# Aligning with Heterogeneous Preferences for Kidney Exchange

By Rachel Freedman
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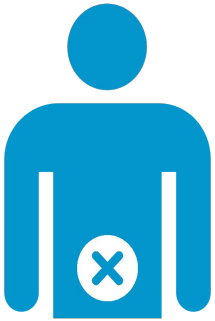
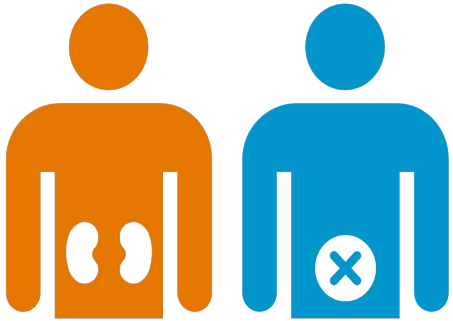
# Kidney Exchanges
# Preference Aggregation
# Methodology and Simulations

# Kidney Exchanges

## Preference Aggregation Methodology and Simulations





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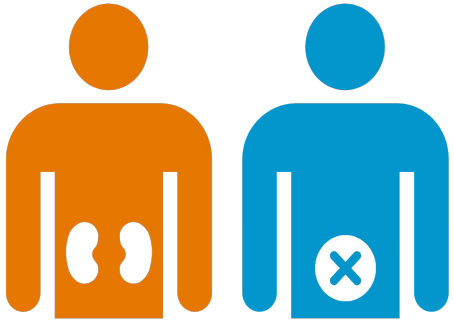

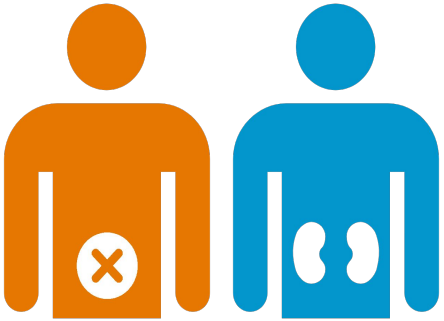

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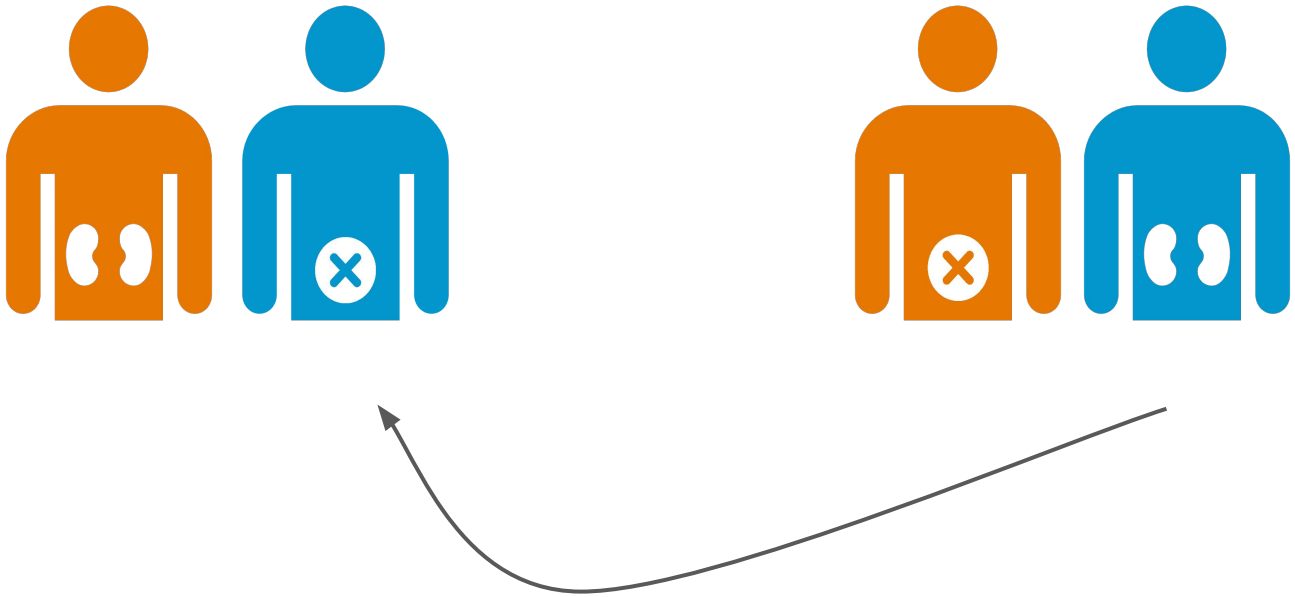

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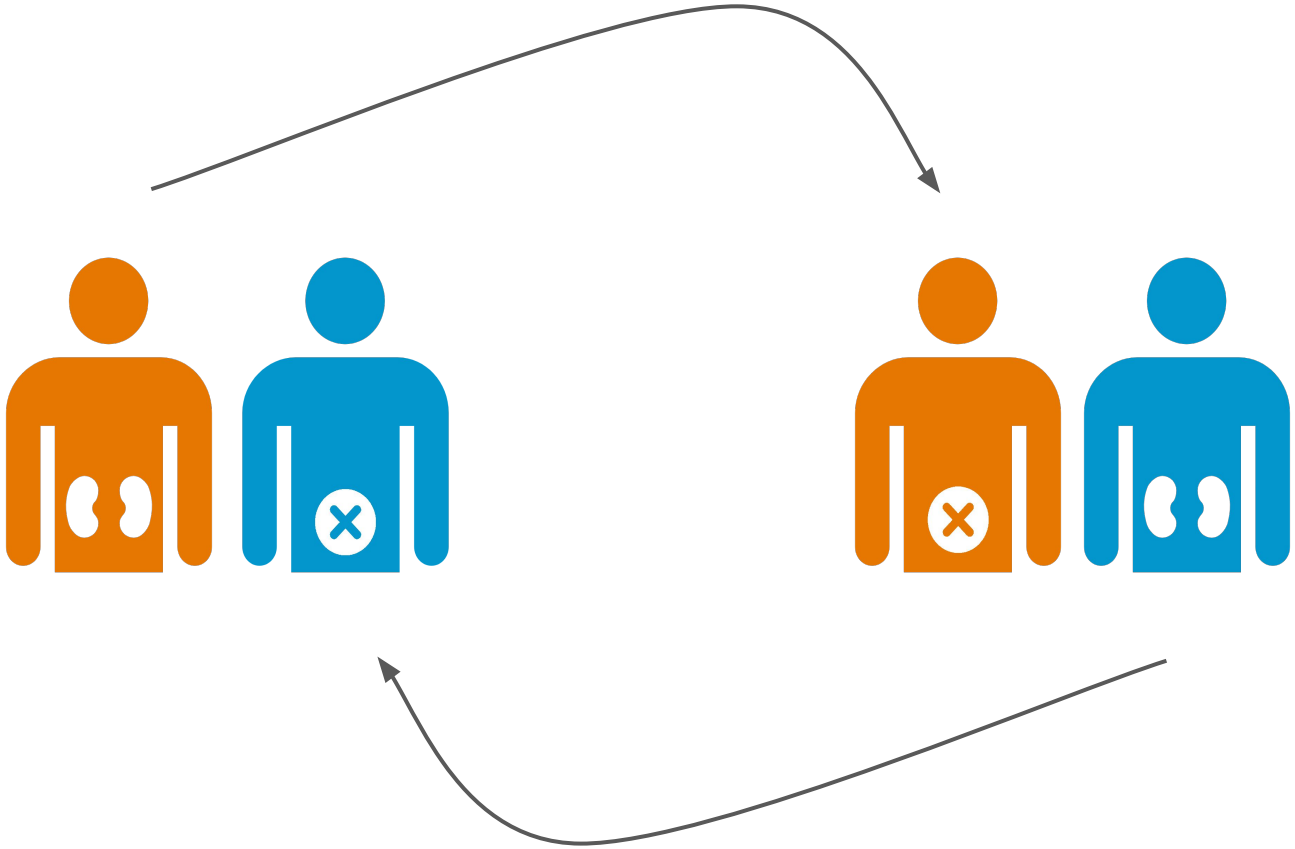

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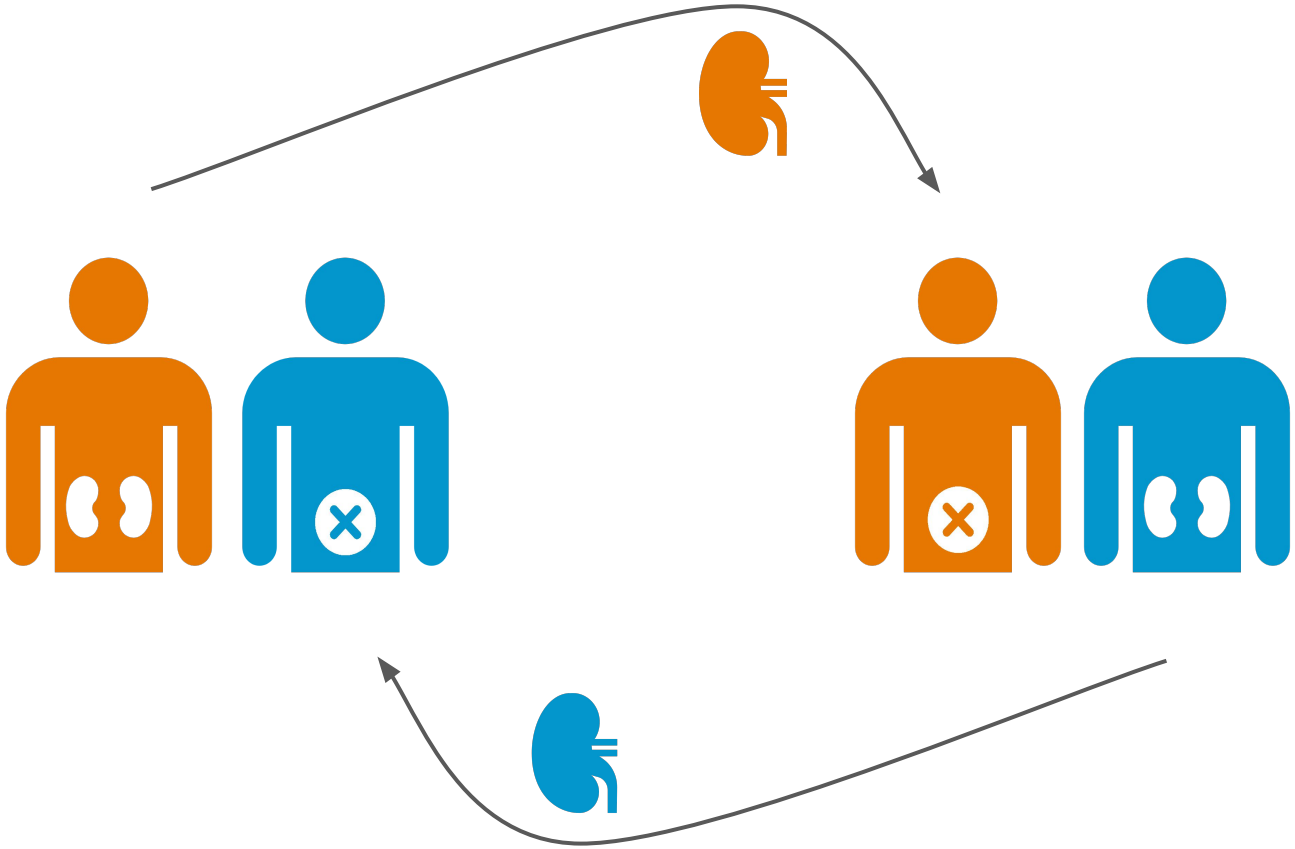

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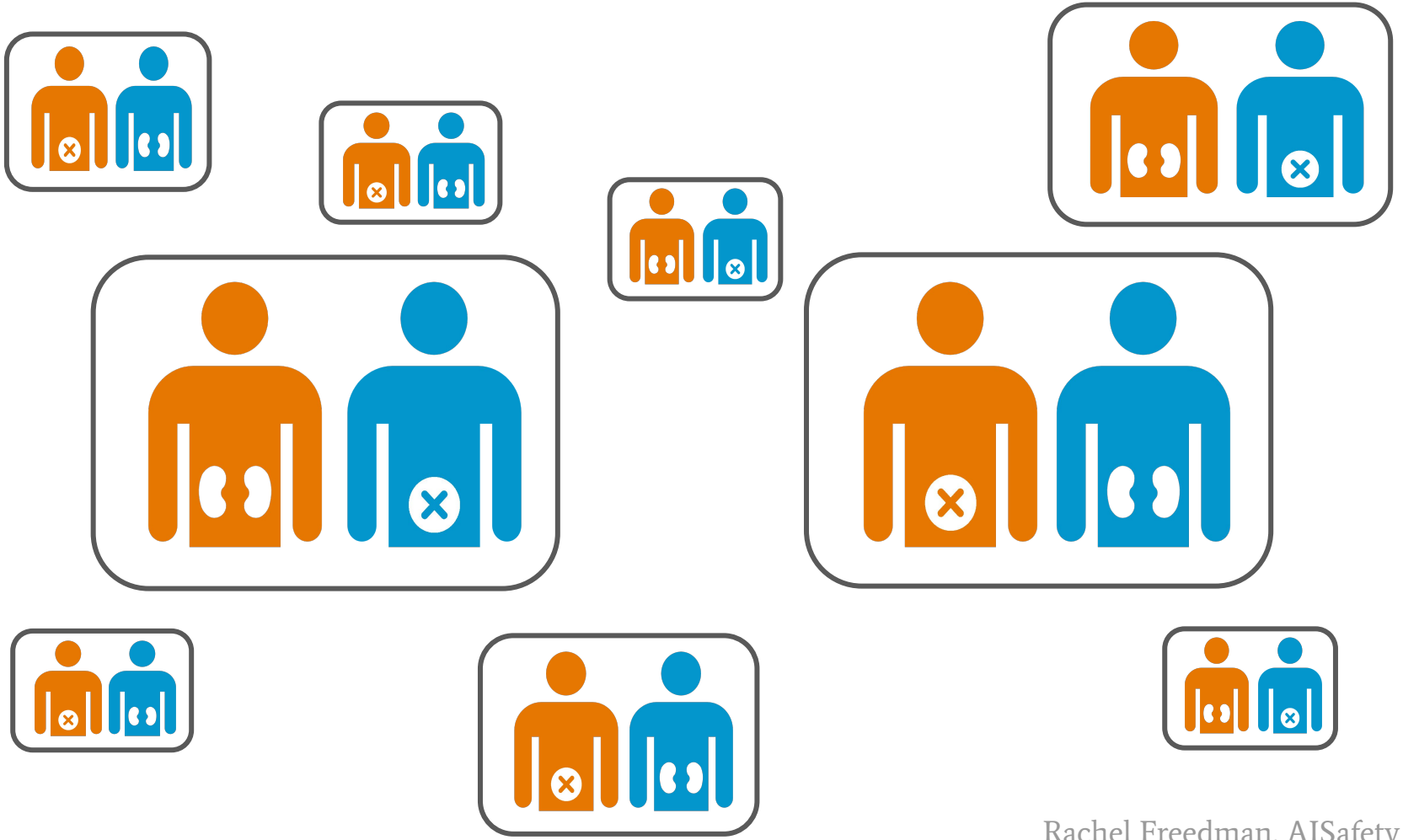

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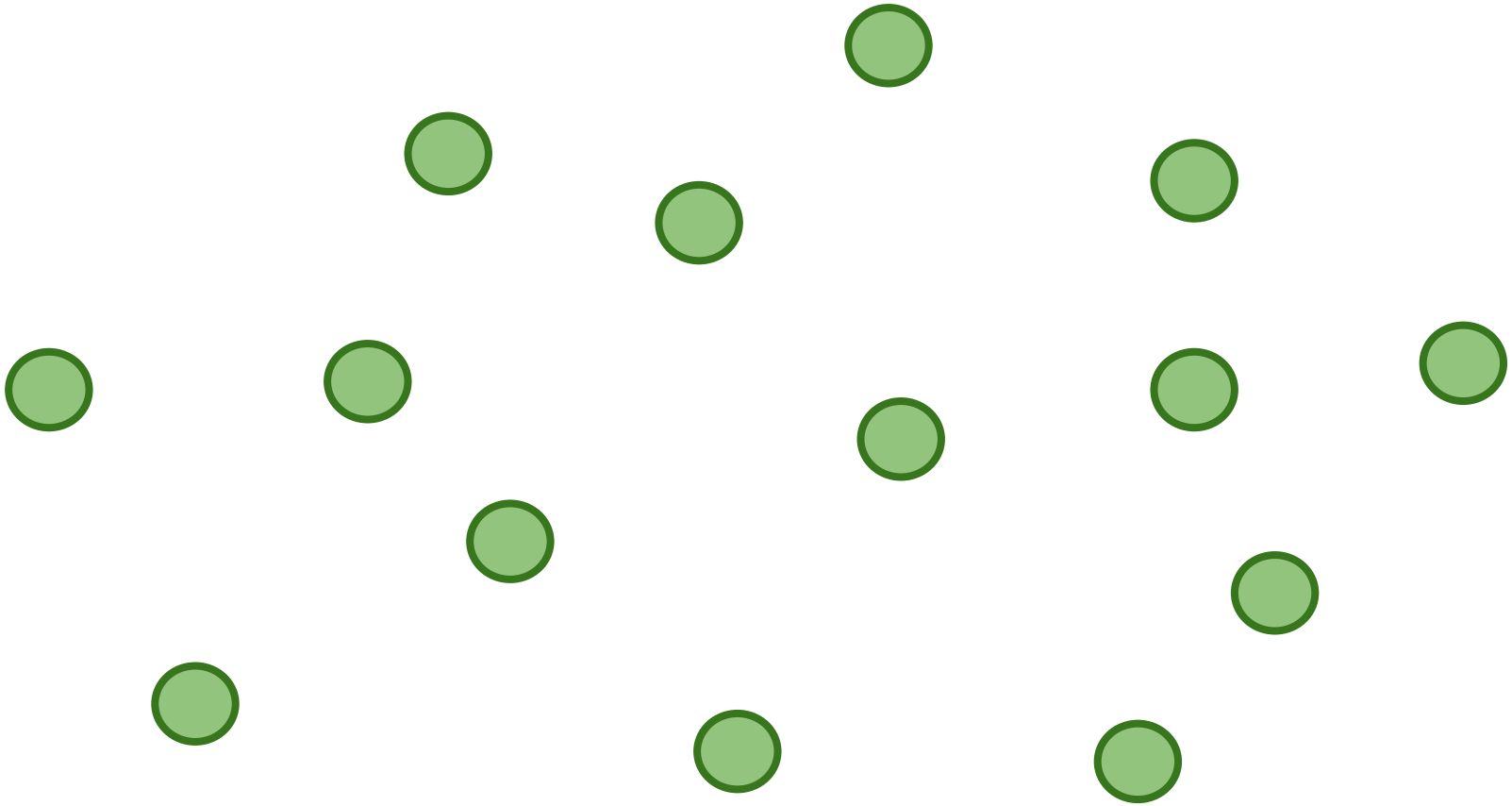

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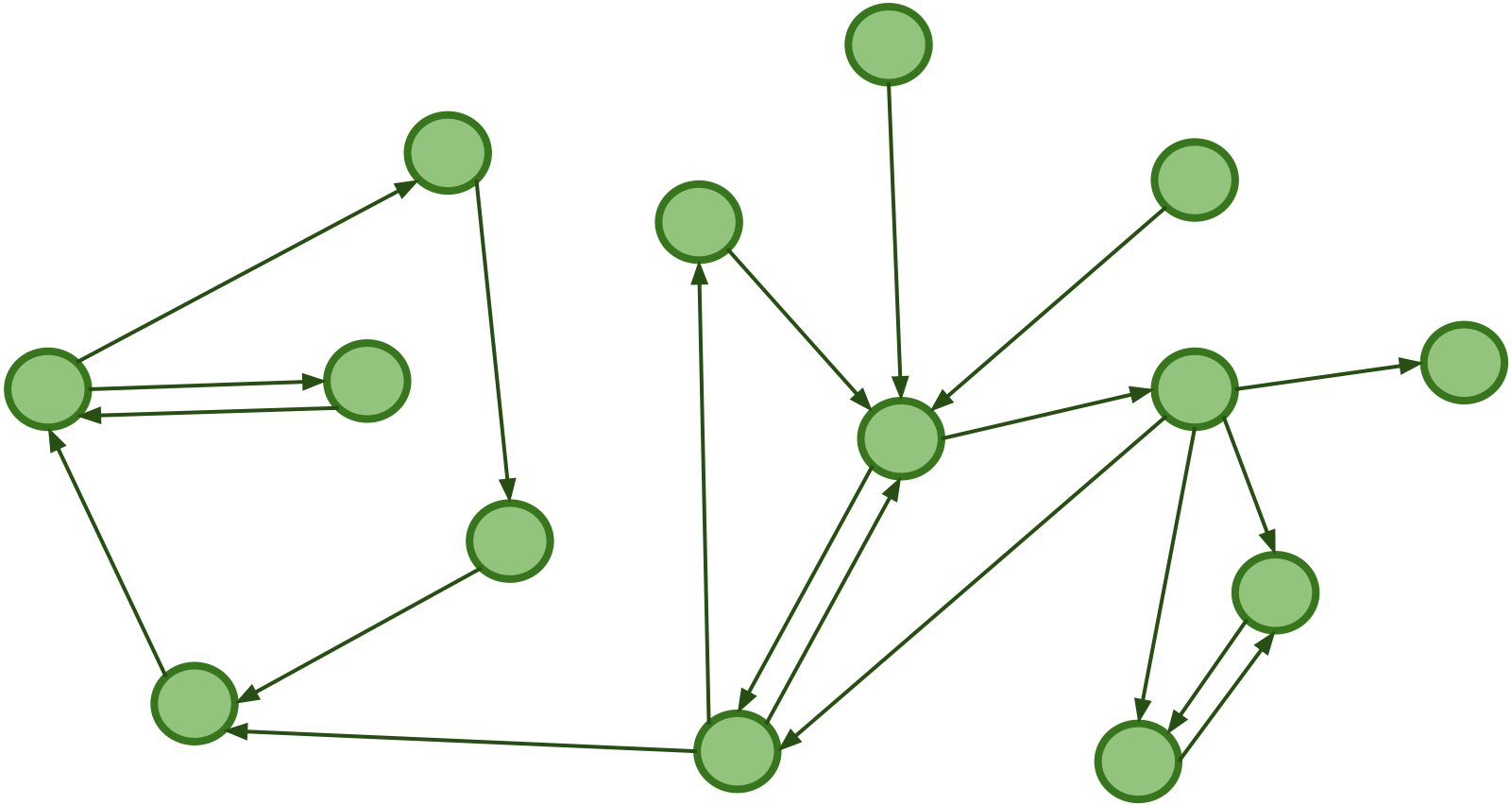

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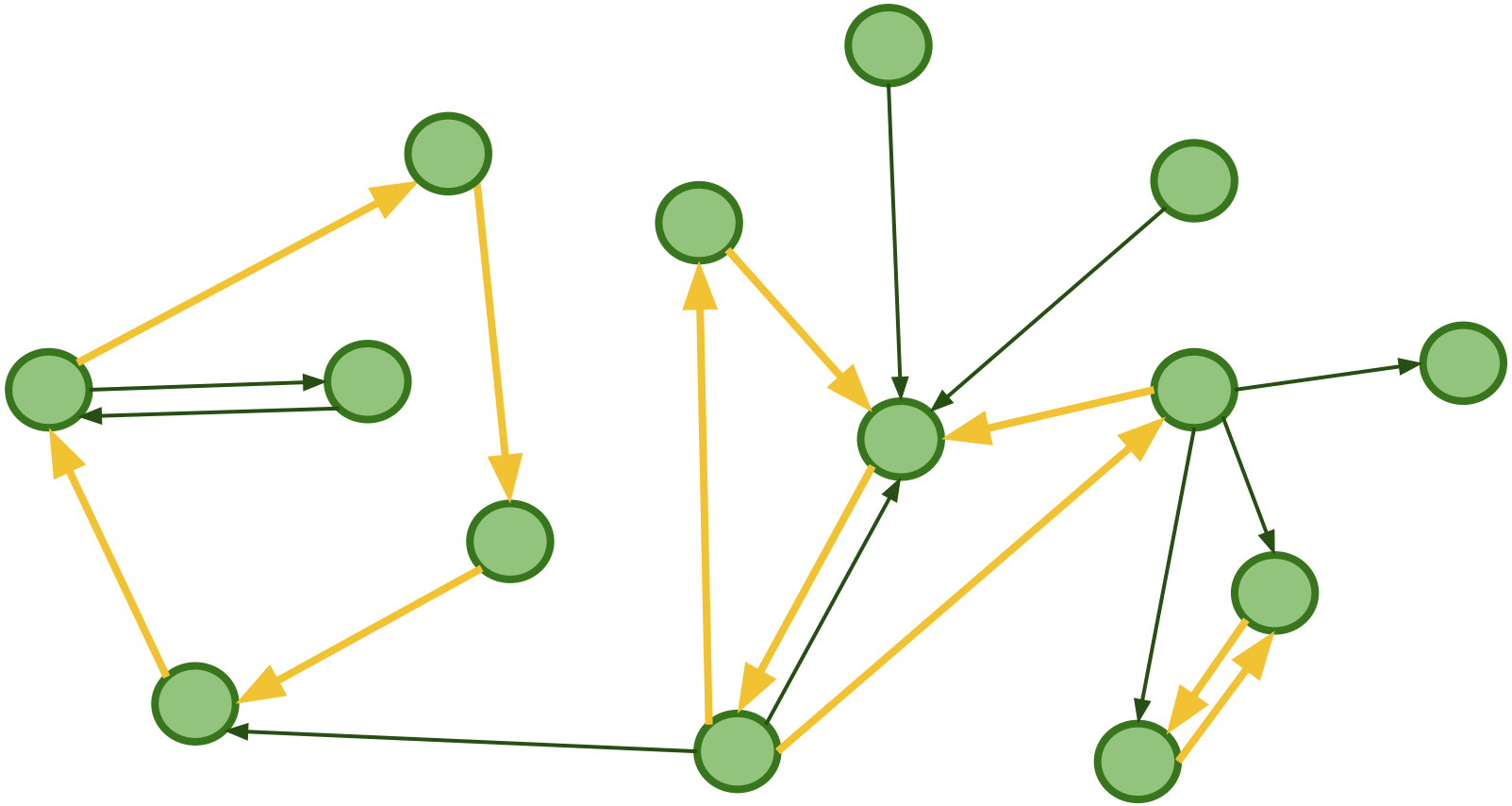

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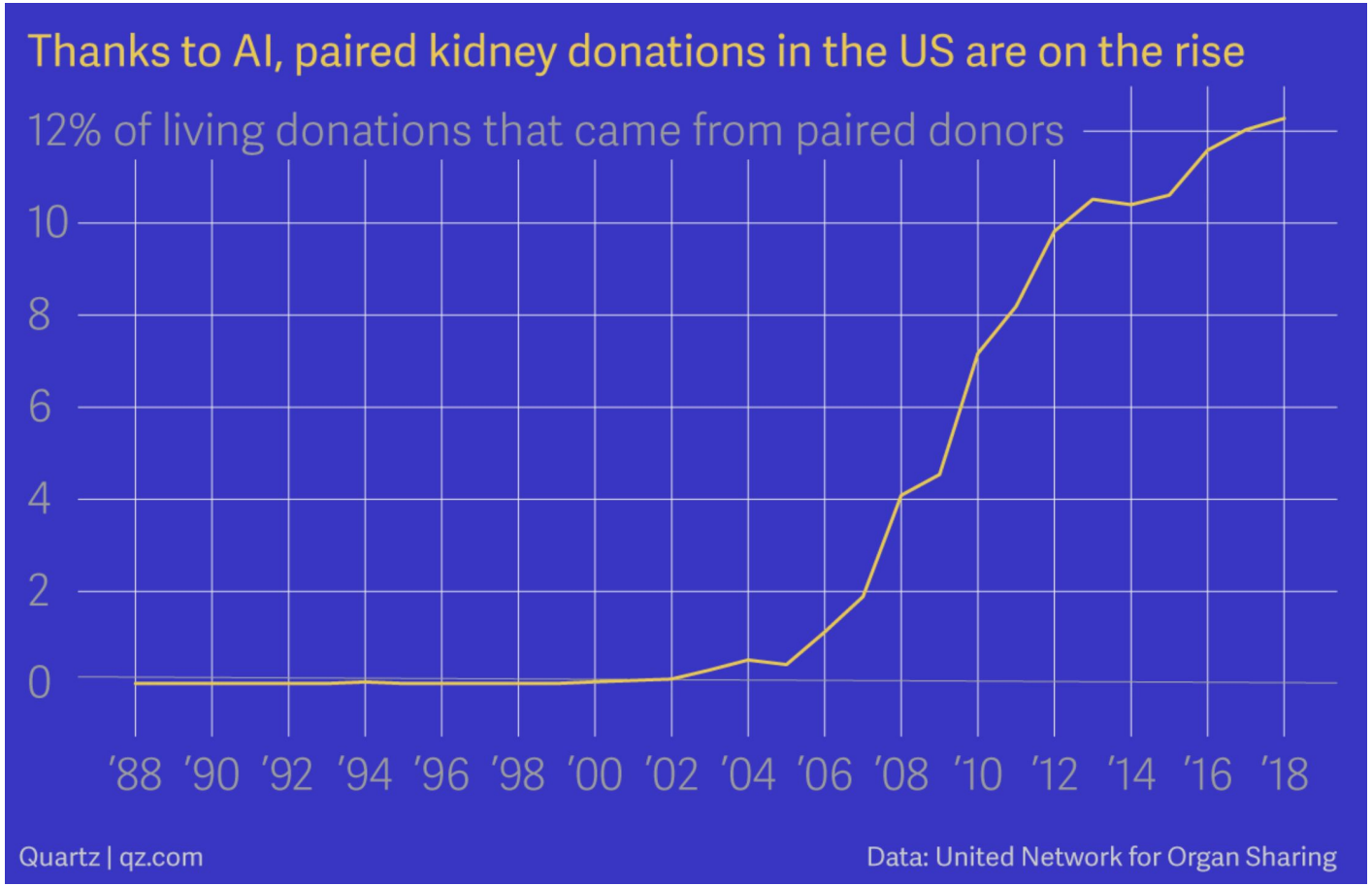


Source: Quartz, *How AI changed organ donation in the US*

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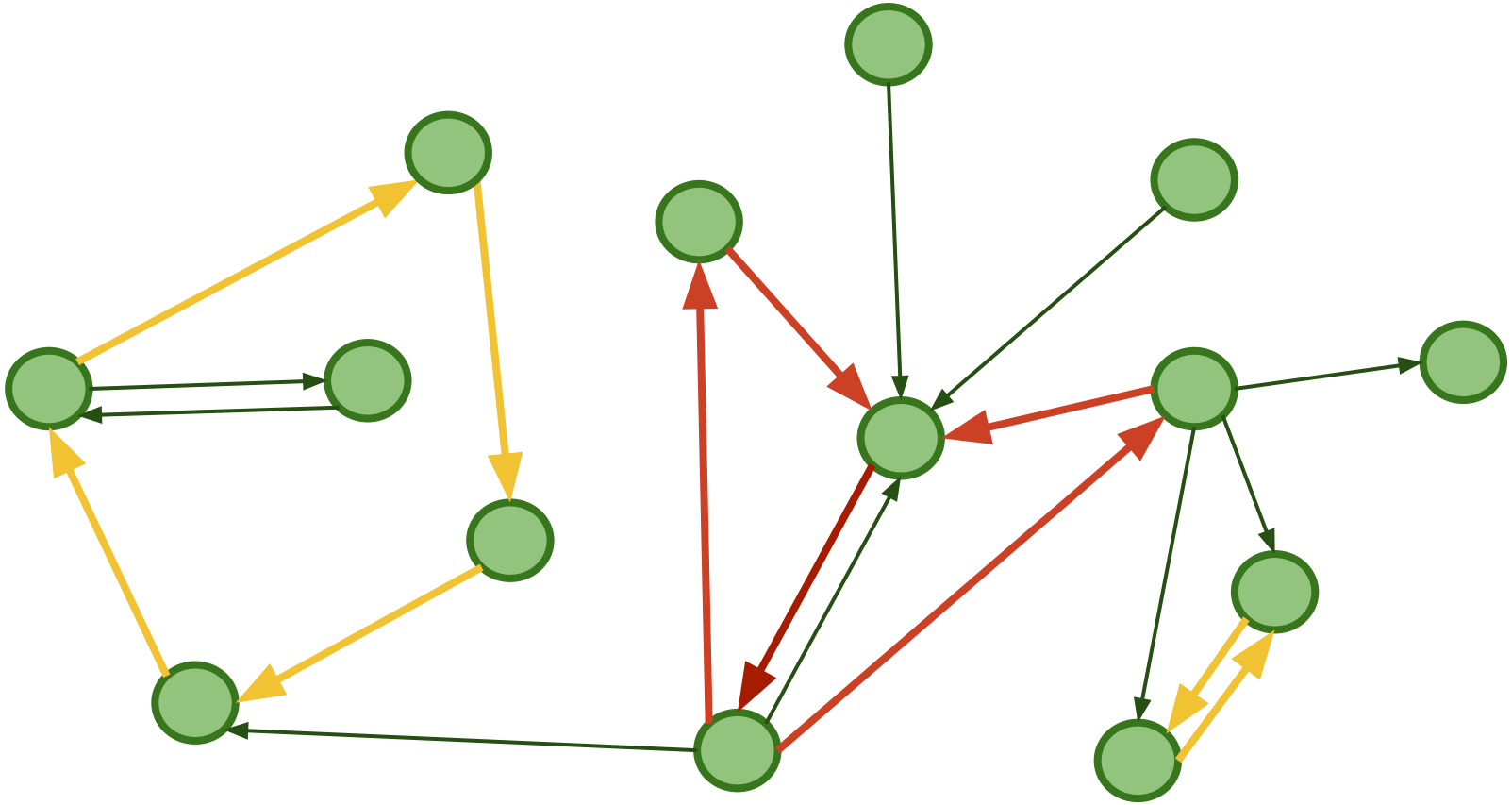

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Kidney Exchanges

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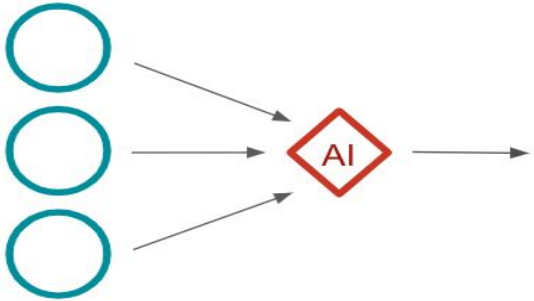
# Value Alignment as Preference Aggregation

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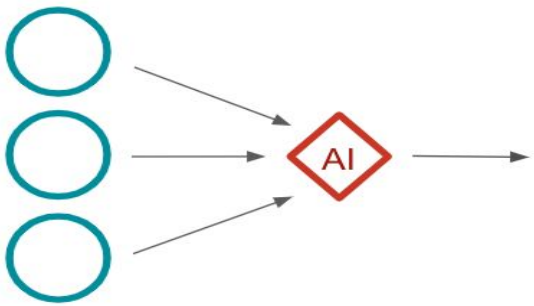


- **"Multi-single Delegation"** from *ARCHES: AI Research Considerations for Human Existential Safety* (Andrew Critch and David Krueger, 2020)

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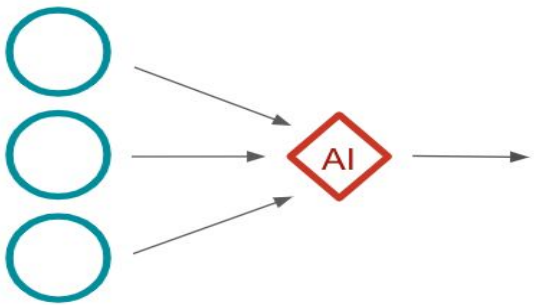


- **"Multi-single Delegation"** from *ARCHES: AI Research Considerations for Human Existential Safety* (Andrew Critch and David Krueger, 2020)
- Examples:
  - **kidney allocation** (ex. *Adapting a Kidney Exchange Algorithm to Align with Human Values*, Freedman et al. 2020)
  - **self-driving cars** (ex. *The Social Dilemma of Autonomous Vehicles*, Bonnefon et al. 2016)
  - **bail decisions** (ex. *Human Decisions and Machine Predictions*, Kleinberg et al. 2018)

# Individual Preferences: Pairwise Comparisons

Patient A is **70 years old**, has **1 alcoholic drink per month**, and has **no other major health problems**.

Patient B is **30 years old**, has **5 alcoholic drinks per day**, and has **skin cancer in remission**.

Who should get the kidney?

*Survey data graciously shared by the Duke Moral AI team.

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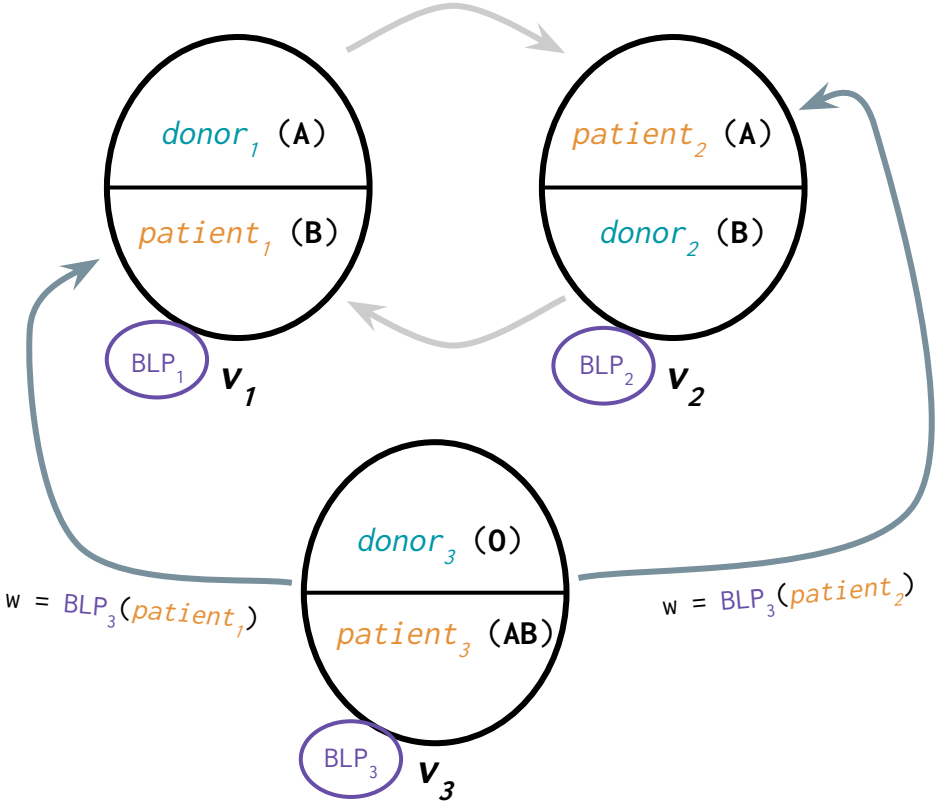
# Model: BLP*




*From Berry, Levinsohn, and Pakes (1995, *Econometrica*)

# Algorithm: Modified LP

$$\max \sum_{c \in C(L)} x_c \qquad s.t. \qquad \sum_{c:v \in c} x_c \leq 1 \quad \forall v \in V.$$

**Our Modification:**

$$\begin{array}{ll} \max & \sum_{c \in C(L)} \left[ \sum_{(u,v) \in c} w_{BLP(u,v)} \right] x_c \\ \text{s.t.} & \sum_{c:v \in c} x_c \leq 1 \qquad \forall v \in V \\ & \sum_{c \in C(L)} |c| x_c \geq Q \end{array}$$

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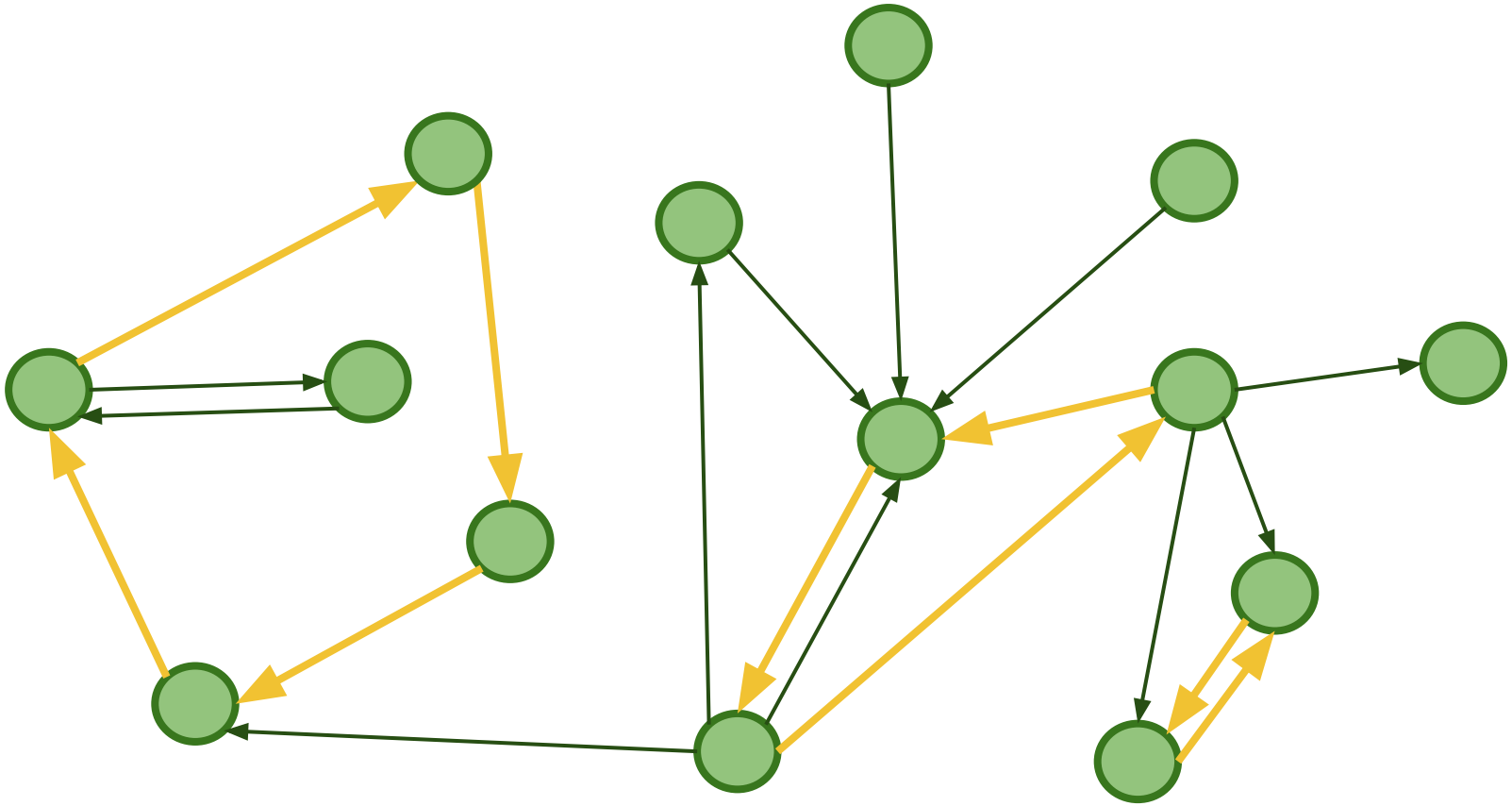

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# I built a simulation...

```java
public class VariationDriver {

        // Experimental conditions
        public enum Condition {
                EQUAL_WEIGHTS,                  // All edges have weight 1.0
                PATIENT_WEIGHTS,                // Edge weights depend on receiving patient only (BT model)
                DONOR_PATIENT_WEIGHTS           // Edge weights depend on donor and receiving patient (BLP model)
        }

        // Probabilities generated based on a match frequency of 1 day
        static final int CYCLE_CAP = 3;
        static final int EXPECTED_PAIRS = 4;
        static final int ITERATIONS = 365*5;
        static final int NUM_RUNS = 50;
        static final double DEATH = 0.00058072543318238116805064369 1;

        public static void runExperiments(){
                String expID = Long.toString(System.currentTimeMillis());
                runSimulationWithEqualWeights(expID);
                runSimulationWithPatientWeights(expID);
                runSimulationWithDonorPatientWeights(expID);
        }
```

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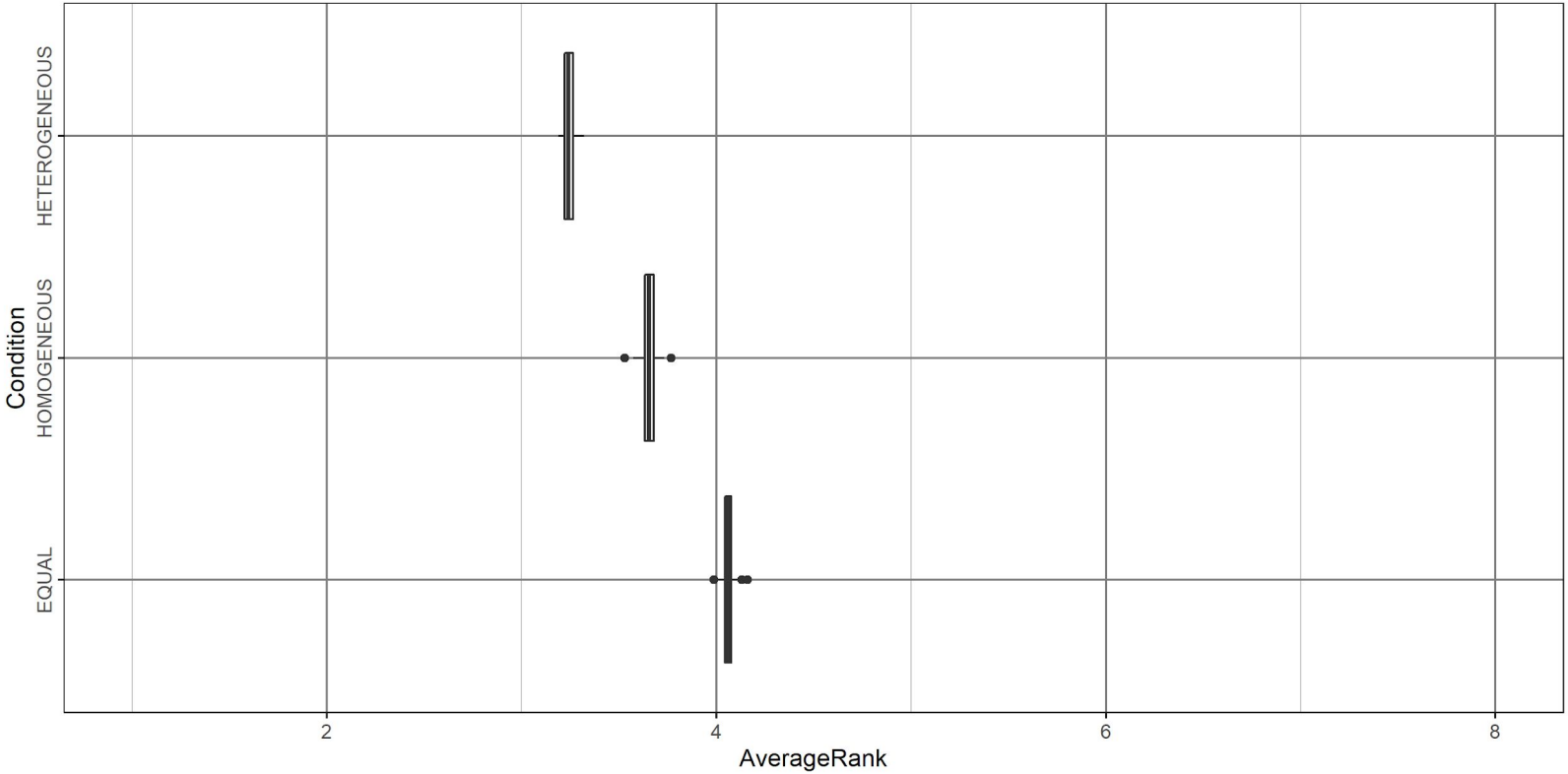
# Considering Heterogeneity Improves Average Rankings

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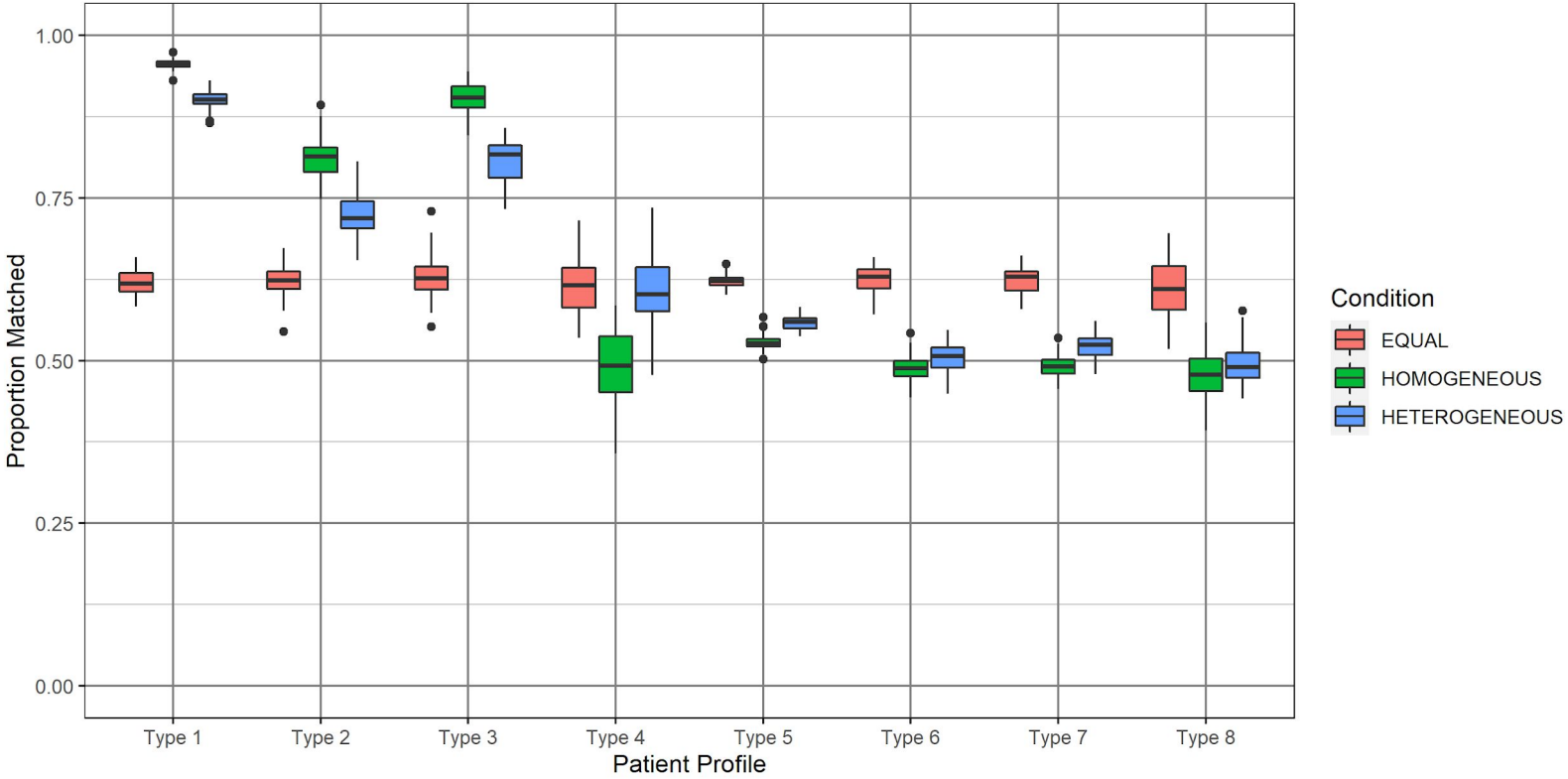
# Most Desirable Profiles Still Prioritized

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# Acknowledgements

Thanks to the **Duke Moral AI team** for the human preference data.

Thanks to **Professor John Dickerson** for an earlier version of the simulation.




And thanks to **Yunhao Huang** for help on the project!

Thank you for listening!
Questions?