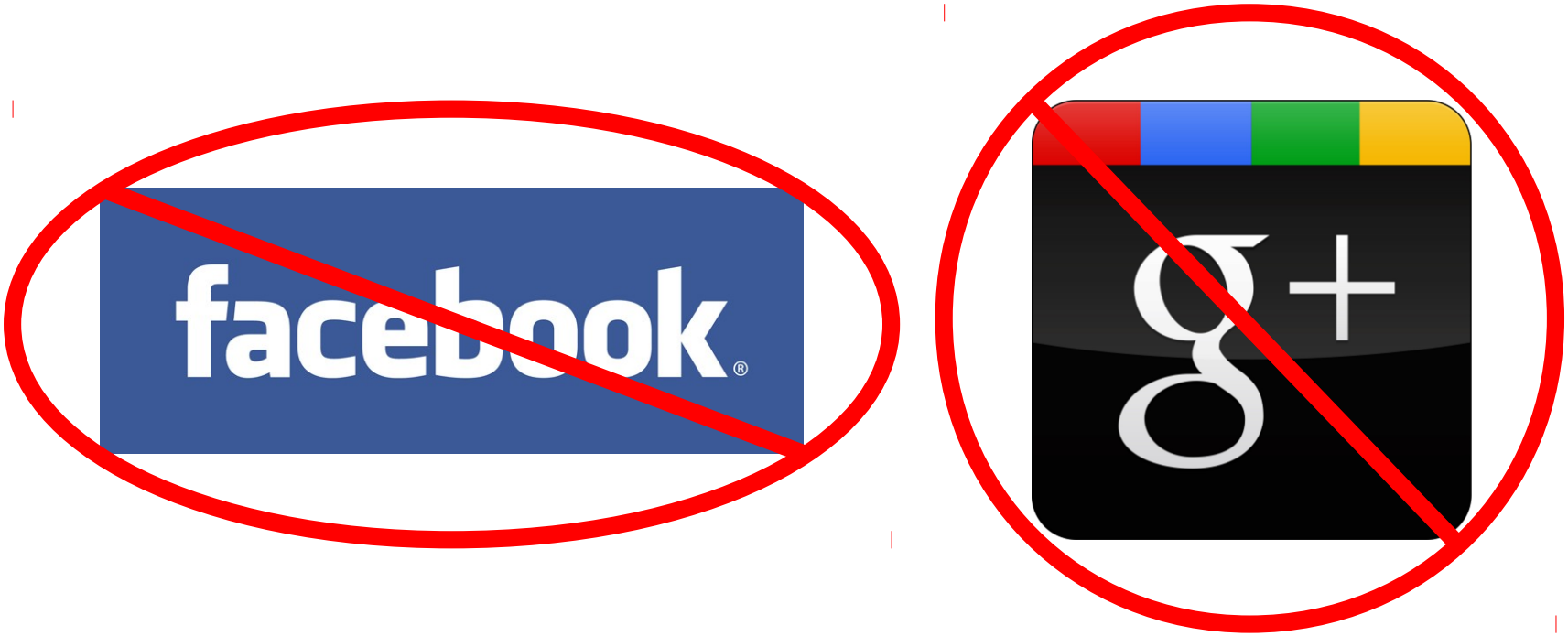
On Finding Better Friends in Social Networks

Philipp Brandes
Roger Wattenhofer

ETH Zurich – Distributed Computing – www.disco.ethz.ch

How to Choose Friends?



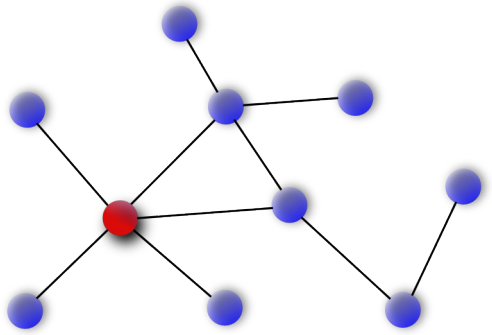
- Not this kind of friends, but actual friends
- Limited, constant number of friends
- Want to maximize global welfare

Overview

- Motivation
- Model
- Global vs Local
- Local vs Local
- Conclusion/Outlook

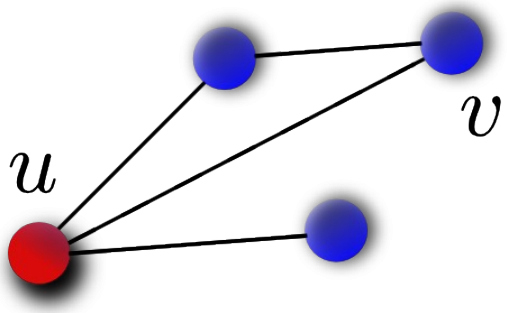
Model

- Given graph with n nodes
- Node v can have k_v friends
- Given symmetric edge qualities $q(u,v) \in [0,1]$
- Welfare of a node u: $\sum_{v \in N(u)} q(u,v)$
- Global welfare: $\sum_{u \in V} \sum_{v \in N(u)} q(u,v)$
- Local, distributed algorithms to find friends
- Local view ℓ

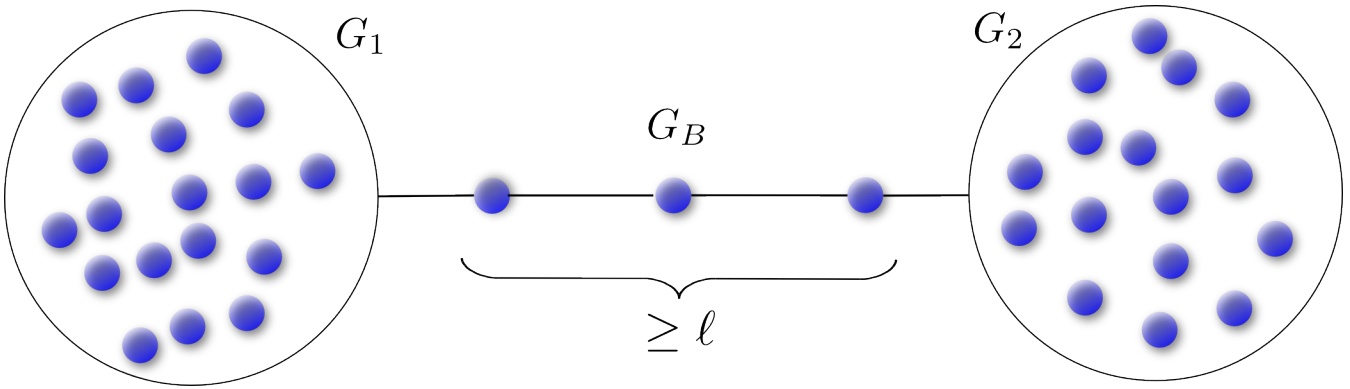


Model

- Node u suggests friendship to v
- Node v can accept
- Only better friends (will reach stable state)
- Round robin activation model



Local vs Global

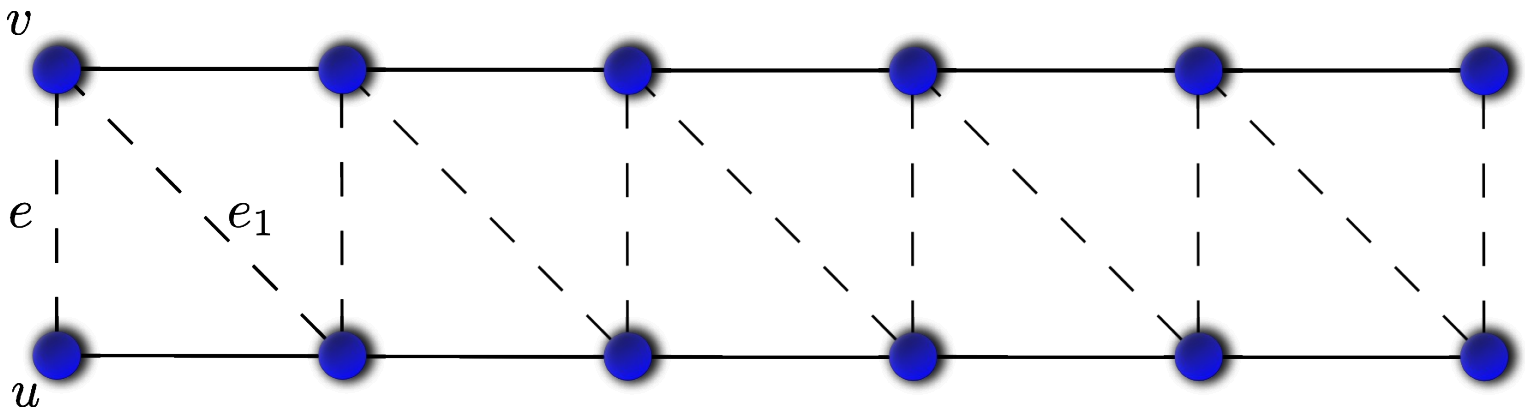


$q(u,v)$	$u \in G_1$	$u \in G_2$	$u \in G_B$
$v \in G_1$	ε	1	ε/2
$v \in G_2$	1	ε	ε/2
$v \in G_B$	ε/2	ε/2	ε

- Welfare achievable by any local algorithm: $O(\varepsilon n)$
- Welfare achievable by optimal, global algorithm: $\Theta(n)$
- Arbitrarily worse than optimum

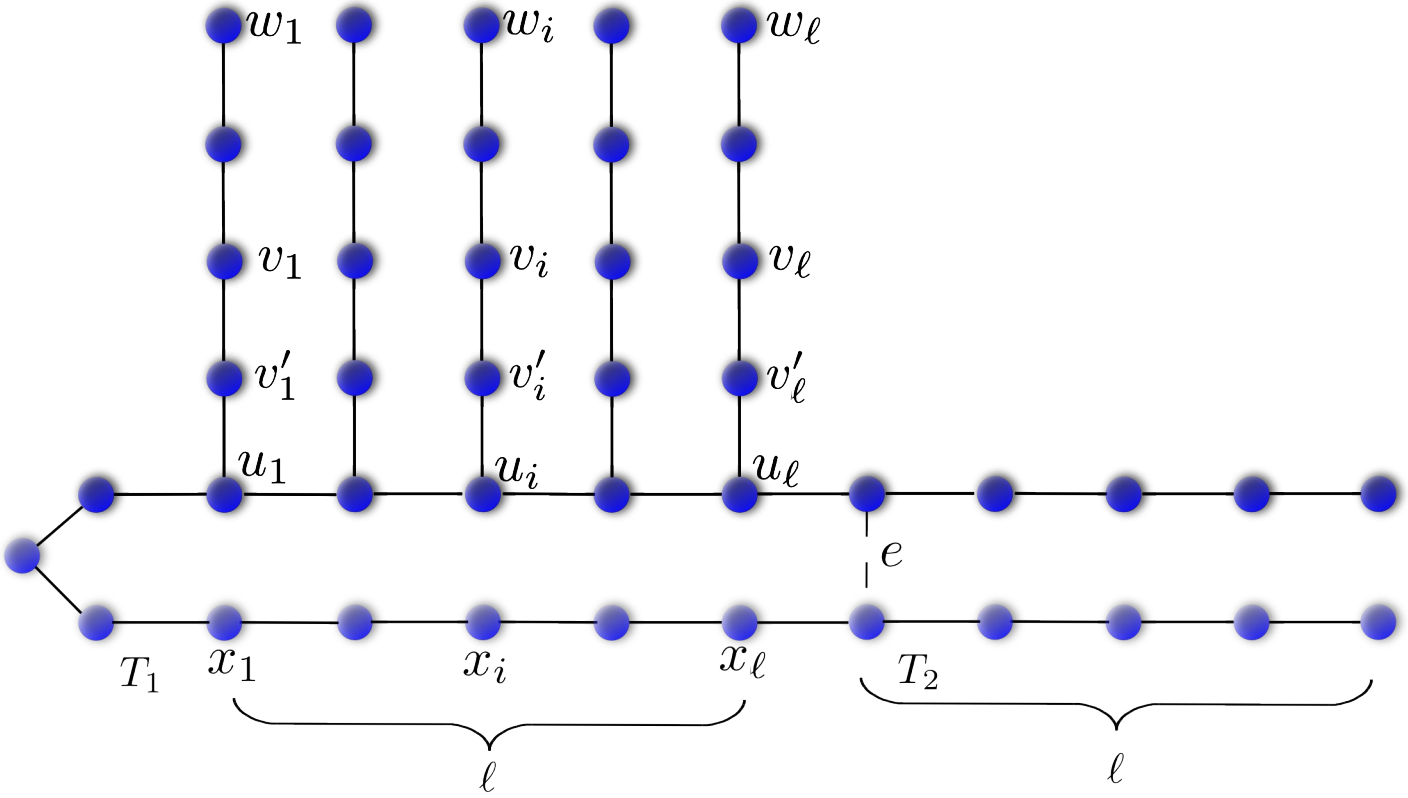
Local vs Local

- Is there a best local algorithm?



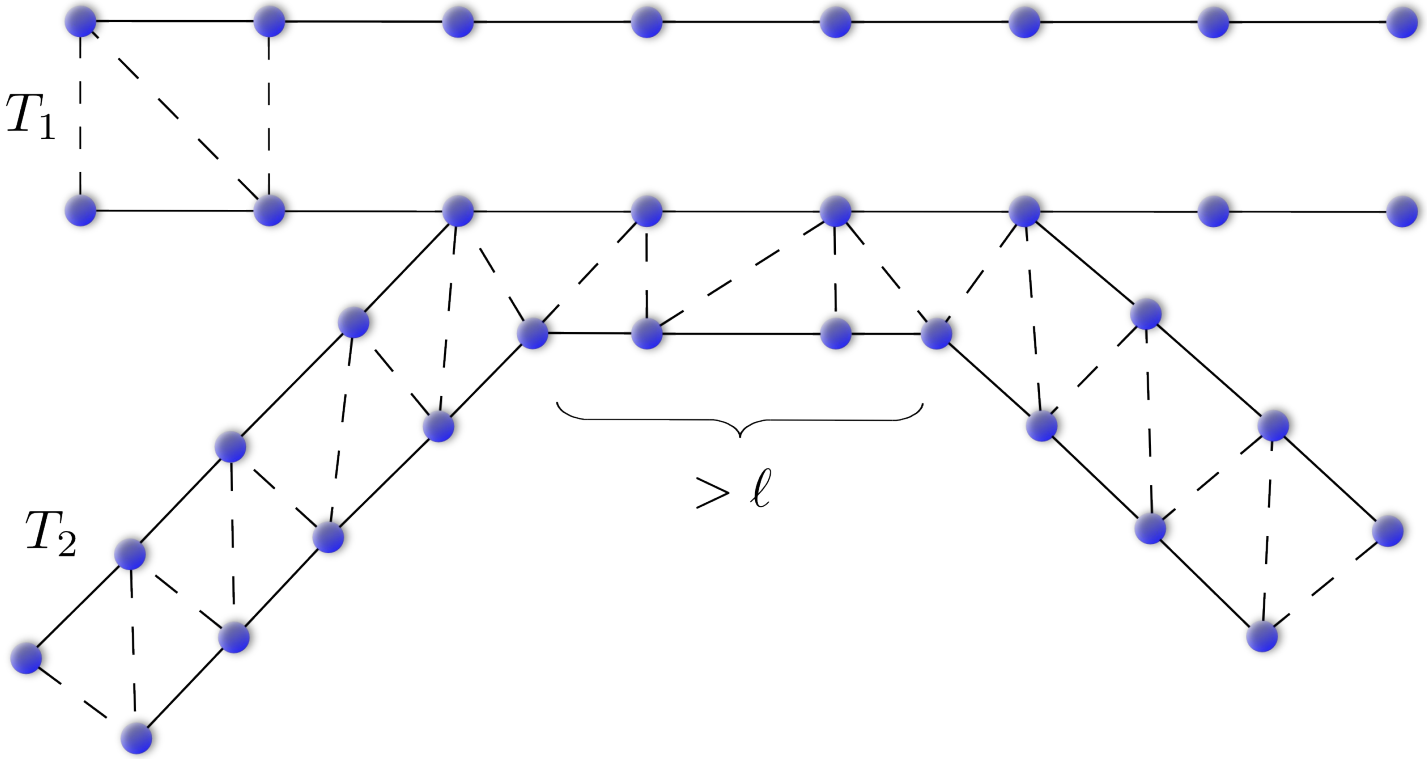
- e needs to be created if track is supposed to be explored
- Successful track if when explored yields welfare of $\Omega(n)$

Local vs Local



- $q(u_i, v_i) > q(u_i, x_i)$
- Any algorithm has to decide whether to explore the track

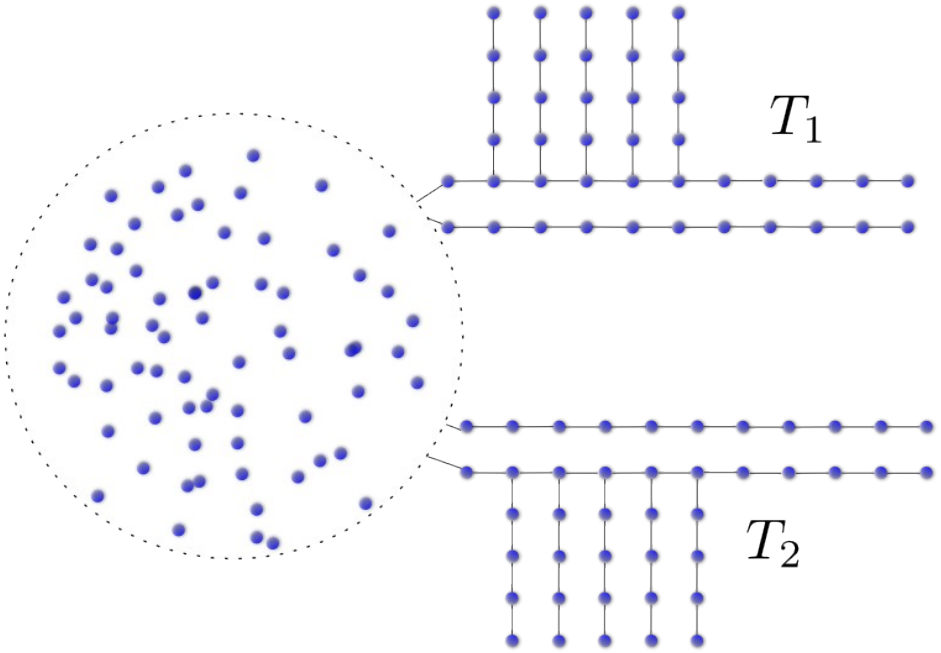
Local vs Local



- Track T_1 is blocked by track T_2
- Combine tracks
- Arbitrarily worse than another local algorithm

Local vs Local

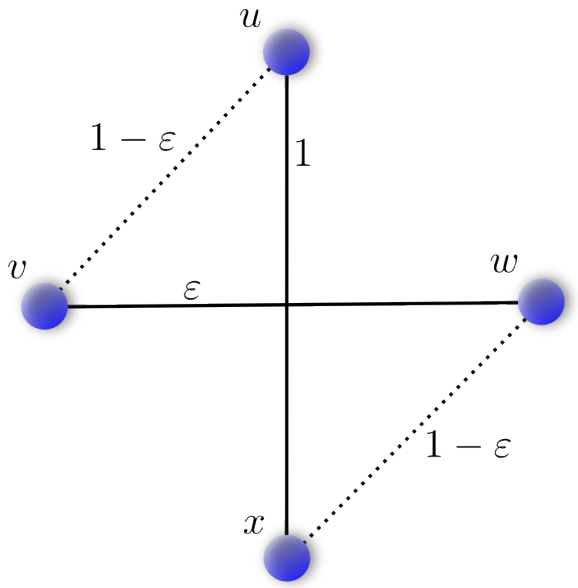
- Execute several algorithms in parallel
- Only constant number of algorithms can be executed



- Concatenate constant number of subgraphs
- Arbitrarily worse than another local algorithm

Local vs Local

- Every node tries to select best friends greedily in the end
- Friendship gets established if both nodes agree
- Can achieve factor 2 approximation compared to best executed algorithm

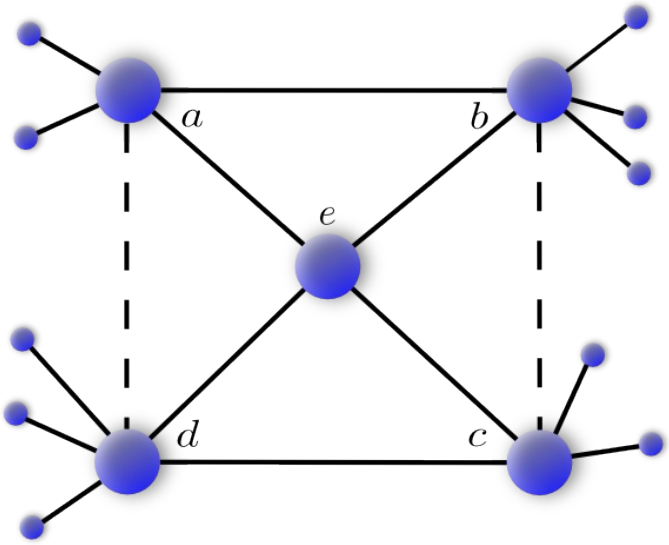


- Bound is tight

Friends of Friends

- Include friends of friends in quality function
- $Q(u,v) := q(u,v) + c \sum_{x \in N(v) \setminus \{u\}} q(u,x)$
- Leads to asymmetric valuations

$Q(a,b) > Q(a,c)$ $\quad$ $Q(b,c) > Q(b,a)$ $\quad$ $Q(c,a) > Q(c,b)$



- Stable roommate problem
- No stable state

Conclusion/Outlook

- Choosing friends is difficult
- Local algorithms perform arbitrarily worse

- How to generalize these results?
- Which are the conditions under which all local algorithms perform badly?

- Questions?