Incentives and Fairness in Societal Resource Allocation

Sanmay Das
Dept. of Computer Science &
Center for Advancing Human-Machine Partnership
George Mason University

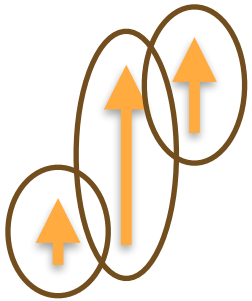
DIMACS Workshop Rump Session
October 28, 2022

The Setting and Local Justice

- Allocation of resources that are:
  - Scarce
  - Controlled or regulated by society
    - We've decided market mechanisms are not appropriate
- Examples: Organ transplantation, homelessness resources, spaces in magnet public schools
- Studied under the moniker *local justice* (Elster, 1992) in political philosophy
  - Call for AI to engage with this explicit framework (Das, AAAI 2022)

Local Decision-Making Based on Welfare of Individuals

- Supposed you can reduce individual welfare to a single dimension ***w***
- Prioritize based on
  - **Minimum pre-allocation *w*:** Greatest need. e.g. Homelessness with VI-SPDAT scores, liver transplant based on MELD scores
  - **Maximum post-allocation *w*:** Best off after allocation of the resource (**level** criterion). e.g. Some elite magnet schools may select those who are already extremely gifted *and* would have highest post-schooling quality (even if the school doesn't contribute much to that)
  - **Greatest increase in *w*:** Most "value added" (**increment** criterion). Battlefield or medical triage (increase in survival probability)



- These are considered in terms of the individual, not their value to society (unlike in the days of the Seattle "God Committee" that determined access to dialysis)

Motivating Example: Homelessness

Say we have 2 units each of Resource Types 1 and 2, and 1 unit of Resource Type 3. Utilities are:

		Resource Types		
		1	2	3
Individuals	A1	0.8	0.5	0
	A2	0.6	0.5	0.7
	B1	1.0	0.8	0.3
	B2	1.0	0.3	0.8
	C	0.5	0.5	0.5

Kube, Das, and Fowler (AAAI 2019):

- Estimate utilities as Pr(Return to homelessness | Assignment)
- Consider optimal (utilitarian) capacitated assignment

Unique features:

- Values are ML predictions based on private/ public feature vectors. $v_i = f(x_i, \tilde{x}_i)$
- Objectives may not correspond to traditional social welfare objectives

Roles for AI/MD: Outcomes and Objectives

- Measuring and predicting “welfare level” *w*
- Can ML better capture what current scoring systems (QALY, MELD, VI-SPDAT, …) seek to measure?
  - E.g. probability of needing medical intervention if a household remains unhoused
- Can we predict how well someone will respond to an intervention?
  - Causal inference problem, with real importance of future prediction!
  - Bansak et al (2018) take advantage of prior random allocation to predict refugee outcomes
  - Kube et al (2019) estimate counterfactual probabilities of return to homelessness under different interventions using BART.
- Risks:
  - Are we learning *good* ***and*** *fair* models?
  - Mashiat, Gitiaux, Rangwala, Fowler, Das (FAccT 2022) prove impossibility theorems for resource allocation in the flavor of the same in Fair ML

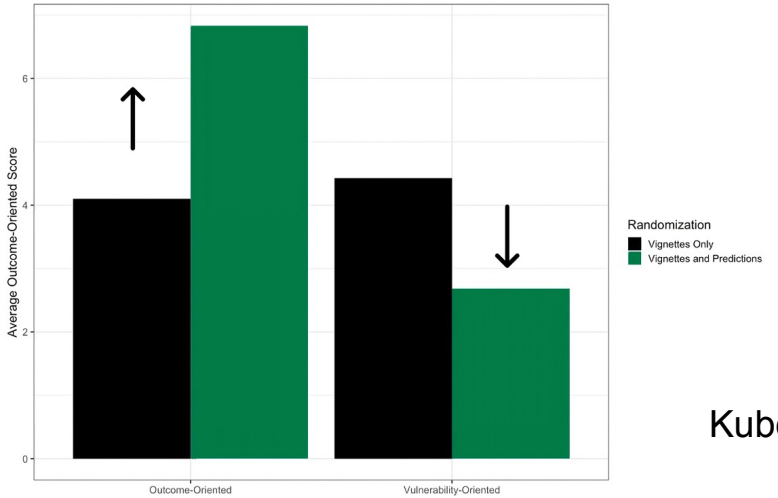
Roles for AI/MD: Preferences and Incentives

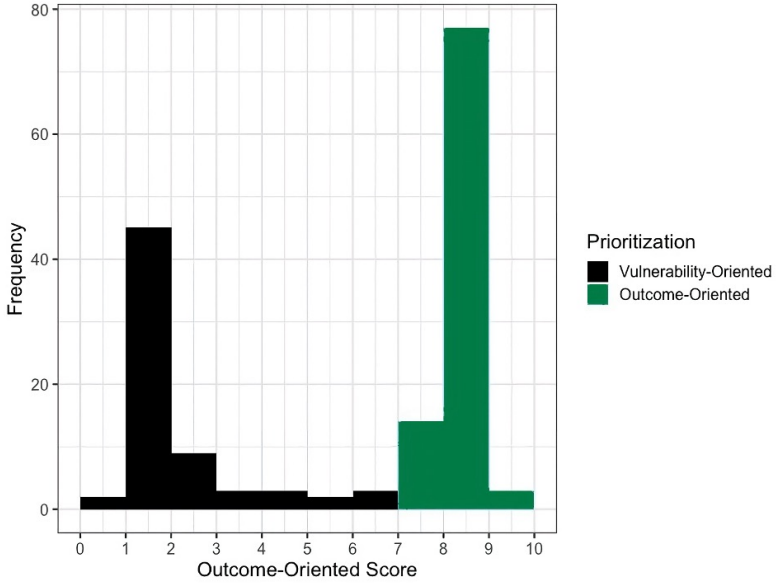
- Al Roth's critique of Elster: More consideration of incentives. How does the allocation system change the incentives of players, and could that change outcomes?
  - If it does, is the system still accomplishing its goals?
- Recent work:
  - Estornell, Das, and Vorobeychik (AAAI 2021): Allocate limited resources based on known plus self-reported features. Self-reported features can be audited, with the threat of non-allocation. How best to allocate audits to incentivize truthful behavior?
  - Aziz and Brandl (2021): Design of an incentive compatible (and efficient, priority-respecting) scheme for allocation of scarce medical resources based on eligibility categories (e.g. Covid vaccines early on)
  - Akbarpour, Dworczak, and Kominers (2022): Redistributive allocation mechanisms
- Slew of fascinating mechanism design problems could emerge in this space

Roles for AI/MD: Interacting with Street-Level Bureaucracy

Which of the following households would you prioritize for Transitional Housing? Select your choice by clicking on the associated column in the image below.

	Household 1	Household 2
Predicted probability of needing future services within 2 years if given Transitional Housing	Low	Medium
Predicted probability of needing future services within 2 years if given Emergency Shelter	High	High





Kube, Das, Fowler, Vorobeychik (EC 2022)