



# Economics and Computation

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Rensselaer

# This Course

- **Economics**: **decision making** by multiple **actors**, each with individual **preferences**, capabilities, and information, and **motivated** to act in regard to these preferences.
- **Computer science**: study of **representation** and **processing** of information for the purpose of specific **calculation** tasks.
- Breadth over depth

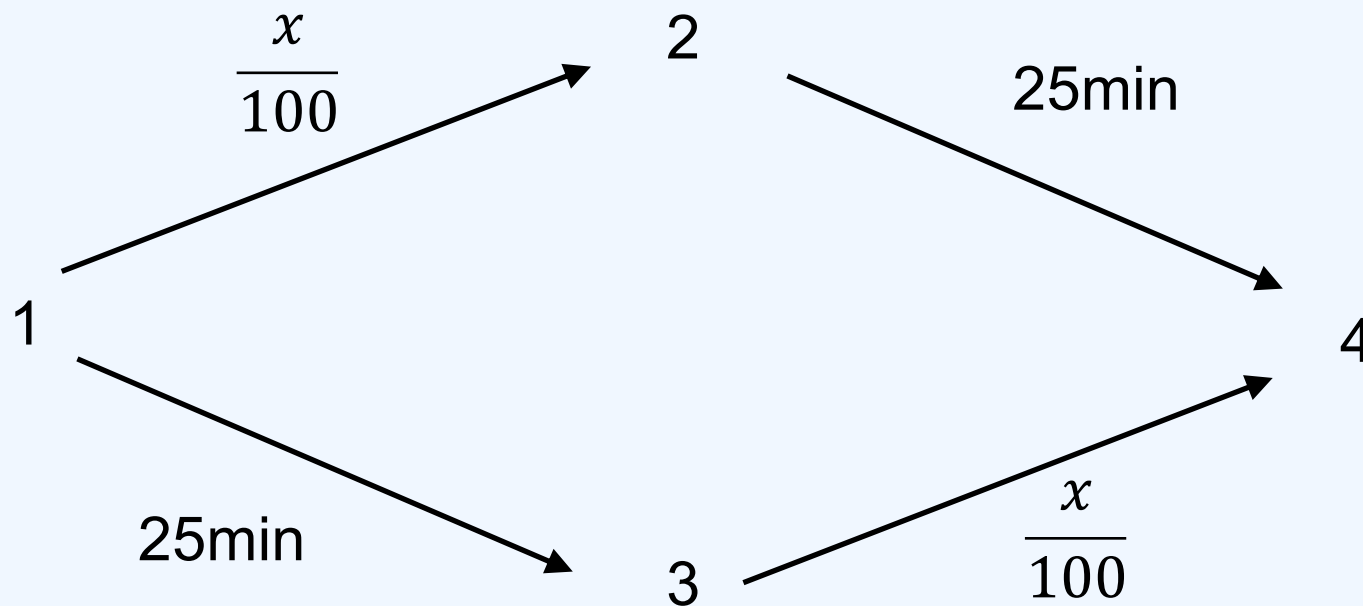
Mostly a math course

# Rules and Suggestions

- “Theater rule”: no electronics in class
  - Unless explicitly told
  - You may printout slides (useful in exams anyway)
  - If you insist on using electronic, please sit in the back row
- Take notes if possible
- Questions are very welcome
  - If you don't ask me, I may ask you (random quiz)

# Tragedy of the commons: Braess' Paradox

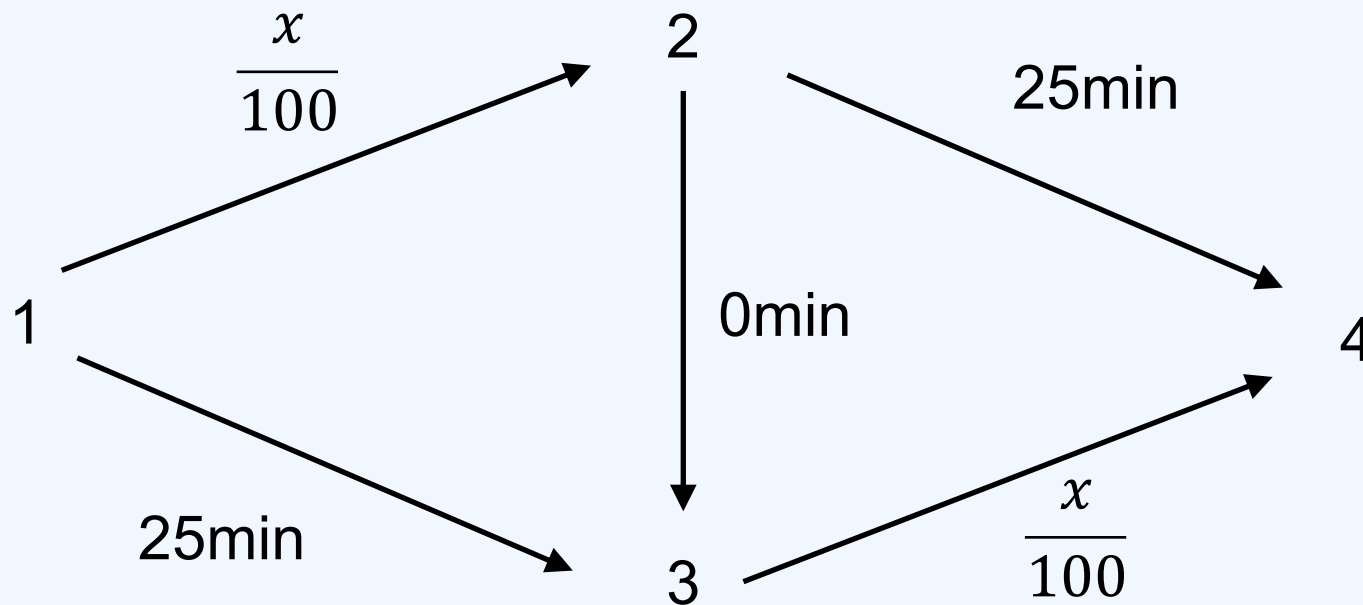
- 2000 travelers from 1 to 4



- Centralized goal: minimize max delay
  - 1000 1 → 2 → 4; 1000 1 → 3 → 4;
  - minimax delay: 35min
- No one wants to deviate

# Tragedy of the commons: Braess' Paradox

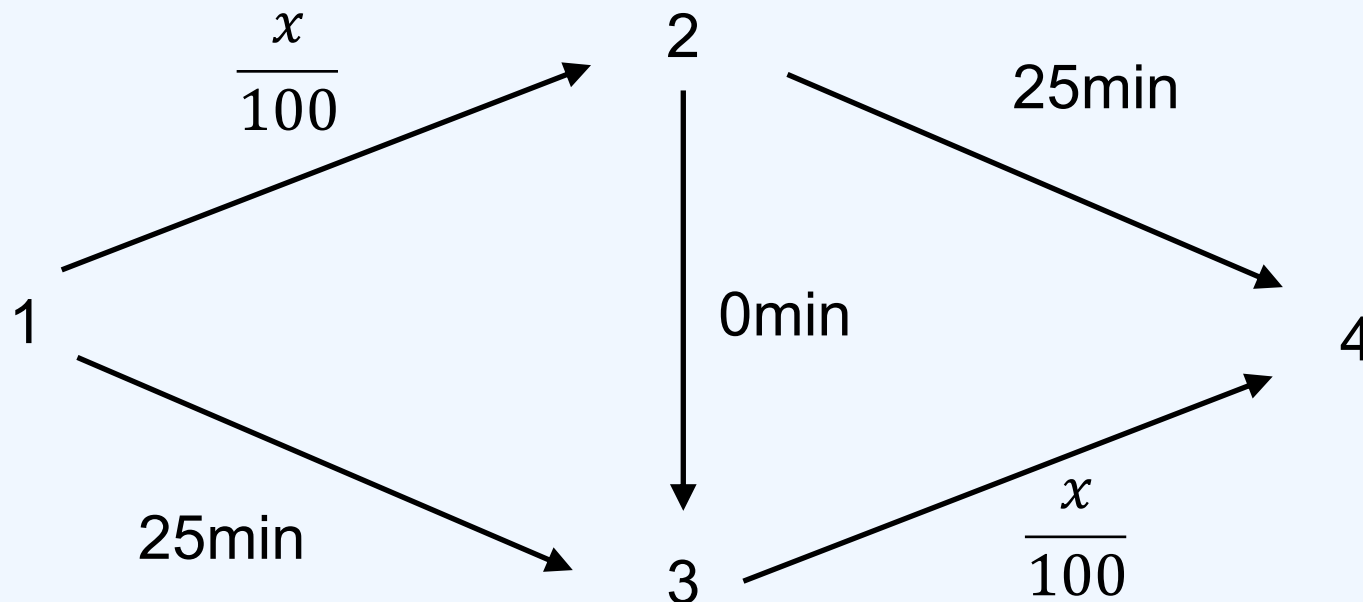
- 2000 travelers from 1 to 4



- Centralized goal: minimize max delay
  - 1000  $1 \rightarrow 2 \rightarrow 4$ ; 1000  $1 \rightarrow 3 \rightarrow 4$ ;
  - minimax delay: 35min

# Tragedy of the commons: Braess' Paradox

- 2000 travelers from 1 to 4



- No one wants  $1 \rightarrow 3 \rightarrow 4$ 
  - $1 \rightarrow 2 \rightarrow 3 \rightarrow 4$  is always better
- No one wants  $1 \rightarrow 2 \rightarrow 4$ 
  - $1 \rightarrow 2 \rightarrow 3 \rightarrow 4$  is always better
- Everyone goes  $1 \rightarrow 2 \rightarrow 3 \rightarrow 4$ , delay is 40min each
- **Paradox**: worse than the system without  $2 \rightarrow 3$
- More in the “game theory” class



# Goal of the course

- How to analyze the outcome?
  - Social choice, game theory
- How to incentivize people?
  - Mechanism design
- Economics + Computation
  - Incentives + computational thinking

# Brief schedule

➤ (Algorithmic) Game theory

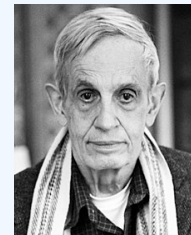
- 3 days



Myerson



Von Neumann



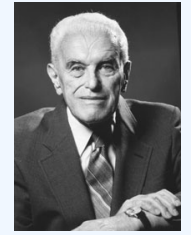
Nash



Selten



Aumann



Harsanyi

➤ Auctions

- 1 day

➤ Mechanism design

- 1 day



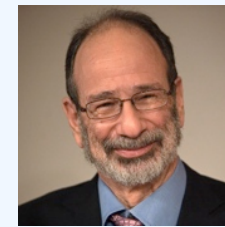
Vickrey

➤ (Computational) Social choice

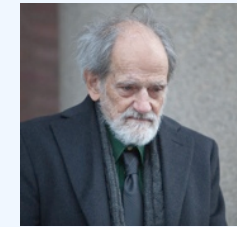
- 2 days



Arrow



Roth



Shapley

➤ Wisdom of the crowd

- 1 day

➤ Preference modeling

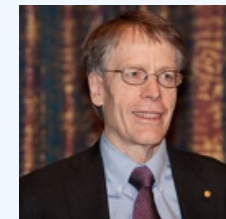
- 1 day



Kahneman



McFadden



Hansen

➤ Bitcoin and blockchain

- 1 day

# Example: Auctions

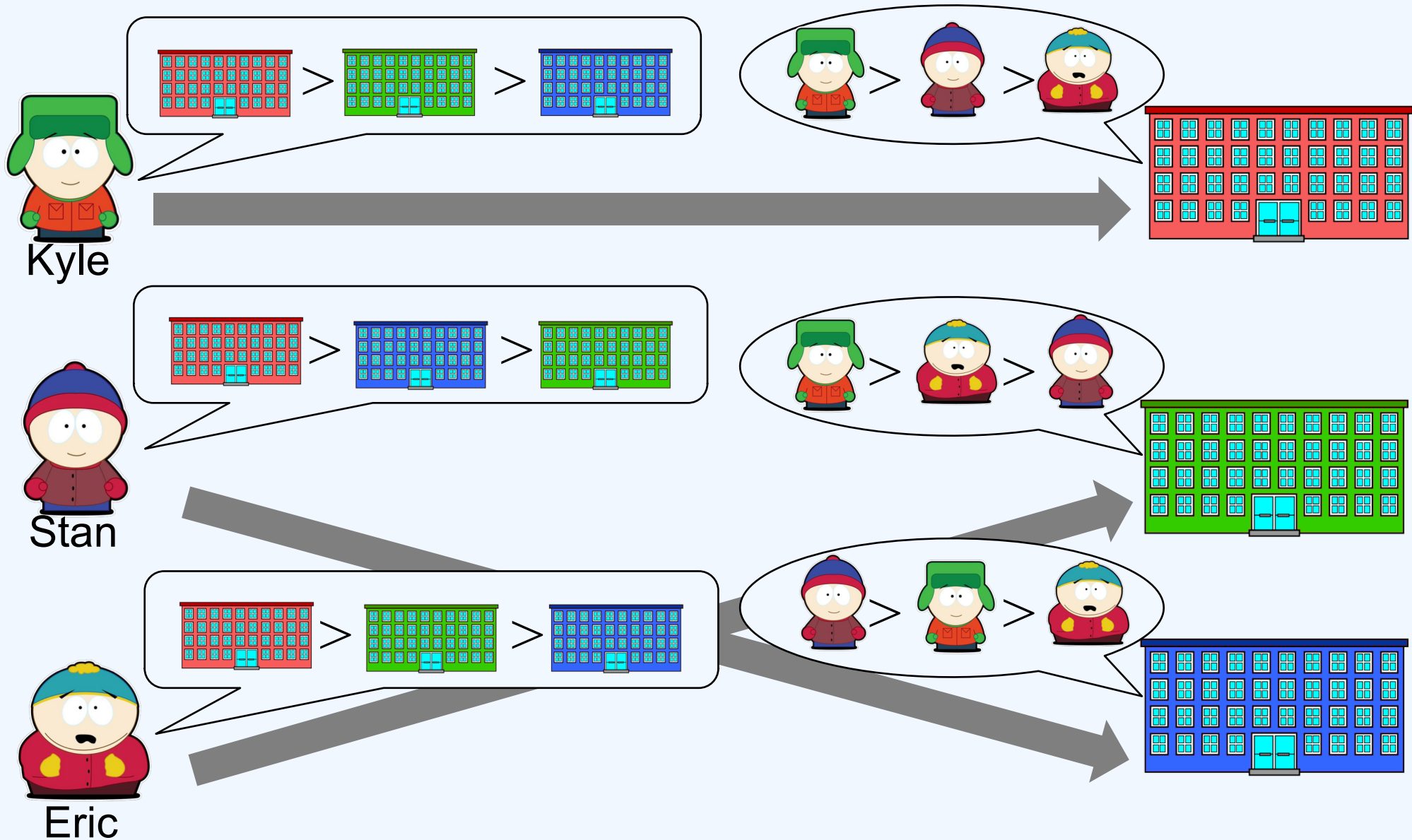


A screenshot of a Google search for 'macbook'. The search bar at the top contains the text 'macbook'. Below the search bar, there are navigation tabs for 'All', 'Shopping', 'News', 'Images', 'Videos', 'More', 'Settings', and 'Tools'. The search results indicate 'About 222,000,000 results (0.61 seconds)'. The main content area is titled 'See MacBook' and features five product listings. The first three are 13-inch MacBook Pro - Space Gray models with prices of \$1,299.00, \$2,399.00, and \$999.00 respectively. The fourth is an Apple Air, Silver model priced at \$374.99. The fifth is a Refurbished Apple MacBook Pro priced at \$349.20. Below the listings is an advertisement for 'MacBook - Behind the Mac | Apple' with a link to 'www.apple.com/' and a description: 'Behind the Mac people are making wonderful things and so could you. Shop now. More powerful than ever. Free two-day delivery. Apple Store pickup. Built-in Apps. Compare Mac models · Buy now · Apple GiveBack · Accessories for Mac'.

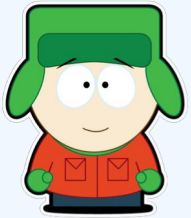
## ➤ 2<sup>nd</sup> price auction

- highest bid wins
- charged the 2<sup>nd</sup> highest price
- more in the “auctions” and “mechanism design” class<sup>10</sup>

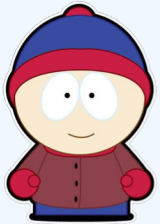
# Example: School choice



# Example: Resource allocation



1 > 2 > 3 > 4 > 5 > 6



1 > 6 > 2 > 3 > 5 > 4



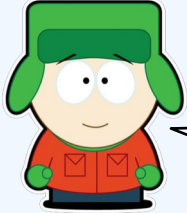
6 > 5 > 4 > 3 > 2 > 1

# Sequential allocation

0

||

Kyle



1 > 2 > 3 > 4 > 5 > 6

v

Stan









1 > 6 > 2 > 3 > 5 > 4

v

Eric



6 > 5 > 4 > 3 > 2 > 1

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
 1	 6	 5	 4	 2	 3

# Is it a good mechanism?

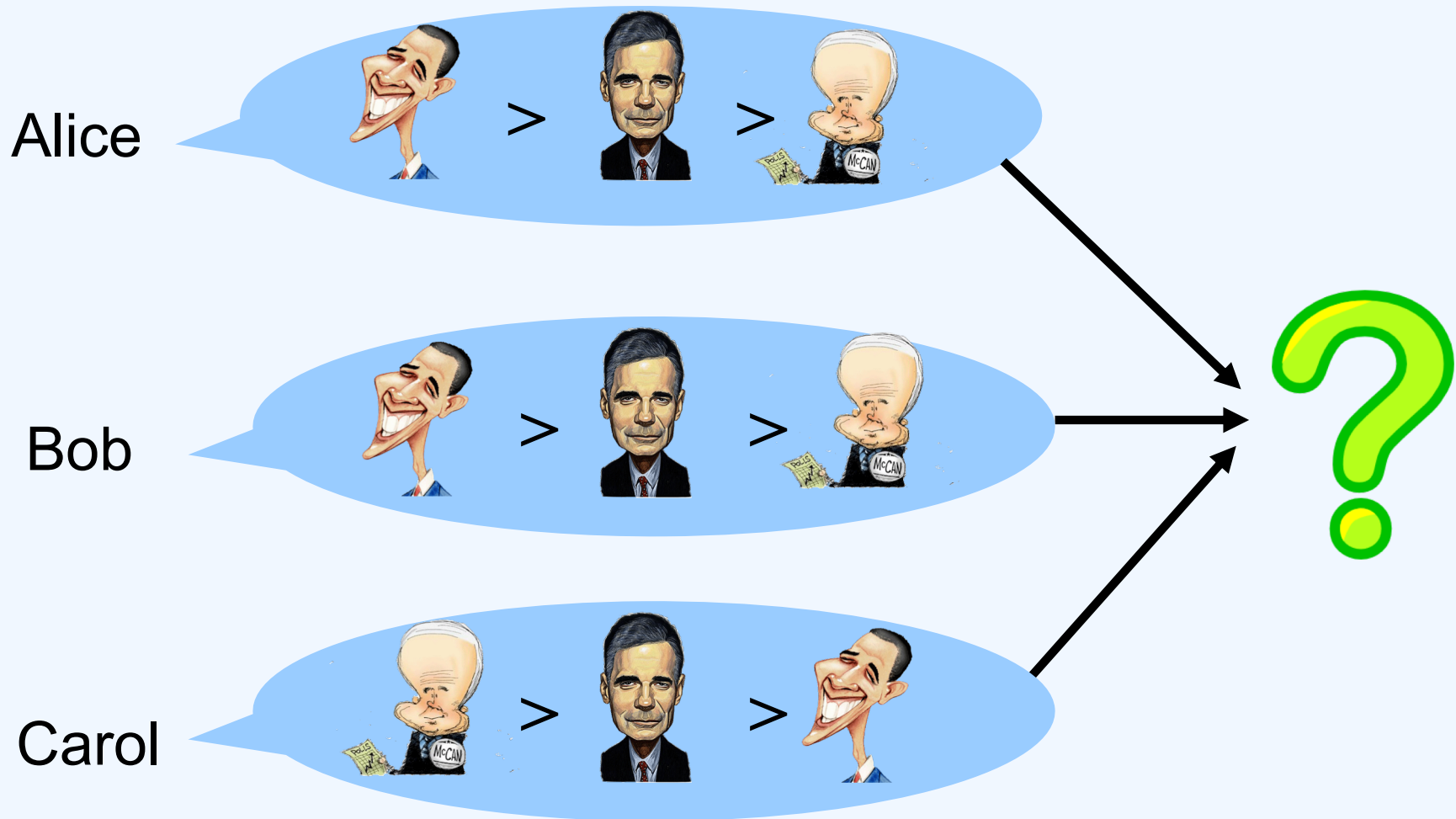
## ➤ Sounds good

- Efficient: if we have different preferences, then we will all (almost) get what we want
- Fair: (1<sup>st</sup> pick, last pick), (2<sup>nd</sup> pick, 2<sup>nd</sup> to last pick)...

## ➤ How can we formalize these ideas?

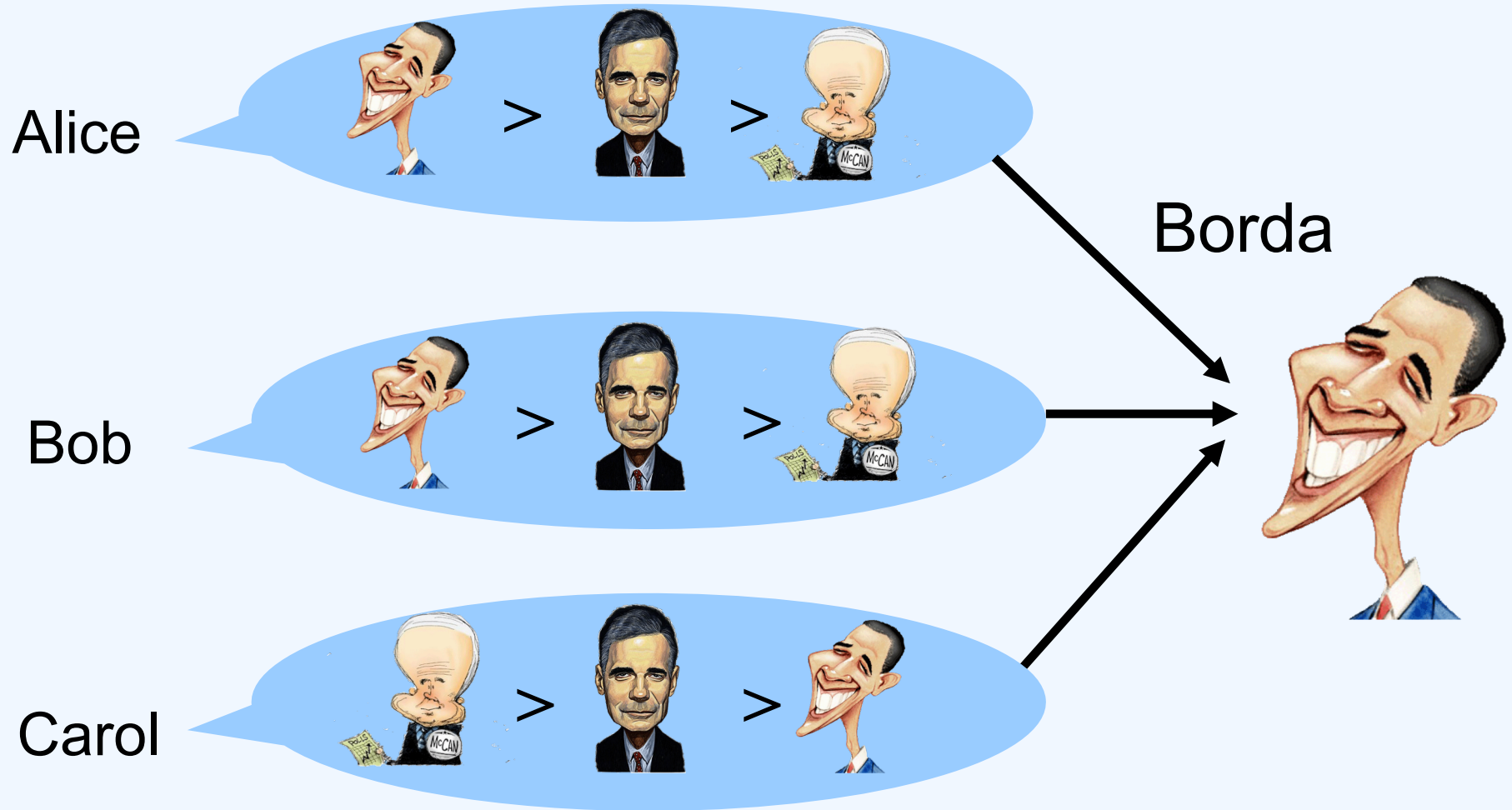
- more in “matching and resource allocation”

# Example 3: Political elections





# Example of Borda

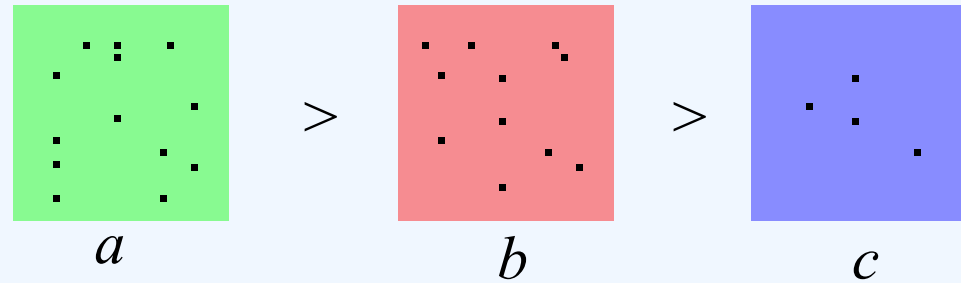


**Total scores** :  $2+2+0=4$  :  $1+1+1=3$  :  $0+0+2=2$

# Other voting rules?


- Many other voting rules beyond Borda will be discussed in the social choice class
- Which one is the best?
  - Hard to compare.
  - Criteria will be discussed in the social choice class

# Example: Crowdsourcing




amazonmechanical turk  
beta Artificial Intelligence

$a > b$


 Turker 1

$b > a$

 Turker 2

...

$b > c$

 Turker  $n$

# Optimal way to make a decision

- How can we make an optimal decision by aggregating noisy answers from strategic agents?
  - more in “Wisdom of the crowd”

# Grading, let's vote

## ➤ Final grades:

- Option1: **Participation** 10%; **Exam** 30%
- Option2: **Participation** 20%; **Exam** 20%
- Option3: **Participation** 30%; **Exam** 10%
- Option4: **Participation** 0%; **Exam** 40%
- Option5: **Participation** 40%; **Exam** 0%
- <https://campusopra.cs.rpi.edu/polls/1072/>



# Before tomorrow

- Sign up on piazza
- Sign up on OPRA and vote
- Print the slides if you want
- Remember to bring computer/smart phone for in-class voting (but don't use it in class otherwise)