Voting with Preference Intensities

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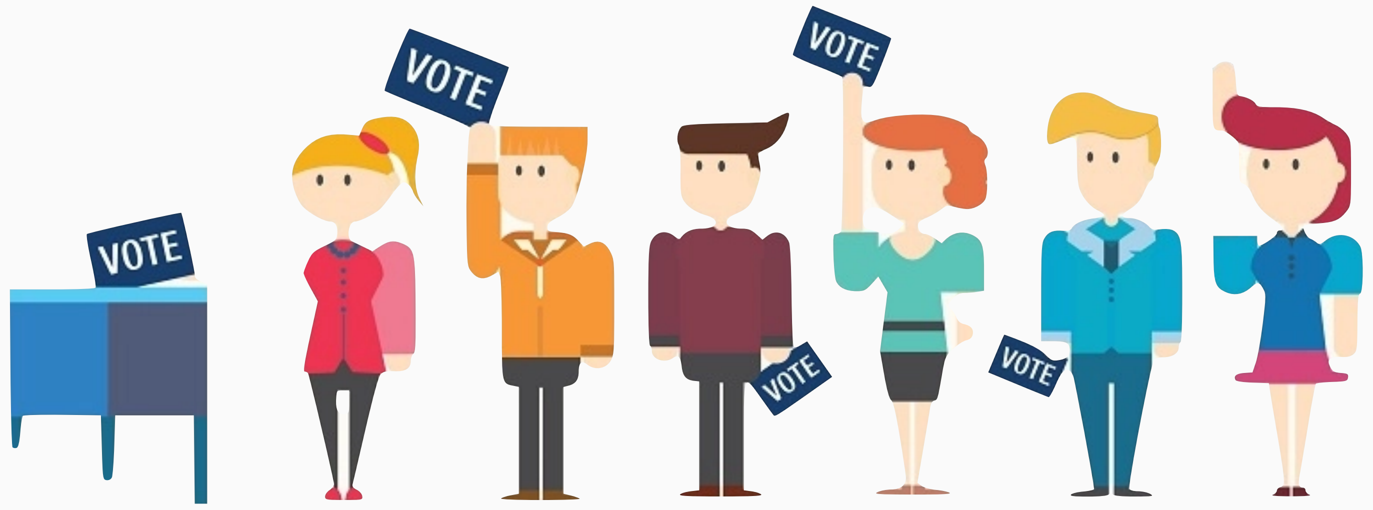
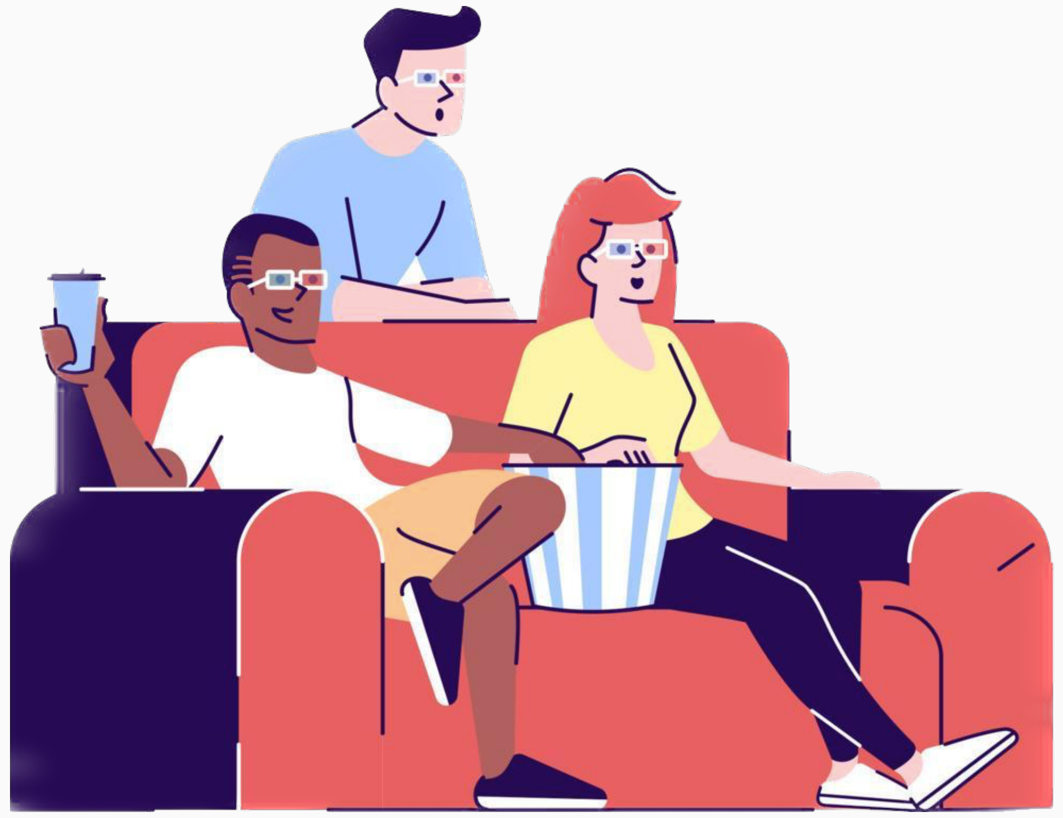
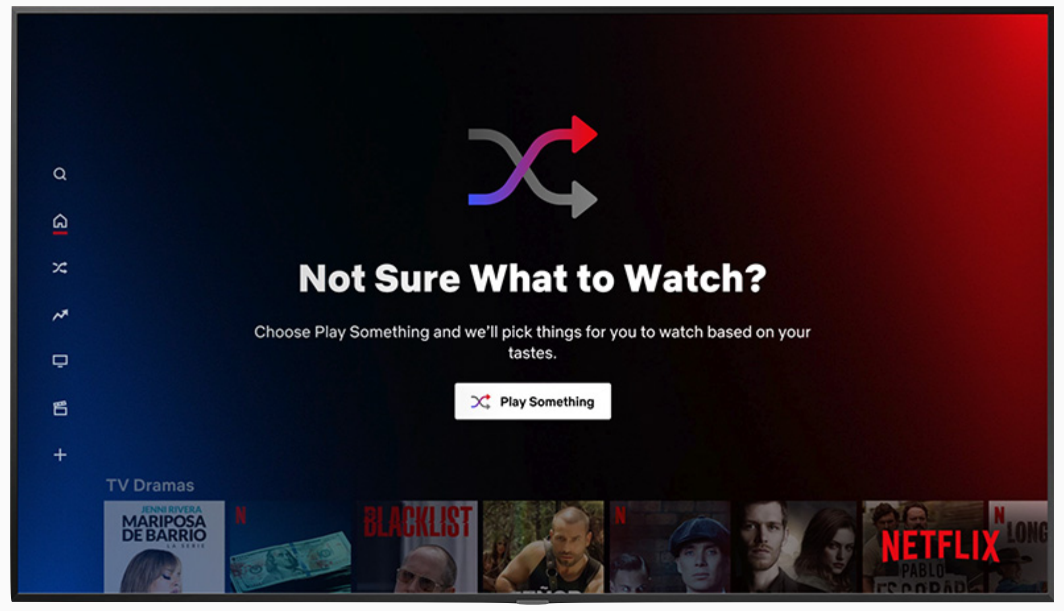
AAAI 2023

Voting

- Voting is a way to aggregate agents' preferences
  - Political elections
  - Movie night
  - Choose a representative committee
  - Recommender systems







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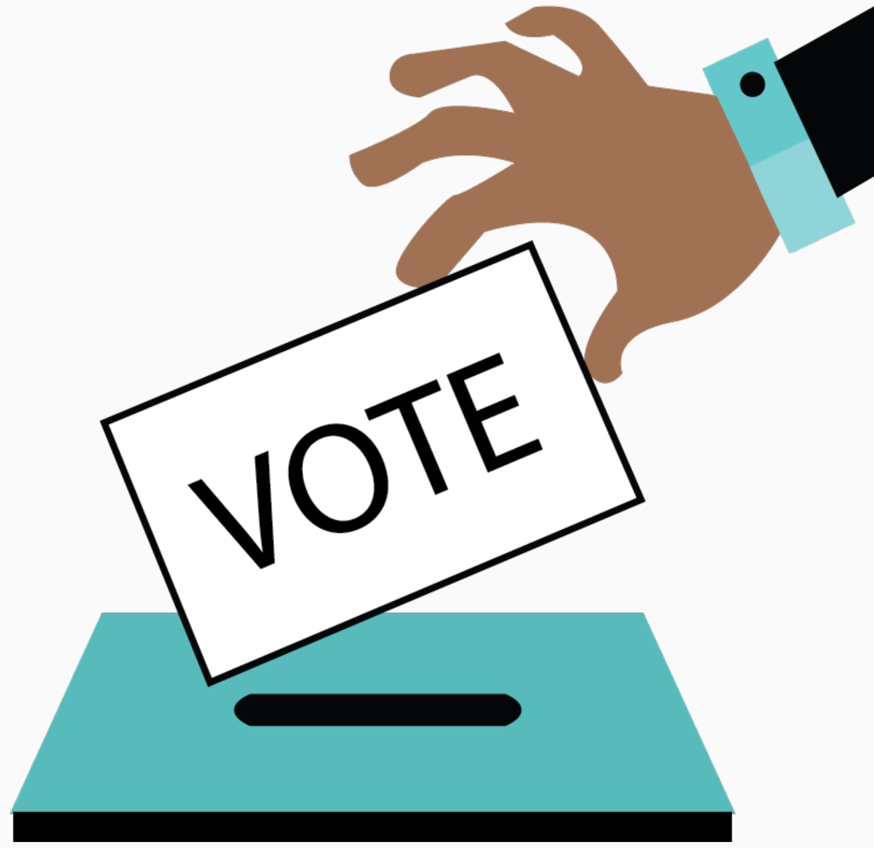

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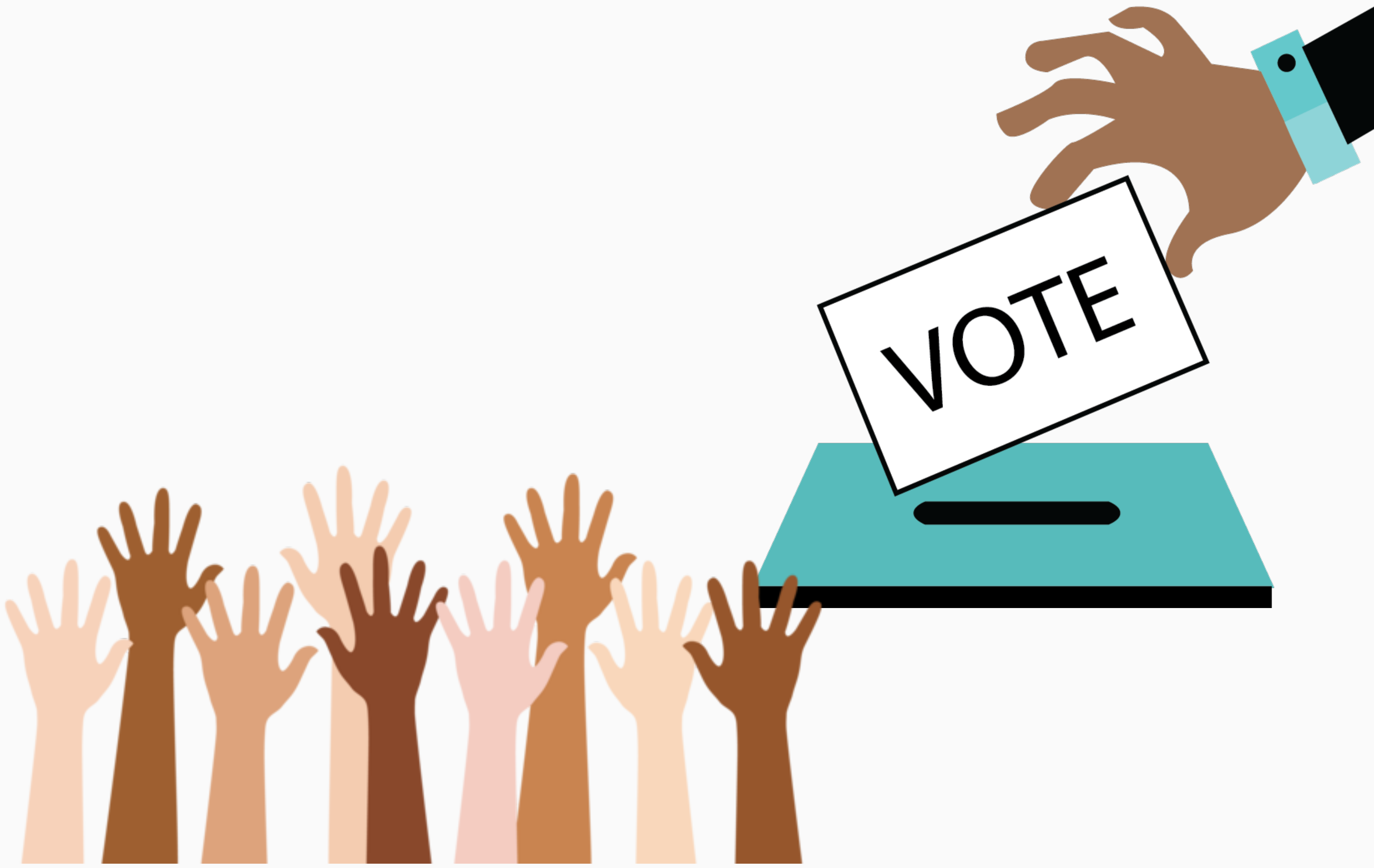

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  - Approval ballots

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We have a surplus of 4000$ in our budget.

What should we do with that?

We can buy a copier, a set of chairs, or go out for lunch for a week? Let’s decide.

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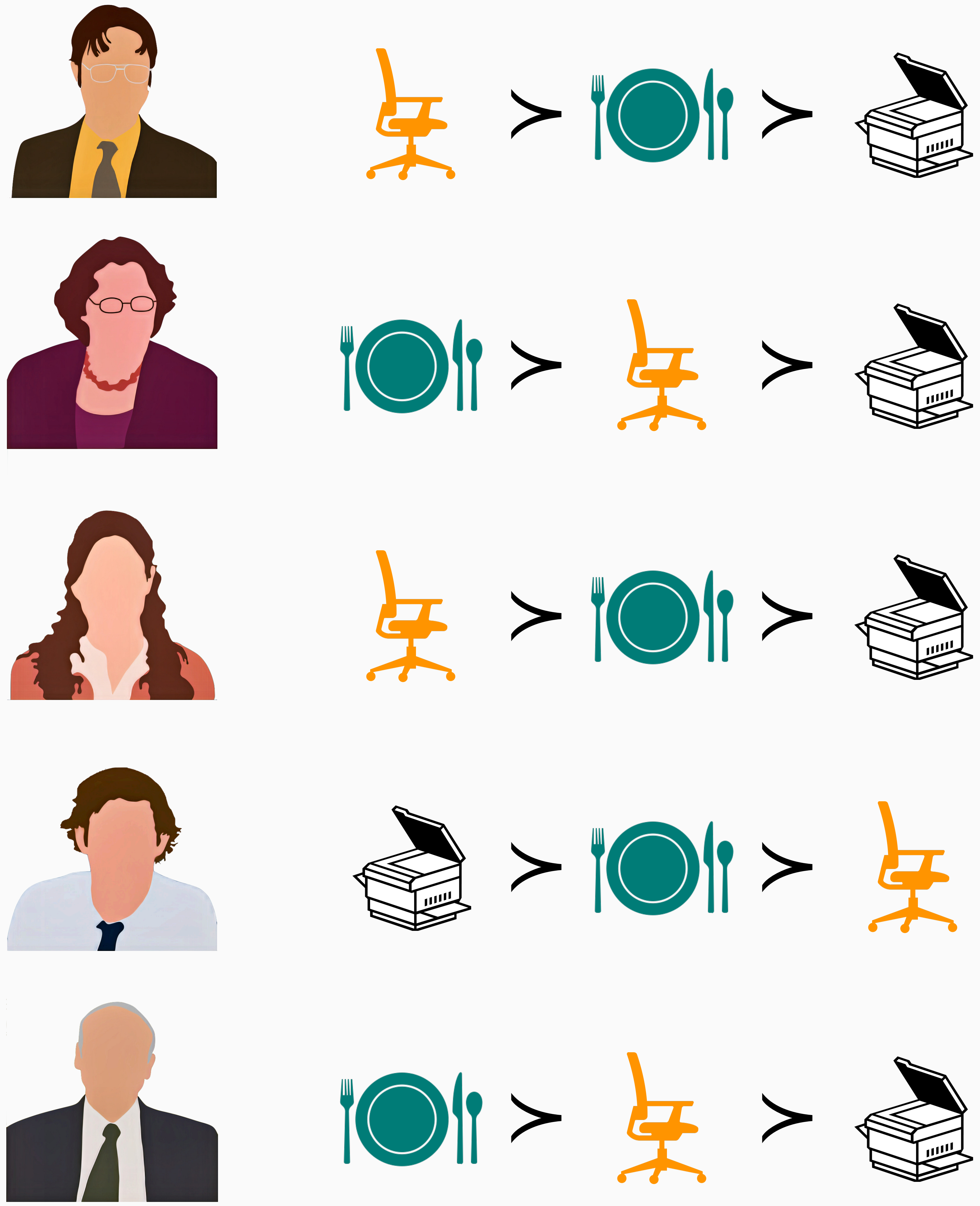

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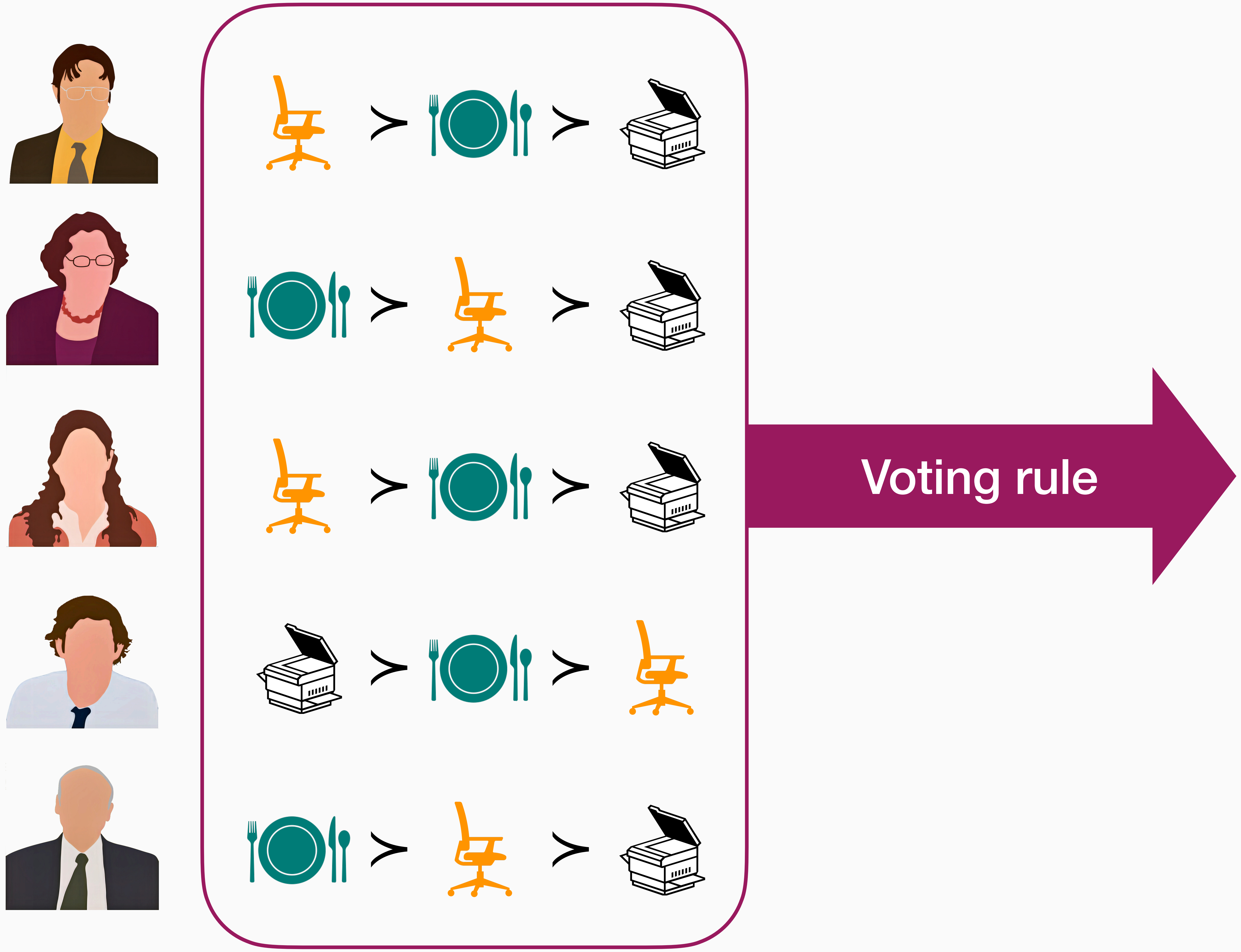

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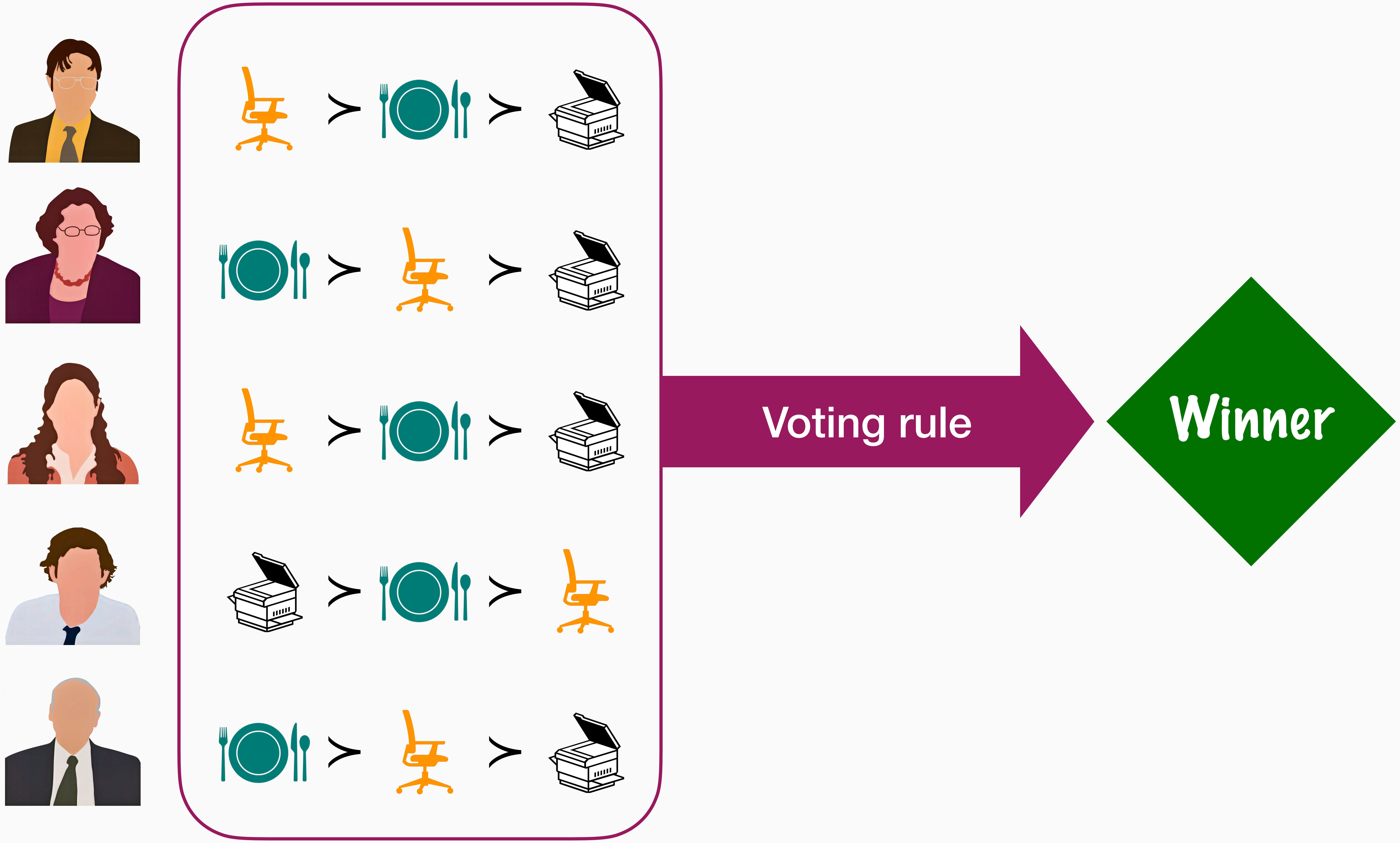

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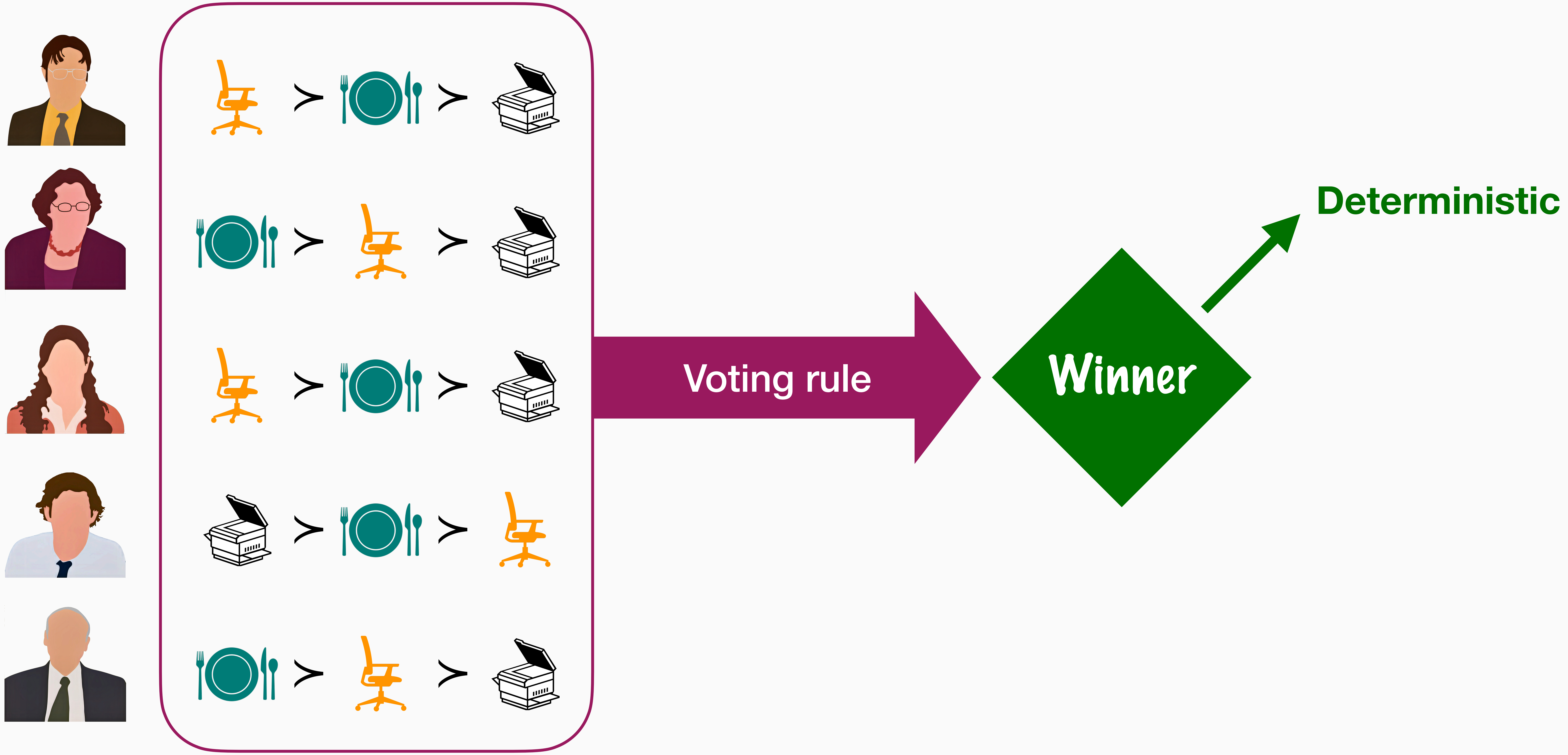

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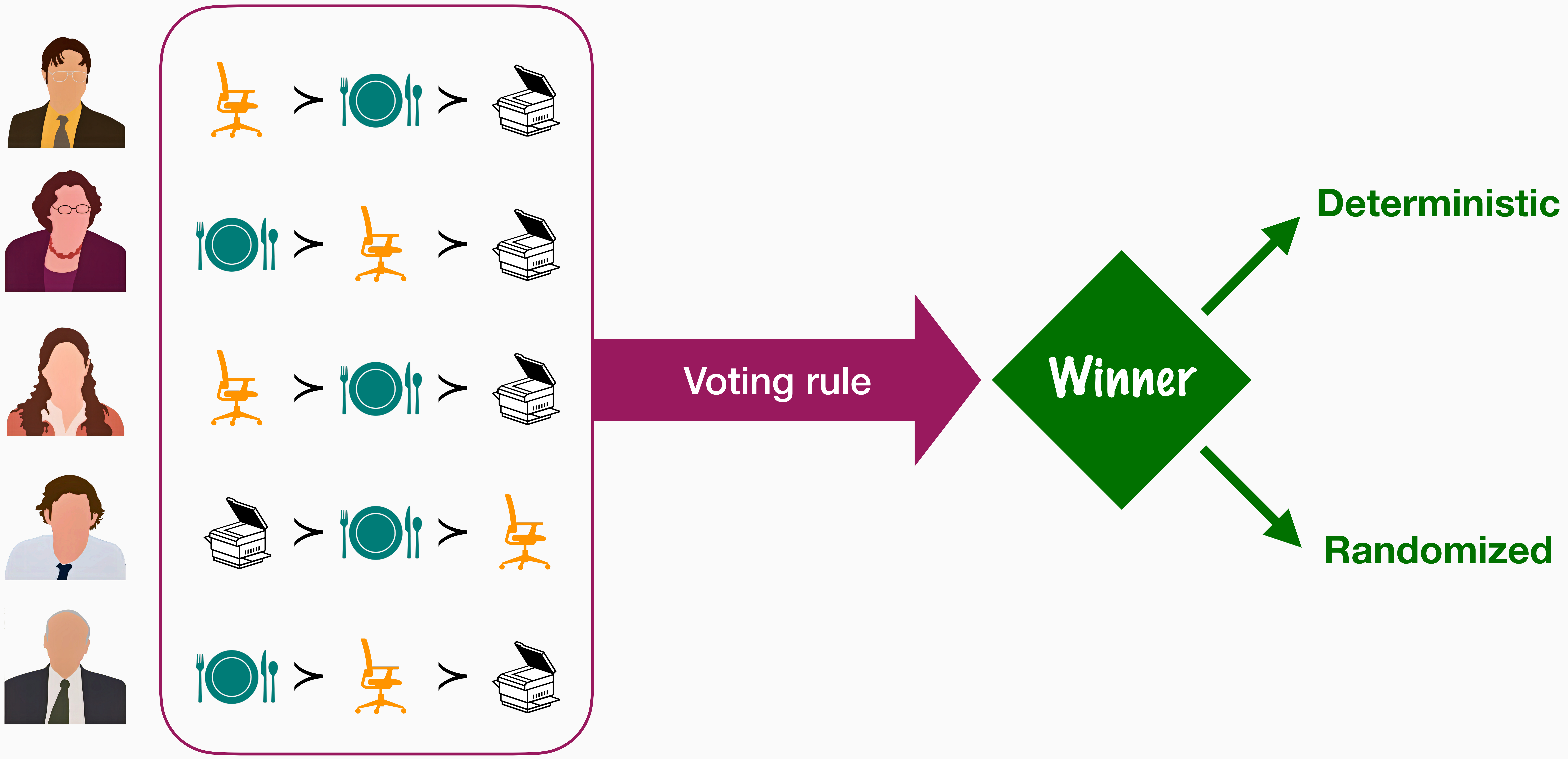

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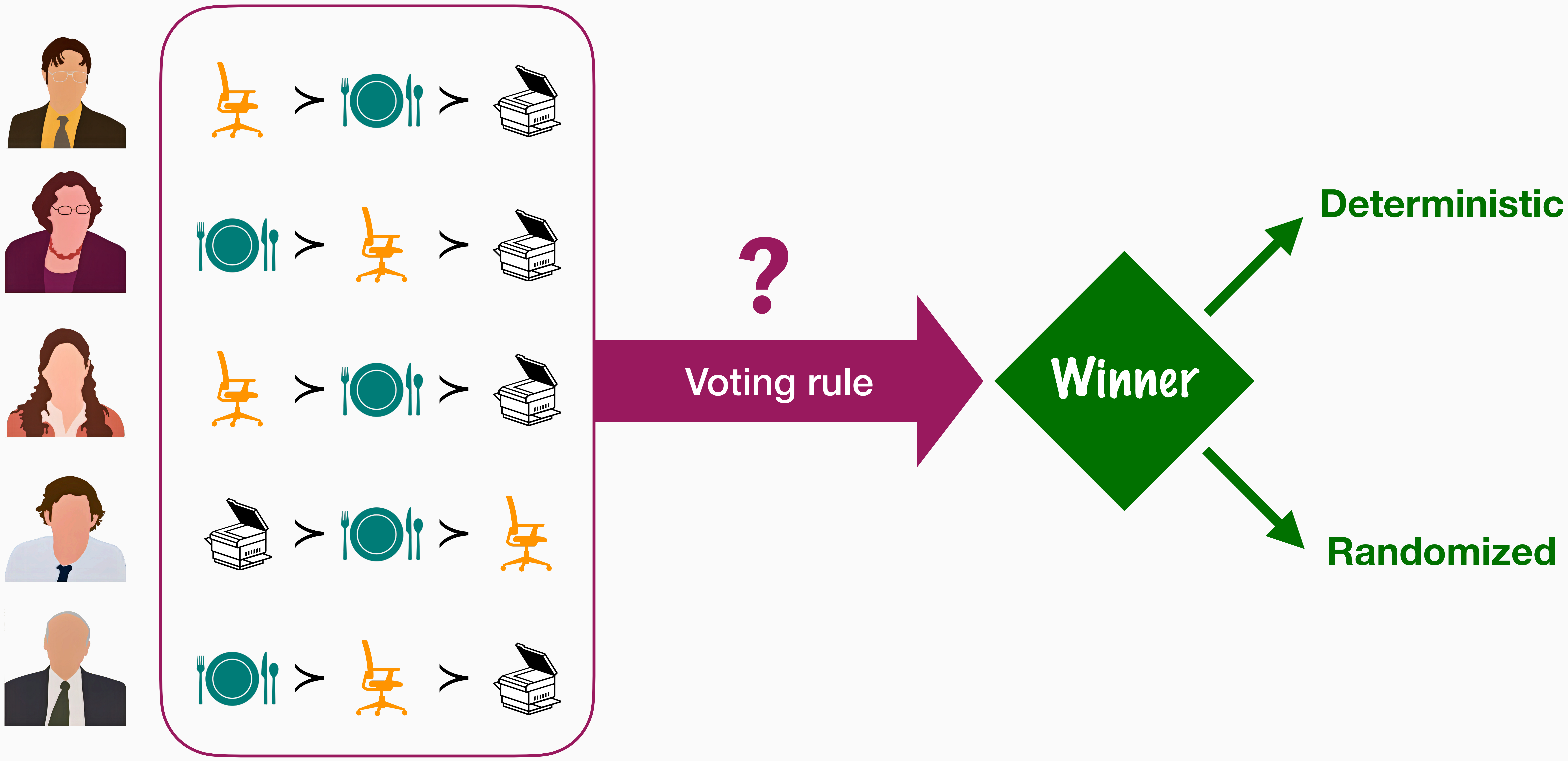

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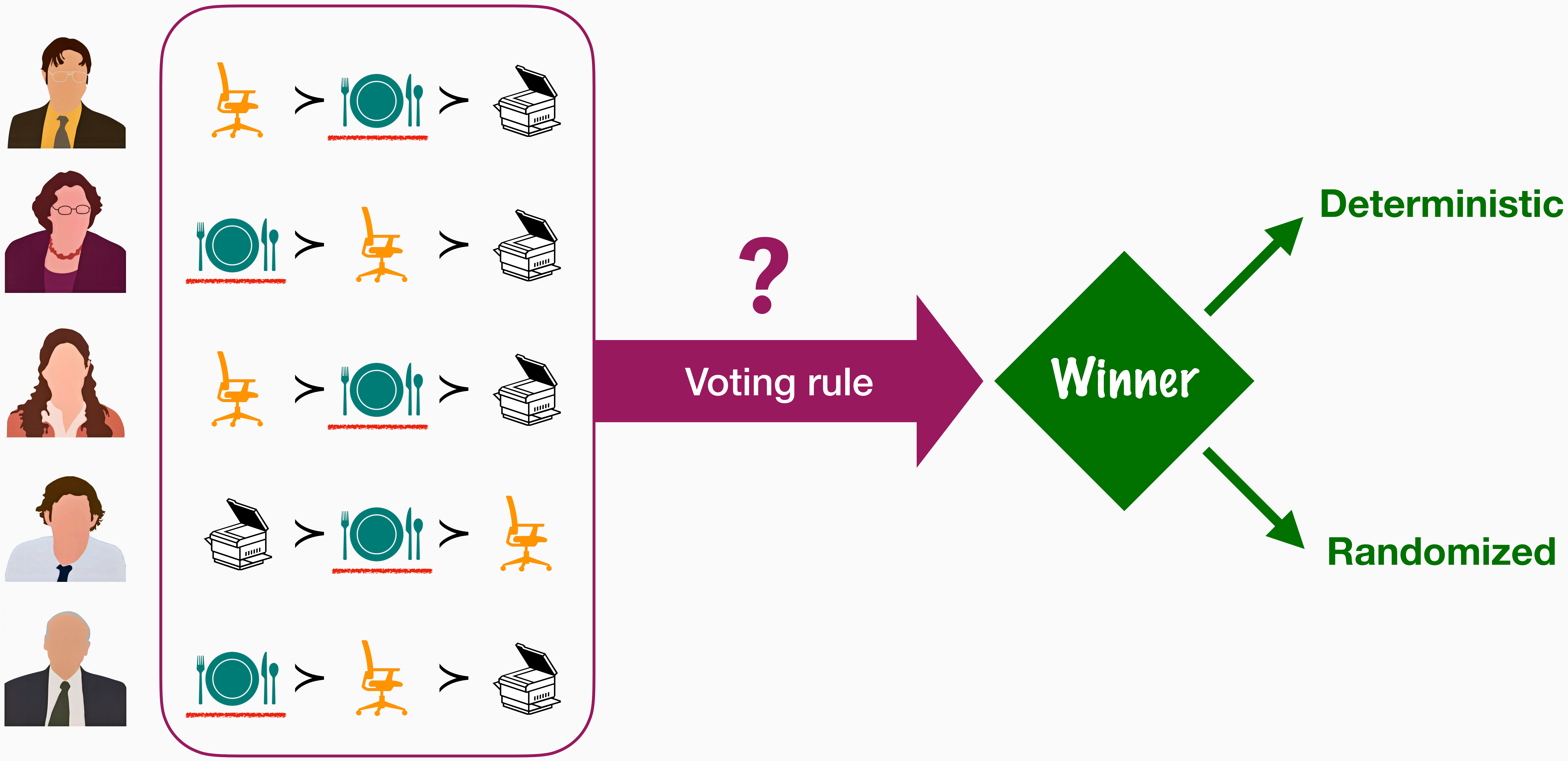

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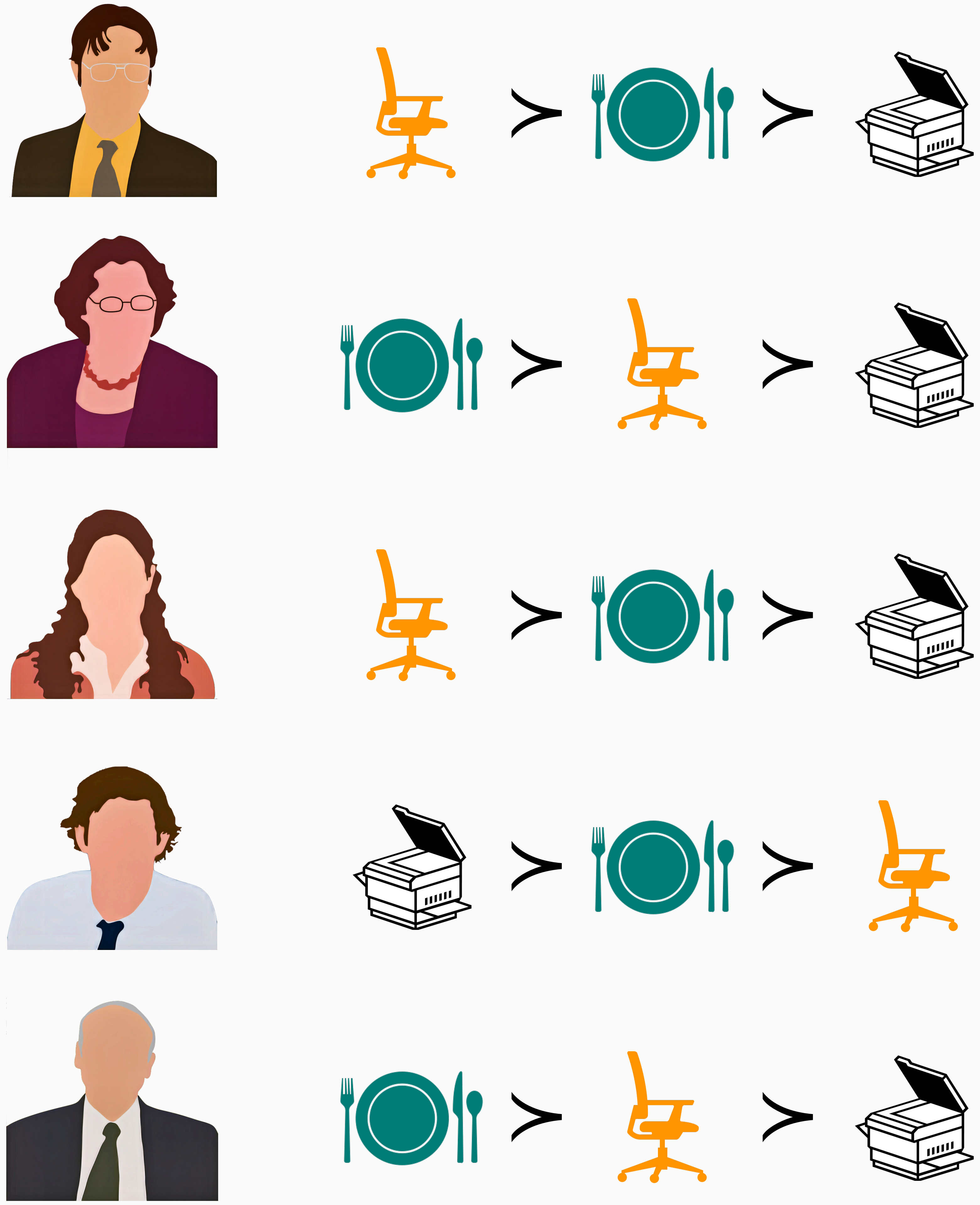

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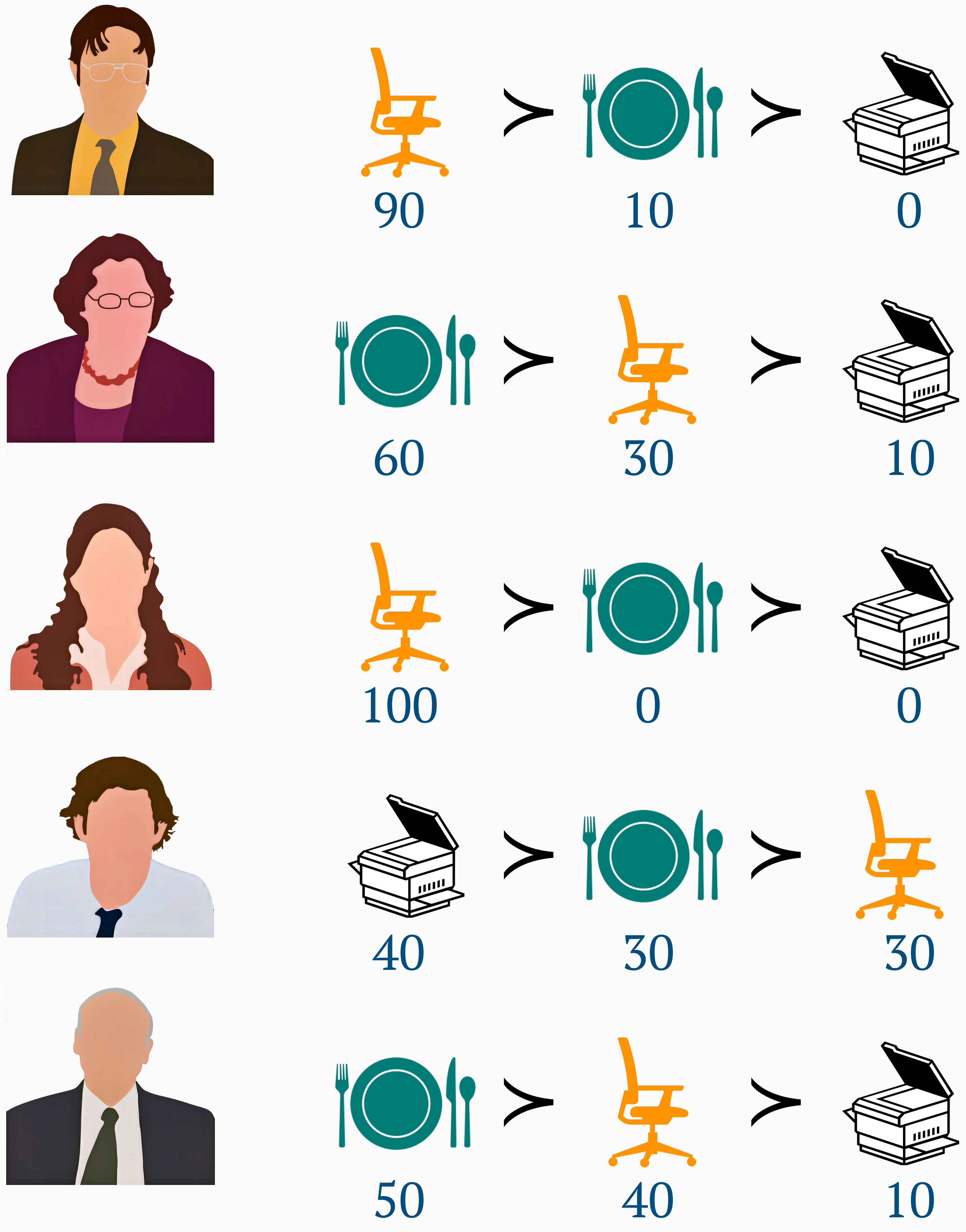

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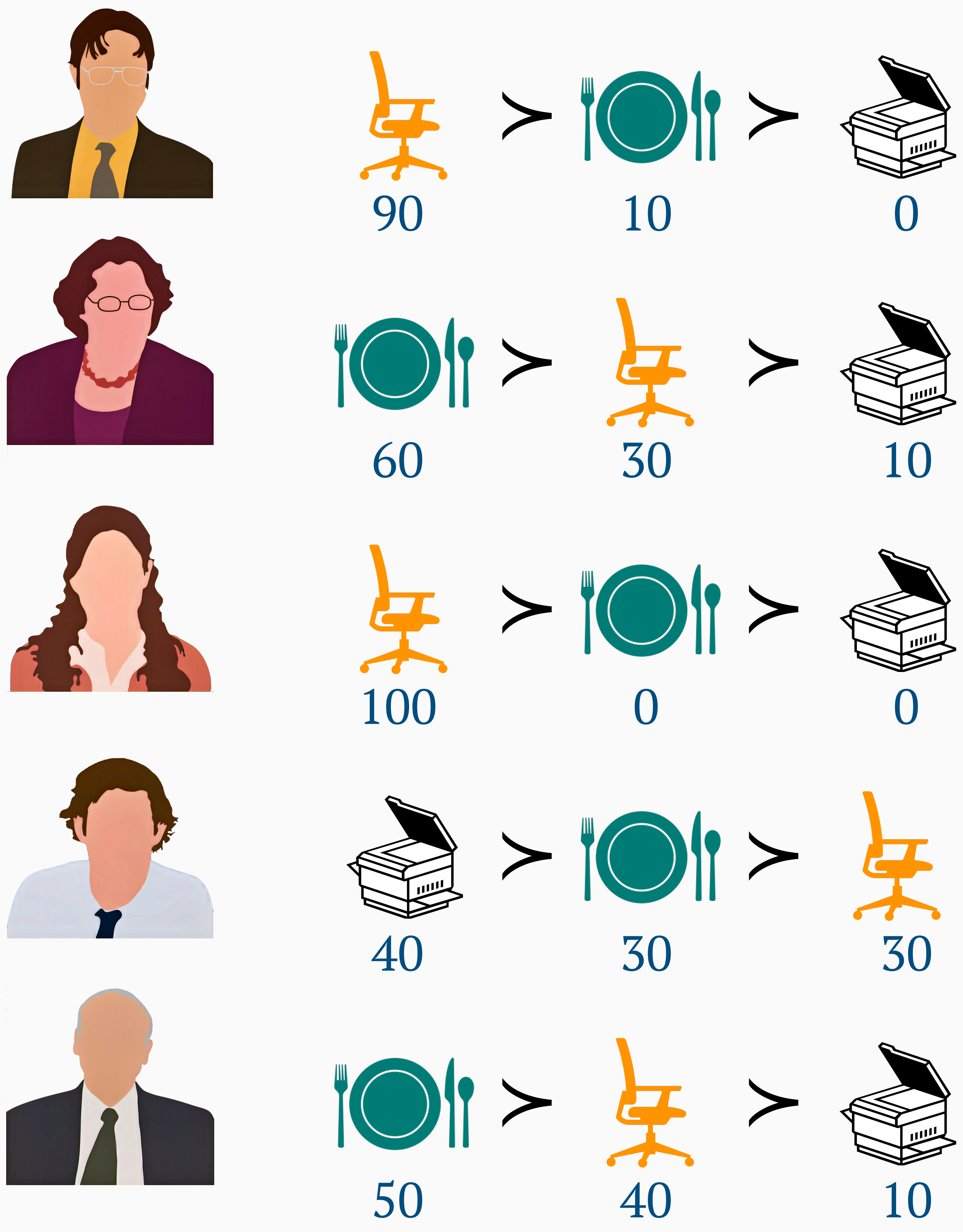

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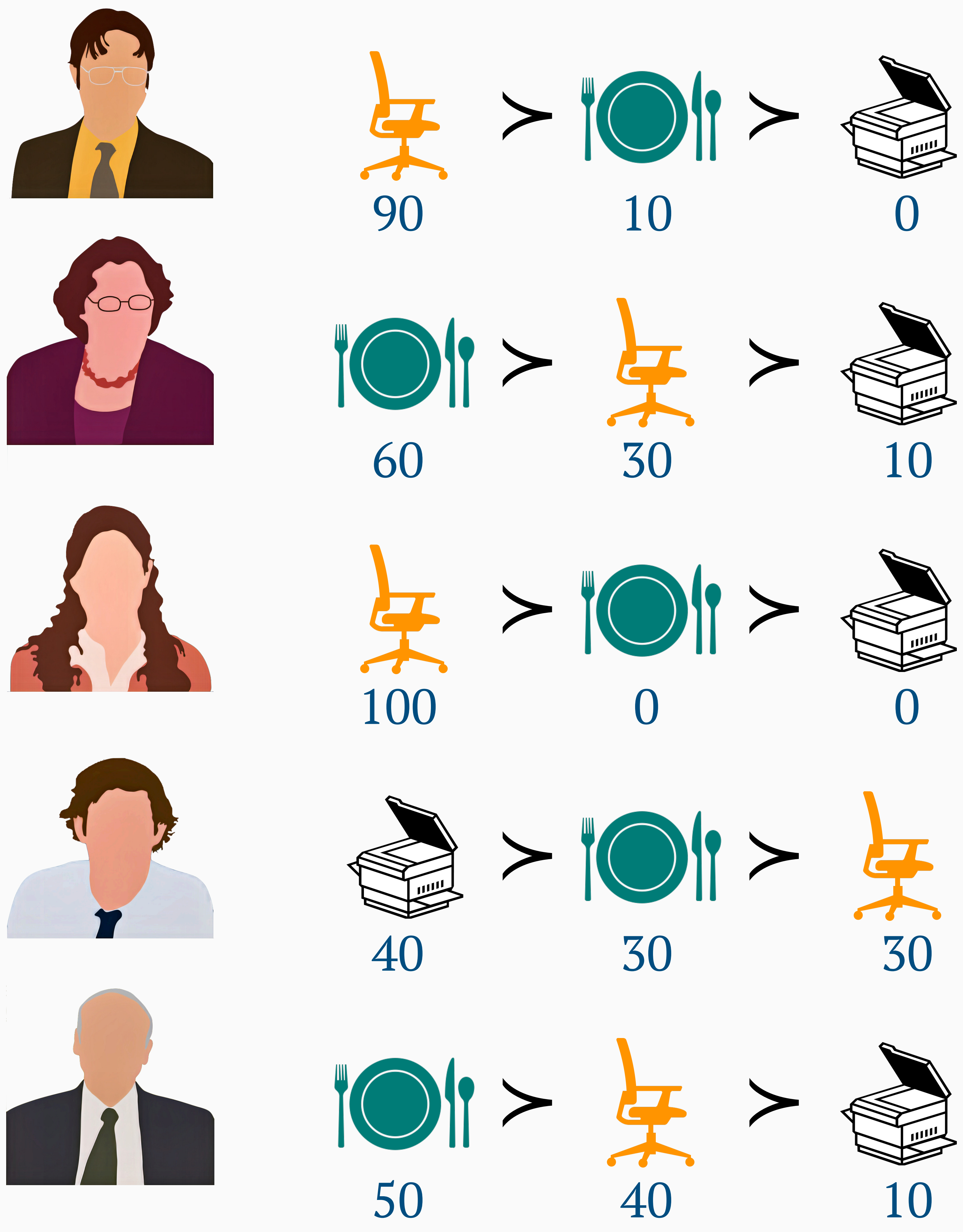

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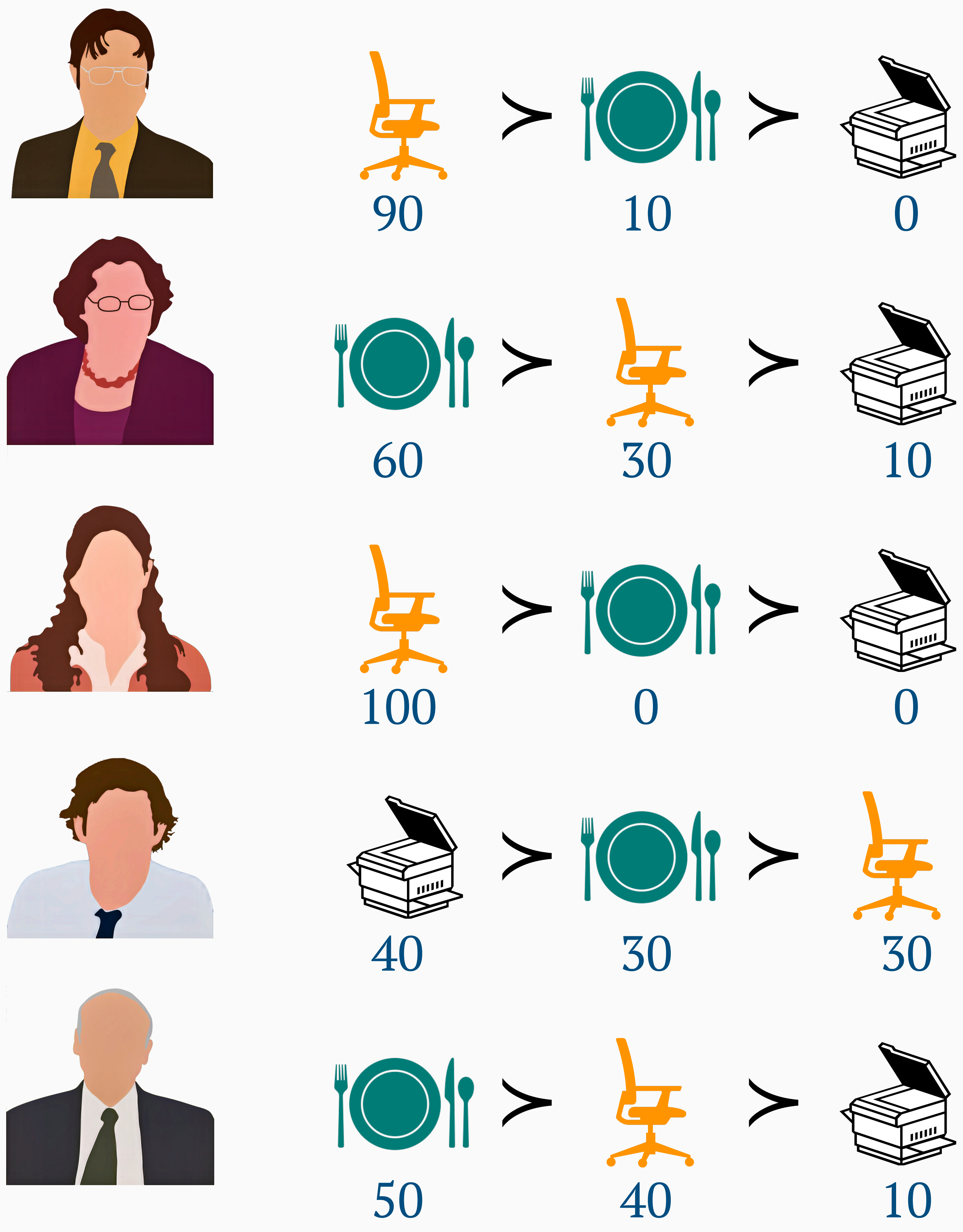

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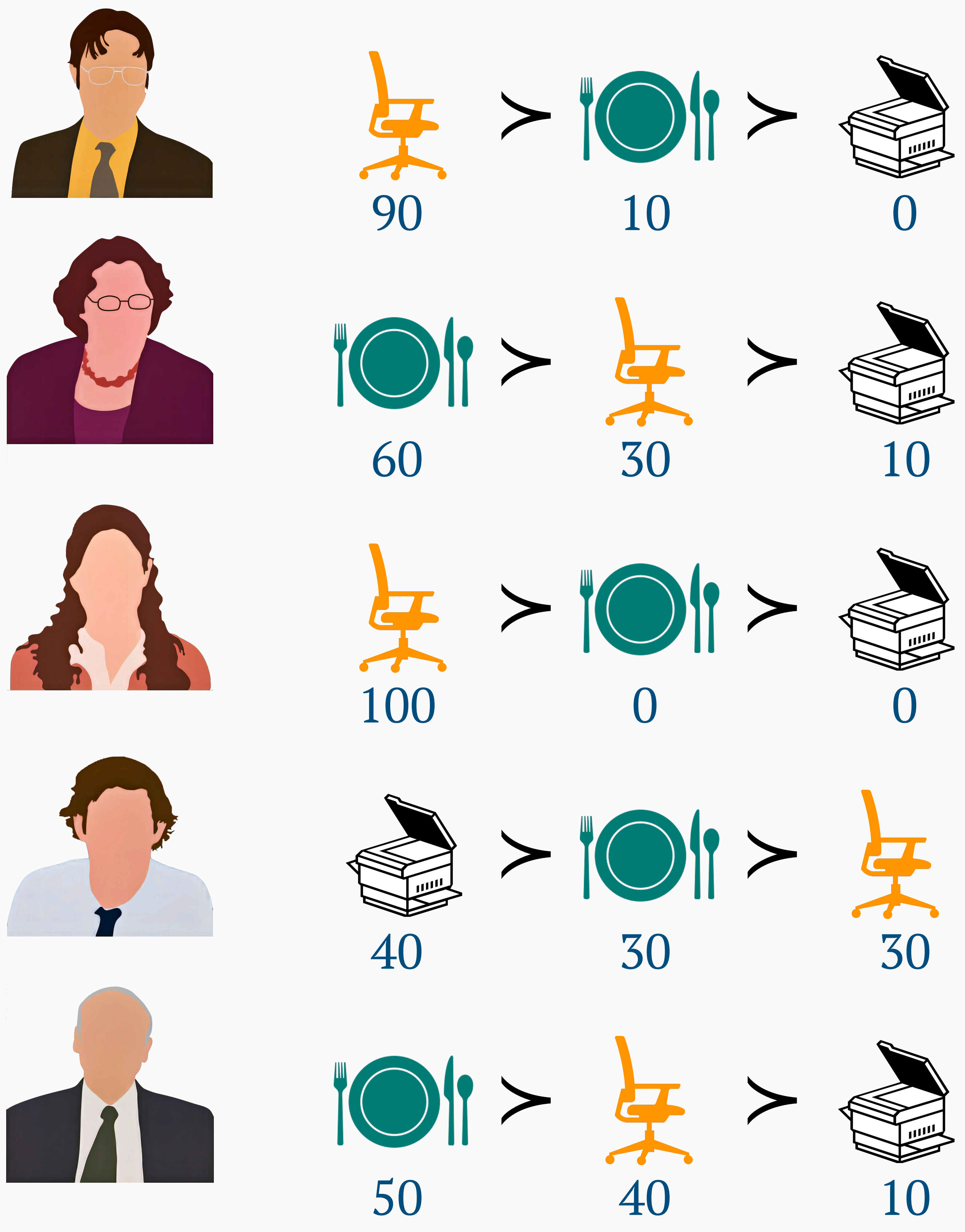

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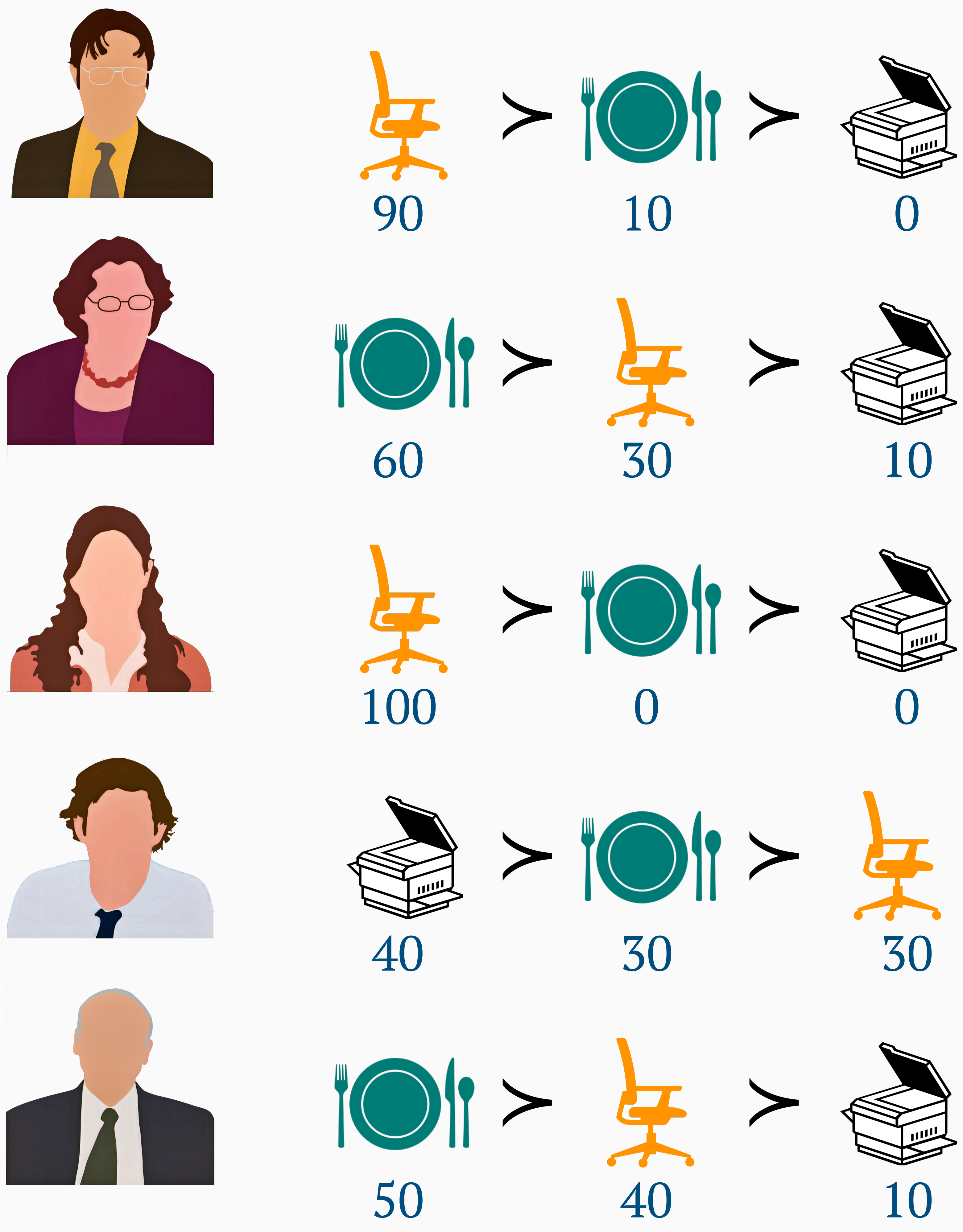

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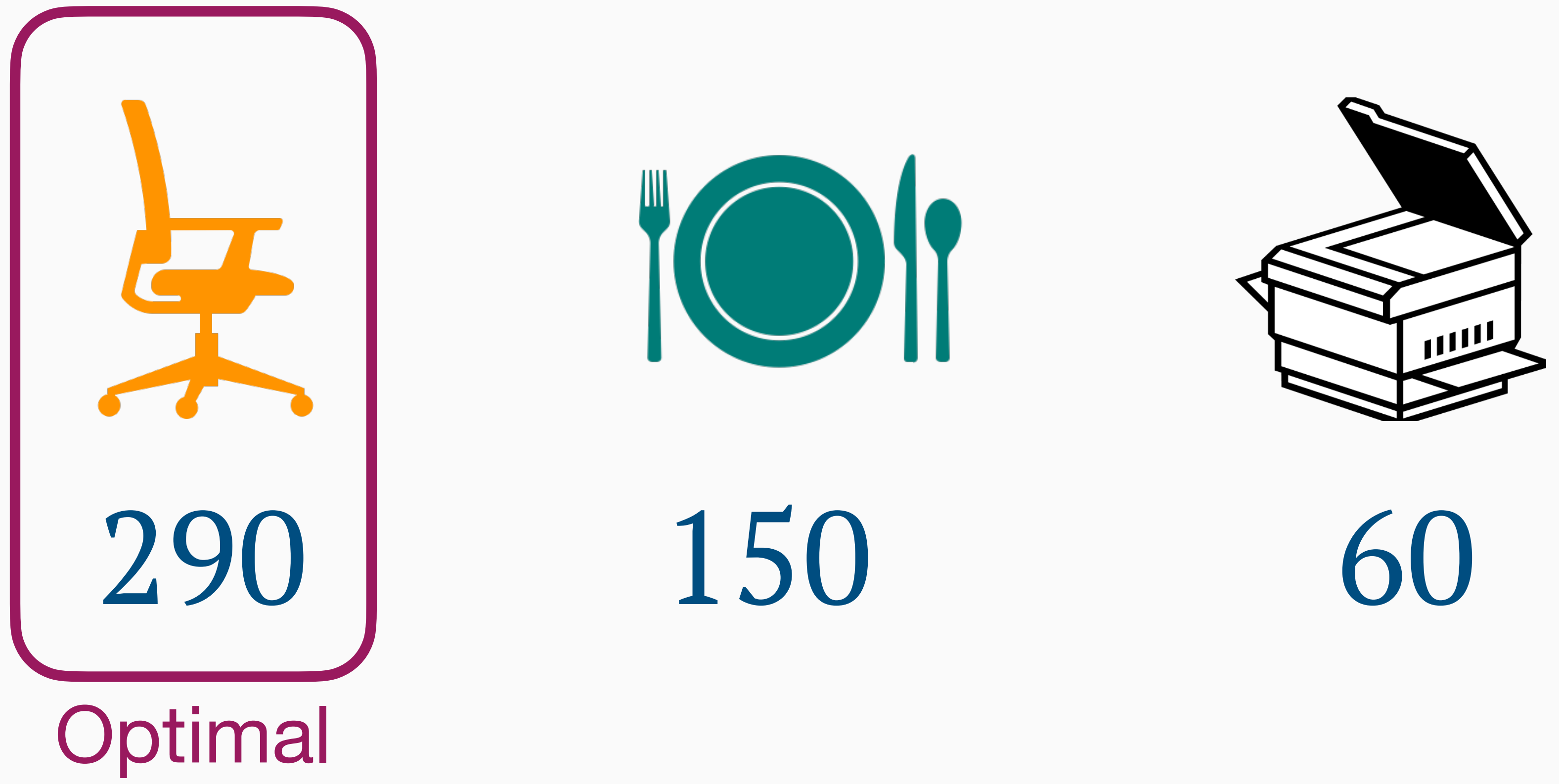

- Can we make sure that the winner is close to optimal?

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- Unit-sum assumption: $\sum_{c \in C} u_i(c) = 1.$

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$$\mathrm{dist}(f) = \max_{\vec{u} \rhd \vec{\sigma}} \mathrm{Apx}(f(\vec{\sigma})) = \max_{\vec{u} \rhd \vec{\sigma}} \mathbb{E}_{c \sim f(\vec{\sigma})}[\mathrm{Apx}(c)]$$

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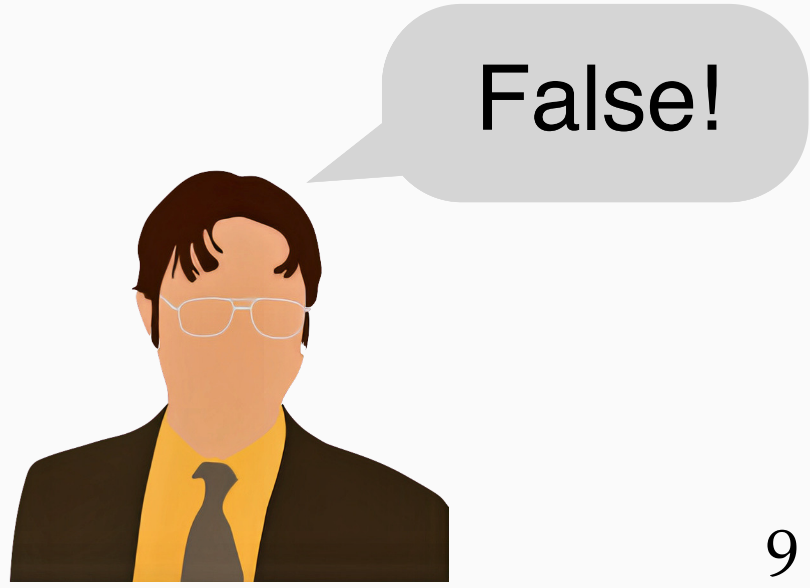

A Voting Scenario

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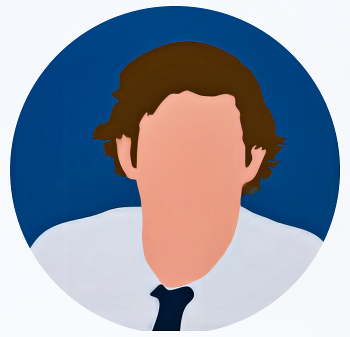

I prefer Steak, then Chinese and then Falafel.
I don't really like Pizza.

I'm a vegetarian, so I don't eat steak.
Among other options I prefer Falafel, Pizza and then Chinese.

Thanks Michael! I prefer Steak.

You're not invited Toby!

A Voting Scenario

I prefer Pizza and then Steak. I don’t really like the two other options but I prefer Chinese to Falafel.

All options seem good to me. But if I have to vote I say Falafel, Pizza, Chinese and then Steak.

The answer is Pizza, and then by far Steak, Chinese and Falafel.

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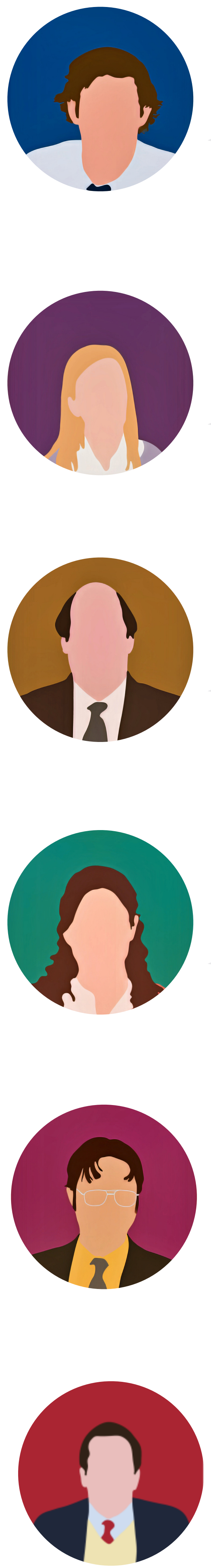
OK. I swallowed all your ideas. I'm going to digest them and see what comes out the other end.

Classic Model



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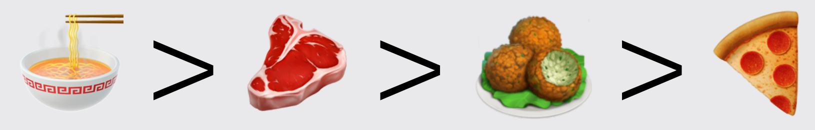

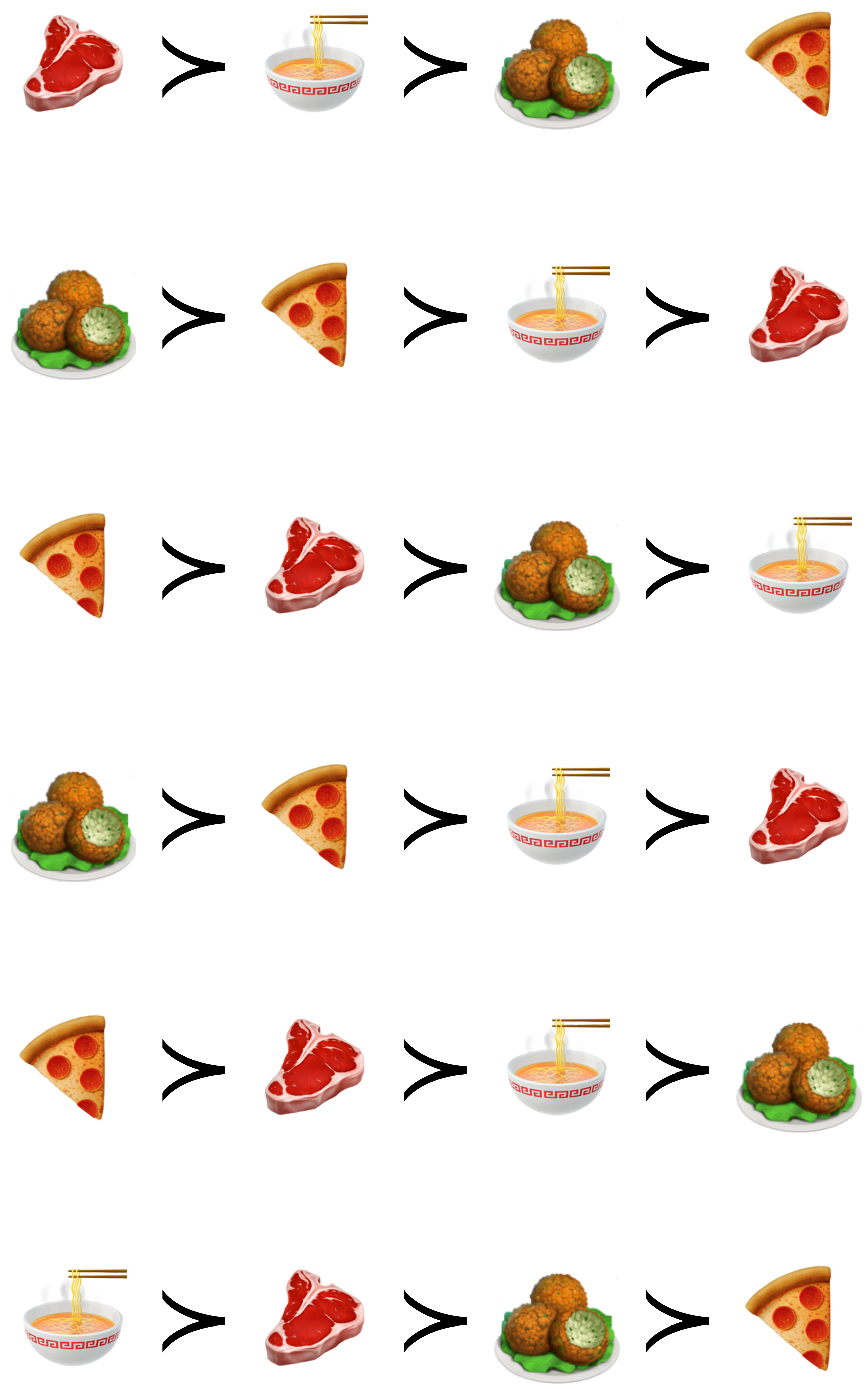

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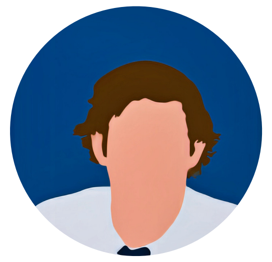

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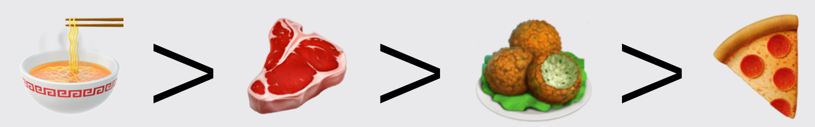

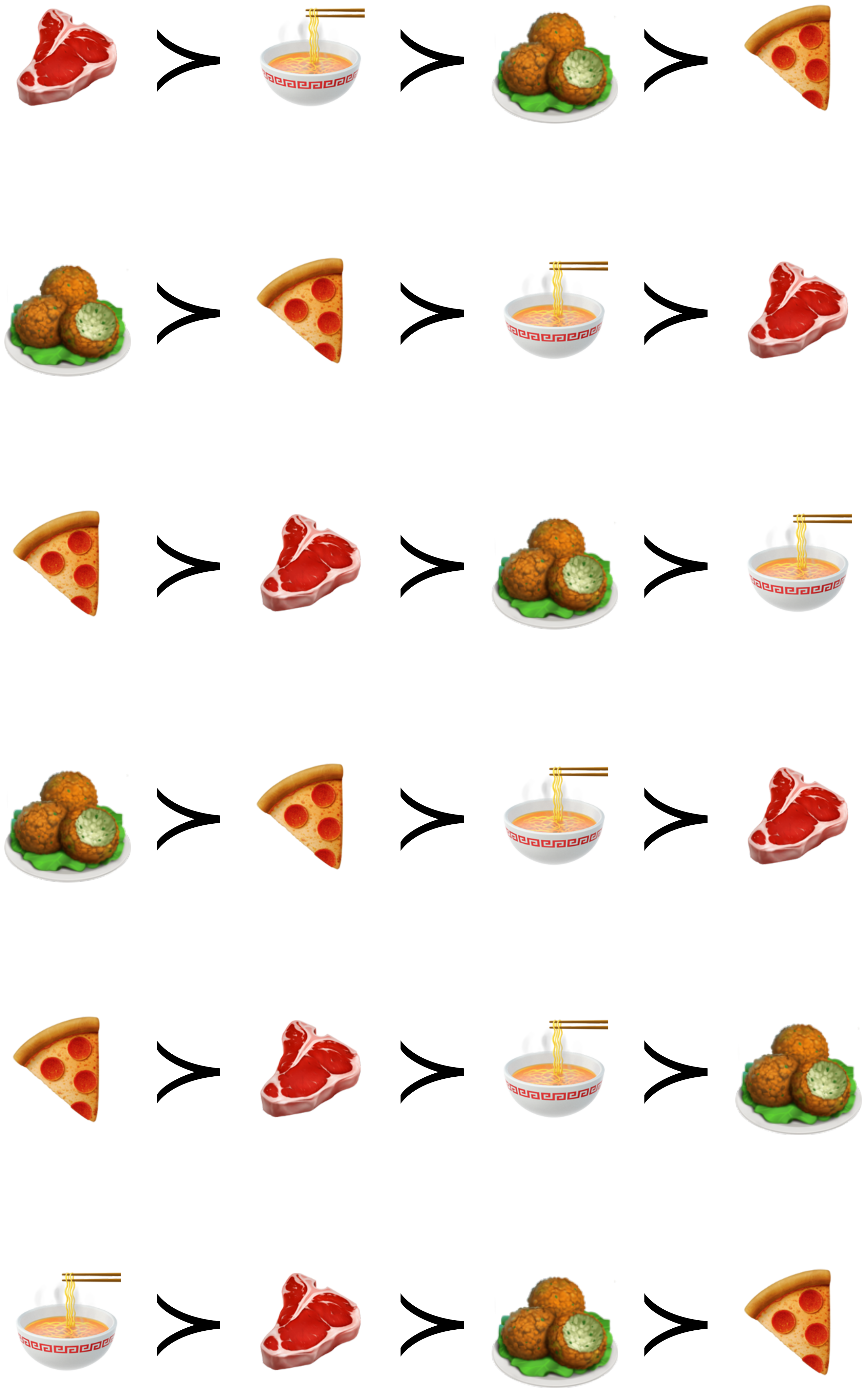

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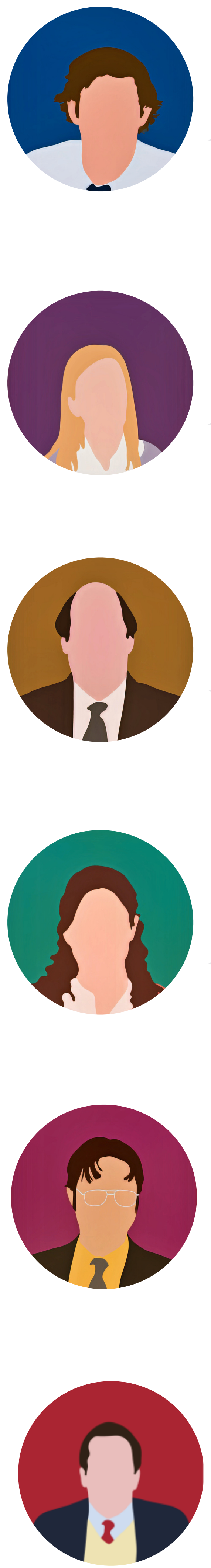

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What if we give them the option to use "≫" sign?

≻ 🍜 ≻ 🥩

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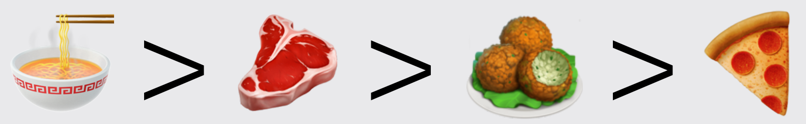

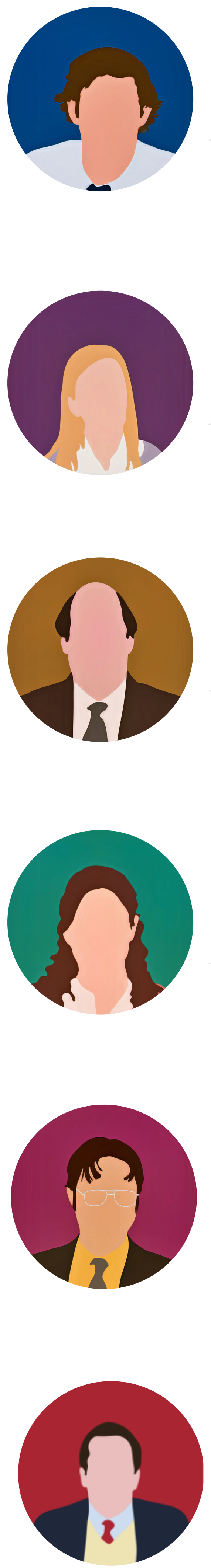

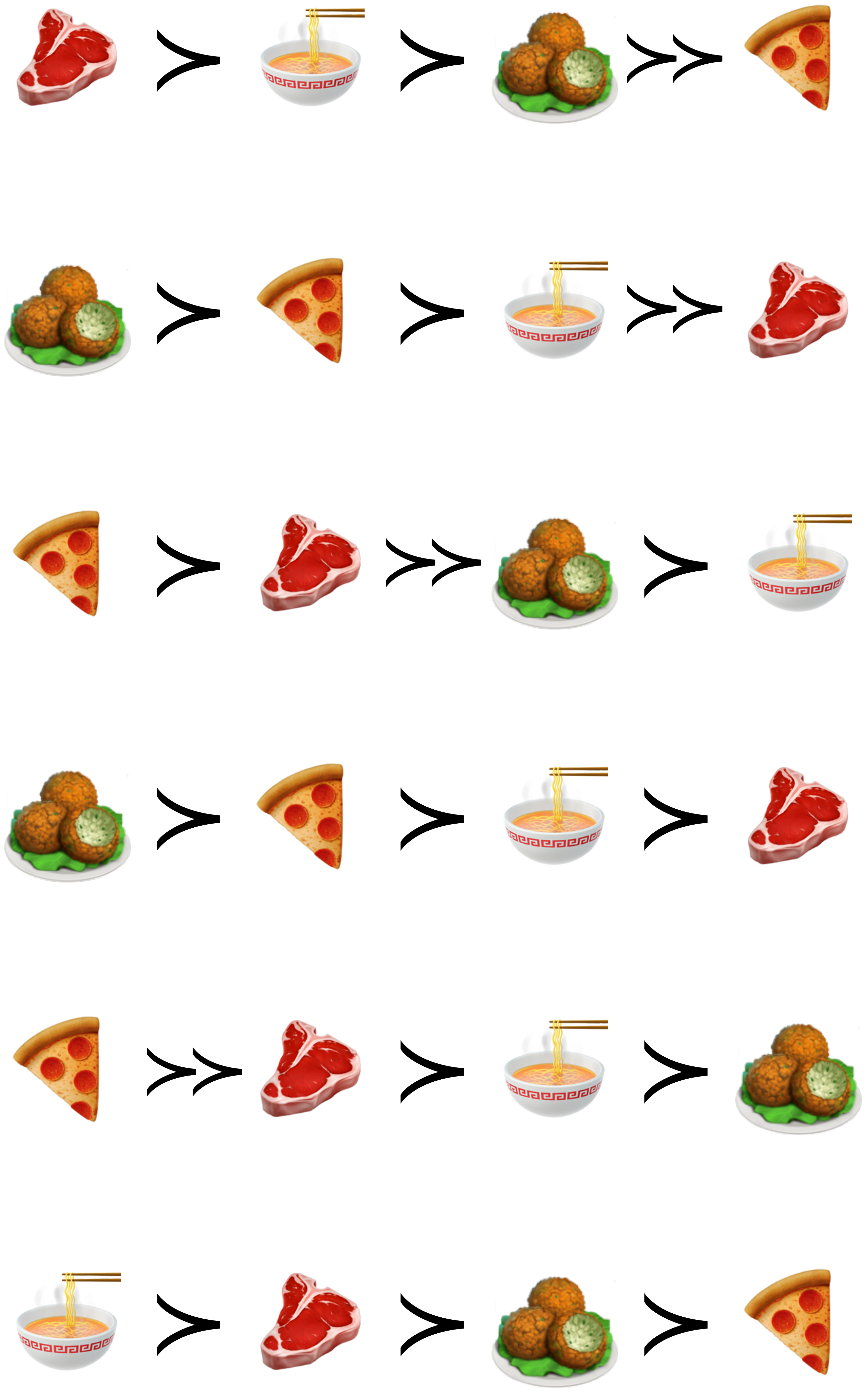

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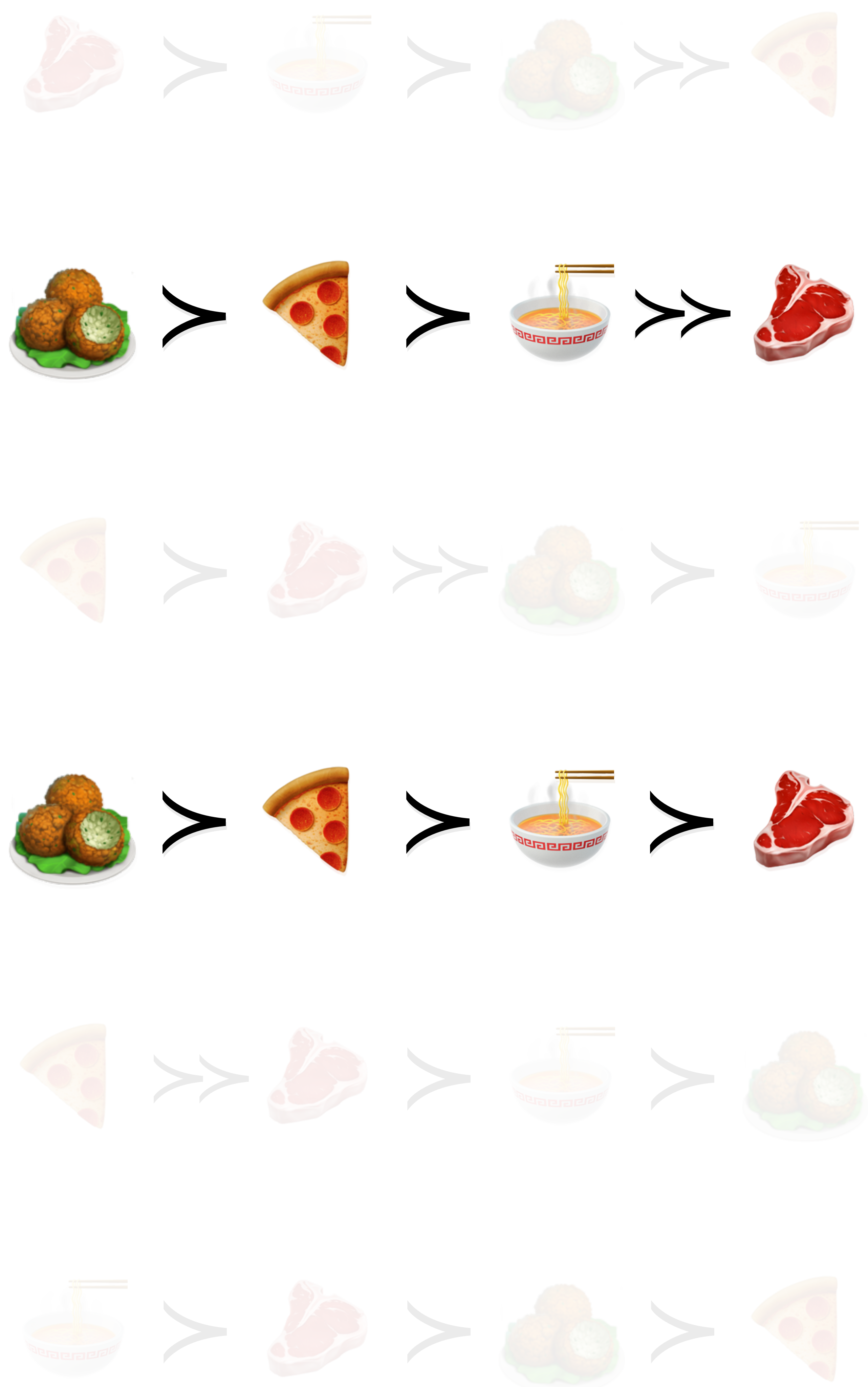

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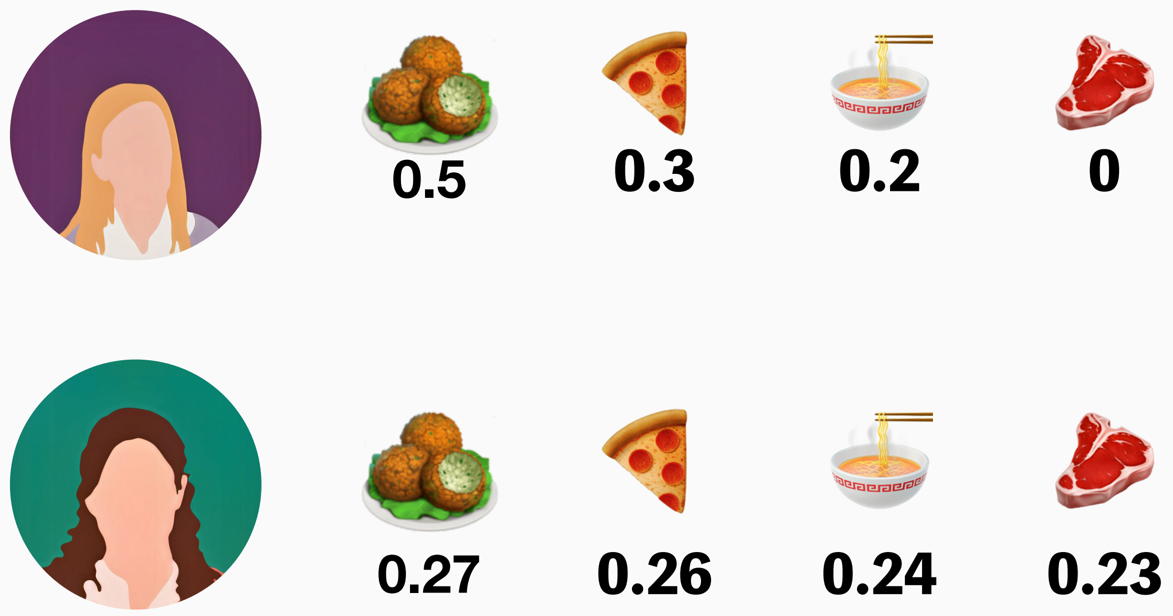

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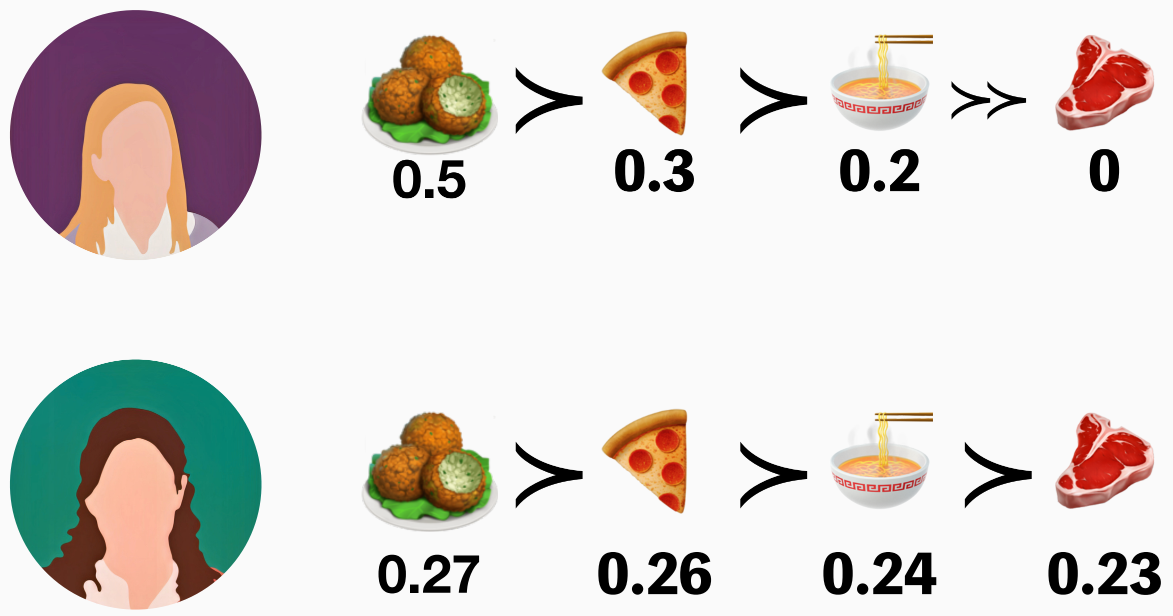

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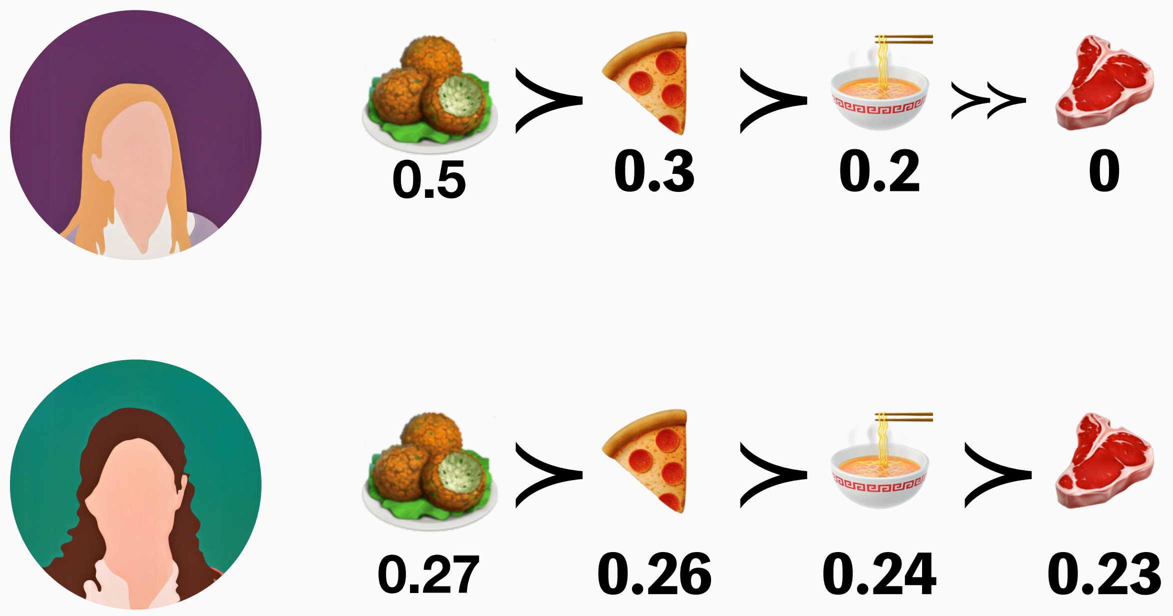

- Extreme cases: $\alpha \simeq 1$, $\alpha = 0$

Special Cases

Deterministic	
Ramdomized	

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	No Intensities $\pi_i = (\succ, \succ, \ldots, \succ)$
Deterministic	$\Theta\left(m^2\right)$ Plurality Winner
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Deterministic	$\Theta\left(m^2\right)$ Plurality Winner	$\Theta\left(\alpha^2 m^2 + 1\right)$ Plurality Winner	$\Theta\left(\frac{(\alpha m + 1)(1-\alpha^m)}{1-\alpha}\right)$ Plurality Winner
Ramdomized	$\Theta\left(\sqrt{m}\right)$ Stable lottery rule	$\Theta\left(\frac{\alpha m + 1}{\alpha\sqrt{m} + 1}\right)$ Decisive SLR	$\Omega\left(\min\left(\sqrt{m}, \frac{1-\alpha^m}{1-\alpha}\right)\right)$

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$$\mathrm{POII}(\alpha) = \max_{(\vec{\sigma},\vec{\pi})} \mathrm{POII}((\vec{\sigma},\vec{\pi}),\alpha)$$

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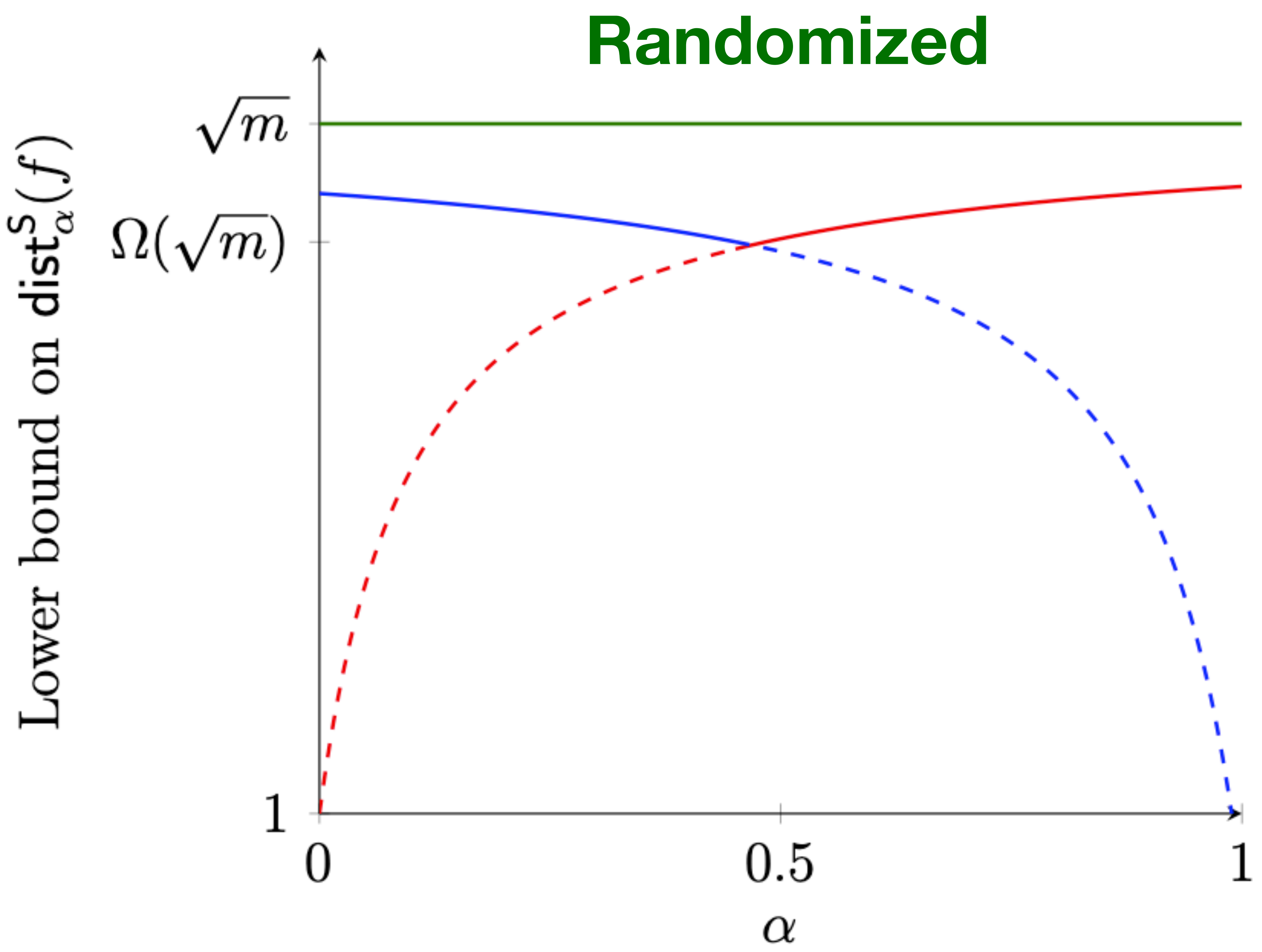

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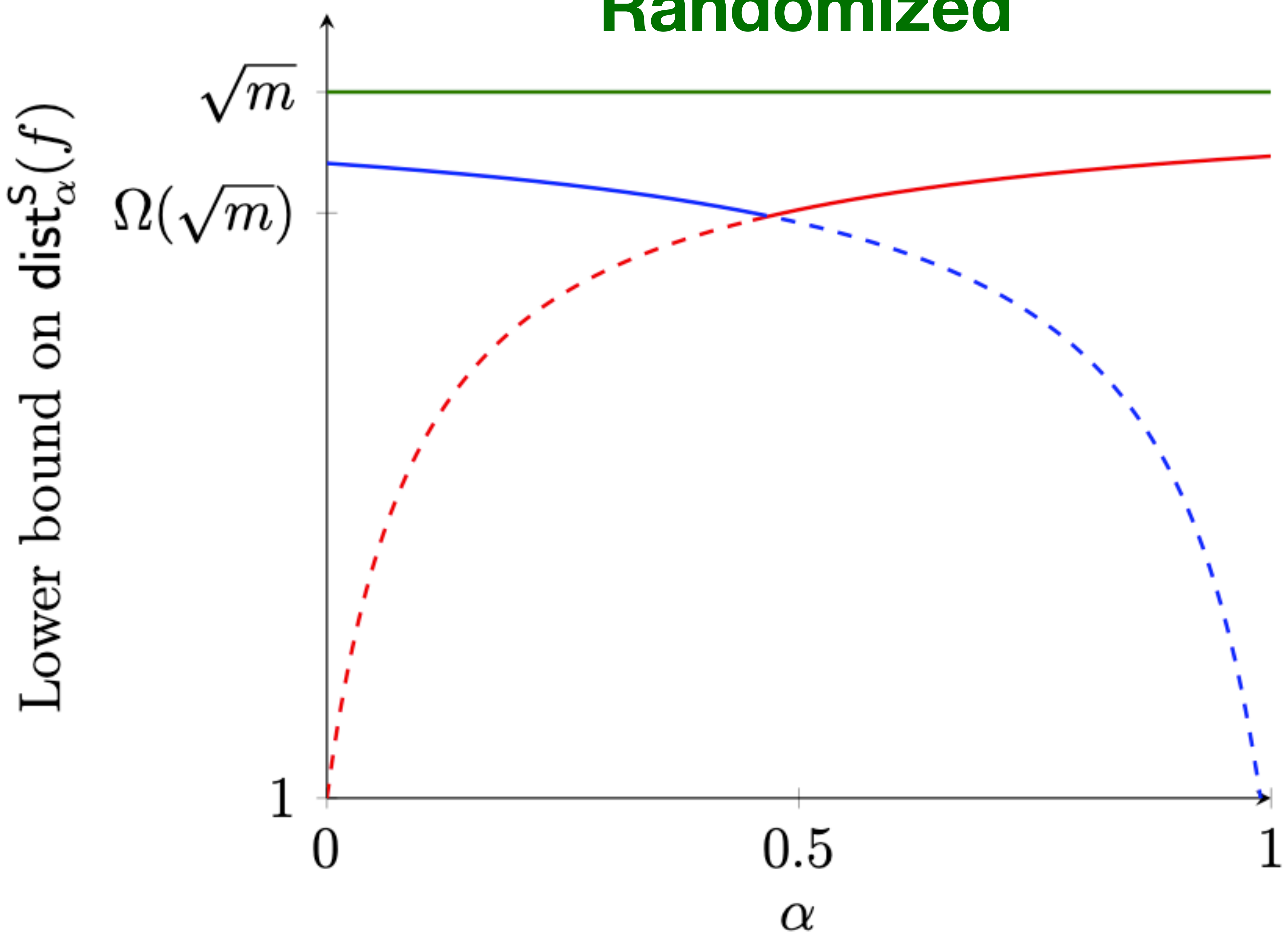

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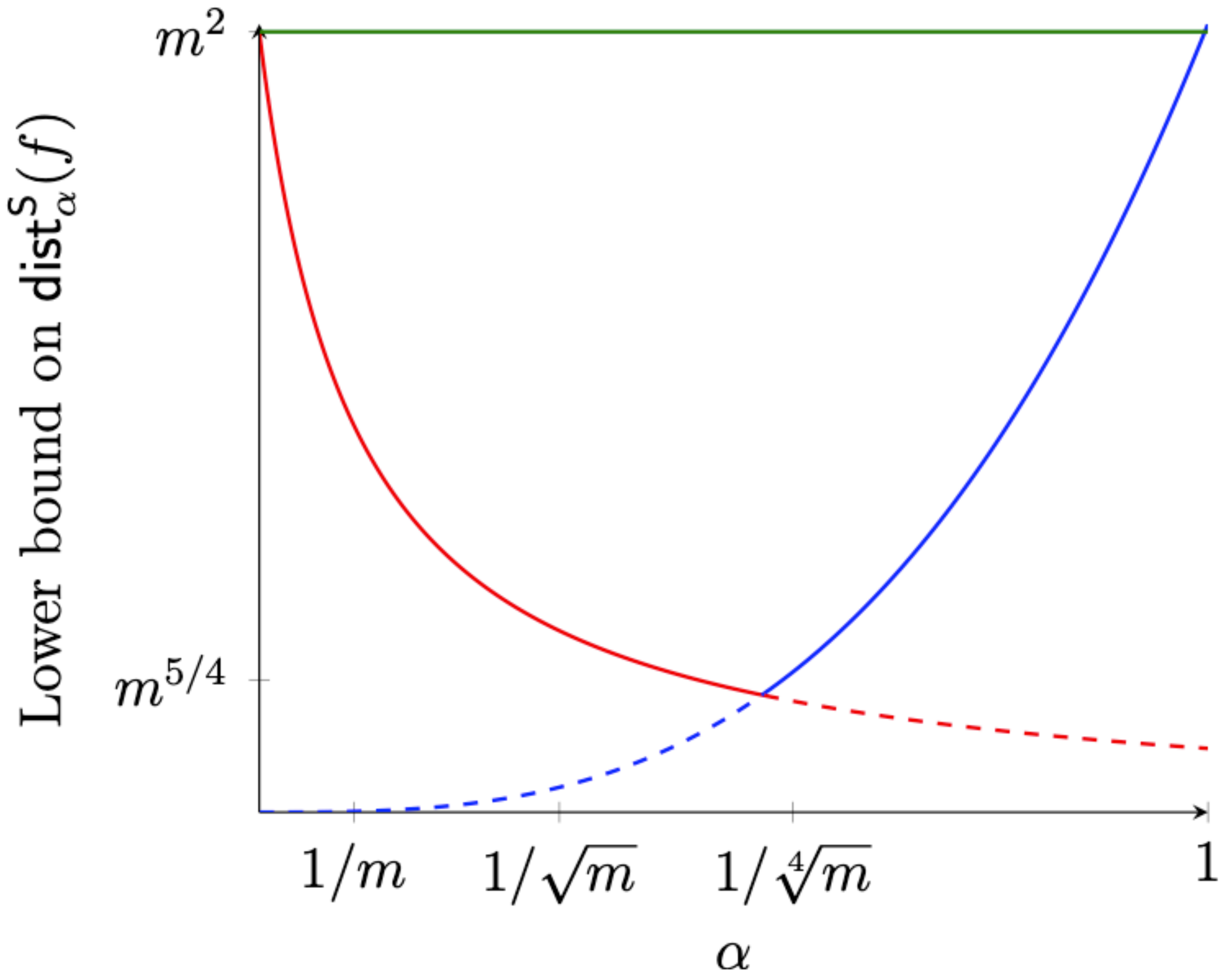

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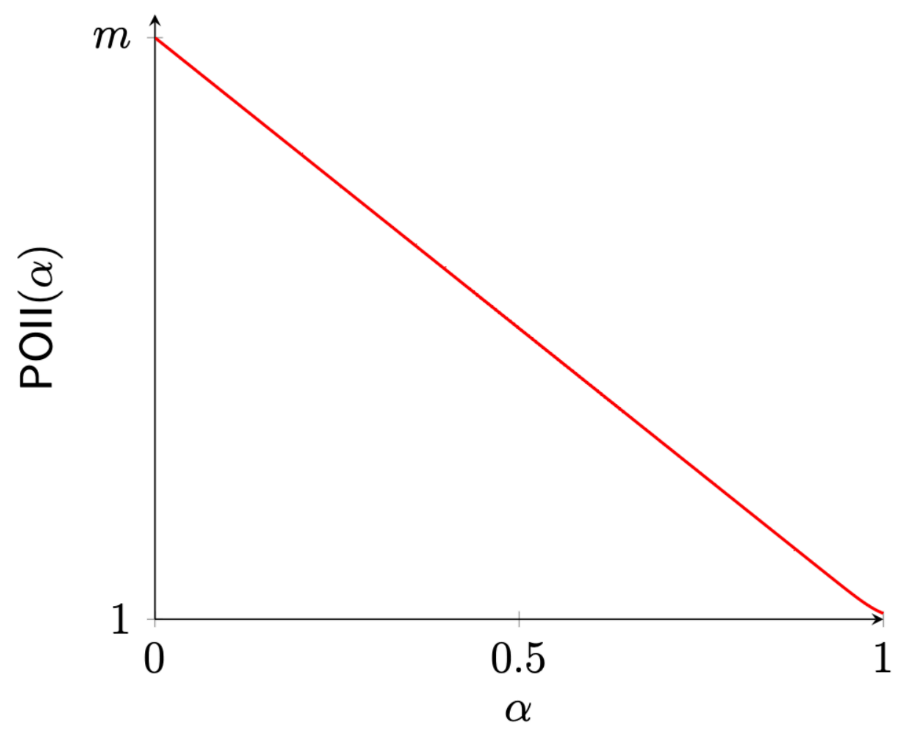

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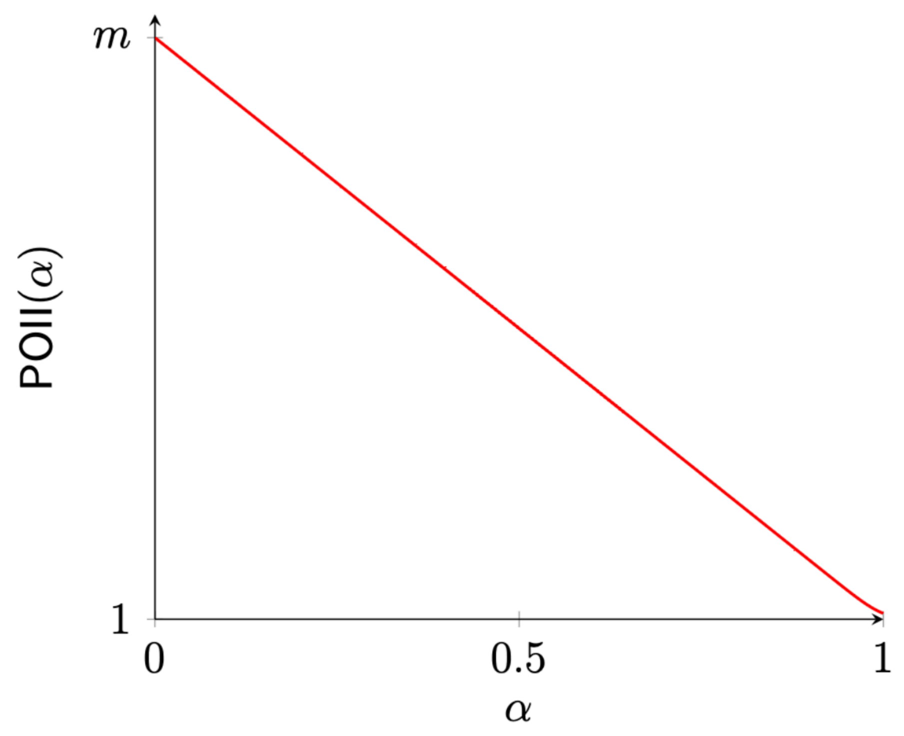

$$\Downarrow$$

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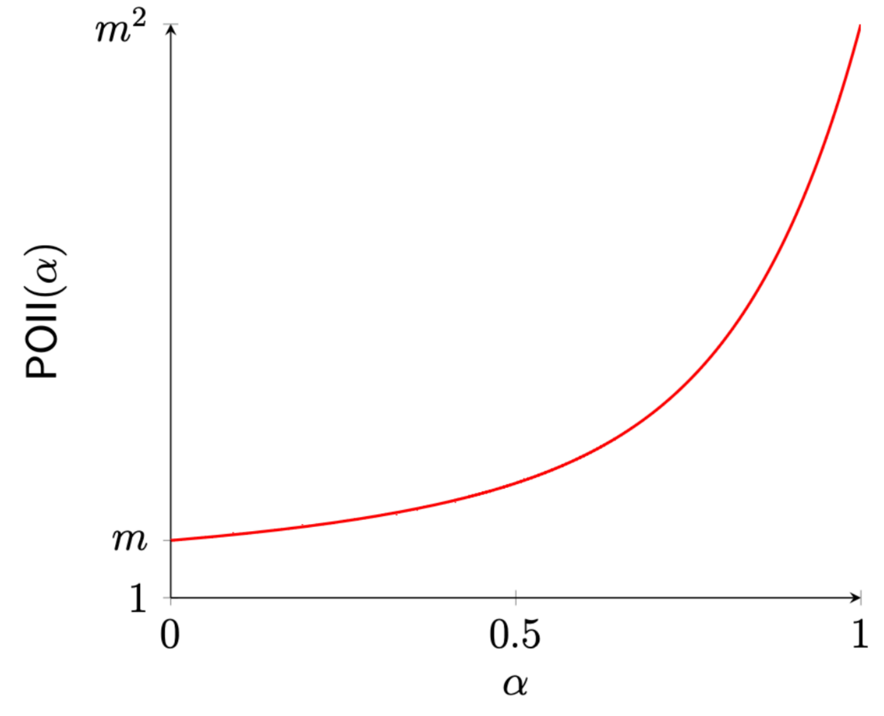

Future Directions

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