Characterization of Large Networks

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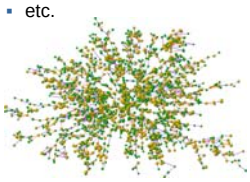
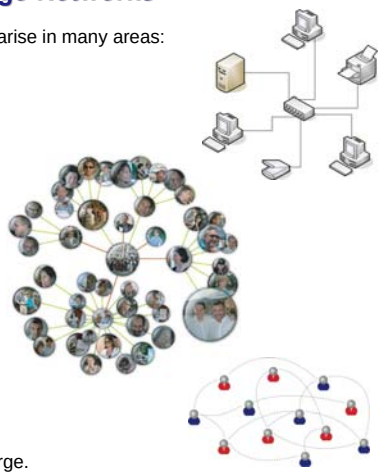
Large Networks

- **Networks of different kinds** arise in many areas:
  - computer networks,
  - web networks,
  - social networks,
  - collaboration networks,
  - co-purchasing networks,
  - citation networks,
  - road networks,
  - biological networks,
  - etc.

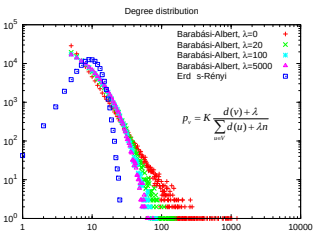


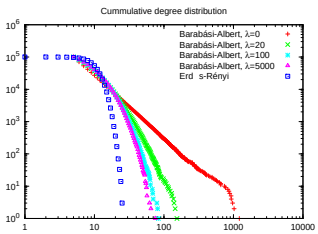


- These networks are usually large.
- They show some similarities but several differences.
- Our goal is the **characterization** and **categorization** of large networks.
- Various real-world networks and several mathematical models were studied.

Models and Generators

- Network generators were implemented based on well-known mathematical models: **Erdős-Rényi** and **Barabási-Albert**.
- The Barabási-Albert (BA) model applies a preferential attachment scheme: a new node is connected to an existing node v with a probability proportional to $d(v)$ or $d(v)+\lambda$.

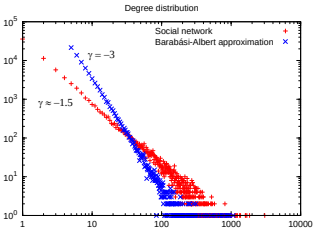


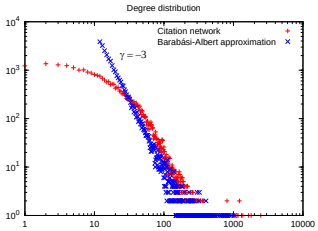


- We also implemented a generator that produces **random graphs for** given **degree distibutions**.
- These generators were mainly used for approximating real-life networks.

Real-World Networks

- The SNAP library provides a collection of large real-world networks.
- Selected instances with 20,000 – 400,000 nodes and 90,000 – 2,350,000 edges were used for this research.





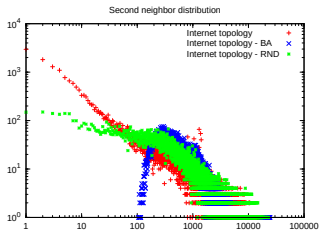
Implementation

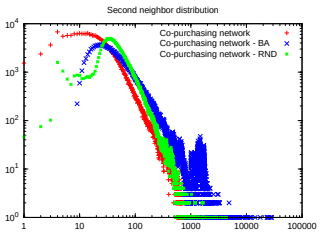
- The **LEMON** C++ network optimization library and the **SNAP** network analysis library were used.
- http://lemon.cs.elte.hu
- http://snap.stanford.edu

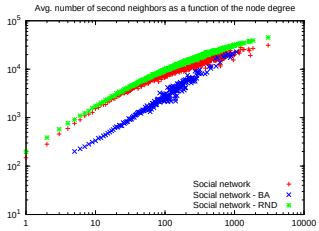
LEMON Graph Library

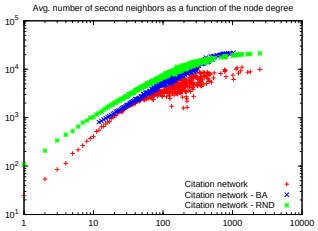
Characterization

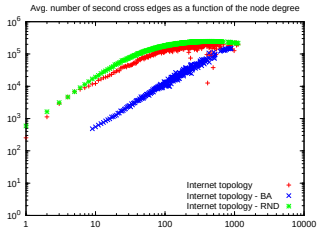
- The following charts compare various **real-world networks** with generated random graphs:
  - **BA: Barabási-Albert network** of almost the same density,
  - **RND: random network** with exactly the same degree distribution.

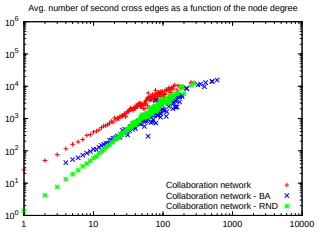


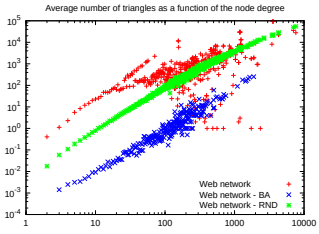


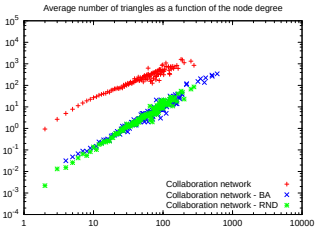


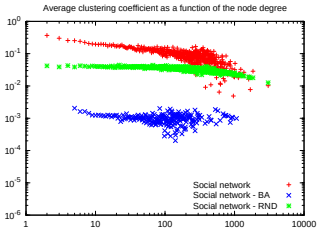


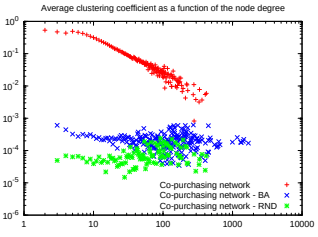












Comparison

- The following charts compare the real-world networks with each other.