Networks and stability

Part 3C. – Examples for networks

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www.weaklink.sote.hu
1. network topology (II.20-27.)
2. network dynamics (III.6.-13.)
   (III.20.-27. no lectures)
3. examples for networks (IV.3.10.-24.)
   (IV.17. Easter)
4. synthesis (V.1. holiday, V.8.)
   (V.13. consultation)
Examples for networks

• molecules
• networks in the cells
• networks from cells
• social networks (social-nets)
• cultural networks
• ecosystems
The Erdős-net

509 co-authors of Pál Erdős
(having an Erdős number of 1)
(Erdős number 2: >6984 persons)

Where is Erdős?
Erdős is already in another dimension...

Pál Erdős
1913-1996
Ant behavior

distribution of 400 corpses after 6, 12, 45 h emergence of scale-free pattern...

PNAS 99, 9645
Scale-free sex: preferential attachment

Nature 411, 907
Dolphin networks

Nature 397, 571
superalliances
(modularity, hierarchy)

small worlds, bridges, VIP-s
Women stabilize the society

Social Bonds of Female Baboons Enhance Infant Survival
Joan B. Silk, Susan C. Alberts, Jeanne Altmann

Lahdenpera et al.
Nature 428, 178

Silk et al. Science 302, 1231

Afghanistan
Romeo and Juliet

Lahdenpera et al.
Nature 428, 178
The society stabilizes women

mortality rate of 50-54 yrs. men/1000 pers.

1938

Hung. Stat. Office

men compete (cortisol)

women cooperate (weak links)

Kopp and Réthelyi, Brain Res. Bull. 62, 351
Examples for networks

- molecules
- networks in the cells
- networks from cells
- social networks
- cultural networks
- ecosystems
Traffic networks

optimal US-traffic net with increasing costs of flight changes
Zipf-law of the language-net

- **Lexicon size**
- **Effort of speaker/hearer**

**Minimal speaker effort:**
- No communication

**Minimal hearer effort:**
- Animal communication, artificial languages

**Human language**

PNAS 100, 788
Drama-scenes
Shakespeare: Troilus and Cressida

weak links connect and stabilize the scenes

Stiller and Hudson,
J. Cult. Evol. Psychol. 3, 57

social dimensions
social circles
catharsis – relaxation
cognitive dimensions – masterpieces
“Some predictions are more interesting than others.”
“...not because they differ boldly from a consensus view but because they relate to a number of other predictions to form a web of interlinked expectations.”
Scientific judgements are not independent

optimistic universe: <5% false results
pessimistic universe: >90% false results
The power of judgements: US elections

- Competent: winner
- Not competent: looser

70% of cases
Science 308, 1623
The benefit of perfect judgements

1926 $\rightarrow$ 1996 one USD to
- US Treasury bills $\rightarrow$ 14 USD
- S&P 500 $\rightarrow$ 1,340 USD
- perfect foresight in each month:
  2,296,183,456 USD

PNAS 96,9991
Examples for networks

- molecules
- networks in the cells
- networks from cells
- social networks
- cultural networks
- ecosystems
Wood-wide web

danger signals elicit stress conditioning

mycorrhiza
100 m/g soil

Science 311, 812
Ecosystem shifts

Table 1 Characteristics of some major ecosystem state shifts and their causes

<table>
<thead>
<tr>
<th>Ecosystem</th>
<th>State I</th>
<th>State II</th>
<th>Events inducing shift from I to II</th>
<th>Events inducing shift from II to I</th>
<th>Suggested main causes of hysteresis</th>
<th>Factors affecting resilience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lakes</td>
<td>Clear with submerged vegetation</td>
<td>Turbid with phytoplankton</td>
<td>Killing of plants by herbicide, Death of Daphnia by pesticide, High water level, Killing of coral by hurricane, Killing of sea urchins by pathogen</td>
<td>Killing of fish, Low water level, Positive feedback of plant growth</td>
<td>Trophic feedbacks, Nutrient accumulation</td>
<td></td>
</tr>
<tr>
<td>Coral reefs</td>
<td>Corals</td>
<td>Fleshy brown macroalgae</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Prevention of coral, Recognition by uncoastal adult algae, Climate change</td>
<td>Fishing, Overgrazing, Climate change</td>
</tr>
<tr>
<td>Woodlands</td>
<td>Herbaceous vegetation</td>
<td>Woodlands</td>
<td>Flea, Tree cutting</td>
<td>Killing of grazers by pathogen, Hunting of grazers, Overgrazing by cattle, Climatic events</td>
<td>Positive feedback of plant growth, Inedibility of adult trees, Positive feedback of plant growth</td>
<td>Climate change, Fishing, Climate change</td>
</tr>
<tr>
<td>Deserts</td>
<td>Perennial vegetation</td>
<td>Various</td>
<td>Various</td>
<td>Various</td>
<td>Various</td>
<td>Climate change, Fishing, Climate change</td>
</tr>
<tr>
<td>Oceans</td>
<td>Various</td>
<td>Various</td>
<td>Various</td>
<td>Various</td>
<td>Various</td>
<td>Climate change, Fishing, Climate change</td>
</tr>
</tbody>
</table>

Nature 413, 591
Keystone species: link-number is not all

67: 52 species
28: 4 species
one link each

Jordán-Scheuring Oikos 99, 607
Diversity leads to stability

data of >3,300 coral reefs

Nature 433, 410
(Top) predator diversity is crucial for stability

Nature 429, 407
Omnivores are good against species-fluctuations and cascading extinctions

Fagan,
Am. Naturalist 150, 554