Focus on structured and heterogeneous data (graphs, sequences)
- Applications in bioinformatics, genetics and ubicomp
- Collaboration with applied scientists and companies

Projects

- Analysis of genetic marker data
  - haplotyping of unrelated genotypes (HaploRec)
  - association-based gene mapping (TreeDT, HPM)
- Analysis of heterogeneous biological networks (Biomine)
- Context recognition by user situation data analysis

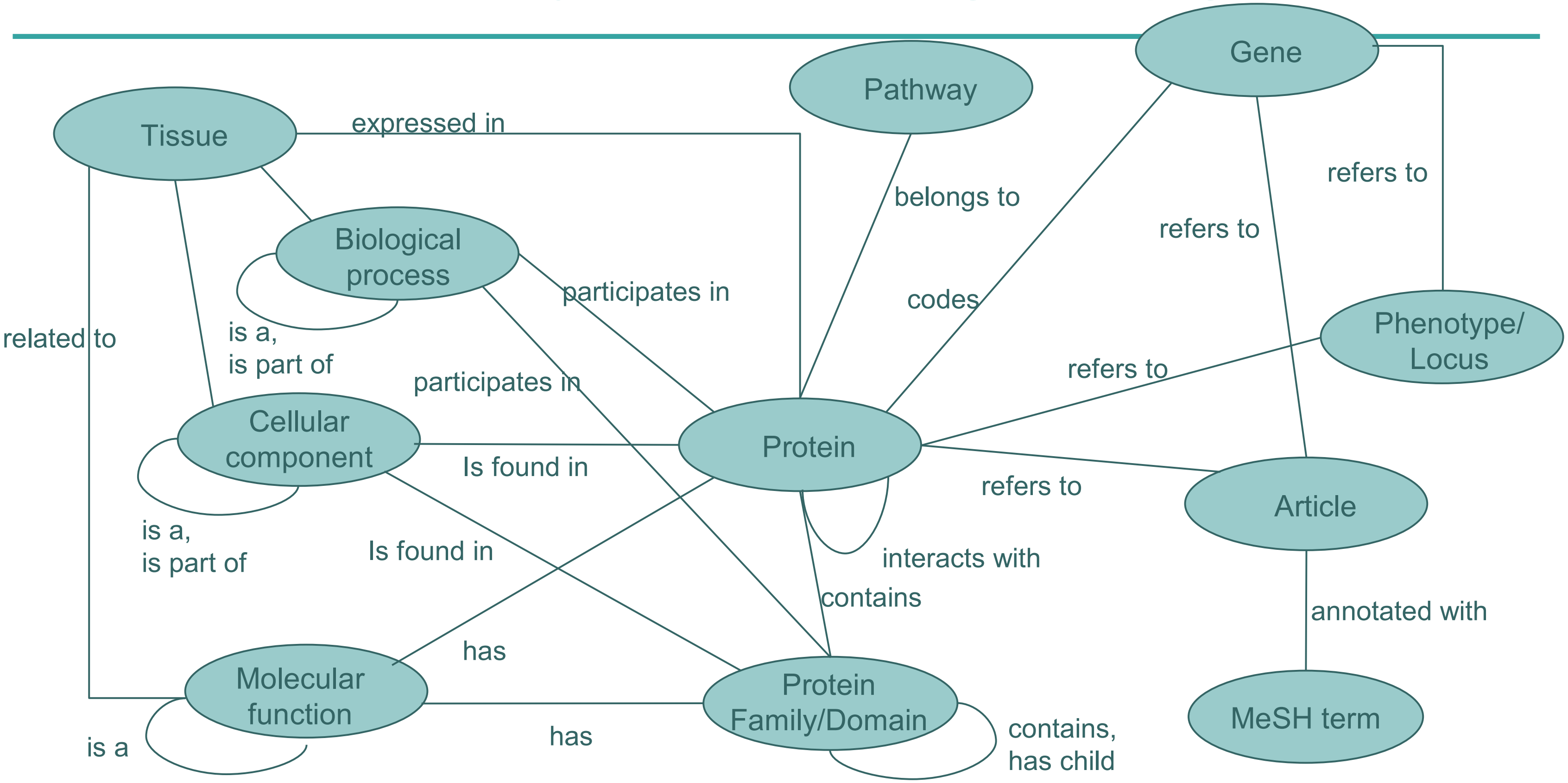
Analysis of genetic marker data

- Goal: Discovery of associations between genomic regions and a disease (gene mapping)



- HaploRec: Haplotyping unrelated individuals using variable-length Markov models (Eronen, Geerts, Toivonen, BMC Bioinformatics 2006)
- TreeDT: gene mapping method measuring disease-association in estimated genealogical trees (Sevon, Toivonen, Ollikainen, IEEE/ACM Transactions on Comp. Biol. and Bioinformatics 2006)
- A medical result: discovery of a novel asthma gene (Science 2004)

Biomine: Analysis of weighted graphs

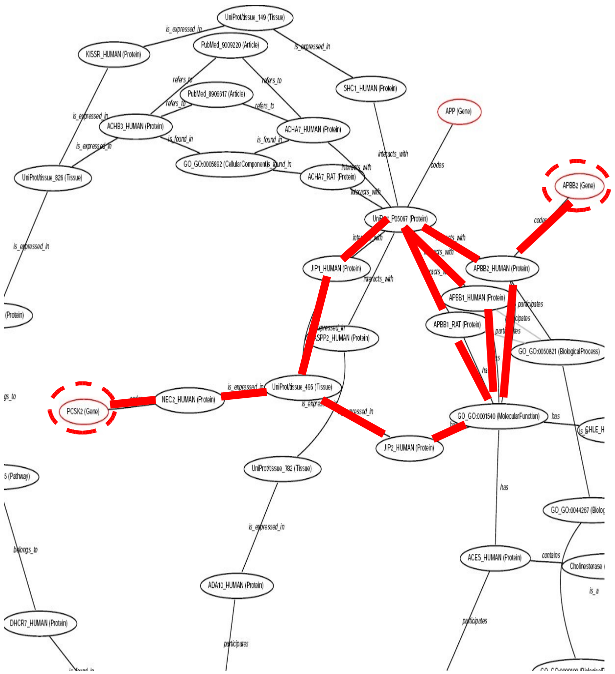


- Millions of heterogeneous nodes and edges in public biological databases
- Edge weight = probability

Example 1: Link discovery and analysis

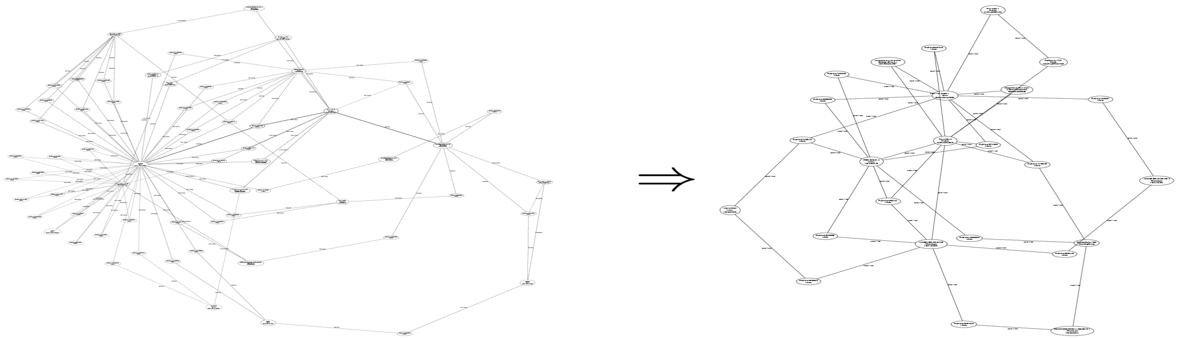
- Goal: discovery and evaluation of non-trivial connections between nodes, e.g., a gene and a disease

- A true link between two nodes is manifested as a subgraph connecting them
- We measure the strength of such a subgraph using two-terminal network reliability (Sevon et al., DILS 2006)
- On-going/future work: use of context-free grammar in complex queries (queries by specific path classes and production rule specific relevance coefficients)



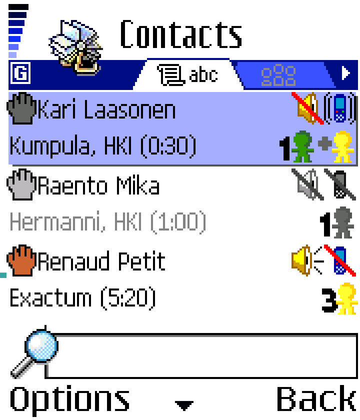
Example 2: Extraction of subgraphs

- Goal: extraction of a maximally relevant subgraph for given nodes or connections



- Concepts and methods for probabilistic graphs:
- Removal of edges that contribute least to the two-terminal network reliability (Hintsanen 2007, submitted)
- Compression of probabilistic Prolog theories with minimal reduction to likelihood of given positive and negative examples (De Raedt et al., ILP 2006)

Context



Contacts

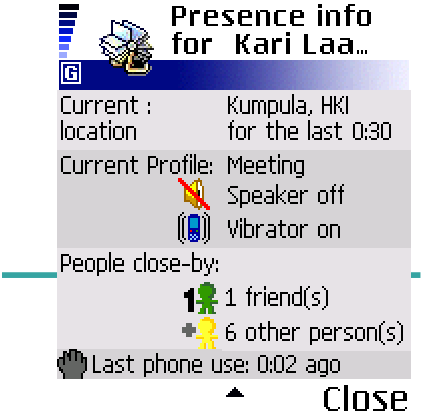
abc

Kari Laasonen
Kumpula, HKI (0:30) 1

Raento Mika
Hermanni, HKI (1:00) 1

Renaud Petit
Exactum (5:20) 3

Options Back



Presence info for Kari Laa…

Current : location	Kumpula, HKI for the last 0:30
Current Profile:	Meeting
	Speaker off
	Vibrator on
People close-by:	
1	1 friend(s)
	6 other person(s)

Last phone use: 0:02 ago

Close

- Goal: discovery of context patterns, studies of privacy issues in social awareness
- ContextPhone (IEEE Pervasive Computing 2005, Raento et al)
  - context data collection, distribution, display
  - the first public toolbox for standard mobile phones
- Applications: presence-augmented phonebook, automatic media annotation and distribution, logger
  - used by MIT, Berkeley, Nokia, ...
  - covered e.g. in The New York Times, New Scientist
- Provides unique data for finding patterns and models of interaction
- Research into algorithms, privacy issues, social networks, ...

Vision

- The importance of data mining in heterogeneous and structured data will grow, especially in scientific applications such as bioinformatics

- We develop novel methods and apply them succesfully to challenging and important applications problems, in collaboration with applied scientists