Reputation Management in P2P Networks

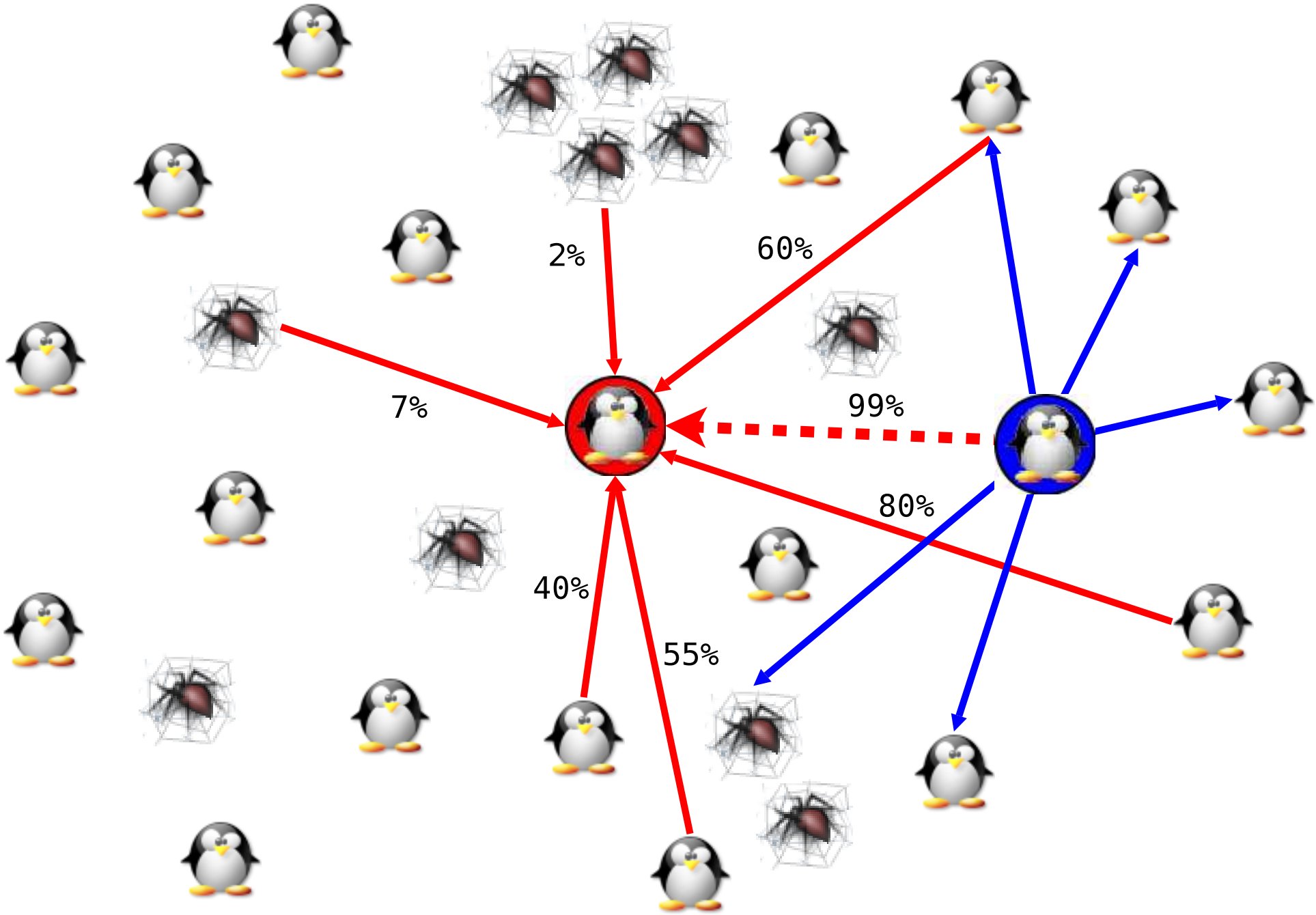
– The EigenTrust Algorithm –

presented by

Adrian Alexa

supervised by

Anja Theobald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- General Overview
- Local and Global Trust Values
- From Basic to Distributed EigenTrust
- What about Security ?
- Results and Conclusions

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Method:

- assign peers *global trust values* based on previous peer's behavior

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- **Trust Management:** a mechanism that allows to establish reciprocal trust

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- **Isolating Malicious Peers**
  - download from the most highly trusted peer
  - select peers from whom to download based on the distribution induced by peer's trust value
  - combine local trust with the global trust value:

$$t = at_{\text{global}} + (1 - a)t_{\text{local}}$$

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- **Incent Peers to Share Files**
  - high trusted peers can be rewarded
  - reduce the numbers of free-riders

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- **newcomers are not privileged:** malicious peers can't gain anything by changing their identity.

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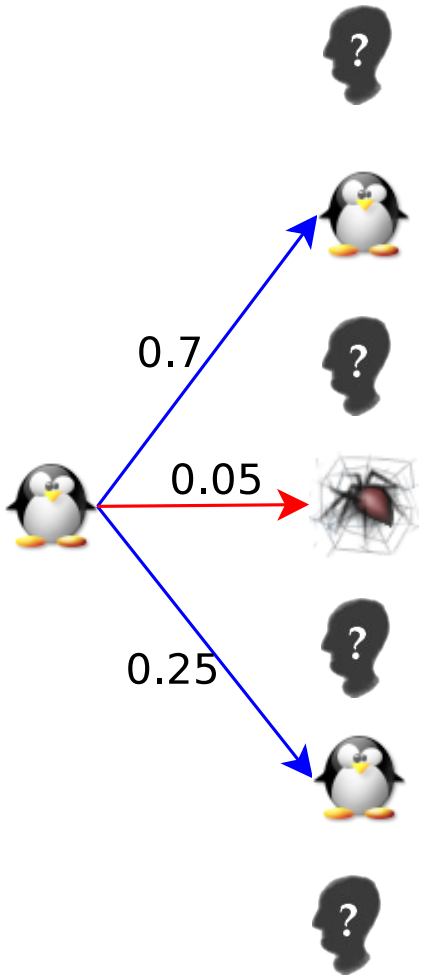
- Fact: $c_{i1} + c_{i2} + \cdots + c_{in} = 1.$

- peer i doesn't know all peers in the network



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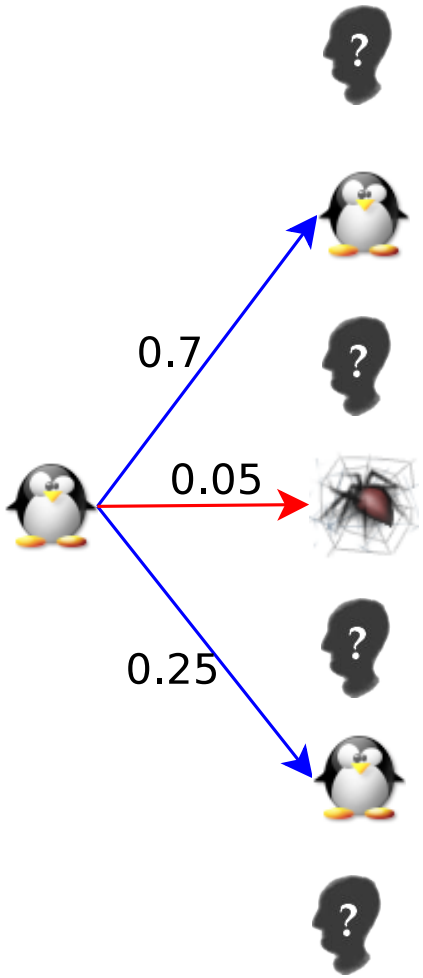

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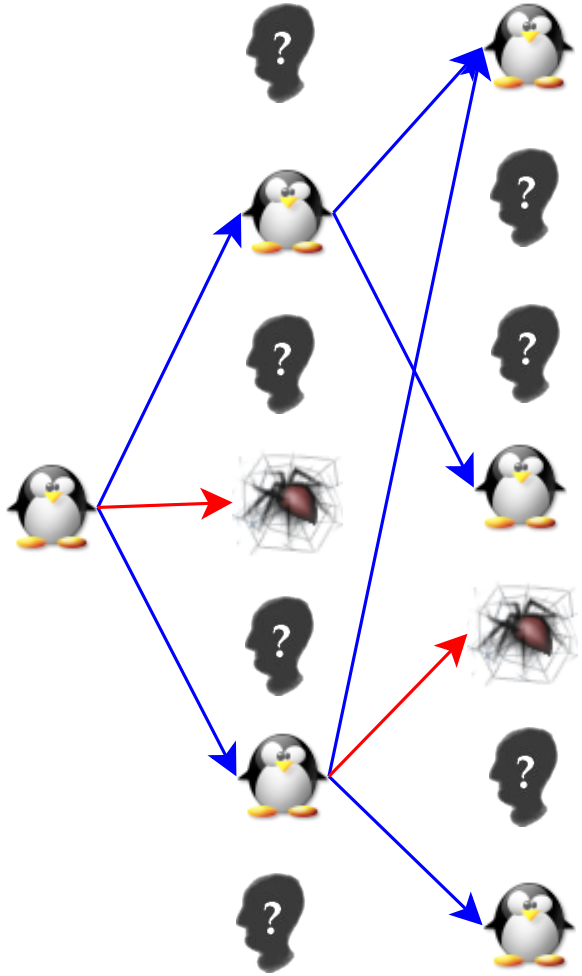

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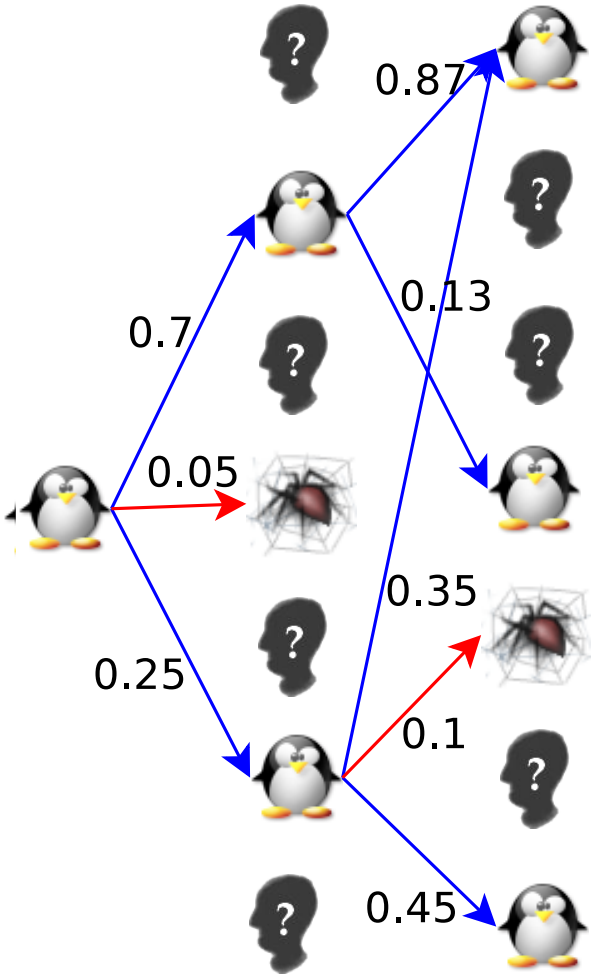
- **Transitive Trust:**
  - ask peers you trust to find trust values of other peers
  - weight their opinion:

$$t_{ik} = \sum_j c_{ij} c_{jk}$$

  - fact: $0 \leq t_{ik} \leq 1$



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- ask friends

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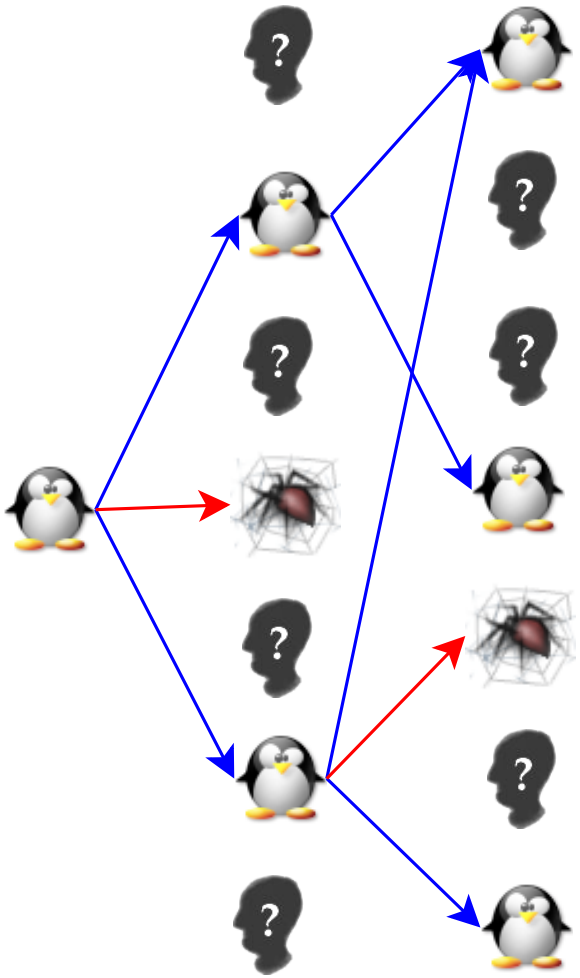

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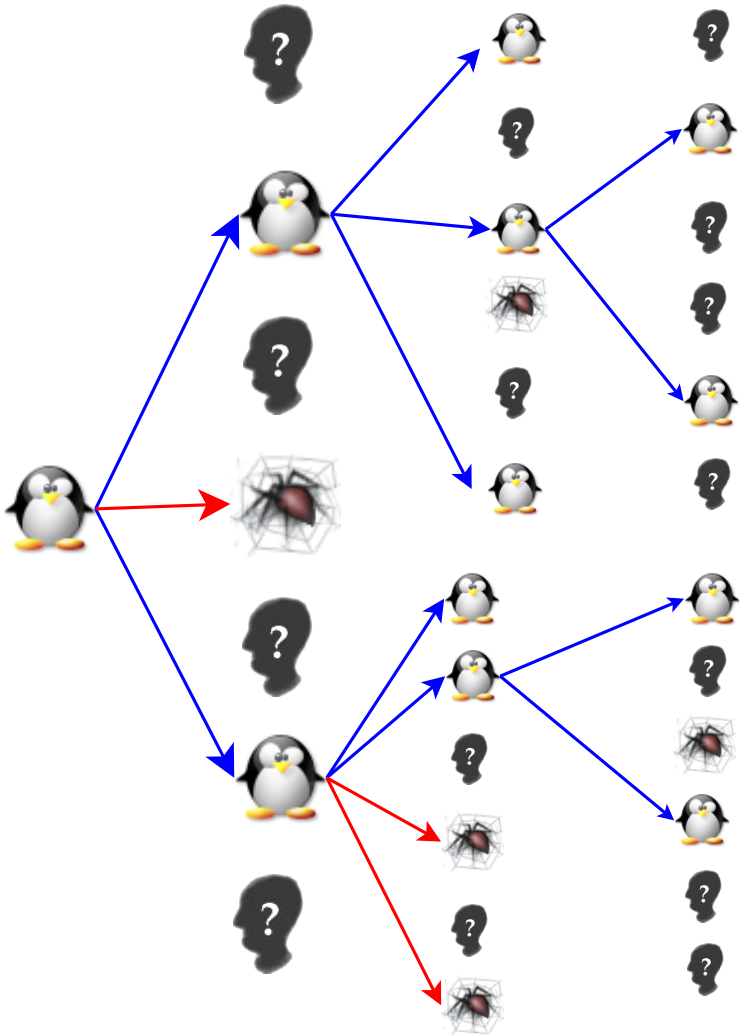

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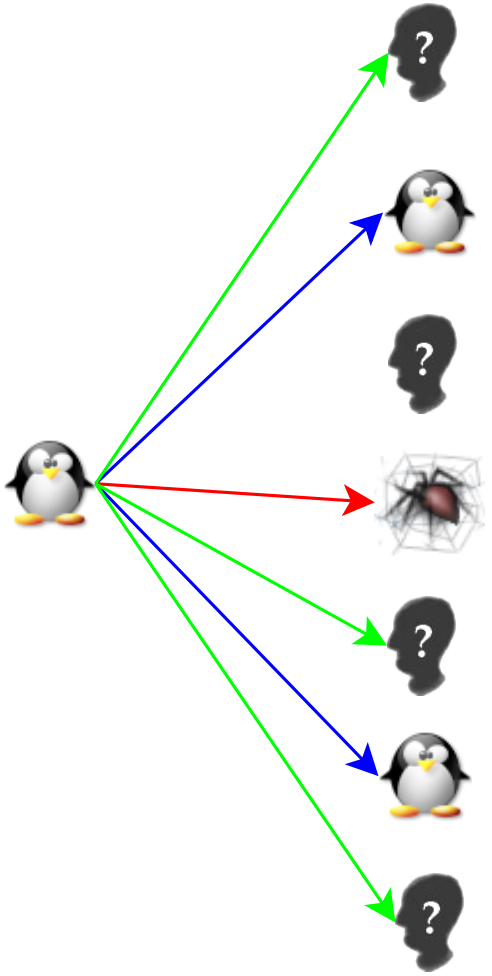
- keep asking until you're bored

$$\vec{t_i} = (C^T)^n \vec{c_i}$$



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- similarity with PageRank:
  - Random-Surfer
  - jump from peer i to peer j with probability c_{ij}
  - $\vec{t}$ is the stationary distribution of the MC define by matrix C

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Simple EigenTrust Algorithm

$\vec{t}^{(0)} = \vec{e}$

repeat

$\vec{t}^{(k+1)} = C^T \vec{t}^{(k)}$

$\delta = \|\vec{t}^{(k+1)} - \vec{t}^{(k)}\|$

until $\delta < \epsilon$

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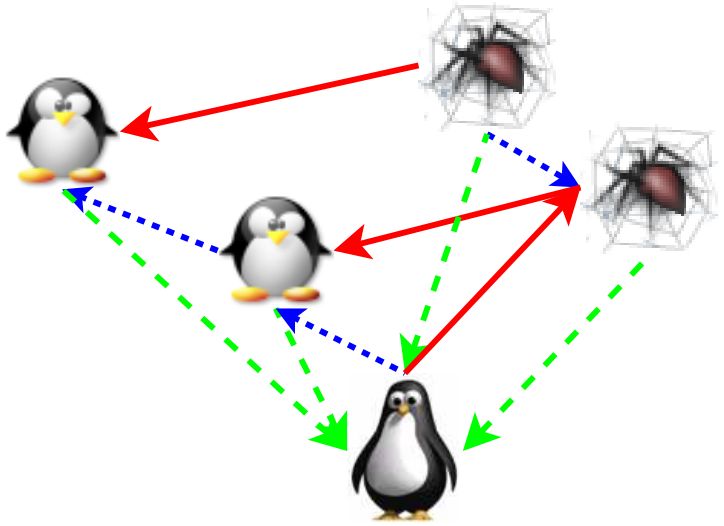
  - define a distribution $\vec{p}$ over pre-trusted peers
- inactive peers: peer i is a newcomer or doesn't have any interaction with other peers

$$c_{ij} = \begin{cases} c_{ij}, & \text{if } \sum_j \max(s_{ij}, 0) \neq 0 \\ p_j, & \text{otherwise} \end{cases}$$



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- Key observation: pre-trusted peers will remain anonymous:
  - *nobody need to know their* p_i

Notations:

- A_i: set of peers which have downloaded files form peer i
- B_i: set of peers from which peer i has downloaded files

Distributed EigenTrust Algorithm

foreach peer i

ask peer $j \in A_i$ for c_{ji} and ${t_j}^{(0)} = p_j$

repeat

$t_i^{(k+1)} = (1-a)(c_{1i}t_1^{(k)} + c_{2i}t_2^{(k)} + \ldots c_{ni}t_n^{(k)}) + ap_i$

send your opinion c_{ij} and trust value $t_i^{(k+1)}$ to all peers $j \in B_i$

wait for all peers $j \in A_i$, to respond with their opinion c_{ji} and trust value $t_j^{(k+1)}$

until $|t_i^{(k+1)} - t_i^{(k)}| < \epsilon$

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- Why hash them ?
  - every peer compute at least a trust value
  - peers doesn't know how's trust value is computing
  - malicious peers are not encouraged to report wrong values

Notations:

each peer has a number M of SM

$\vec{pos}_i$ the hash mapping of peer i

D_i - the set of peers for whom i is SM

for each $d \in D_i$, c_d^i is LTV of d maintained by i

Secure EigenTrust Algorithm

foreach peer i **do**

submit local trust values to score managers

collect local trust values

submit local trust values c_{dj} to score managers

foreach daughter peer $d \in D_i$ **do**

ask peer $j \in A_d^i$ for $c_{jd}p_j$

repeat

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Load Distribution Algorithm

get $T = \{t_1, t_2, \ldots, t_R\}$

repeat

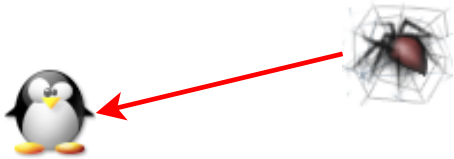
choose a peer j with $t_j \in T$

if receive inauthentic file form j **then**

delete t_j from T

until authentic file received

- **Malicious Individuals:**
  - peers that always provide inauthentic files.



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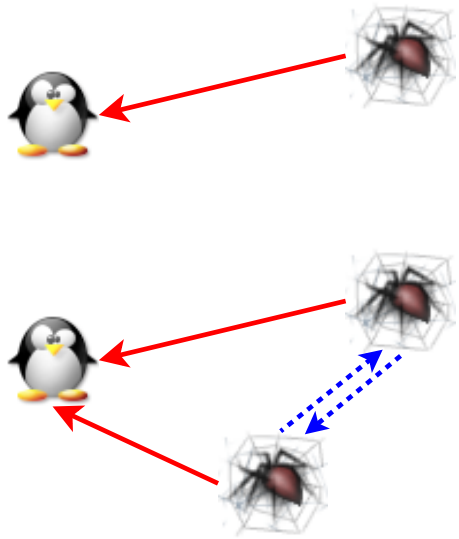

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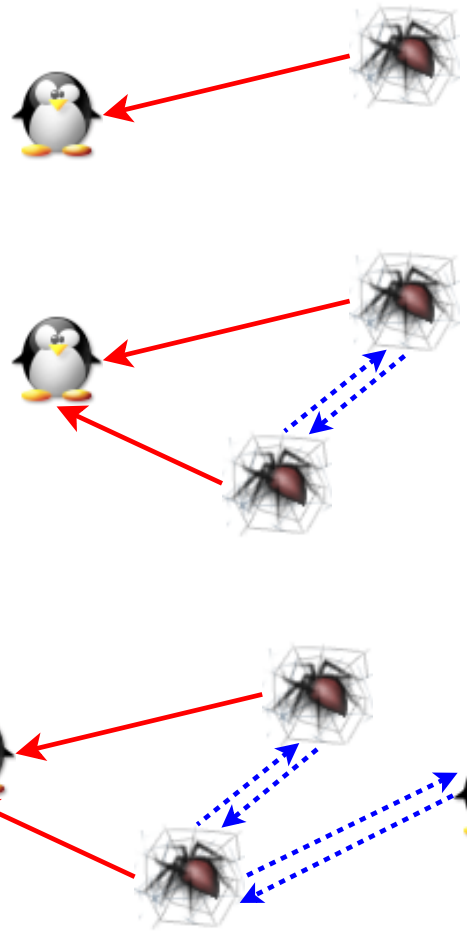

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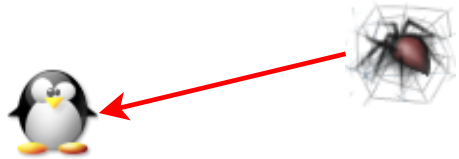
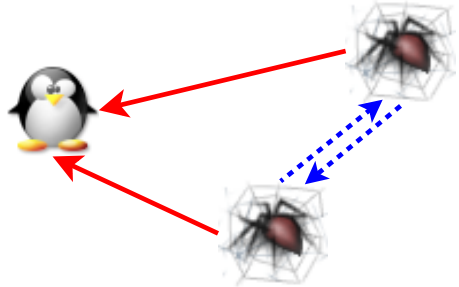
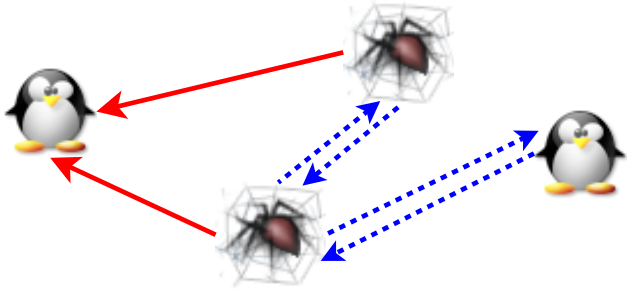
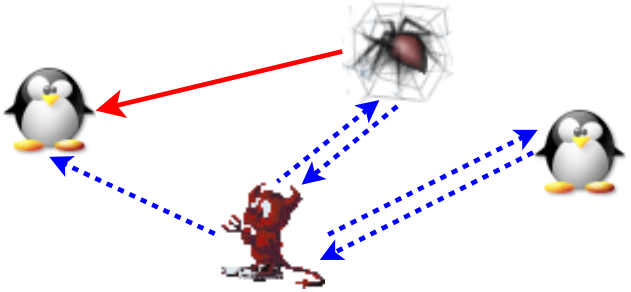
  - some members of the collective give good files all the time, but give good feedback to malicious peers.









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- **lows:**
  - what happens with a dynamically changing network ???