Link Spam Detection Based on Mass Estimation

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Roadmap

- Web spamming
- Link spamming
- PageRank contribution
- Spam mass
  - Definition
  - Estimation
  - Algorithm
- Experiments

Web Spamming: Example

#3 search result for the query “kaiser pharmacy online”

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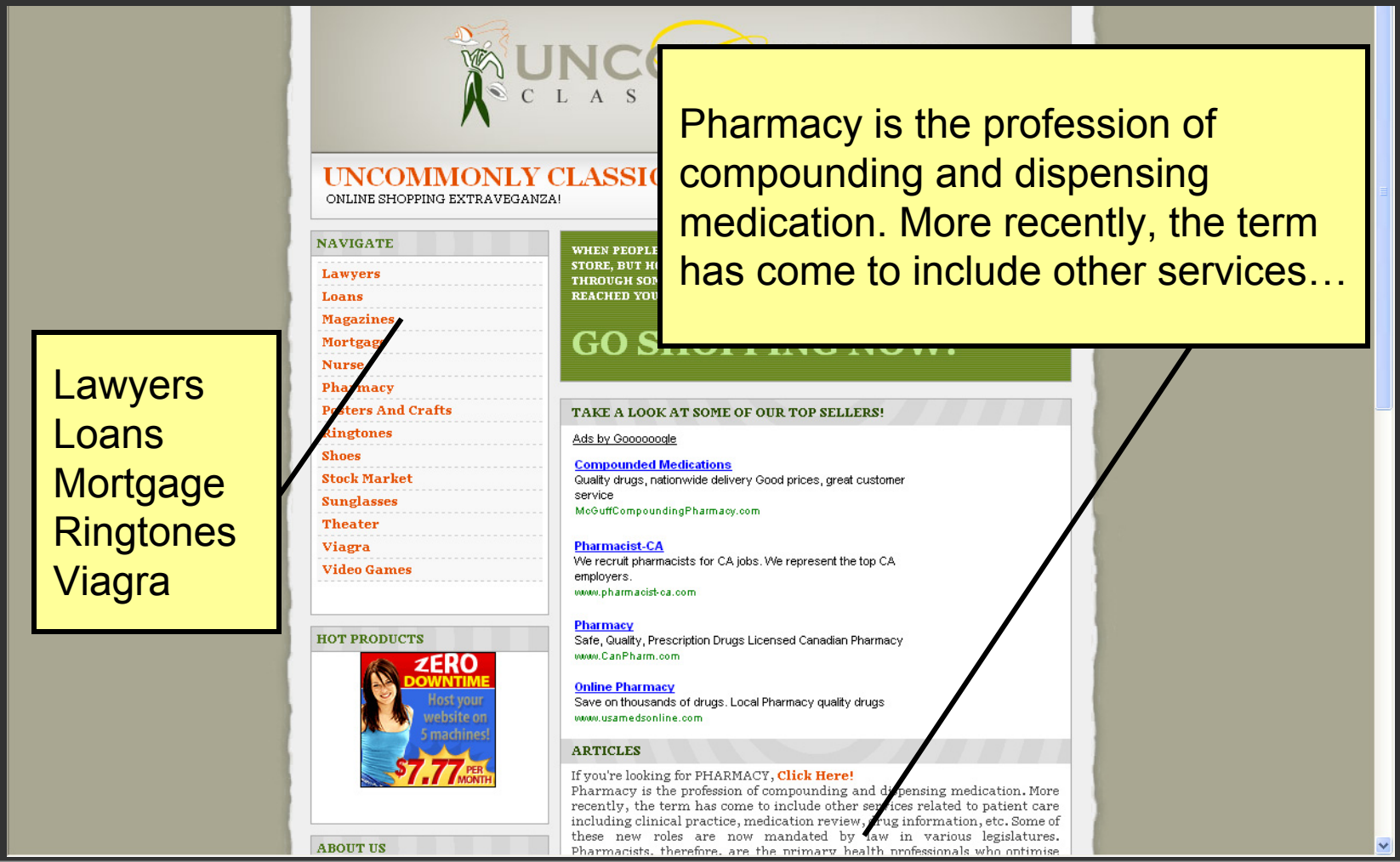

Lawyers
Loans
Mortgage
Ringtones
Viagra

Pharmacy is the profession of compounding and dispensing medication. More recently, the term has come to include other services…

Web Spamming: Techniques

Spamming = misleading search engines to obtain higher-than-deserved ranking

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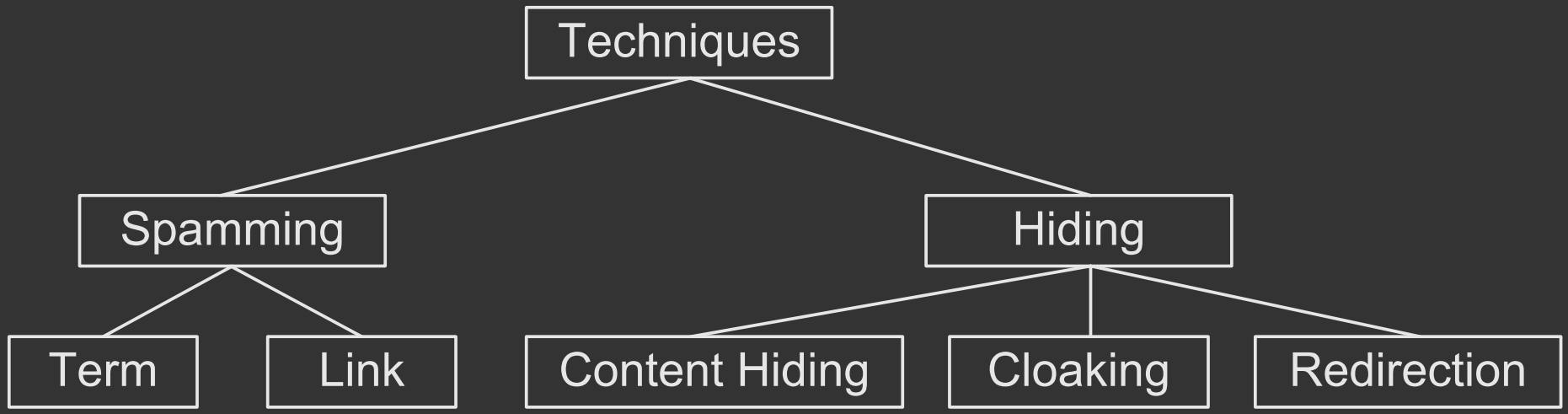

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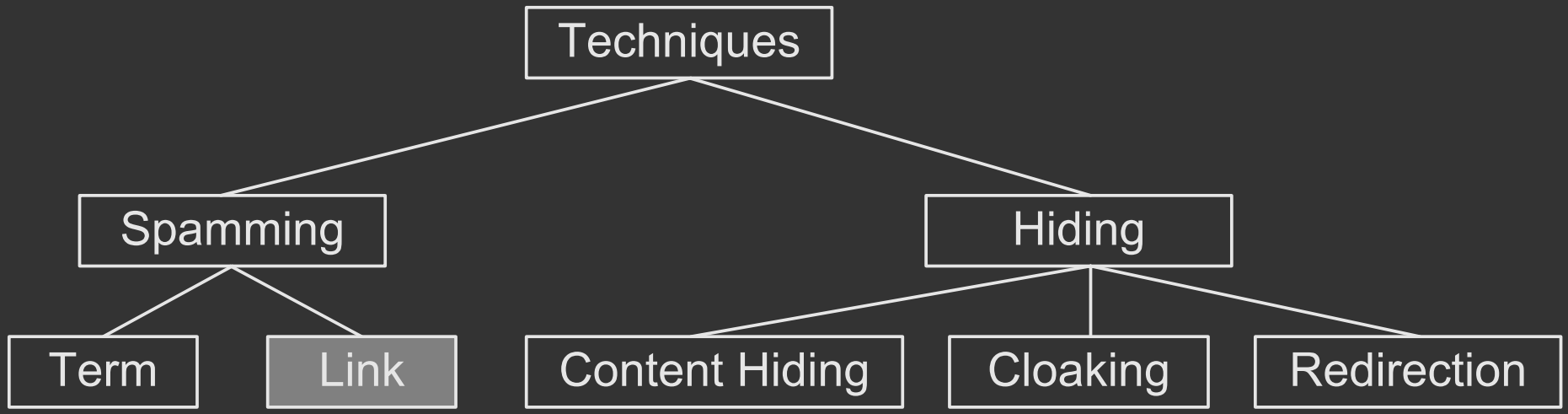
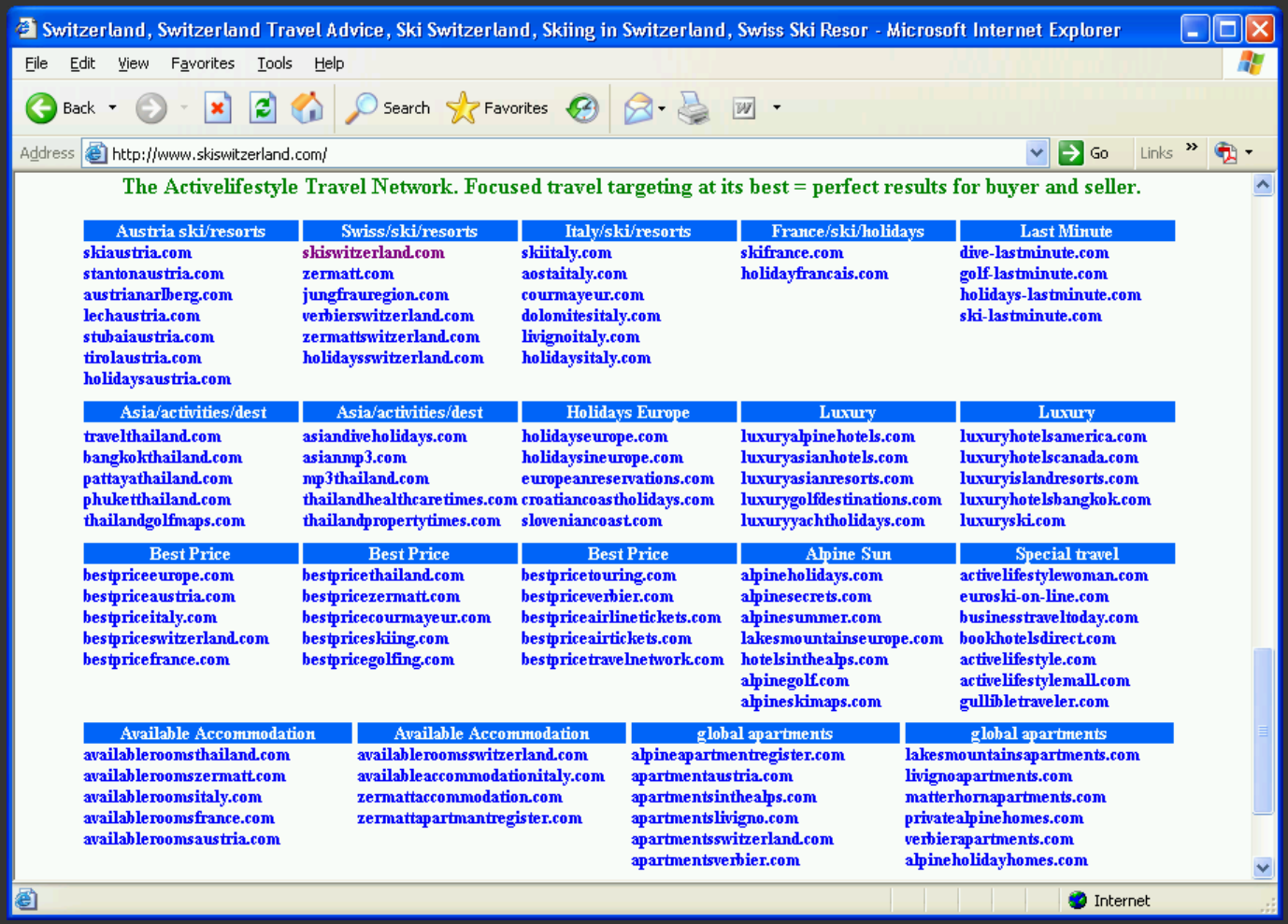


Link spamming = building link structures that boost PageRank score

Link Spamming: Example

#1 search result for the query “switzerland ski”



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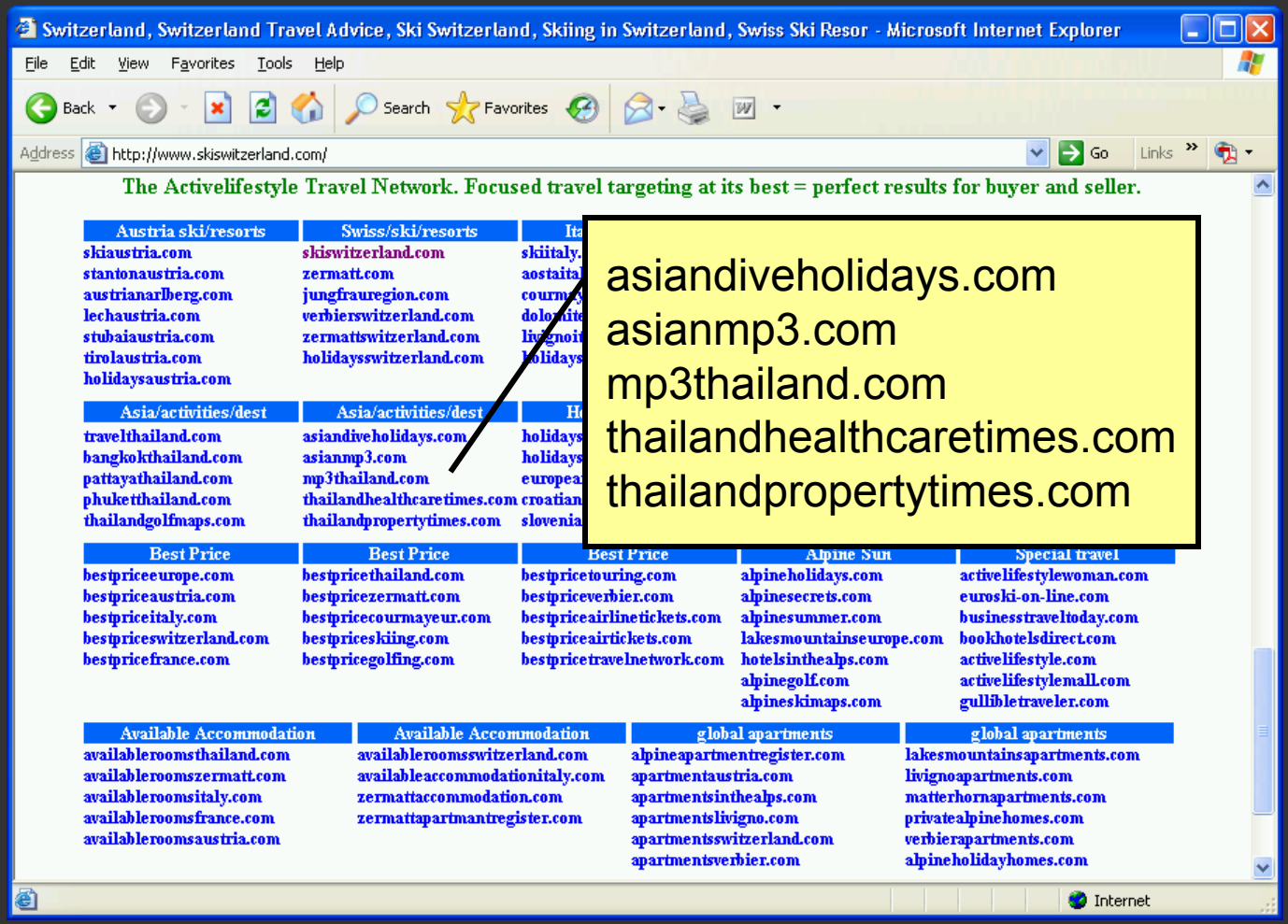
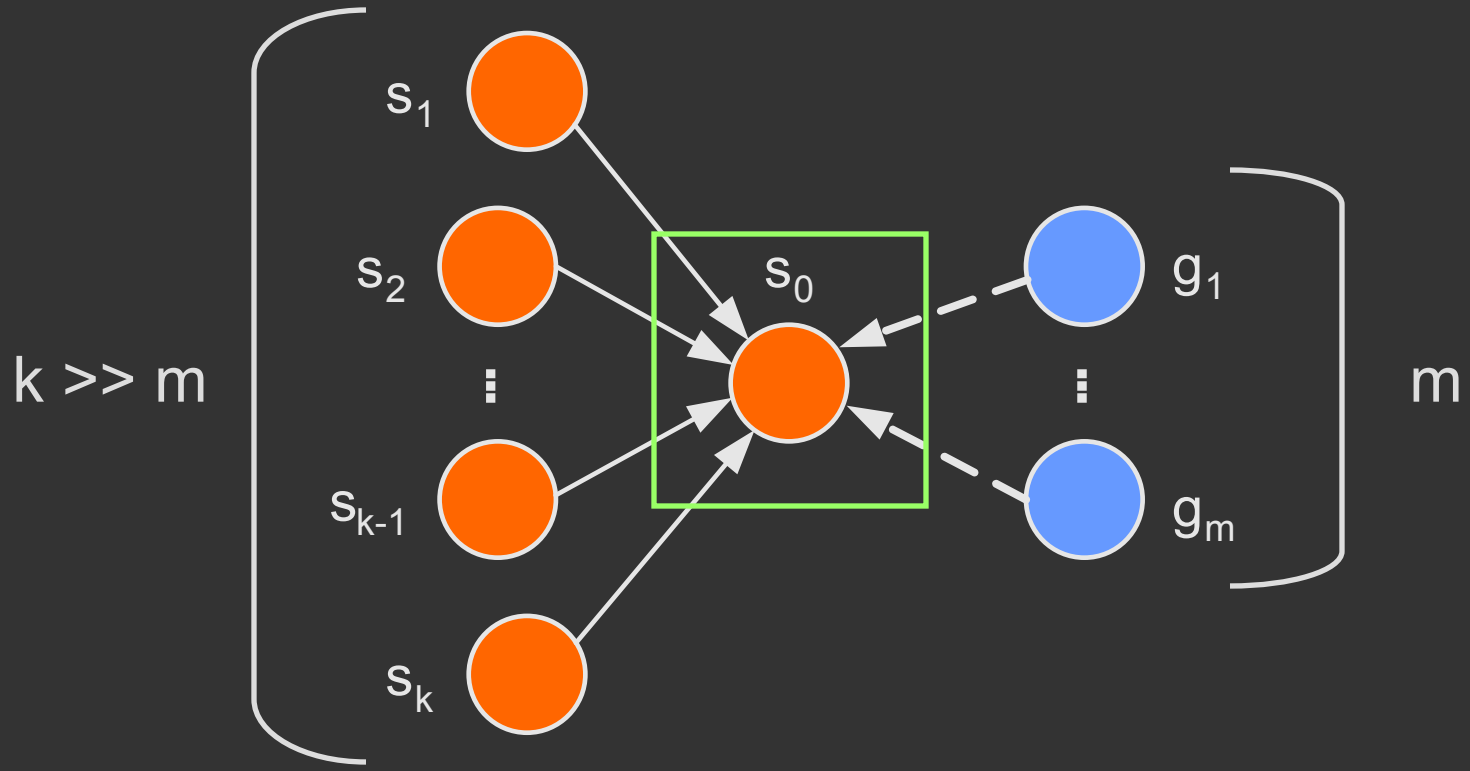
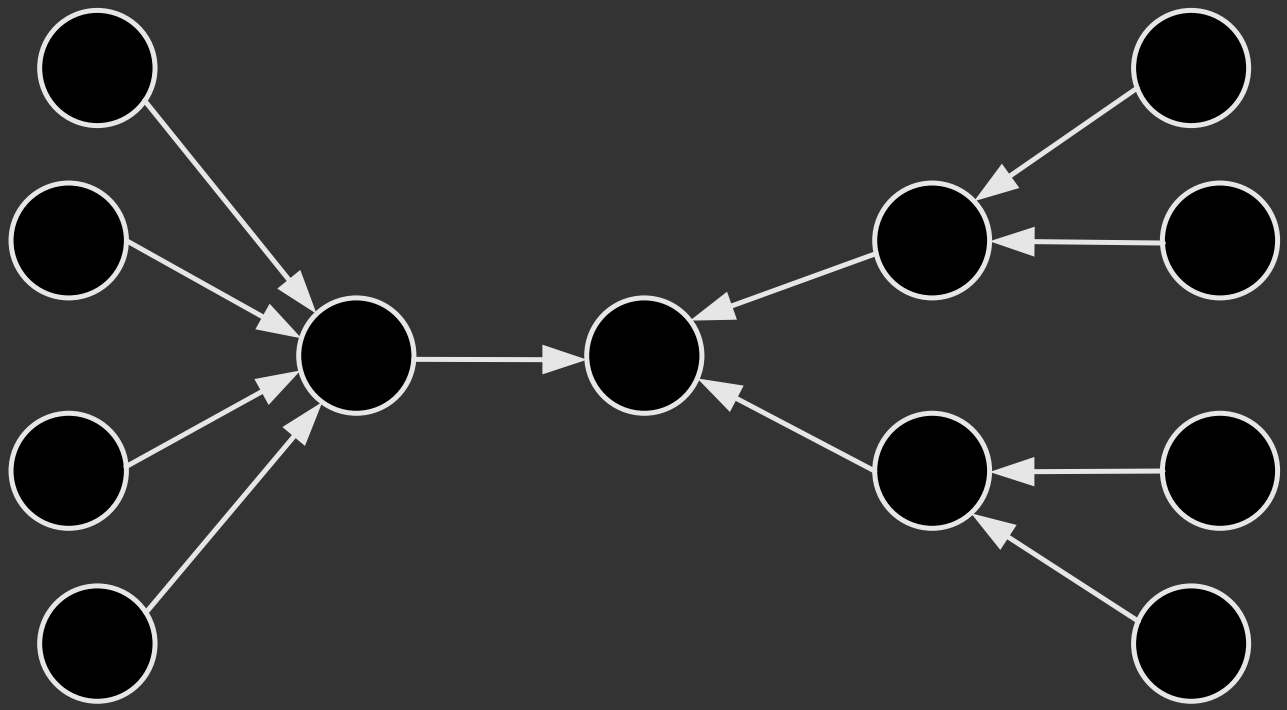


Link Spamming: Our Goal

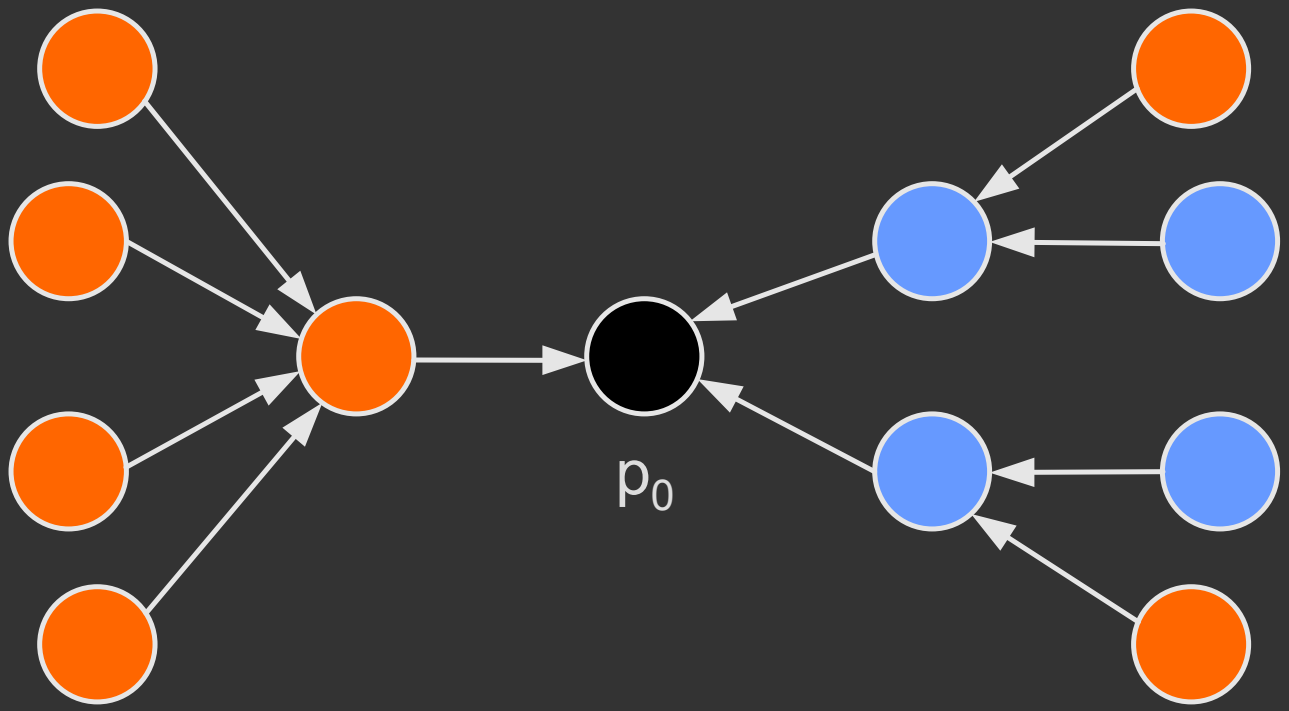
Detect pages that achieve high PageRank through link spamming



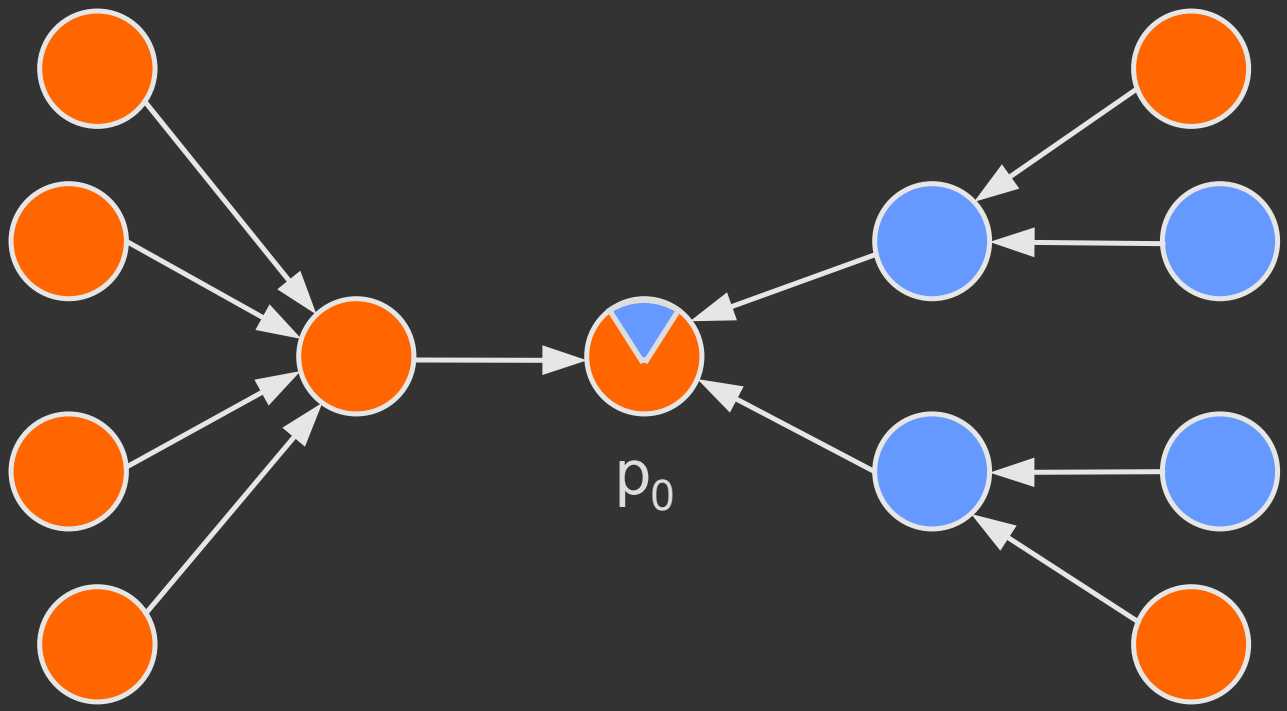
PageRank Contribution



PageRank Contribution



PageRank Contribution



$$p_0^+ = c^2\, 2\,(1 - c) / n + c\, 2\,(1 - c) / n$$

$$p_0^- = c^2\, 6\,(1 - c) / n + c\,(1 - c) / n$$

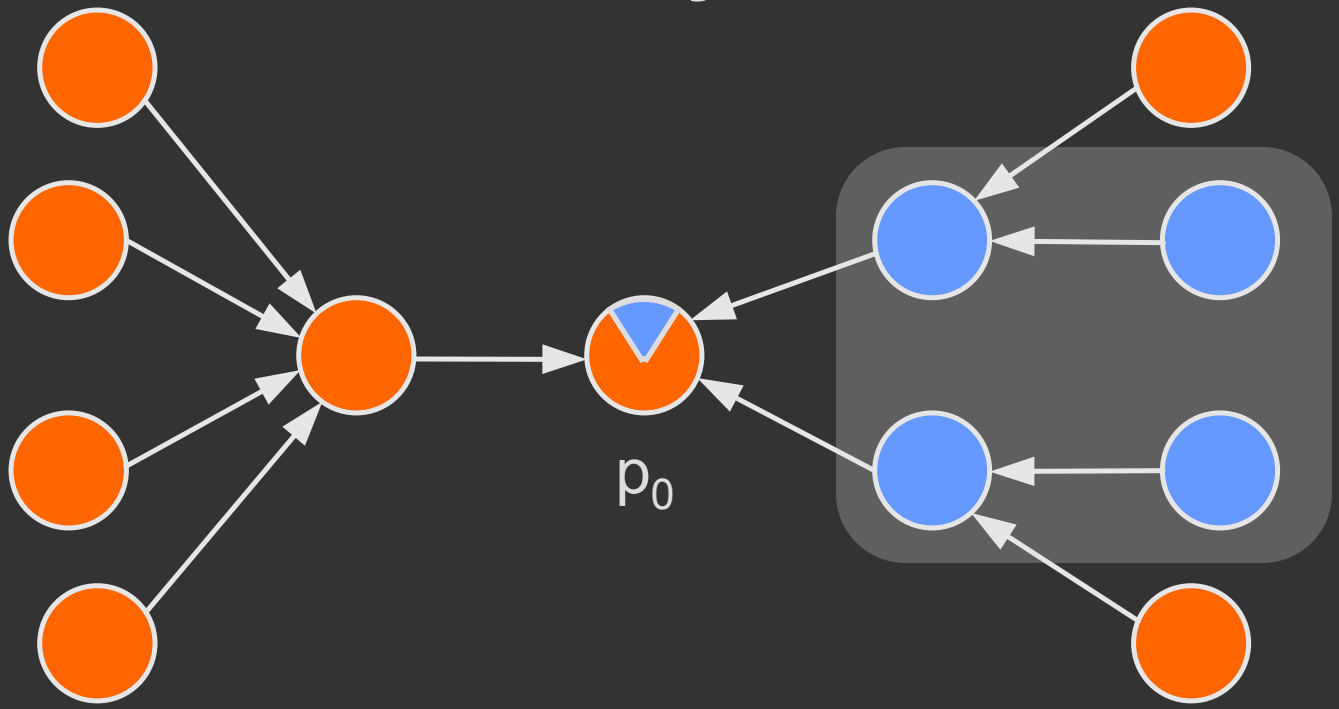
Spam Mass: Definition

- Absolute mass
  - **Amount** of PageRank coming from spam

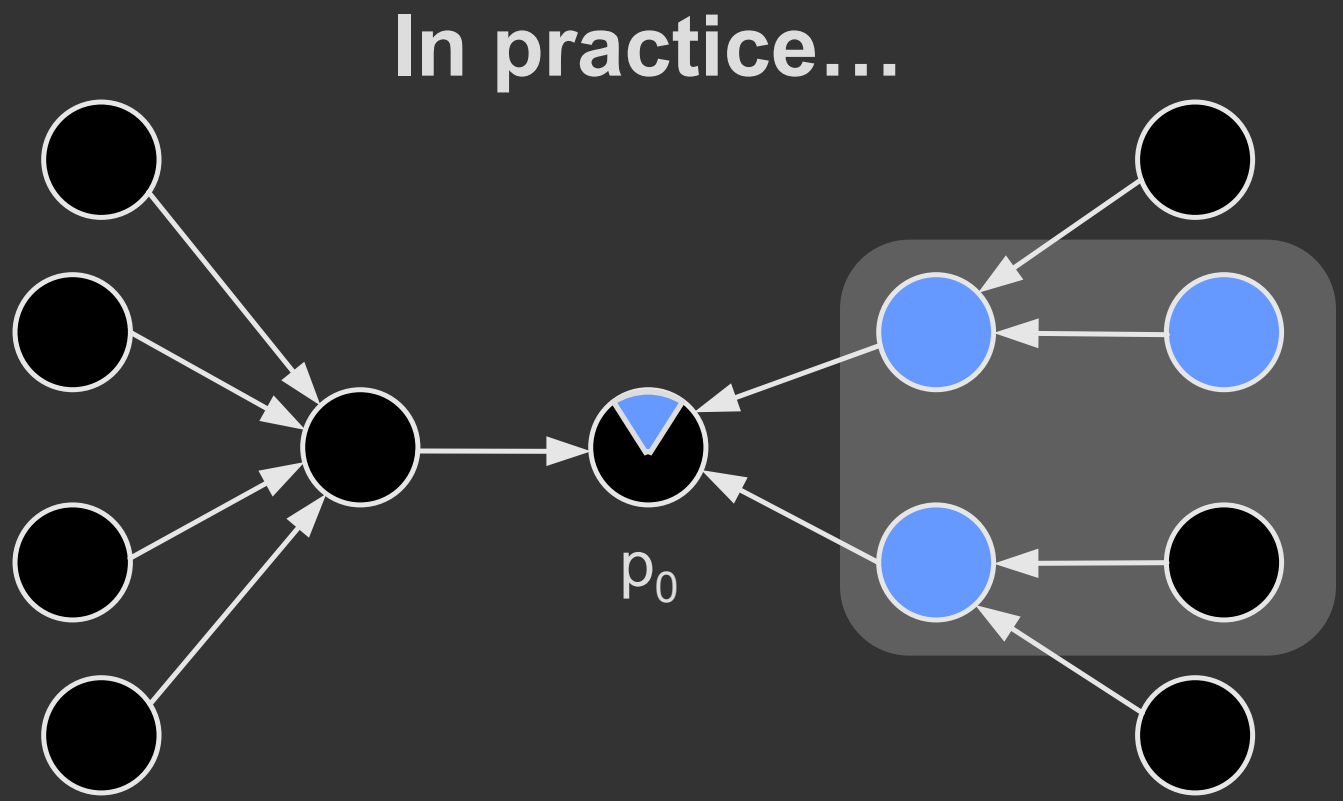
- Relative mass
  - **Fraction** of PageRank coming from spam
  - More useful in practice

Spam Mass: Estimation

Ideally…



Spam Mass: Estimation



- Approximate the set of good nodes by a subset called **good core**

Spam Mass: Algorithm

1. Create good core
2. Compute PageRank scores p_i and p_i^+
3. Compute estimated relative mass m_i as $(p_i - p_i^+) / p_i$
4. For all pages **i** with large PageRank

   Mark page as spam if m_i > threshold

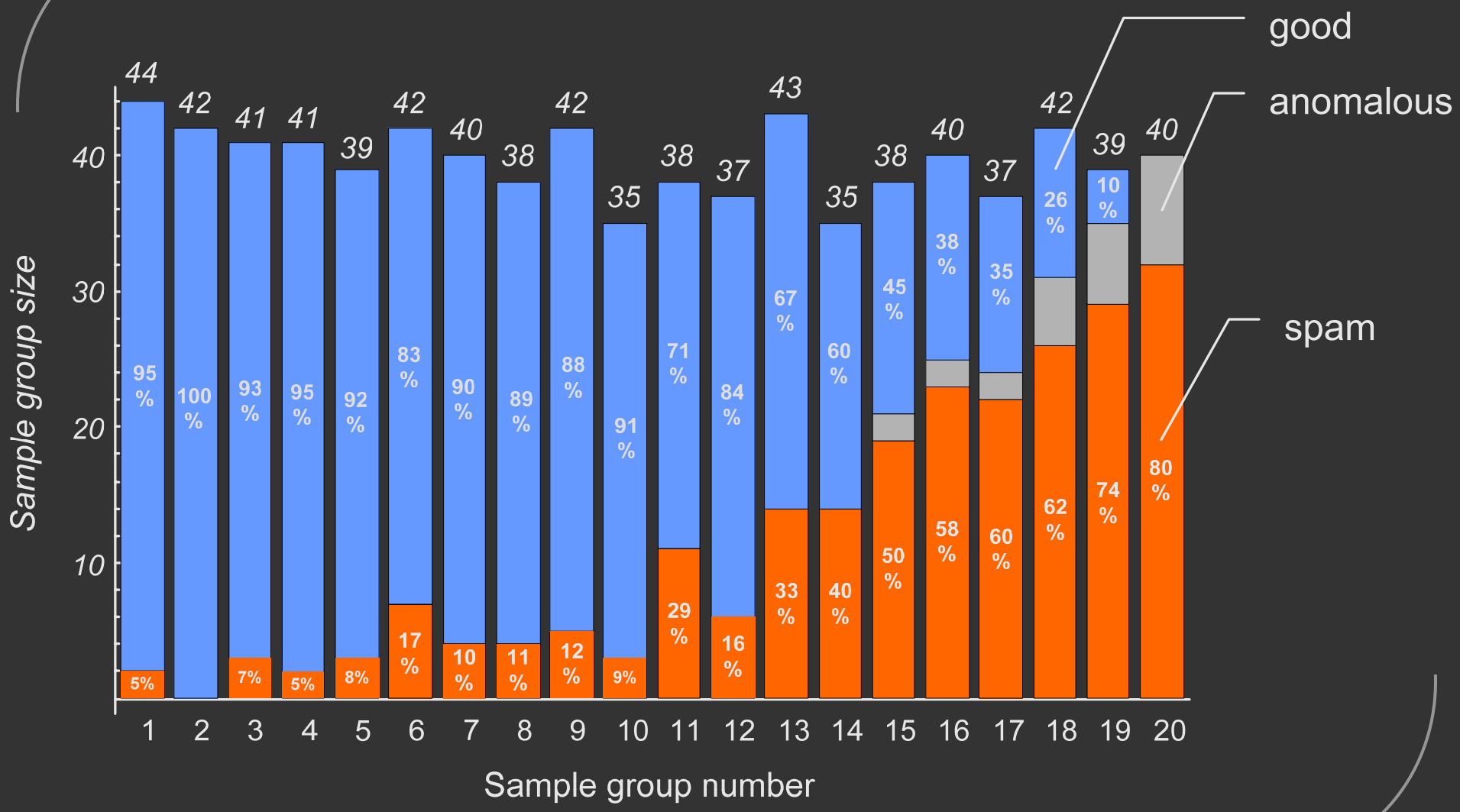
Experiments: Data

- Yahoo! web index → host graph
  - 73.3M nodes
  - 979M links
- Good core
  - High-quality web directory: 16,780
  - Governmental hosts: 55,320
  - **Educational hosts: 434,000**

Experiments: Data

- Sample
  - 0.1% of nodes with PageRank > 10x minimum
  - 892 nodes
  - Manually labeled good, spam
- Relative mass groups (approx. same size)
  - Group 1: 44 samples with smallest rel. mass
  - …
  - Group 20: 40 samples with largest rel. mass

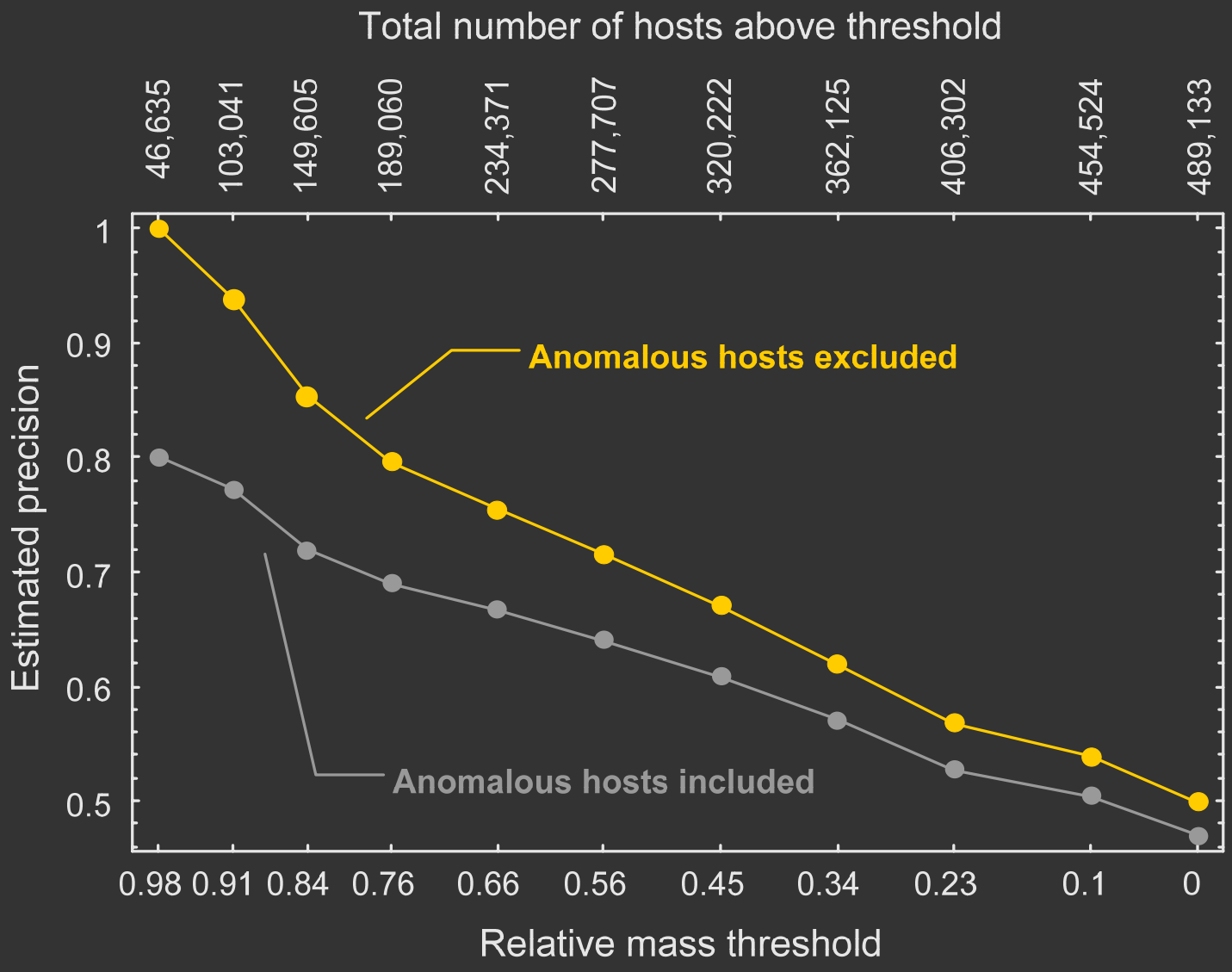
Experiments: Relative Mass



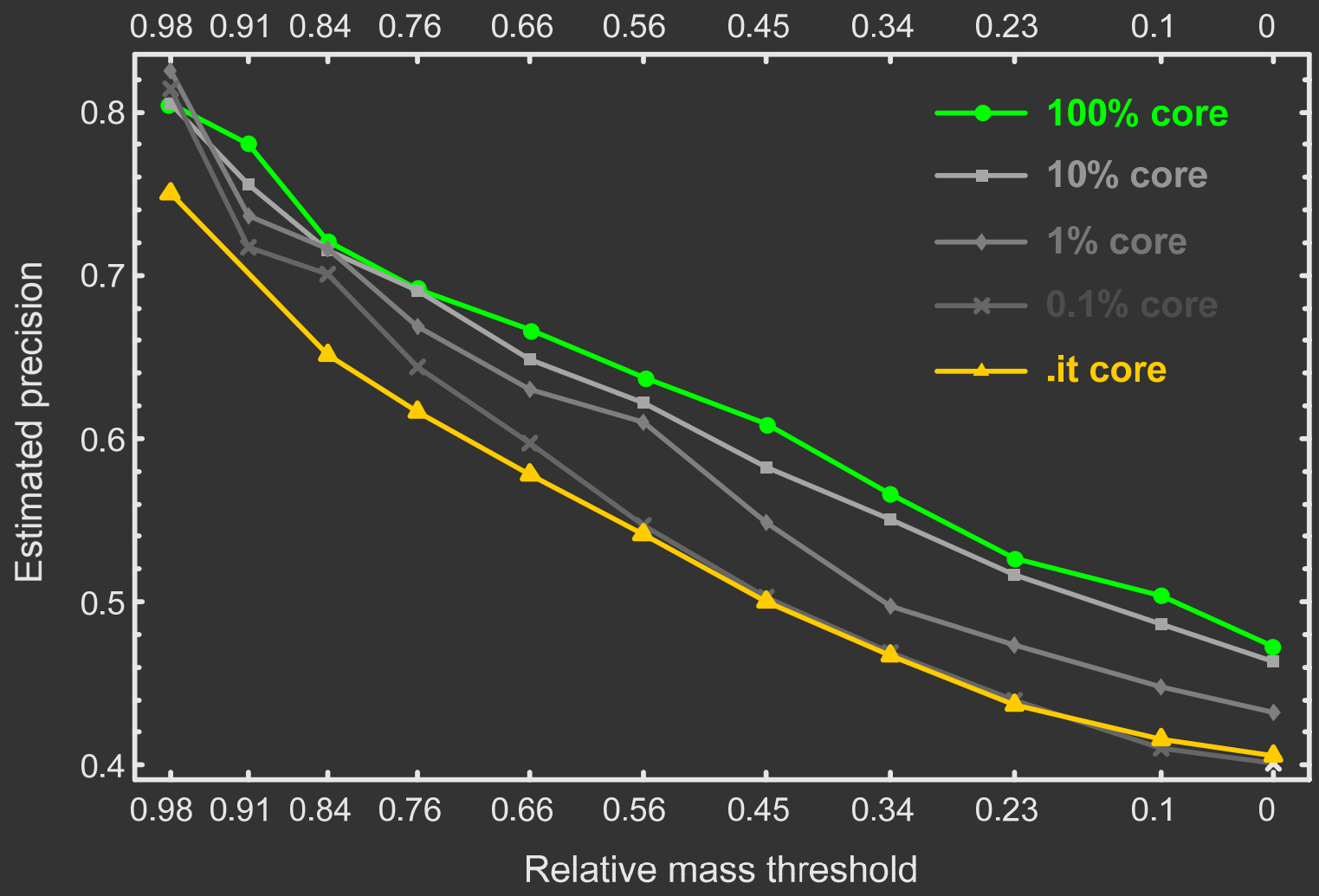
Experiments: Relative Mass

- Anomalies
  - *.alibaba.com
  - *.blogger.com.br
  - Polish hosts → only 12 .pl in good core

Experiments: Relative Mass



Experiments: Relative Mass



Related Work

- PageRank analyses
  - [Bianchini+2005], [Langville+2004]
- Link spam analyses
  - [Baeza+2005], [Gyöngyi+2005]
- Link spam detection
  - Statistics: [Fetterly+2004], [Benczúr+2005]
  - Collusion detection: [Zhang+2004], [Wu+2005]
- TrustRank
  - [Gyöngyi+2004]

Conclusions

- Web spamming
  - Manipulation of search engine ranking
  - Focus on link spamming
- Spam mass
  - ~ PageRank contribution
  - Useful in link spam detection
- Strong experimental results
  - Virtually 100% of top 47K nodes spam
  - 94% of top 105K nodes spam