# Task Routing for Prediction Tasks

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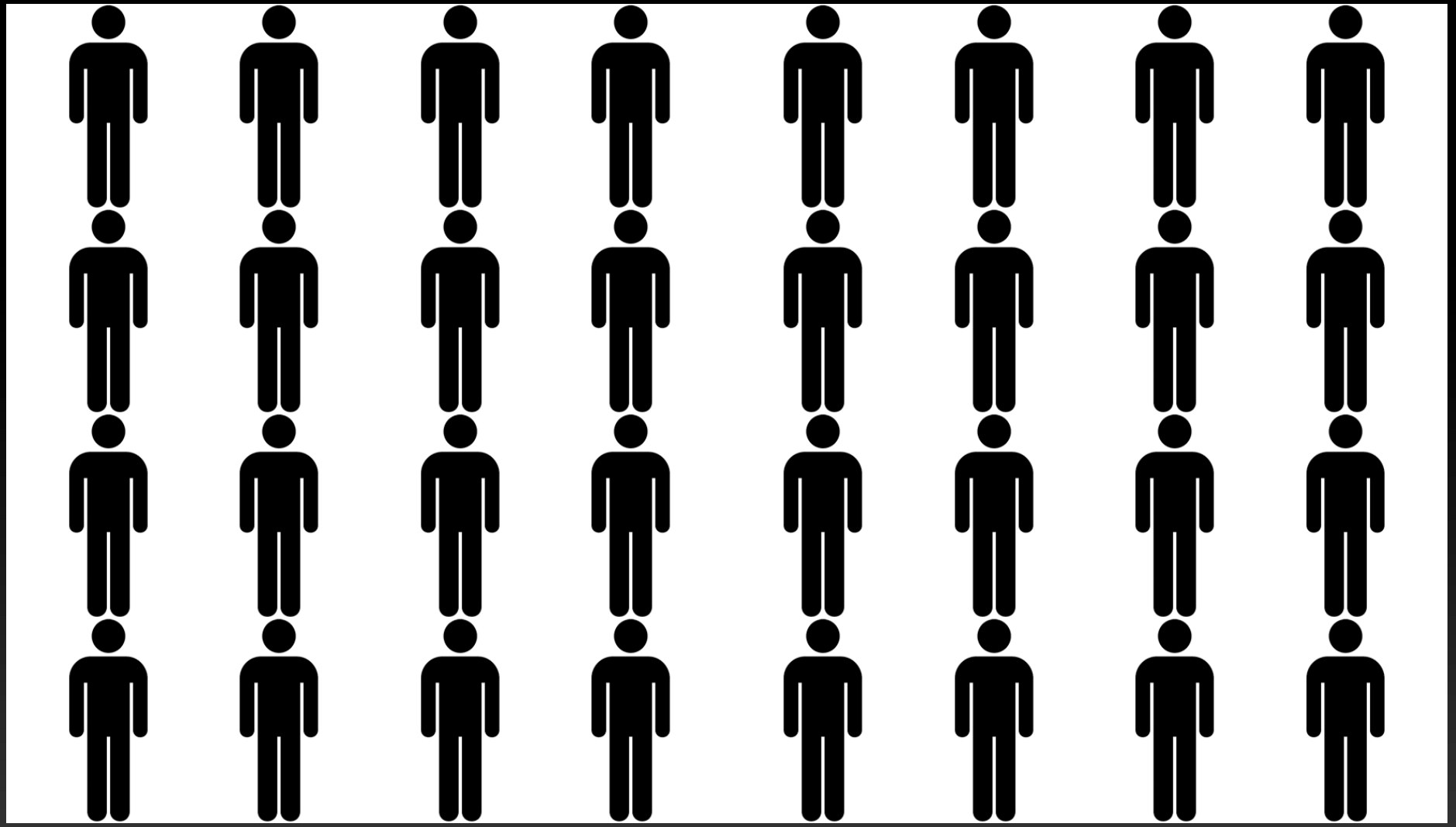
Workshop on Social Computing and User Generated Content

# Let’s do a poll.

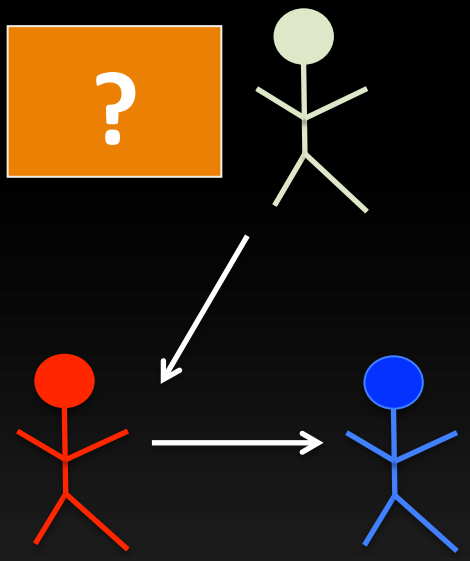
# Expertise is among us



# We know each other's expertise

facebook

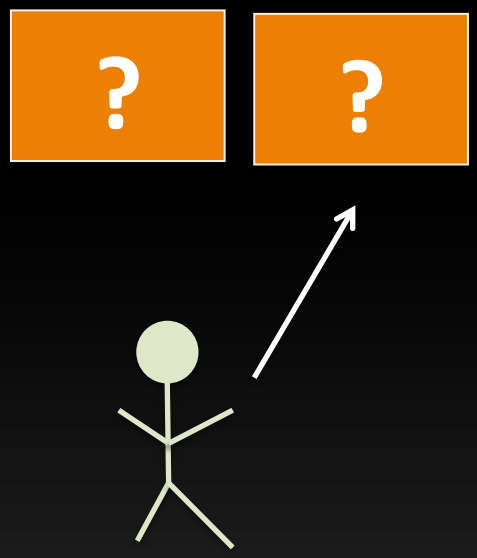
# Leveraging expertise and knowledge of others' expertise



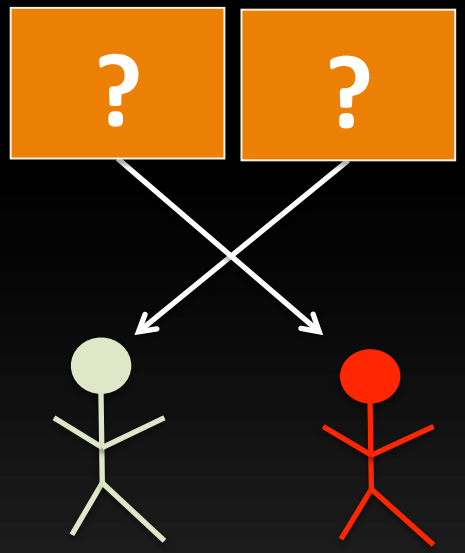
# Task Routing

Leverage people's abilities to jointly solve problems and to route problems to others who can further contribute.

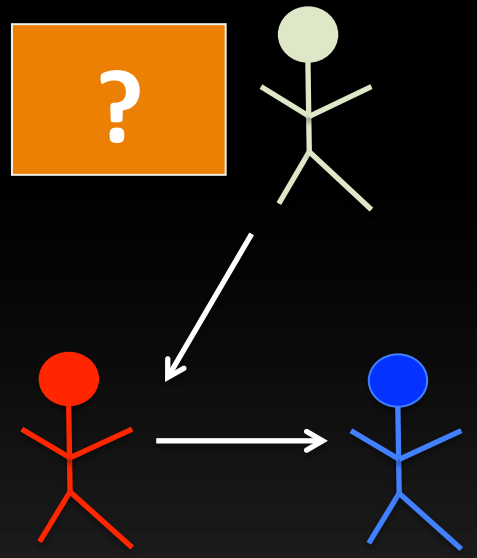
Pull




Push




Route



# Our work

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- Task routing for prediction tasks
  - Incentives for solving and routing

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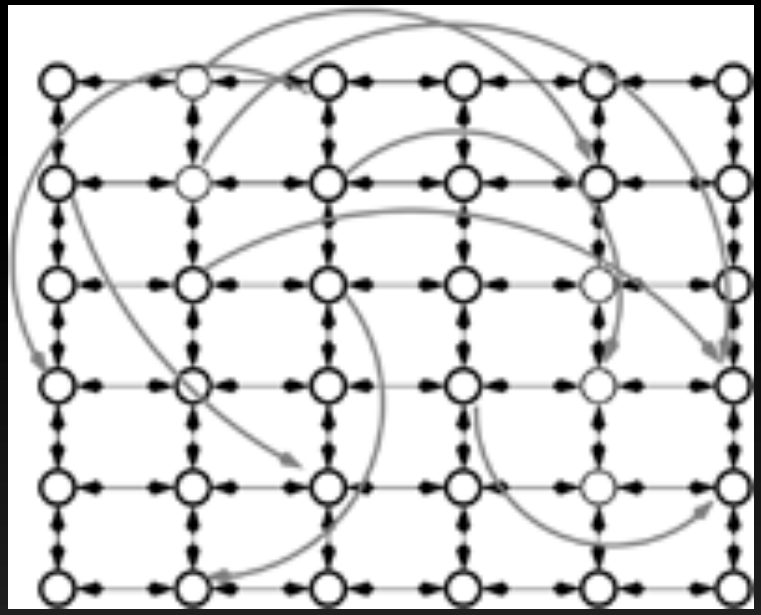
- Task routing for prediction tasks
  - Incentives for solving and routing
- Two cases:
  - Common knowledge
  - Local common knowledge
    - Local routing rules (tractable and good)

# MIT's red balloon mechanism
[Pickard et al.]


Provides incentives for "spreading the word."

# Decentralized Search
[Kleinberg]



Route message towards destination using only local information

# Model

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- Task: predict answer to a yes/no question whose answer is revealed in the future

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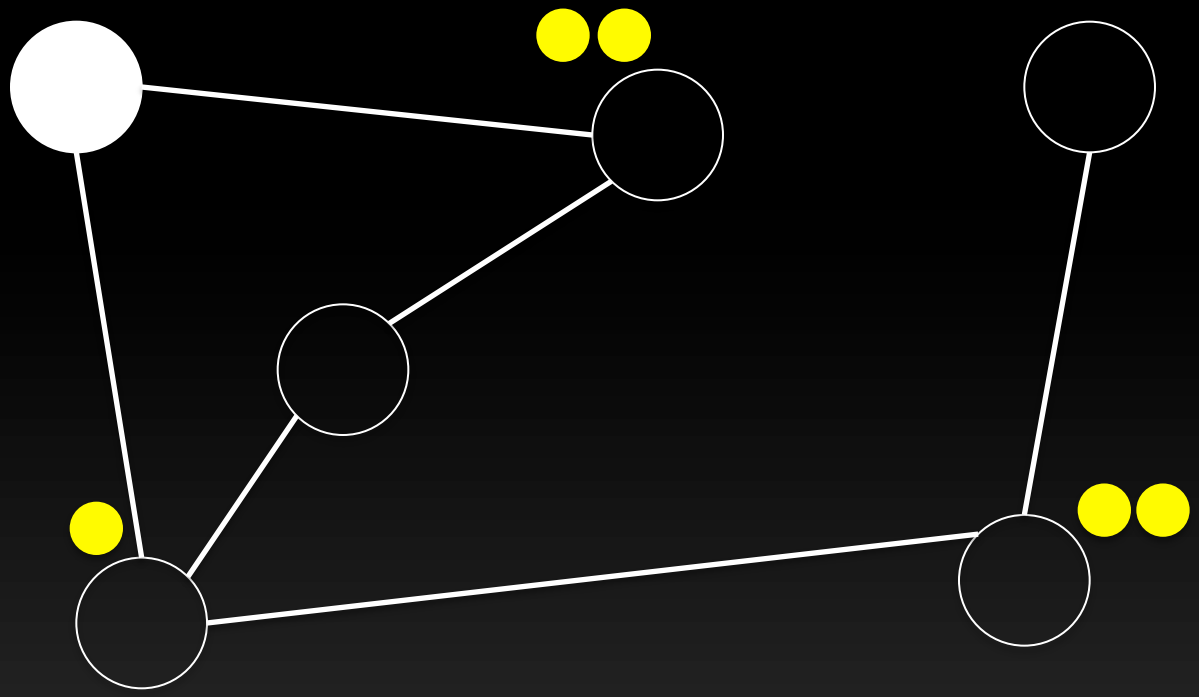
- Task: predict answer to a yes/no question whose answer is revealed in the future
- Discrete time $t = 1, 2, 3, \ldots, R$
- A person receiving the task can:
  - update the current probability estimate
  - route the task to a neighbor on the network

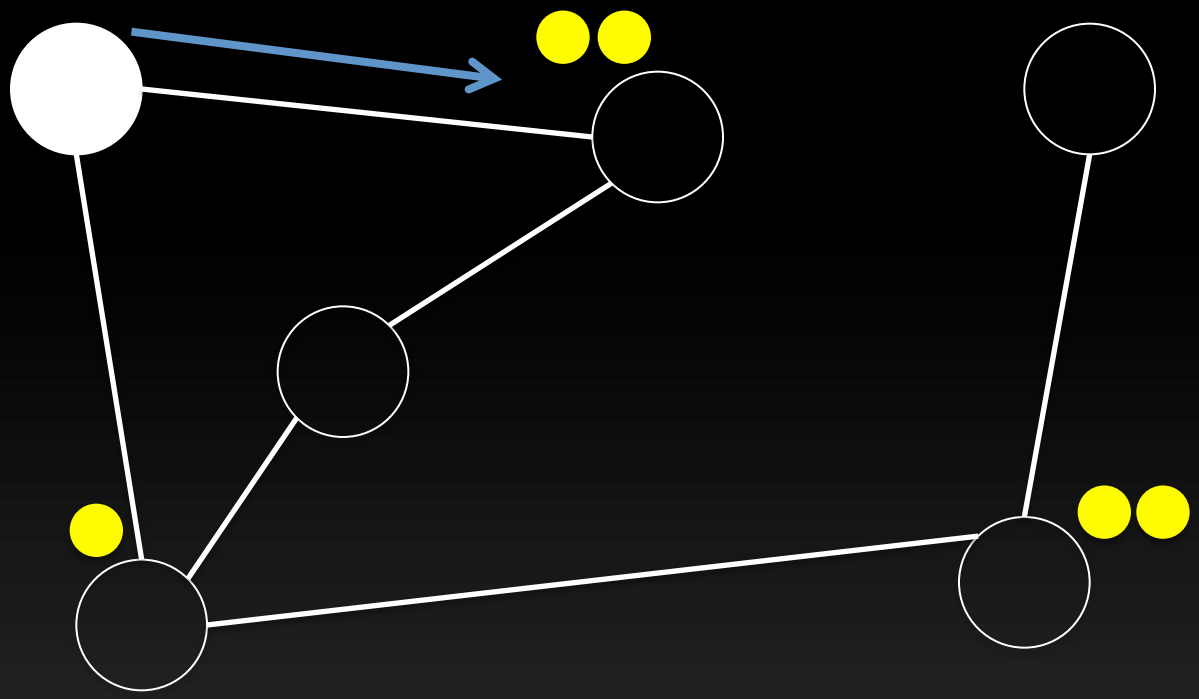
# Information structure

- Players observe coin flips
  - Probabilistic signal of what the answer is
  - More coin flips == more information
- Assume coin flips are conditionally independent
- Players may know how many coin flips others observe

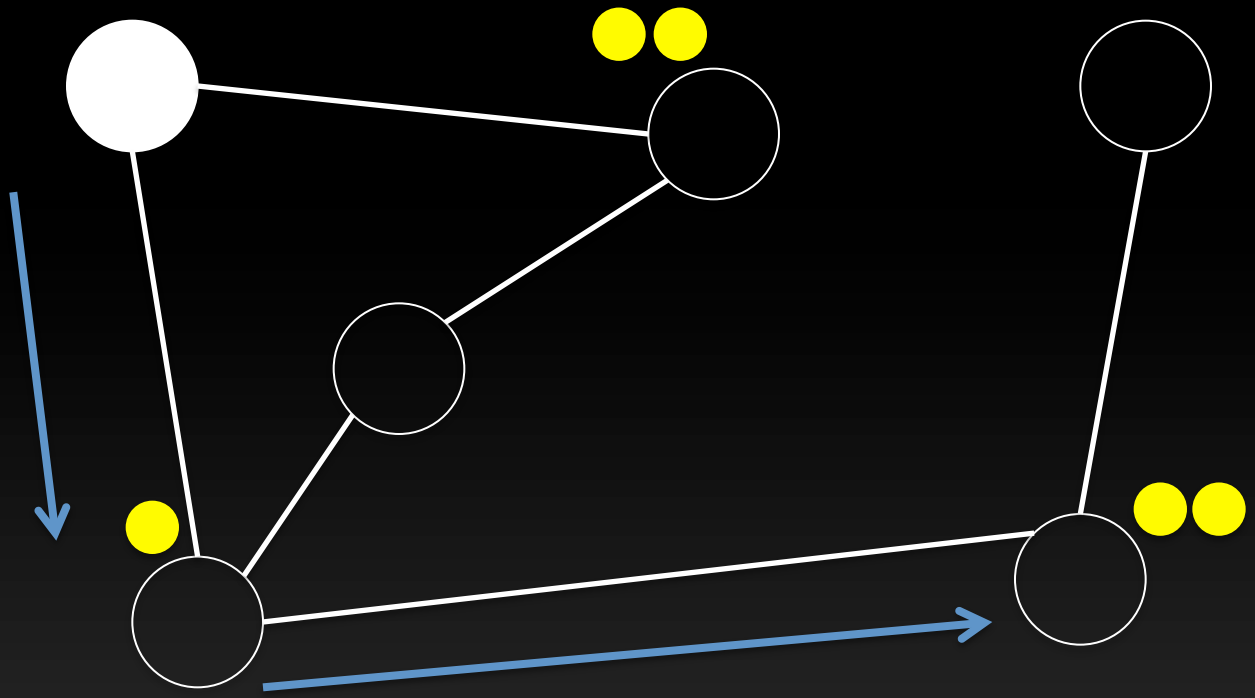
# Example



# Example with routing



# Example with routing



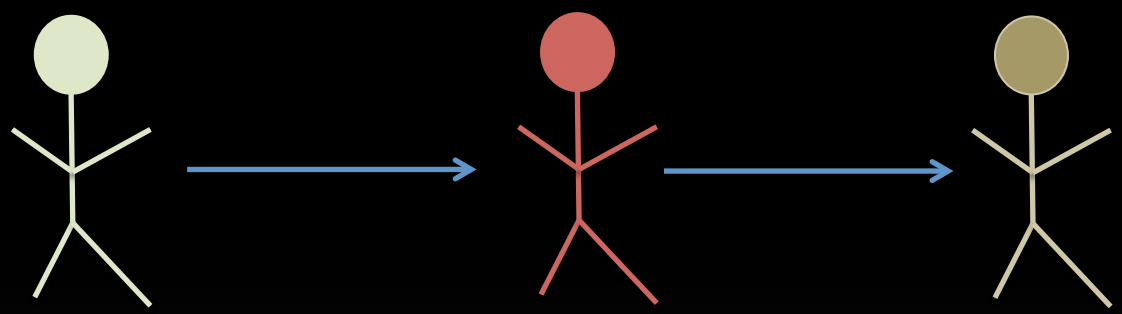
# Goal

- Want each player to:
  - Properly update probabilities
  - Route task to someone with many coin flips
- Idea:
  - Use proper scoring rules to incentivize update
  - `Properly score' routing decisions?

# Common knowledge

**Assumption:** everyone knows how many coin flips everyone else has, and this is common knowledge.

# k-step routing scoring rule



$$\alpha S_i - S_{i-1} + (1-\alpha)S_k$$

Score for update

Score for routing decision

# Theorem

Under the *R*-step routing scoring rule, it is a Perfect Bayesian Equilibrium for people to update probabilities truthfully and to route to the next person in the optimal path of length *R*.

# Implications

- Can incentivize local routing decisions that follow the optimal coin-collecting path.

- But…
  - Computing the optimal path is in general NP-hard
  - Common knowledge assumption is unreasonable for large networks

# Without common knowledge

- People may have different information about others' expertise on the network

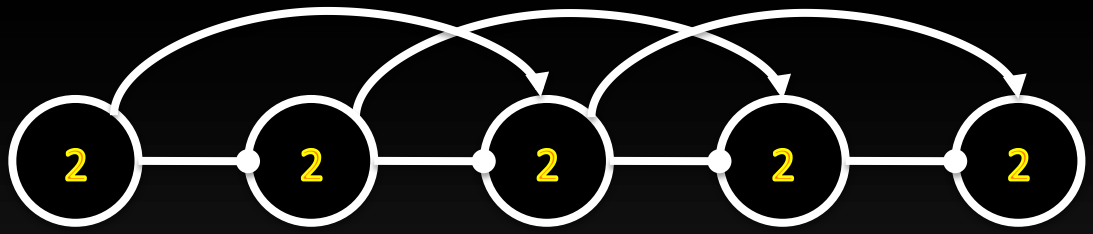
- To route optimally, have to reason about what other's know and don't know

  → "optimal routing" is highly impractical

# Local common knowledge

**Assumption:** everyone that is within some distance of a person has the same information about that person.

# 2-2-2-2



# 2-1-2-1


Breaks the chain of reasoning

# *m*-hop local routing rules

1-1-1-1 (myopic)

2-1-2-1

3-2-1-3-2-1

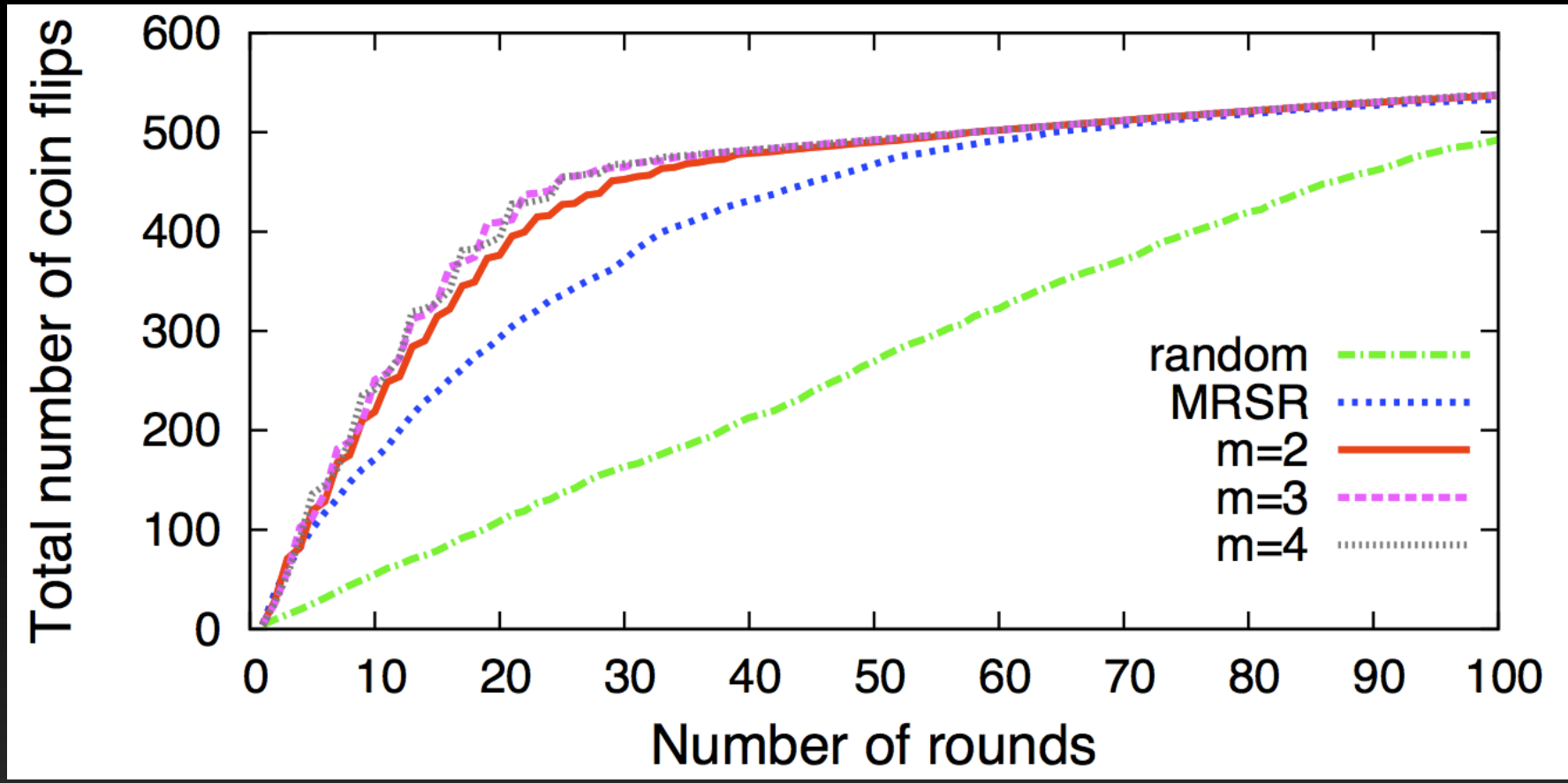
4-3-2-1-4-3-2-1

….

# Theorem

Assume *m*-hop local knowledge holds. Under a *m*-hop local routing rule, it is a Perfect Bayesian Equilibrium for everyone to update probabilities truthfully and to route to the next person in the optimal path of length *m*.

# Simulation results

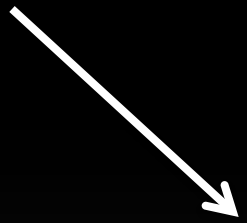


# Conclusion

- Task routing for prediction tasks explores connection among incentives, solving, routing, and knowledge
- Intriguing class of local routing rules that induce effective routing behaviors while promoting a simple equilibrium where people only reason about what they know
- Rich space of practical and theoretical questions

# Thank you

Comments



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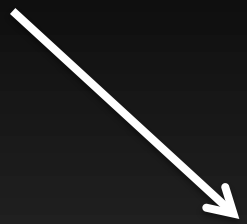

my co-authors