Trust Overlay Networks for Global Reputation Aggregation in P2P Grid Computing

by

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Outline

- Objectives of the paper
- Sample trust data and its distribution
- Trust Overlay Network (TON)
- PowerTrust reputation system
- Critique
- References

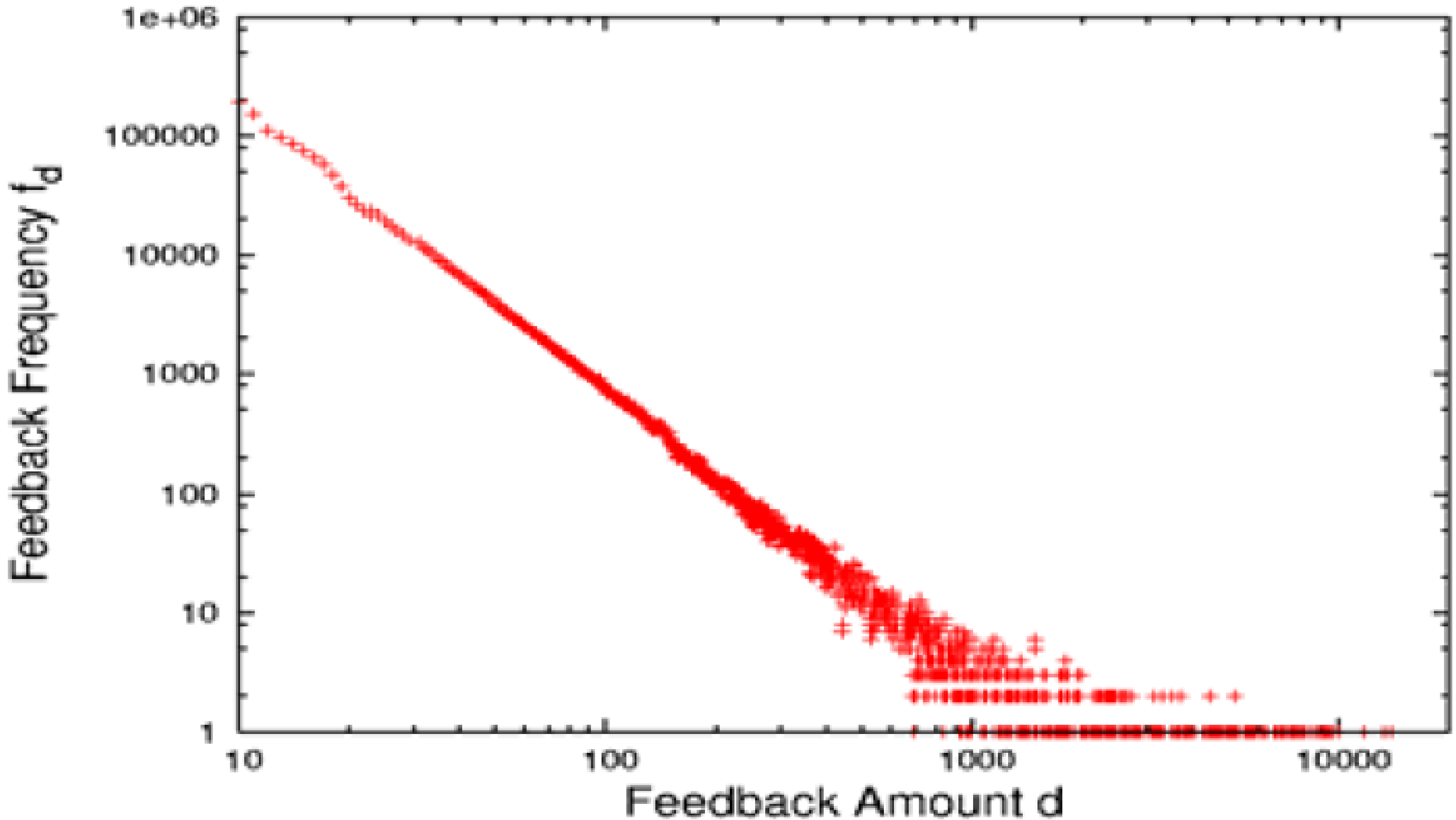
Objectives

- Aggregate trust information in P2P trust management systems to selectively use the network's services in contrast to arbitrary use
- A trust overlay network (TON) aggregates the reputation information
- Compare created trust aggregation system to other similar systems
- eBay reputation system used as a source of sample reputation data

Reputation

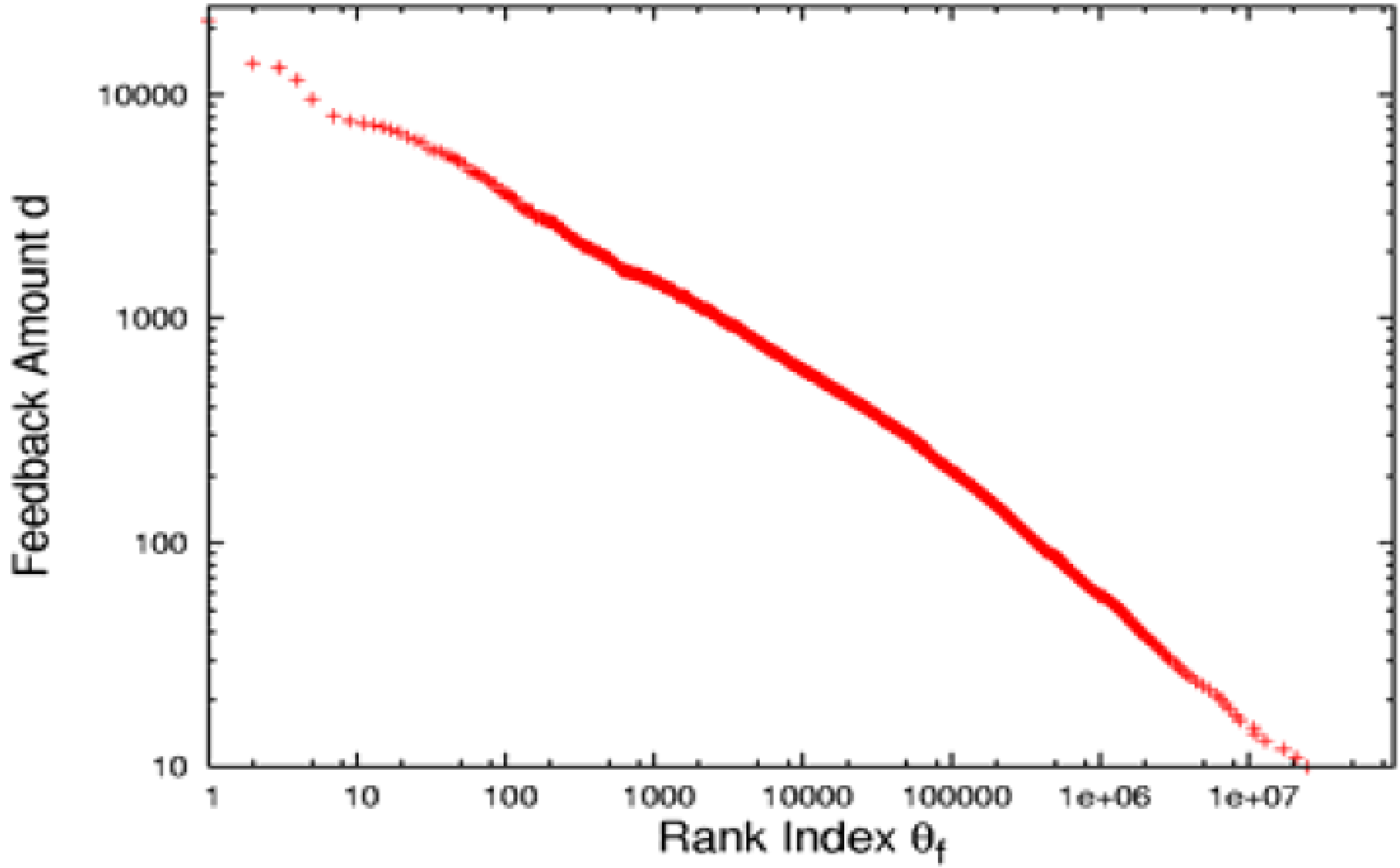
- Reputation is a number
- Reputation is additive
  - score accumulation finishes when a cumulative score change drops below threshold limit
- Proposed PowerTrust system cumulates trust scores locally and normalises them
  - a local score for each neighbour node
  - score manager nodes maintain & store global reputation values for the nodes they manage

eBay feedback data



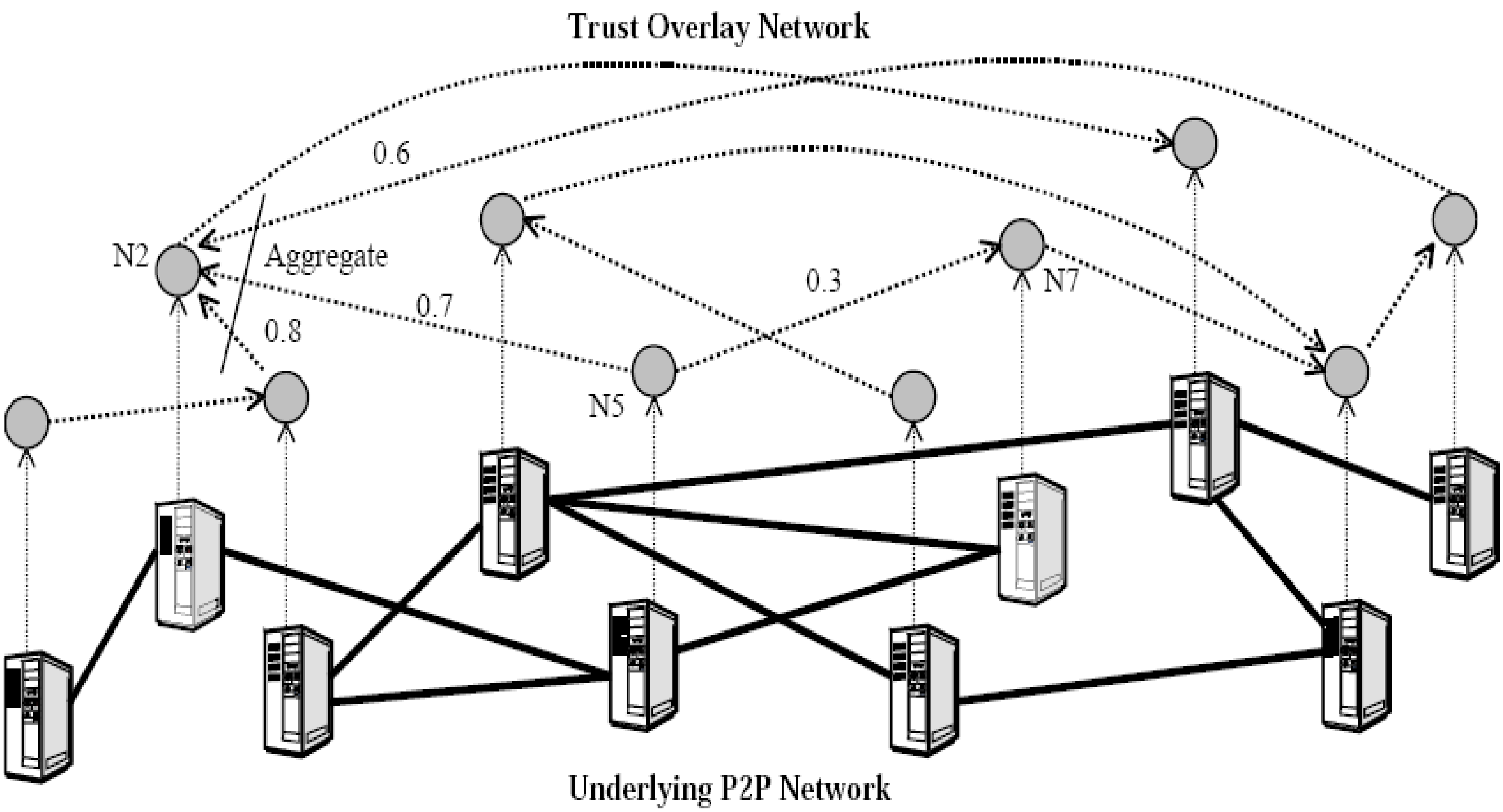
(a) Feedback frequency vs. feedback amount

eBay feedback data/2

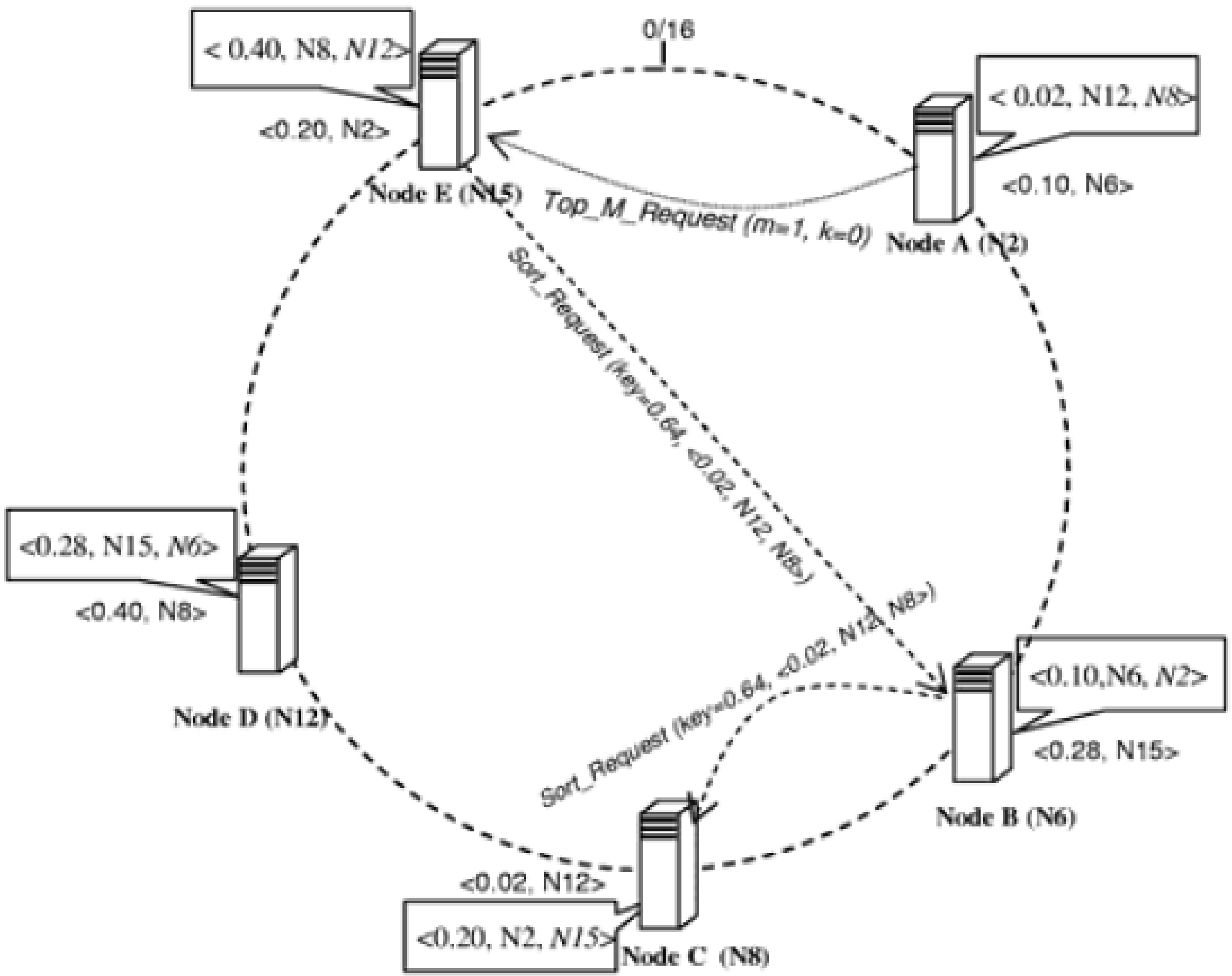


(b) Feedback amount vs. rank index

TON system


Trust Overlay Network
0.6
N2
Aggregate
0.7
0.8
0.3
N7
N5
Underlying P2P Network

Score managers and queries



Locality-Preserving Hashing (LPH)

- Used for (distributed) storing & querying of reputations
- Properties of LPH hash function **H**:

1. Order preservation

$$H(v_i) < H(v_j), \text{ iff } v_i < v_j$$

2. Interval split

$$\text{if } v_i < v_k < v_j, \text{ then}$$
$$[H(v_i), H(v_k)] \wedge [H(v_k), H(v_j)]$$

Trust matrix

$$R=(r_{ij})=\begin{vmatrix} 0.1 & 0.2 & . & 0.4 \\ 0.3 & 0 & . & 0.3 \\ . & . & . & . \\ 0 & 0.2 & . & 0 \end{vmatrix}$$

- "i assigns j the trust score r_{ij}"
- A row is a node's local view of others' trust scores
  - Normalisation: each row sums up to 1
  - Zero means there is no trust feedback relationship between nodes i and j

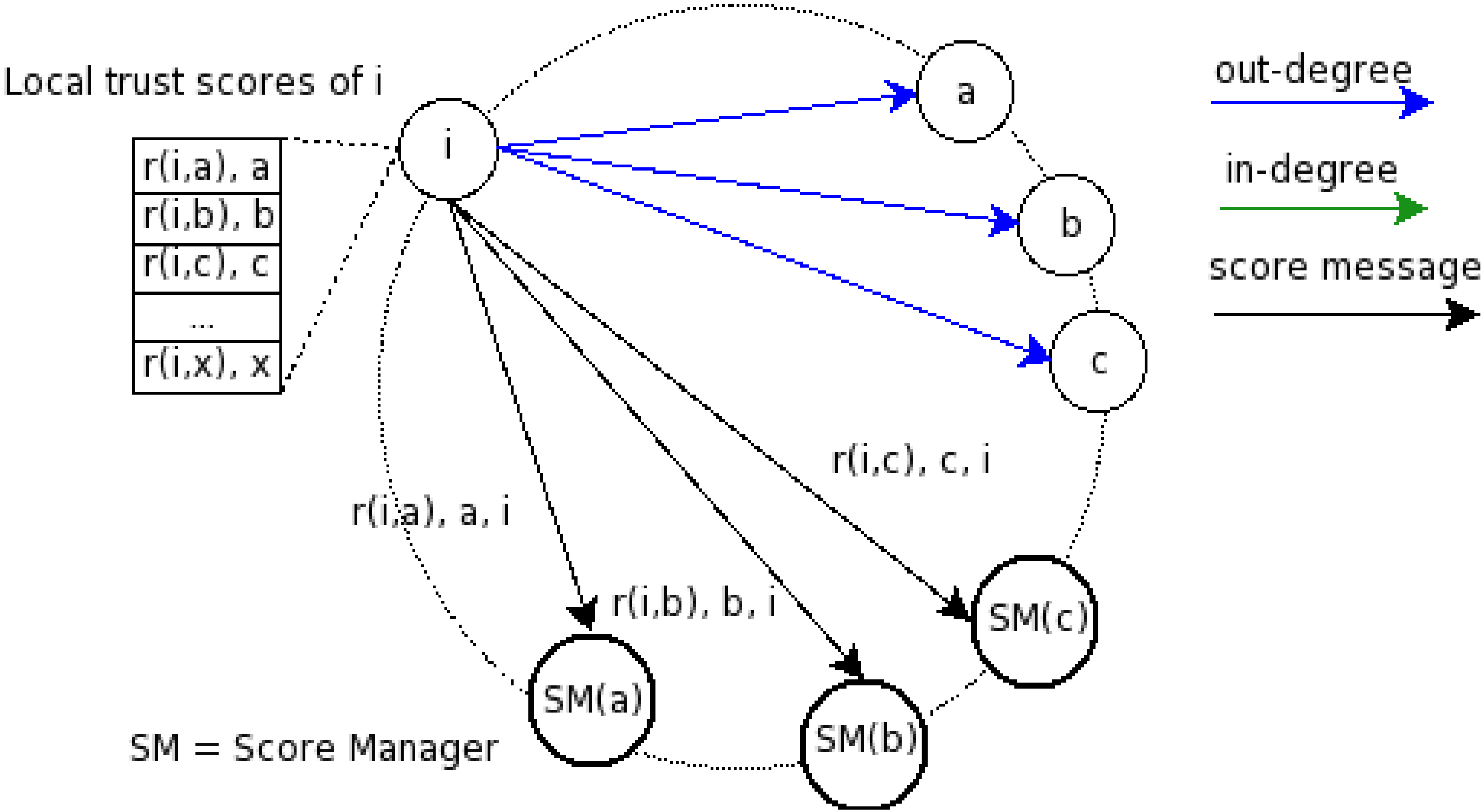
Global reputation

- Initialisation $\vec{V}^{(0)}, \epsilon$
- Termination condition $|\vec{V}^{(i)} - \vec{V}^{(i-1)}| > \epsilon$
- Update rule $\vec{V}^{(i+1)} = R^T \cdot \vec{V}^{(i)}$

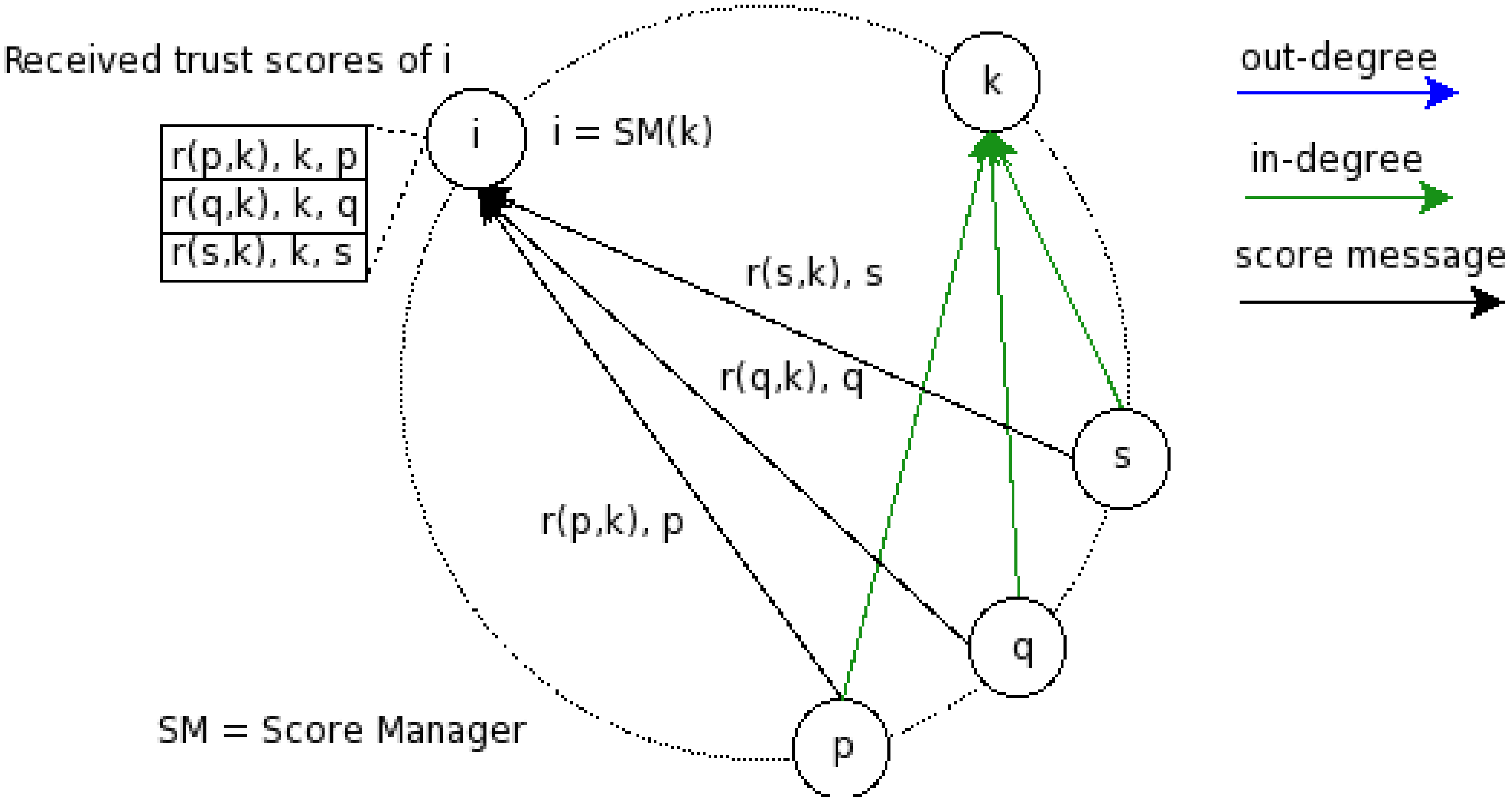
Trust aggregation

- Initialisation algorithm
- Update algorithm
- Two-phase operation
  - trust score aggregation
  - calculation of reputation by weighting

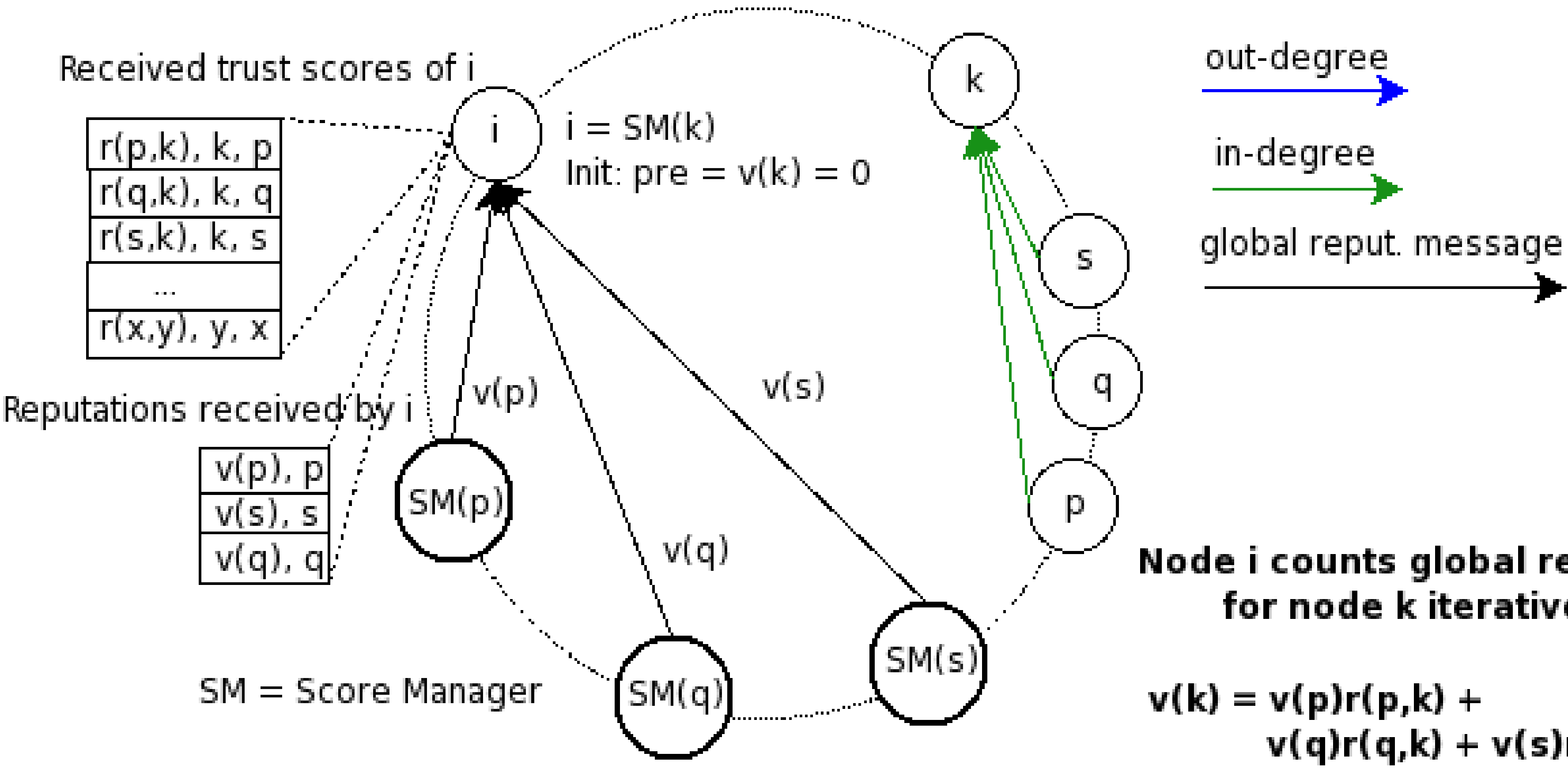
Initialisation algorithm



Initialisation algorithm/2



Initialisation algorithm/3

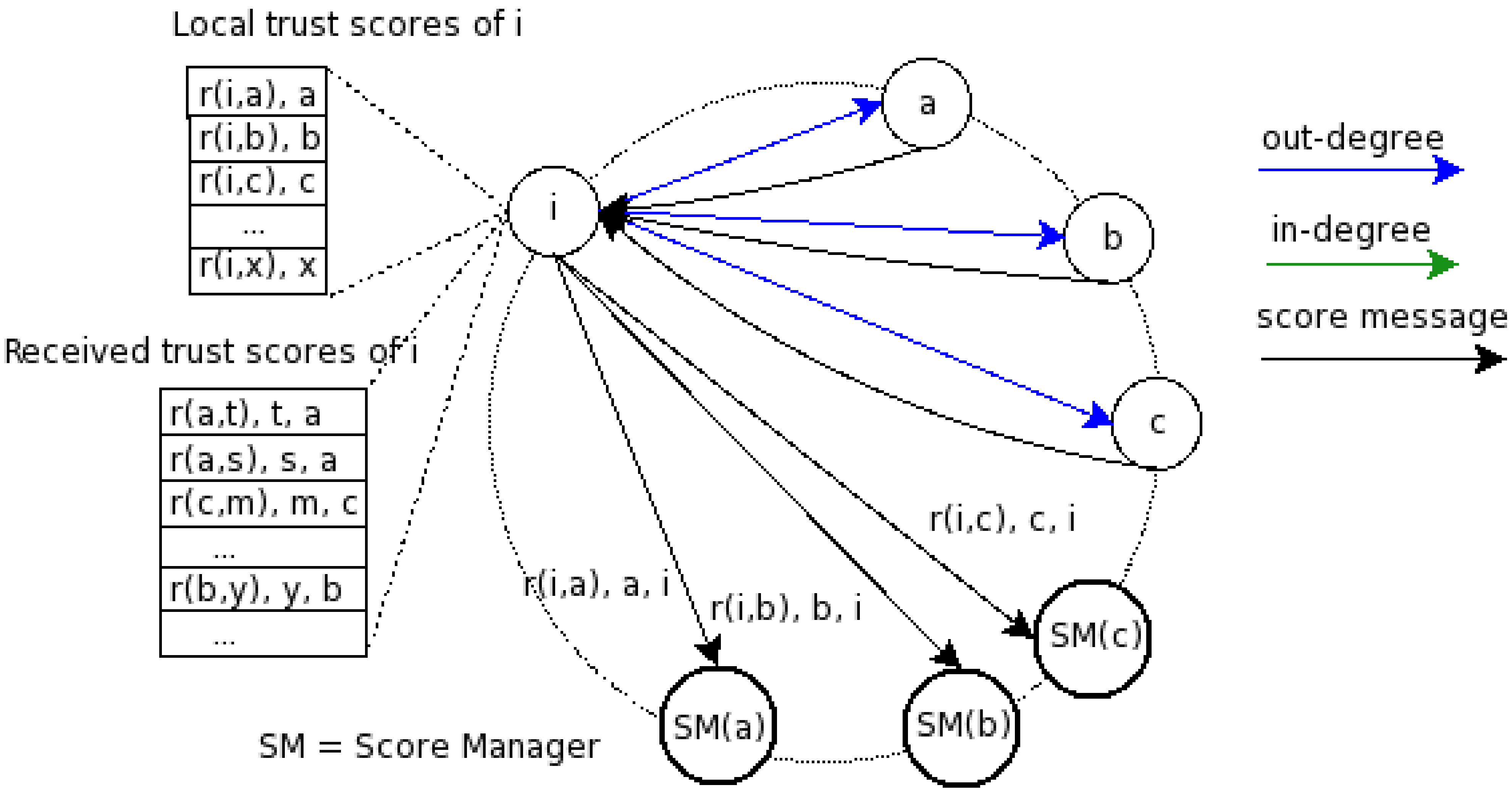


Node i counts global reputation for node k iteratively:

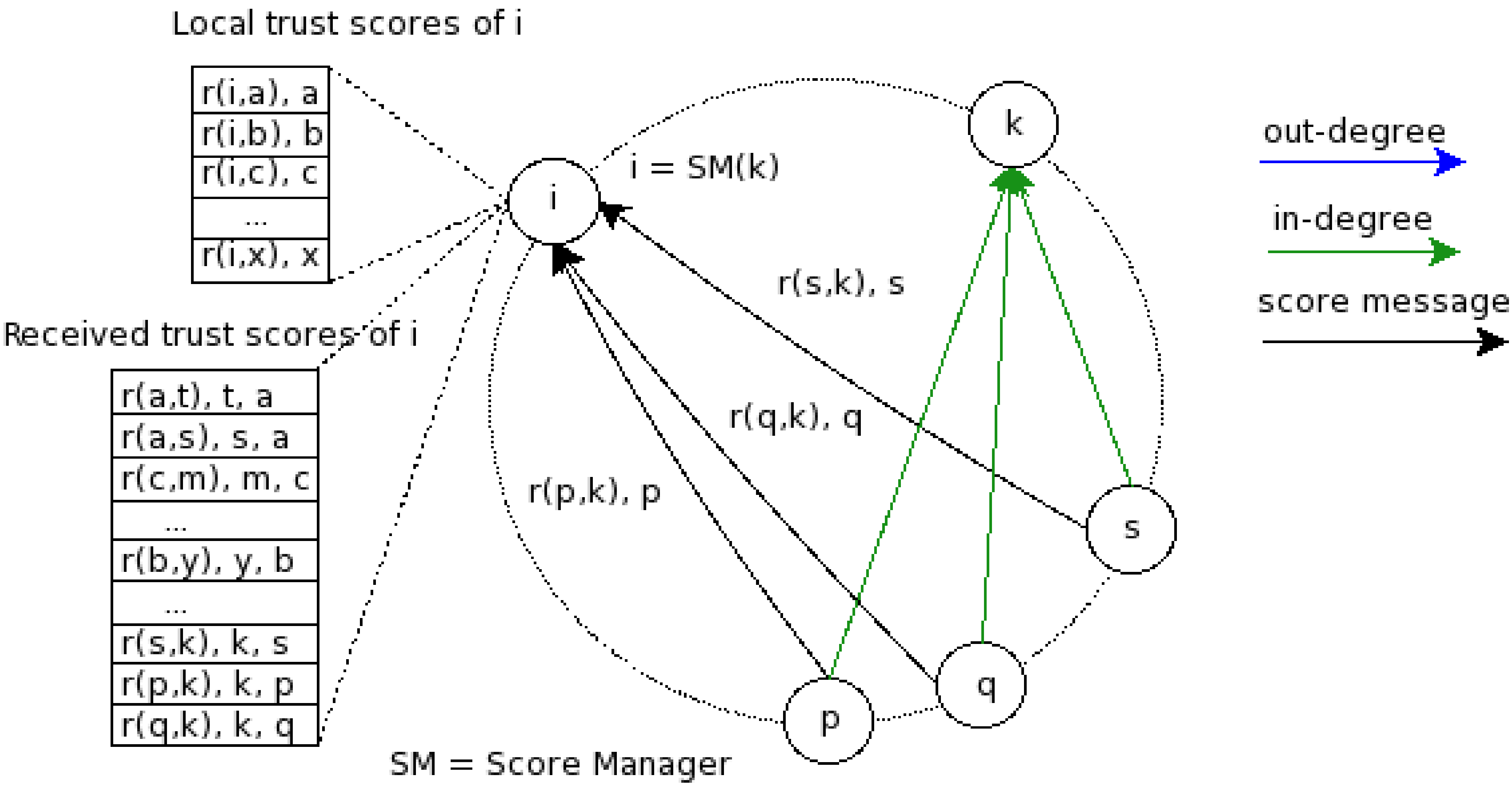
v(k) = v(p)r(p,k) + v(q)r(q,k) + v(s)r(s,k)

Stop when | v(k) - pre | < epsilon

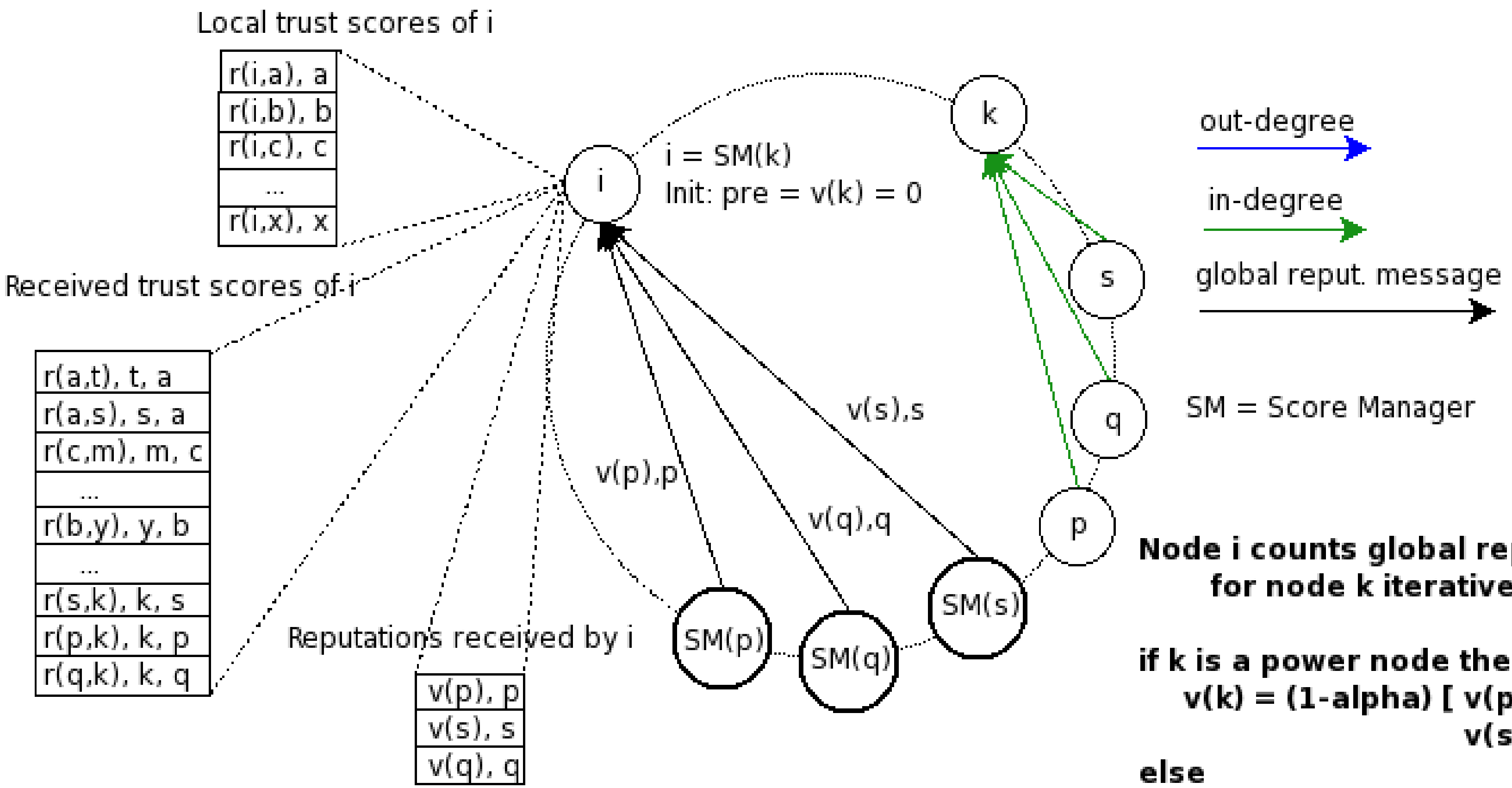
Update algorithm



Update algorithm/2



Update algorithm/3

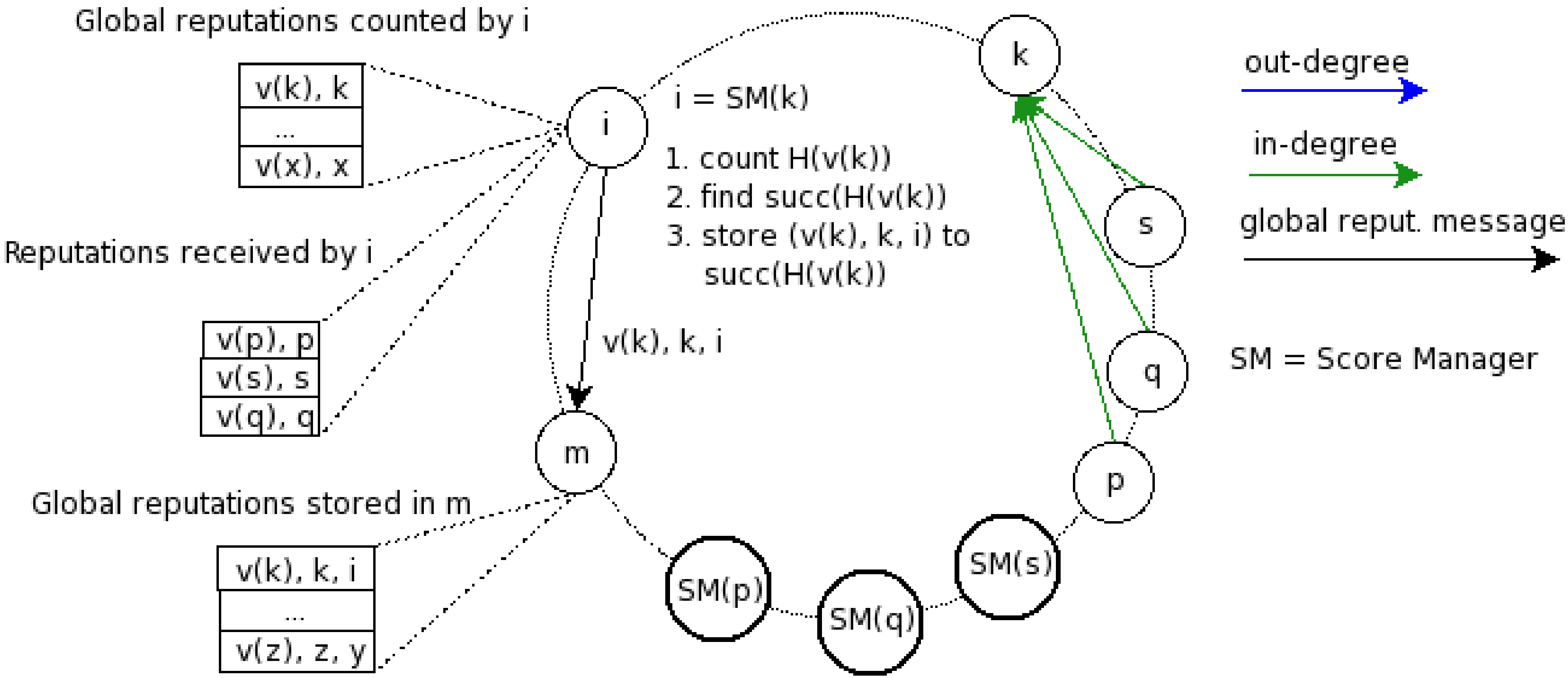


Node i counts global reputation for node k iteratively:

if k is a power node then
v(k) = (1-alpha) [v(p)r(p,k) + v(q)r(q,k) + v(s)r(s,k)] + alpha/m
else
v(k) = (1-alpha) [v(p)r(p,k) + v(q)r(q,k) + v(s)r(s,k)]

Stop when | v(k) - pre | < epsilon

Storing the global reputation



Transition matrix T

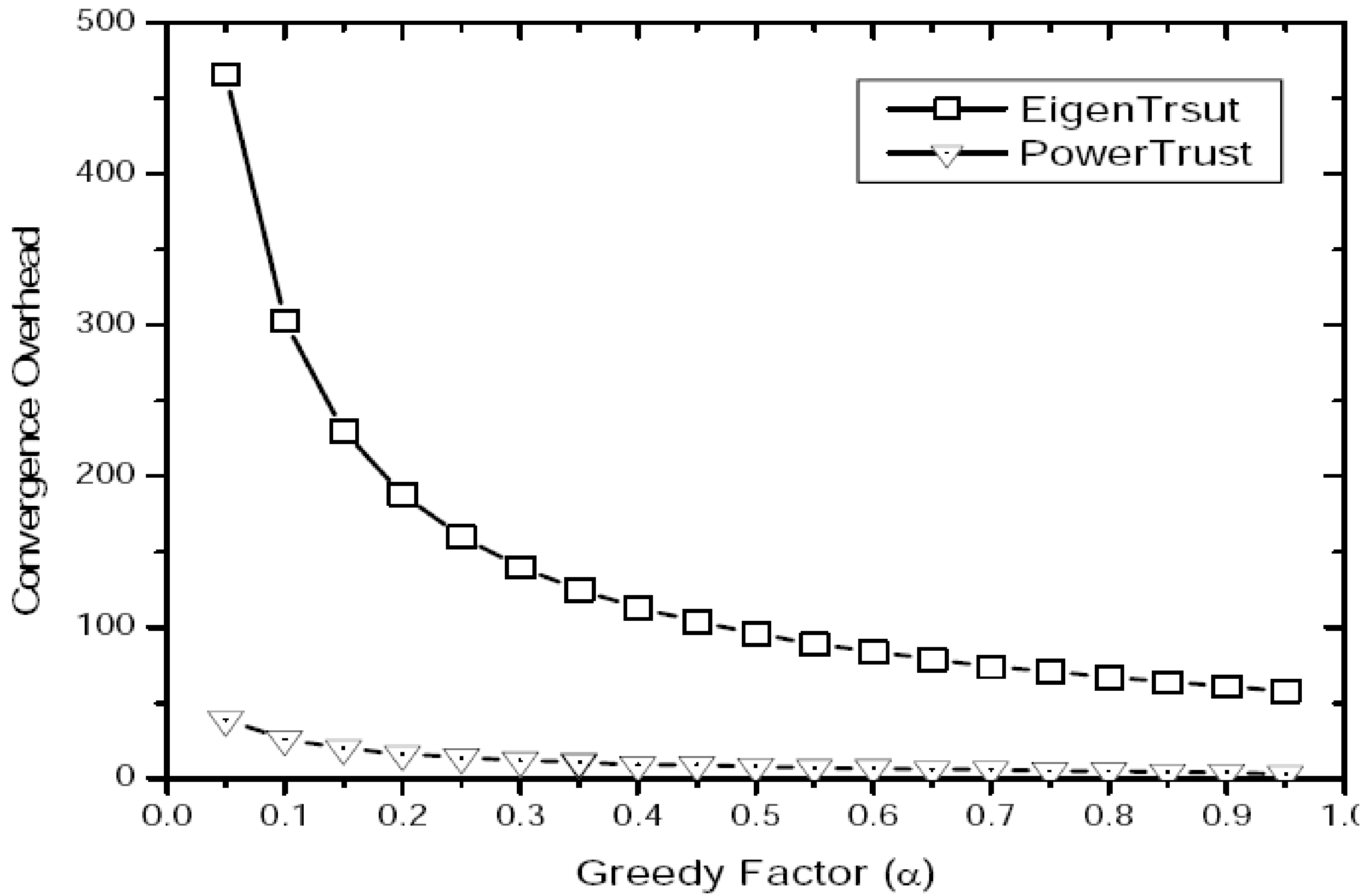
$$T = (1-\alpha) R^T + \alpha P^T$$

- Defines the probability by which a node x surfs to a power node y
  - α is the greediness factor
- R is the trust matrix, P the power node matrix

PowerTrust simulations

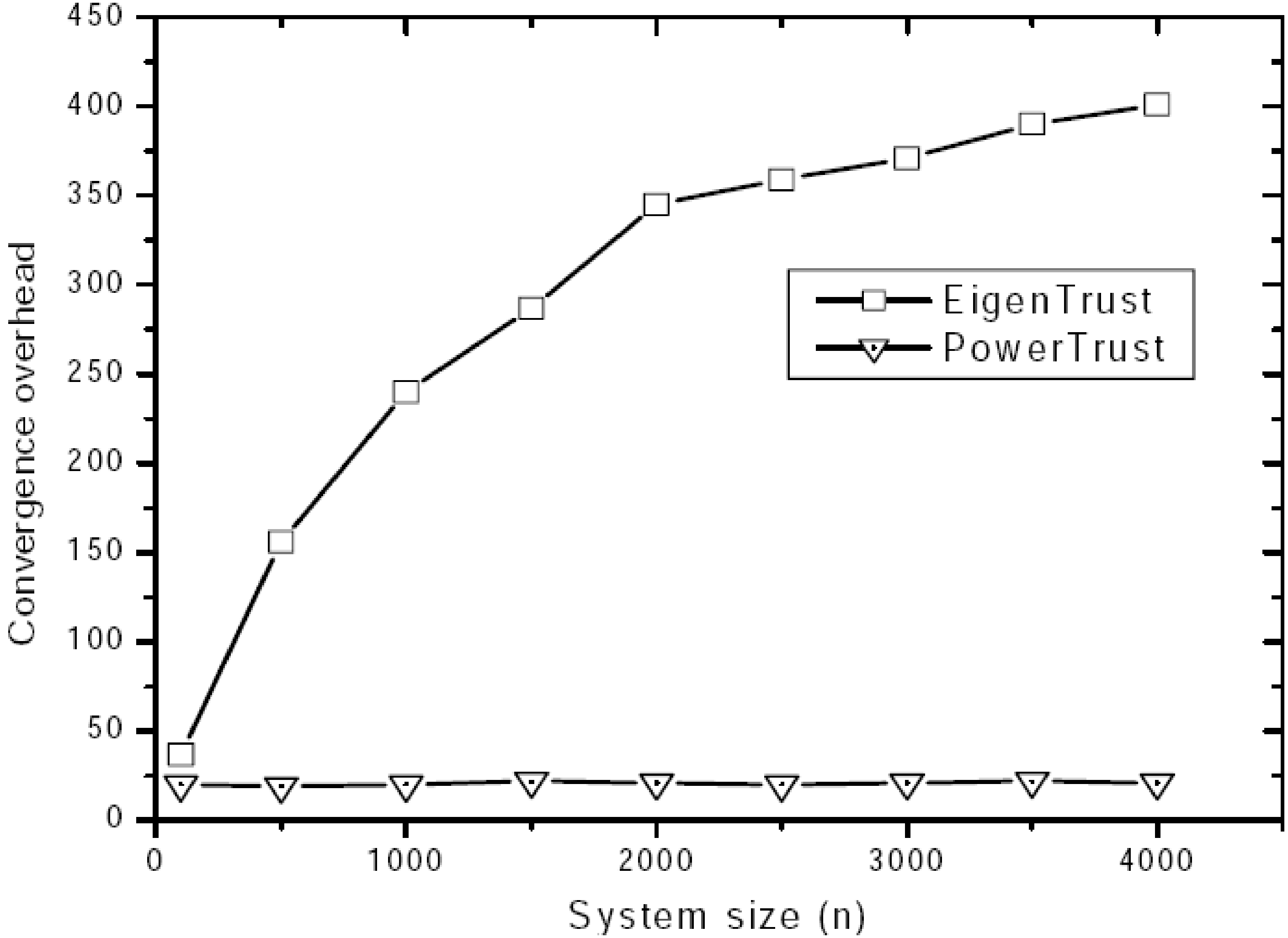
- Convergence overhead of reputation aggregation
- P2P file sharing application
- Parameter Sweep Application (PSA) and its job success rate on P2P Grid
  - makespan improvement

Overhead in reputation aggregation



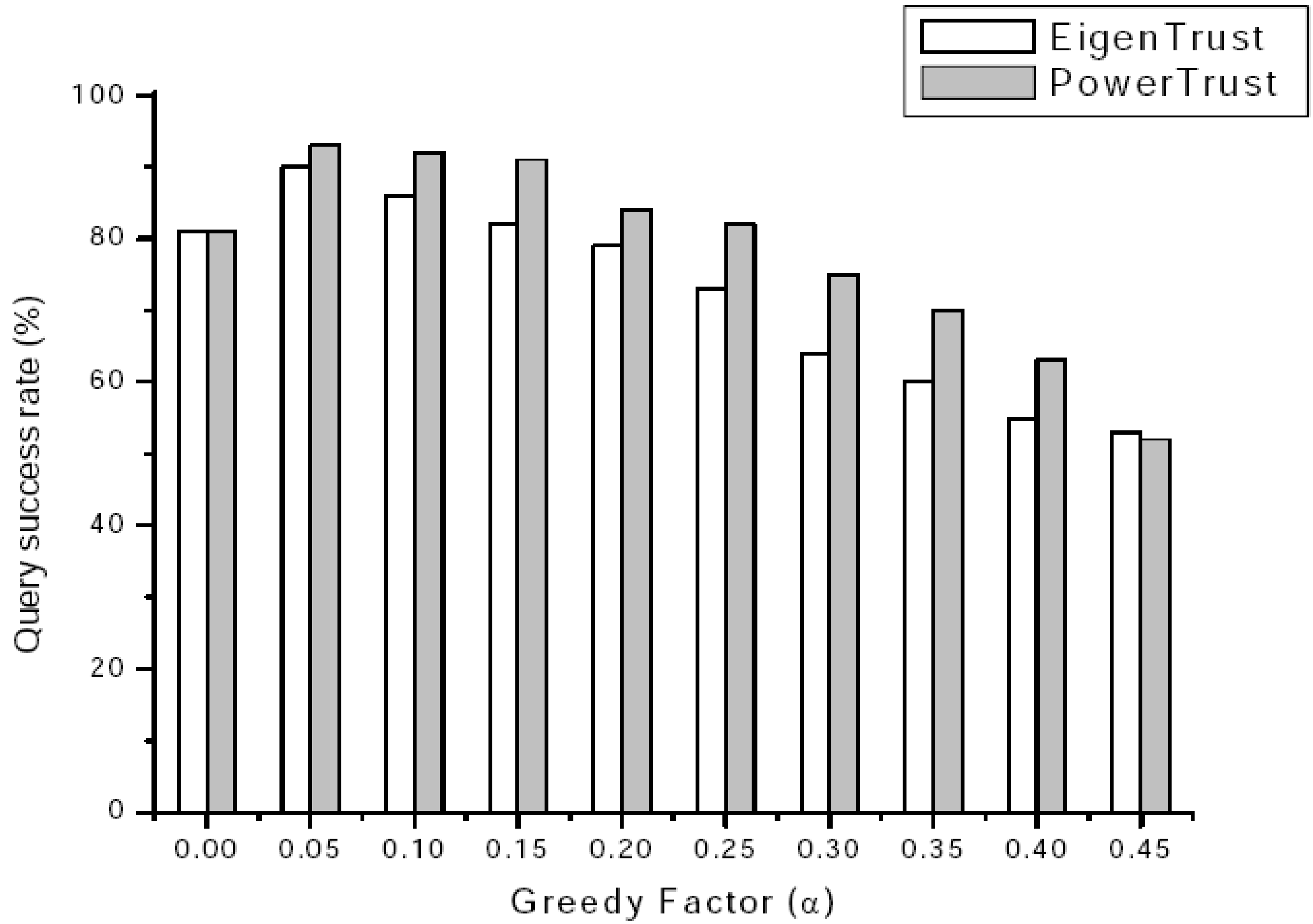
(a) Effects of greedy factor α for a P2P system of 1,000 peers

Overhead in reputation aggregation/2



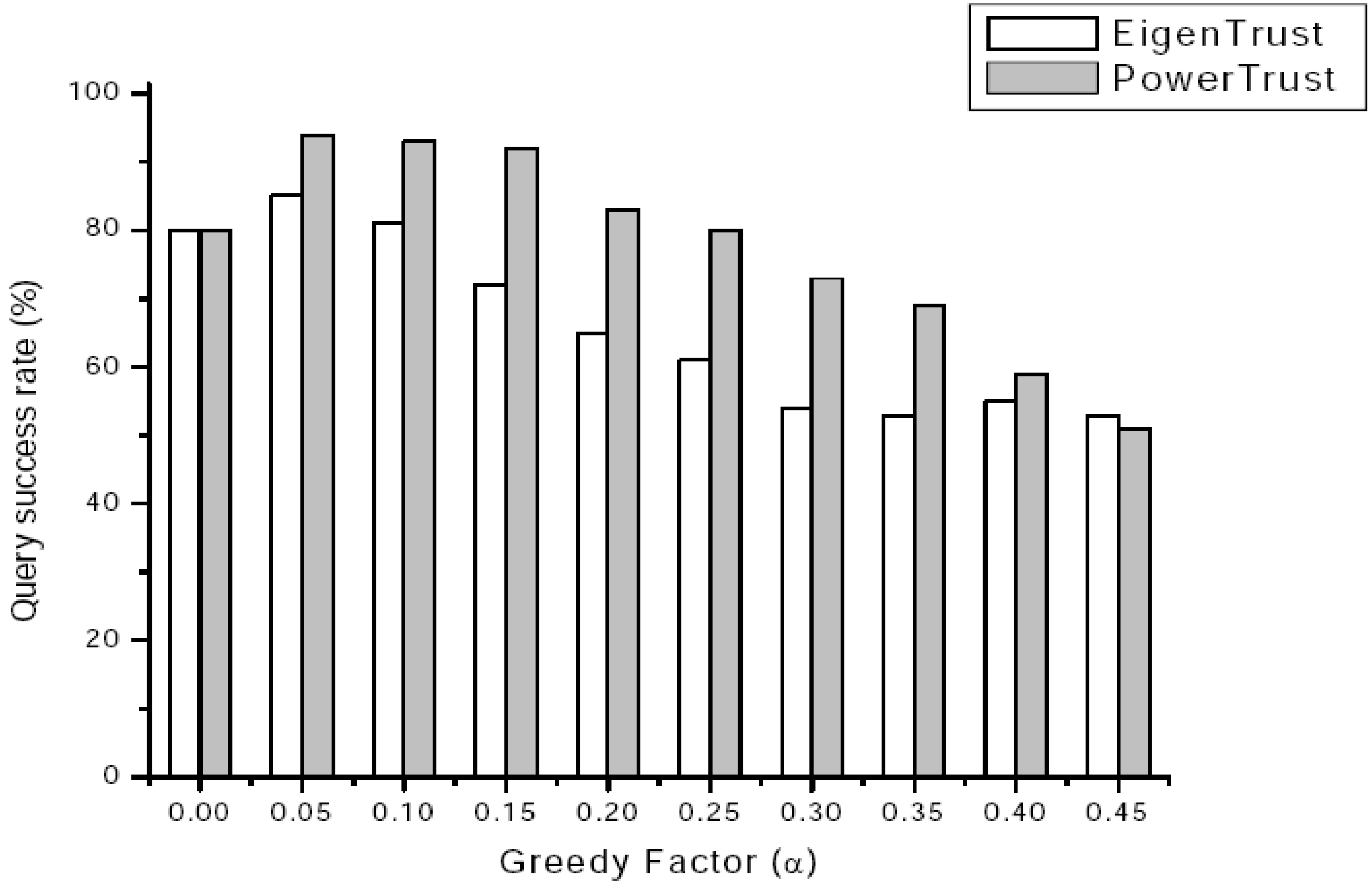
(b) Effect of system size *n* with a fixed *greedy factor* $\alpha = 0.15$

Query success rate in P2P file sharing



(a) After the first round global reputation aggregation

Query success rate in P2P file sharing/2

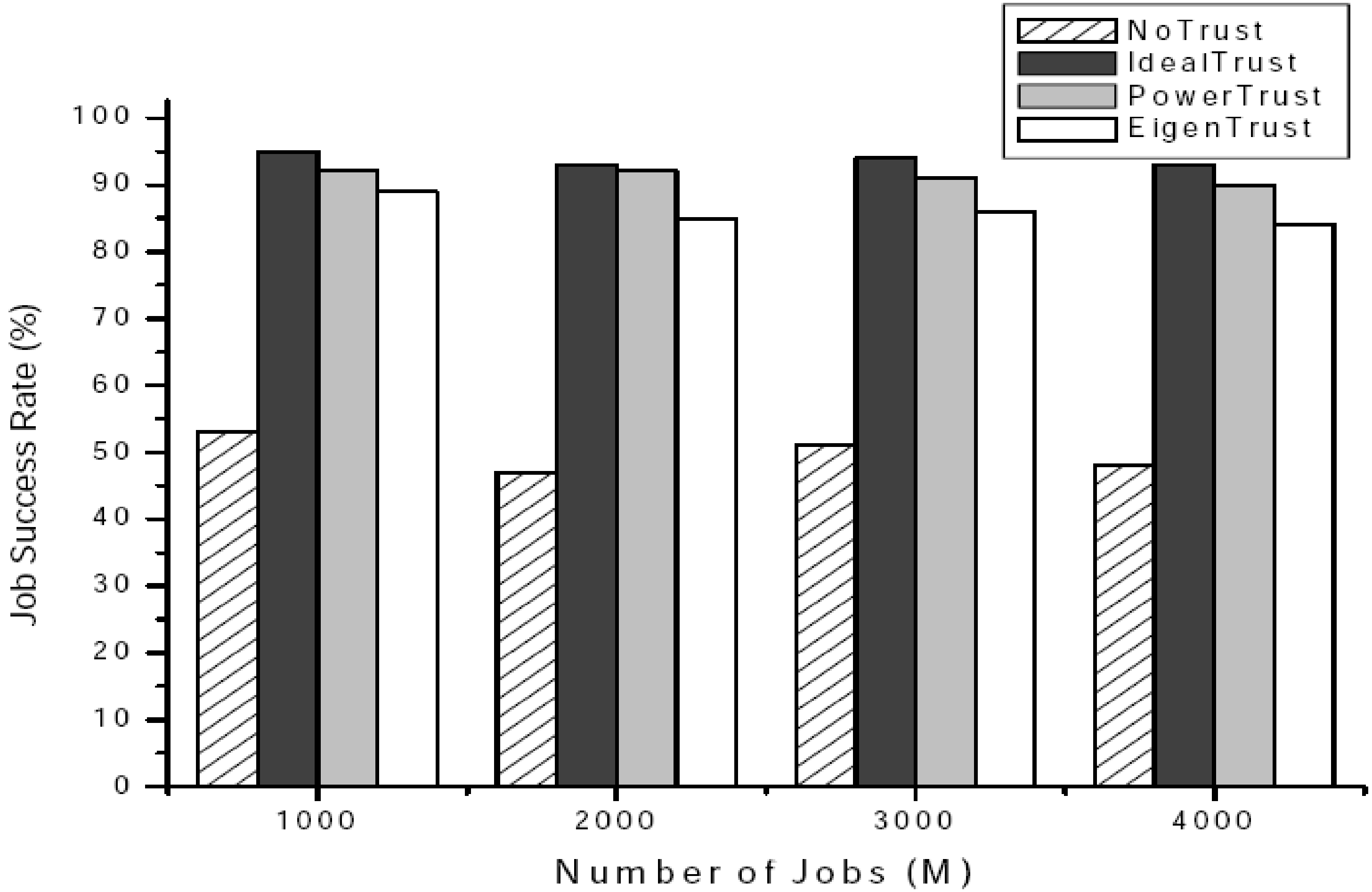


(b) After ten rounds of global reputation aggregation

Job makespan/second

(a) Job Makespan in second

Job success rate (avg.)



(b) Average job success rate

Criticisms

- At times clumsy and confusing language
- Missing or inadequate definitions & information
  - E.g. parameter value in Chord image doesn't match the corresponding one in the text
- Algorithm steps not thoroughly explained
  - some steps appear redundant
  - some steps appear missing
- The paper doesn't provide enough details to allow a complete understanding of the architecture of PowerTrust

Criticisms/2

- The sample data selection procedure gave data that is power-law distributed
  - no proof that this matches a real random sample
- It is not clear to what extent the assumed power-law distribution of reputation data contributes to the improvement of PowerTrust wrt. EigenTrust in simulations
- *"Power nodes are re-elected after each [global reputation update] round"*

Criticisms/3

- Understanding of Grid middleware appears superficial
- Authors were extremely collaborative:
  - no response by neither one of them despite sending them separate email inquiries on the details of PowerTrust
- Found longer paper from the web
  - One more algorithm: power-node selection
  - Proofs & some more details

Questions?

References

1. *Trust Overlay Networks for Global Reputation Aggregation in P2P Grid Computing*, R. Zhou and K. Hwang, IEEE International Parallel and Distributed Processing Symposium, April 2006
2. *PowerTrust: A Robust and Scalable Reputation System for Trusted Peer-to-Peer Computing*, http://gridsec.usc.edu/files/publications/TPDS-0463-1105.R2-Final-June21.pdf
3. *The Eigentrust Algorithm for Reputation Management in P2P Networks*, S. Kamvar, M. Schlosser and H. García-Molina, ACM WWW'03, p.640-651, 2003
4. *Power-law distributions*, http://en.wikipedia.org/wiki/Power_law