Evaluation of Marketing Heuristics in Social Networks

Bachelor Thesis Presentation
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Presentation Structure

- Motivation
- Introduction
- Data
- Investigated Marketing Strategies
- Evaluation
- Conclusion
- Discussion

Motivation

Motivation

- Rising popularity of social networks
- Product marketing in social networks
- Effective / efficient ways to promote product?
  - Exploit network structure
  - Tradeoff price and number of products sold
- How to improve marketing strategies to increase revenue from selling products?

Introduction

Introduction
Setting

- Social networks represented as graphs
- Positive network externalities
- Uniform additive model
  - Models neighbours' influence on client's valuation
  - Non-negative weights $w_{i,j}$ for each edge
  - For set *S* of active neighbours the valuation for client *i* is drawn from $[0, \sum_{j \in S \cup \{i\}} w_{i,j}]$ uniformly at random

Introduction
Setting

- Marketing Strategies
  - One offer to each client
  - Offer accepted if client's valuation higher than price
  - Only clients who purchased prior to current round influence neighbours
- Myopic prices: Maximize the expected payment for a single client
  - Easily computed for the UAM
  - Does not consider (positive) influence on other clients

Introduction
Setting

- Influence-and-exploit strategies (Hartline et al. [2])
  - Influence step: Free (or discounted) products
  - Exploit step: Full prices; utilization of network structure
- Based on Cigler et al. [1]
  - Limited price discrimination: *l* groups
  - Limited duration of selling process: *k* rounds
  - Ergo: *(k, l)*-PP strategies

Introduction
Research Question

- Primary
  - Empirical evaluation of strategy proposed in [1]
  - Design and evaluation of additional heuristics for mapping clients to groups
  - Comparison of all available (grouping) heuristics
- Secondary
  - Distribution of myopic price sums among groups

Data

Data

- Four real-world social network datasets
- Anonymized
- Datapoints: Edges, (sometimes) edge weights
- Two during development, two during evaluation
- Preprocessing:
  - Sorting
  - Elimination of redundancies
  - Merging of multiple edges (incl. calculation of new edge weight)

Data

Dataset	Vertices	Edges	Weights	Directed	Phase
Epinions	75879	508837	None; no multiple edges.	No	Development
Slashdot	82168	948464	None; no multiple edges.	No	Development
Advogato	6551	51332	Positive weights; no multiple edges.	Yes	Evaluation
DBLP	1248427	17631144	None; multiple edges.	No	Evaluation

Investigated Marketing Strategies

Investigated Marketing Strategies

- Simulation workflow:
  - (1) Pick influence set
  - (2) Calculate myopic prices
  - (3) Map clients to groups
  - (4) Offer to clients
- Own contributions:
  - Group mapping heuristics
  - Price setting mechanisms

Investigated Marketing Strategies
Group Mapping Heuristics

- Determines how clients are grouped
- Calculation of group limits:

$$G_j = \{i \mid \frac{\hat{p}_{max}}{2^{j-1}} \geq p_i \geq \frac{\hat{p}_{max}}{2^j}\}$$

- Four heuristics – clients sorted by specific criterions:
  - *CDHS* [1]. Criterion: Myopic price
  - *Degrees*. Criterion: Node degrees
  - *Neighbourhood*. Criterion: Edge weights to *all* neighbours (similar to CDHS)
  - *Chaos*. Criterion: None (random approach)

Investigated Marketing Strategies
Price Setting Mechanisms

- How are PPs for groups calculated?
- For each group
  - pick one client and
  - adopt his myopic price as group price
- Several possibilities examined:
  - Minimum, Maximum
  - First quartile, median, third quartile
  - Random

Evaluation

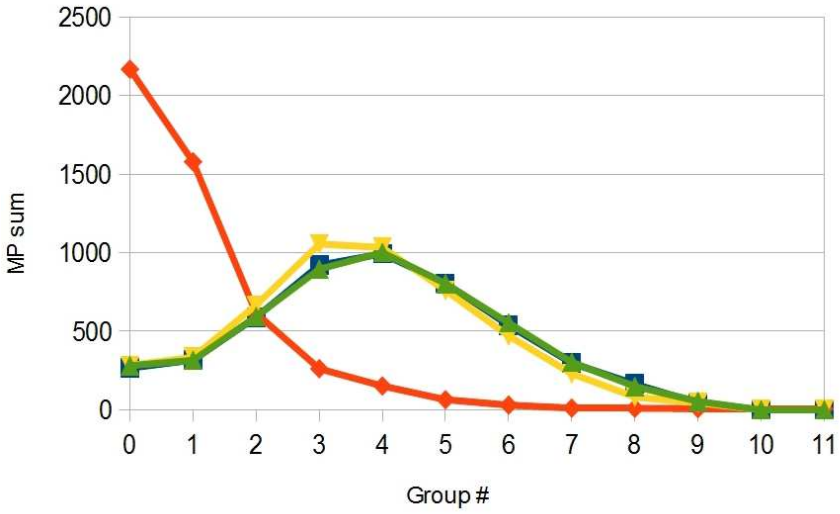
Evaluation

- Datasets: DBLP and Advogato
- Success measured by revenue
- No analysis of runtime or memory usage
- Source code and raw data available online [3]
- Three phases
  - (1) MP distribution
  - (2) All GMH & PSM combinations
  - (3) Two pairings in detail

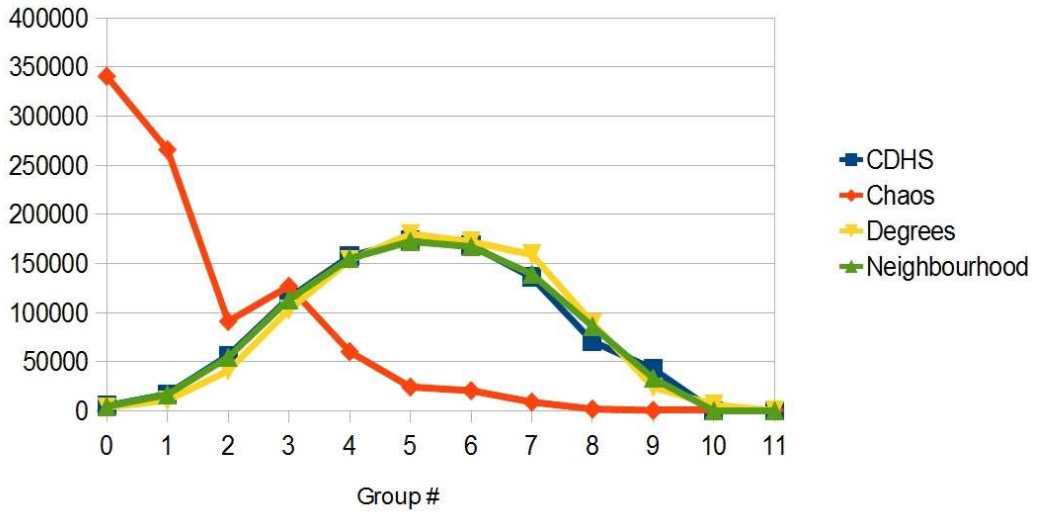
Evaluation
Distribution of Myopic Prices

- Distribution among groups: „Middle-class“ contributes more than top & bottom

Advogato



DBLP

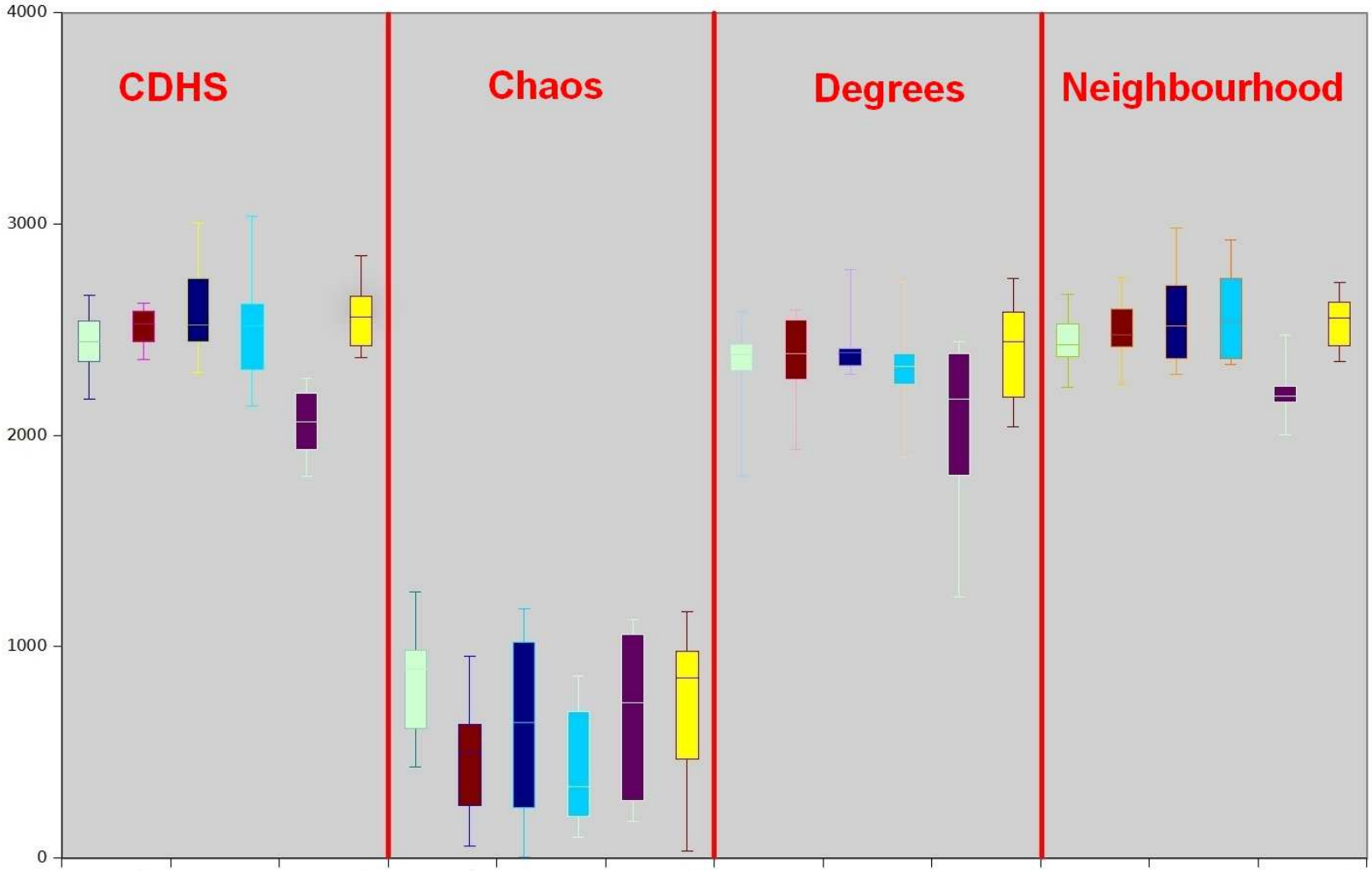


Evaluation
All GMHs & PSM Combinations

- All pairings of GMHs and PSMs
- Two rounds, eight groups
- 100 runs with Advogato, 10 runs with DBLP dataset
- Probability for entries into the influence set $q = 0.5$

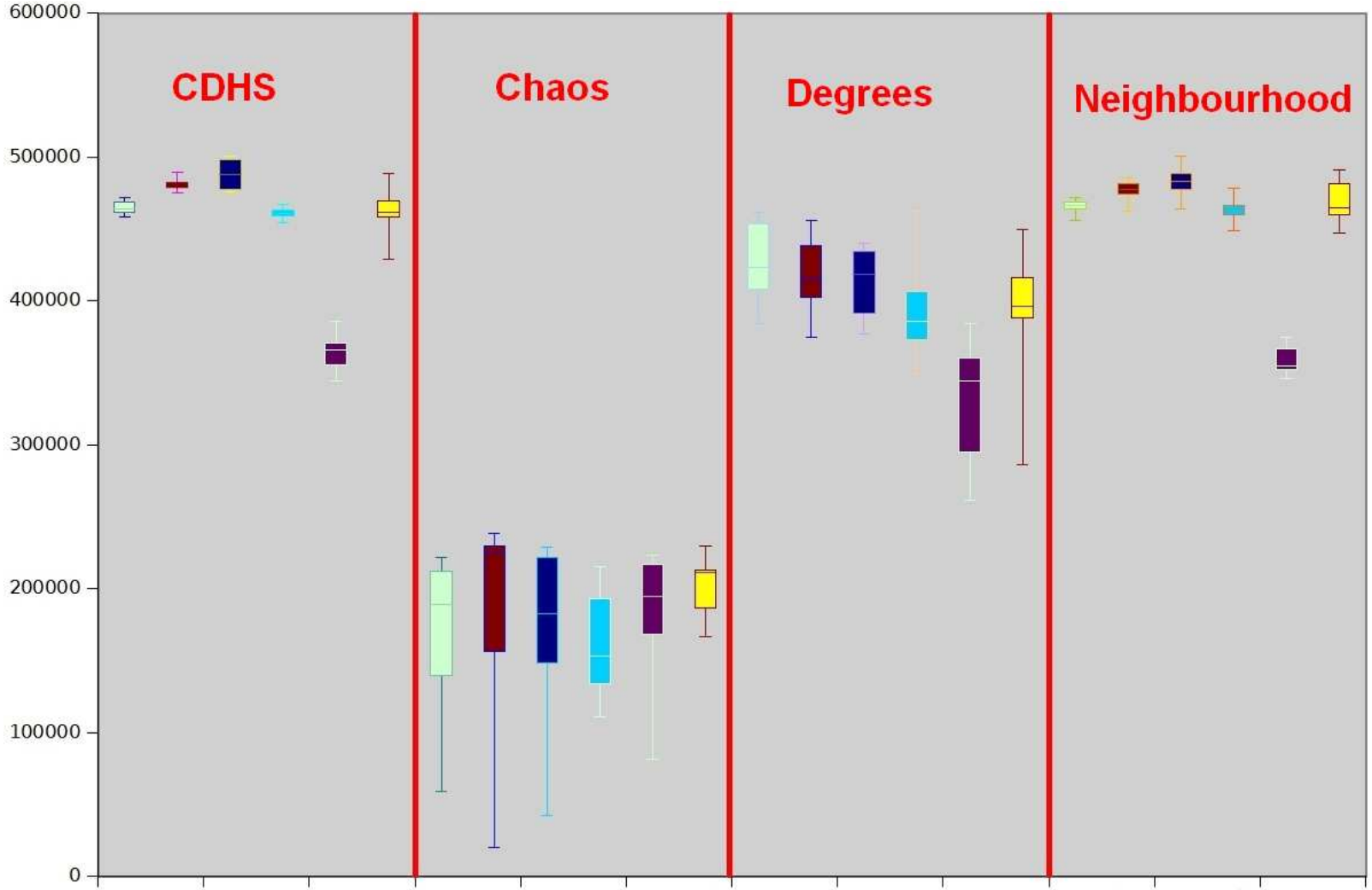
Evaluation
All GMHs & PSM Combinations

Advogato



Evaluation
All GMHs & PSM Combinations

DBLP



Evaluation
All GMHs & PSM Combinations

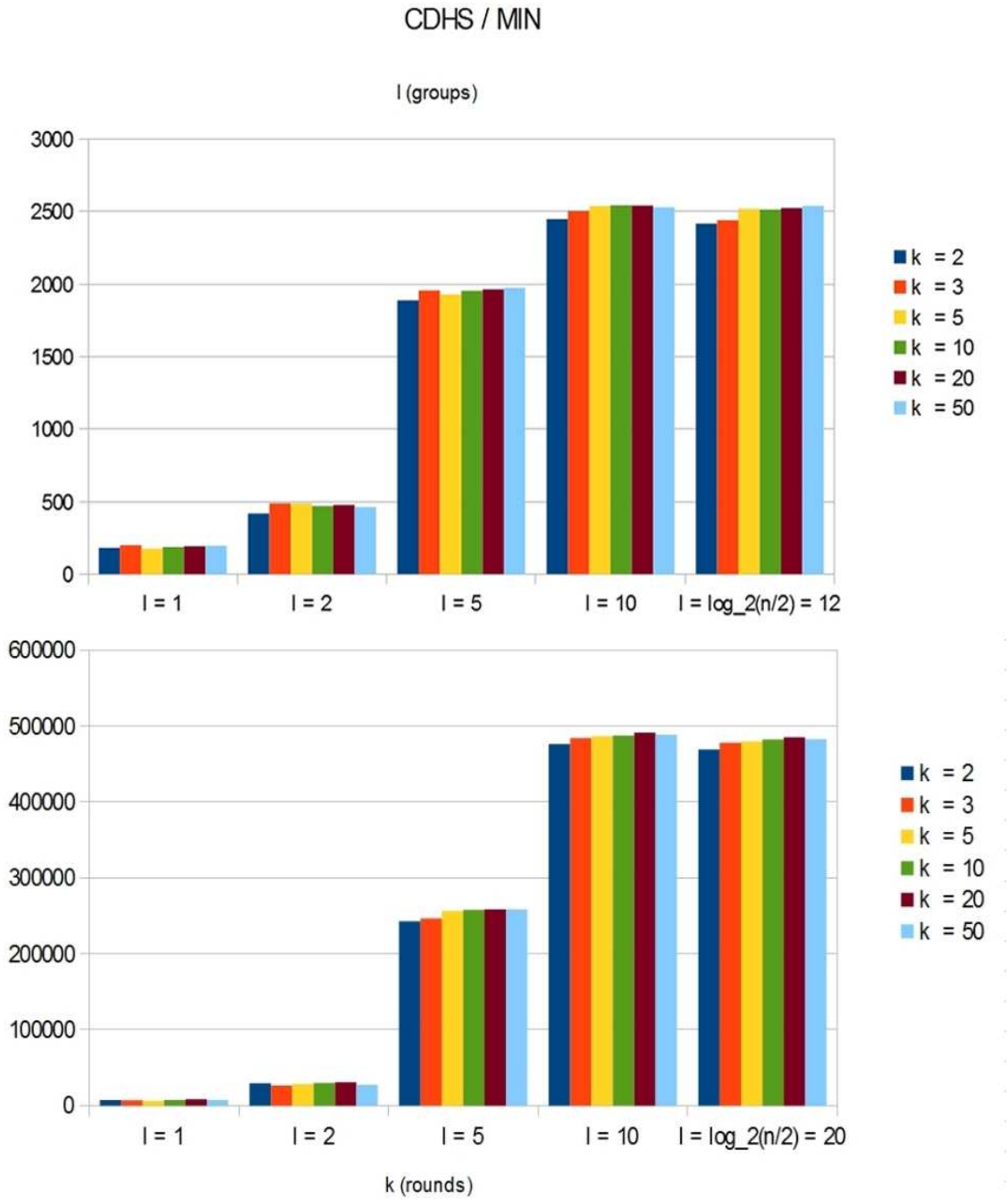
- Results:
  - Best performance: *CDHS* / *Neighbourhood*
  - *Degrees* slightly worse; much more volatile
  - *Chaos* as expected
- PSM makes a (small) difference
- *CDHS / MIN* and *Neighbourhood / MIN* selected for further evaluation

Evaluation
Selected Pairings in Detail

- Investigation of strategies with more than two rounds
- Two most promising pairings investigated in detail
  - Rounds: $k \in \{2, 3, 5, 10, 20, 50\}$
  - Groups: $l \in \{1, 2, 5, 10, \log_2(n / 2)\}$
- Again: $q = 0.5$

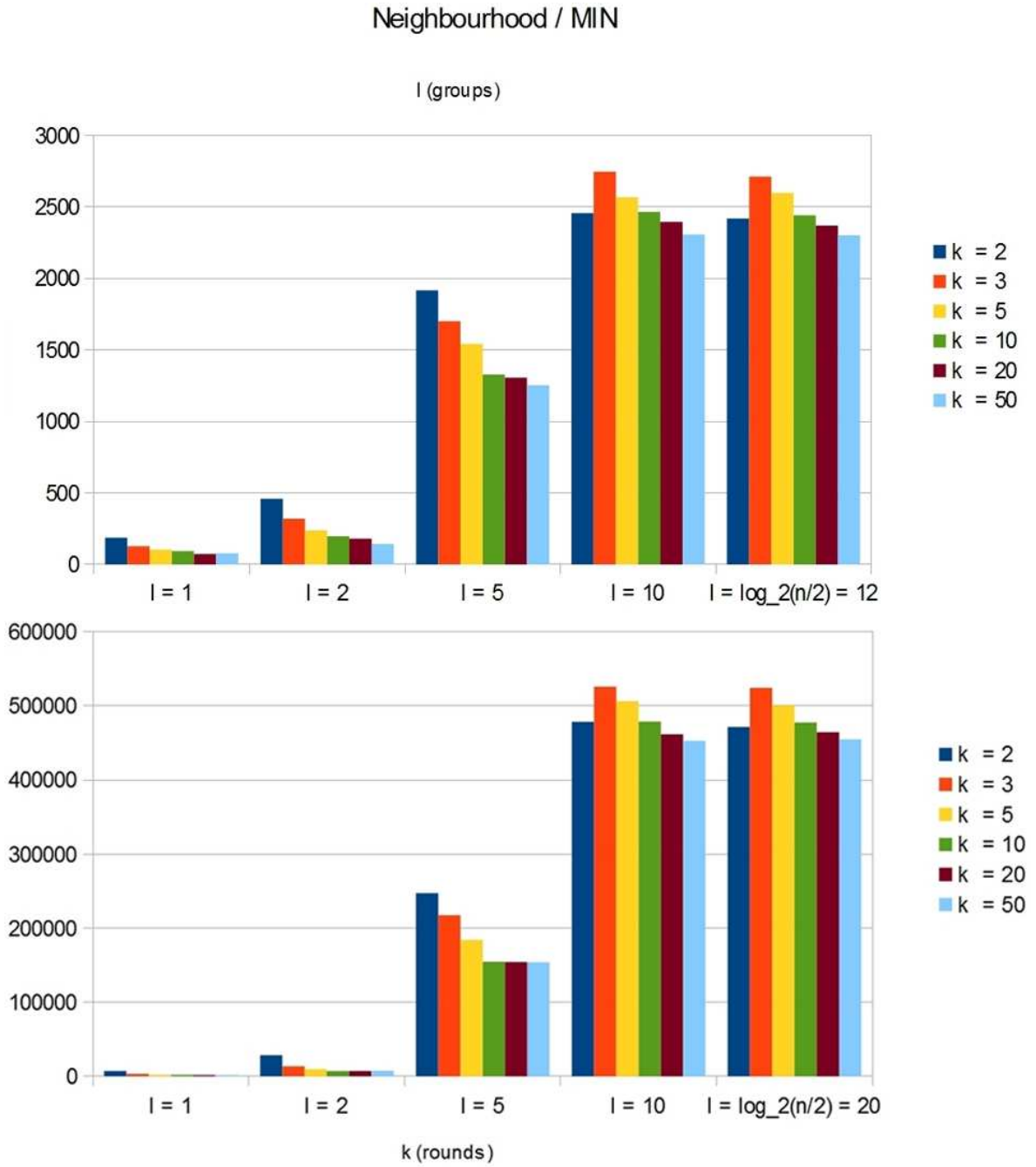
Advogato

DBLP



Advogato

DBLP



Evaluation
Selected Pairings in Detail

- Groups much more important than rounds
- CDHS: Superior in most cases
- Neighbourhood: Unexpected behaviour as well as best results

Conclusion

Conclusion

- Bell-shaped distribution of MPs over groups
- Better choices for selection of PP for groups than minimum myopic price
- Different heuristics for grouping evaluated
  - *CDHS* with constantly good results under varying circumstances
  - Best heuristic (*Neighbourhood*): Ambigious results, takes non-IS neighbours into consideration for MP calculation

Conclusion
Open Questions

- Why the ambigious results with the *Neighbourhood* heuristic?
- Uneven distribution of MPs over groups may pose target for optimisations. Was not investigated further.

- **Discussion**

References

- [1] Cigler, L., Dvorak, W., Henziger, M., Starnberger, M.: Posted price strategies to exploit positive network externalities. Working Paper (2013)
- [2] Hartline, J., Mirrokni, V., Sundararajan, M.: Optimal marketing strategies over social networks. In: Proceedings of the 17th International Conference on World Wide Web. pp. 189198. WWW '08, ACM, New York, NY, USA (2008), http://doi.acm.org/10.1145/1367497.1367524
- [3] Marketing Heuristics Evaluation Simulation for Social Networks, https://code.google.com/p/mheson-sn/ (2014)