Network science

Analytics SIG, 2020-6-8

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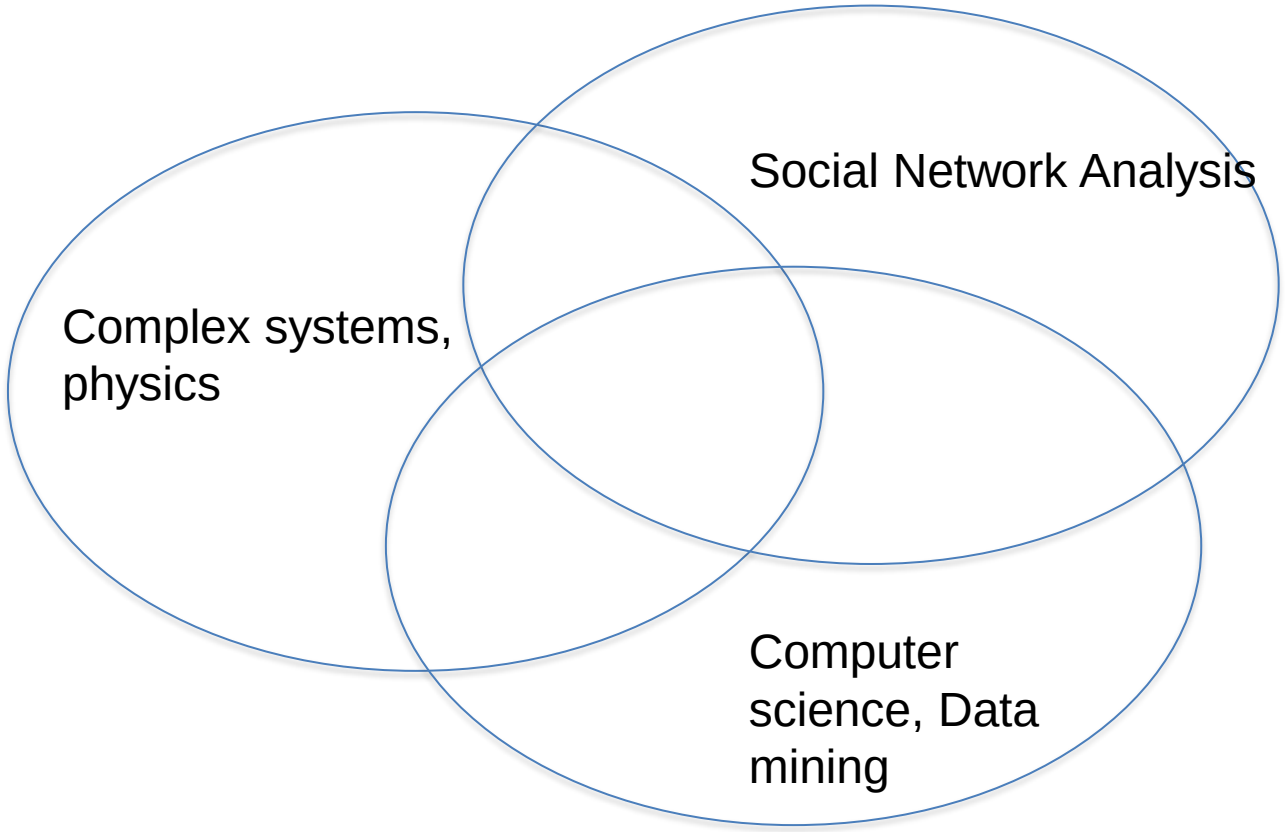
by SURF & NWO

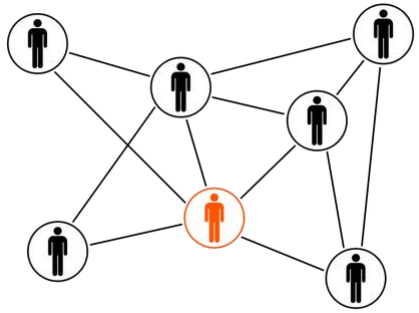
Why network science?

- ESI-FAR projects
- My interest
- Get discussion going

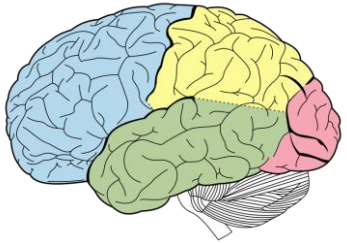
Network science: umbrella term



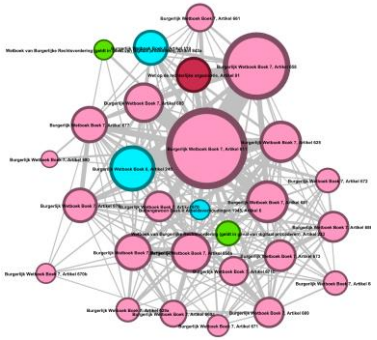
Application examples



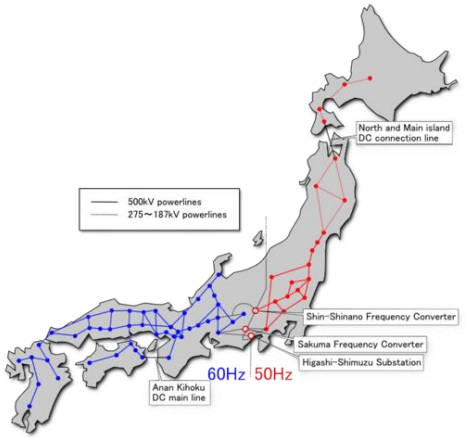
Social systems



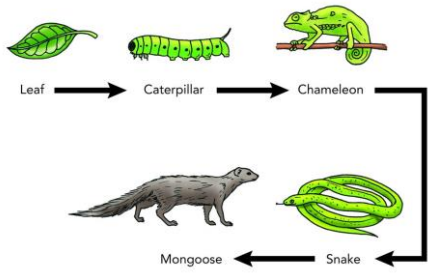
Brain networks



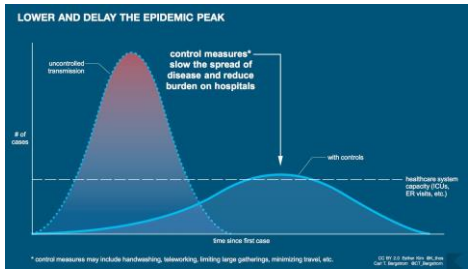
Information networks



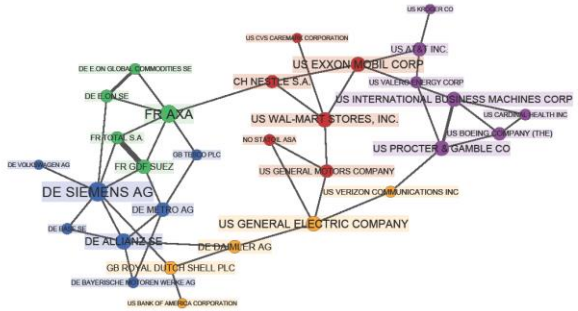
Power grids / communication networks



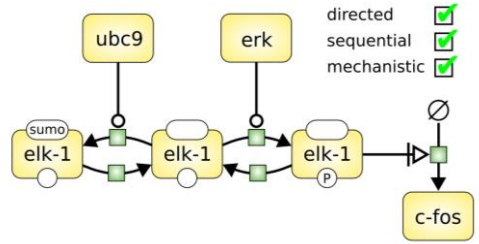
Ecological networks



Epidemics



Economical networks



Biological networks

Topics

- Small world and scale free networks
- Network models
- Centrality measures
- Agent-based models
- Percolation and robustness
- Community detection
- Spread
- Evolving networks

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Small world and scale free

- **Observation: many real world networks have small shortest path:**

$$L \propto \log N$$

- **Observation: many real world networks seem to have (sort-of) scale free / power law distribution:**

$$P(k) \sim k^{-\gamma}$$

(but topic of controversy)

Network model

- Watts-Strogatz (satisfies small world)
- Preferential attachment (satisfies scale free)
- Configuration model
- Exponential random graph model

Centrality measures

- Degree
- Closeness
- Betweenness
- Eigenvector / Pagerank
- Many more

Community detection

- Methods that optimize quality score
  - Modularity (Louvain algorithm)
- Generative models
- Flow-based models
- Structural model

Challenges:

- What is a ‘good’ division?
- Degeneracy of solutions

Discussion