

Matching Algorithms and Organ Distribution

Embedded EthiCS module for CS 120: Introduction to Algorithms and
their Limitations

Modified module and slides originally from Entwistle (2022).

Agenda

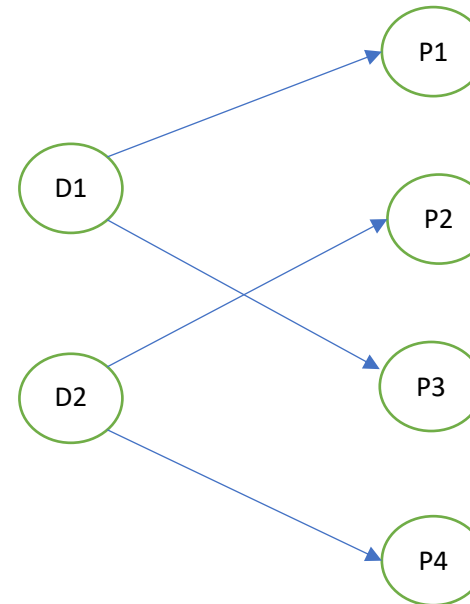
- Intro
- Background on organ donation and motivation
- Warmup
- Two different ethical approaches
 - Maximization (utilitarian)
 - Maximin (needs-based)
- Class Activity
- Prioritarianism
- Class Vote

Background on Organ Donation

- Approximately 103,485 people are currently waiting for an organ transplant.
- In 2022, about 42,800 organ transplants were performed.
- Motivating Question: how should we arrange matches under conditions of scarcity?

Donor matching under scarcity

- There may be multiple ways to maximize matches based on compatibility alone.
- This leaves an open question about which donors and patients we should pair, and therefore which patients we should prioritize.



Warmup

- By yourself:
 - think about what factors should be considered when deciding which patients to prioritize for matches? Write 2-3 down. (3 min)
- With the person or few people next to you:
 - share the factors you wrote down and discuss why those factors might be relevant. (3 min)

Kidney Donations:

Factors listed as relevant by the United Network on Organ Sharing (UNOS) website.



Kidney

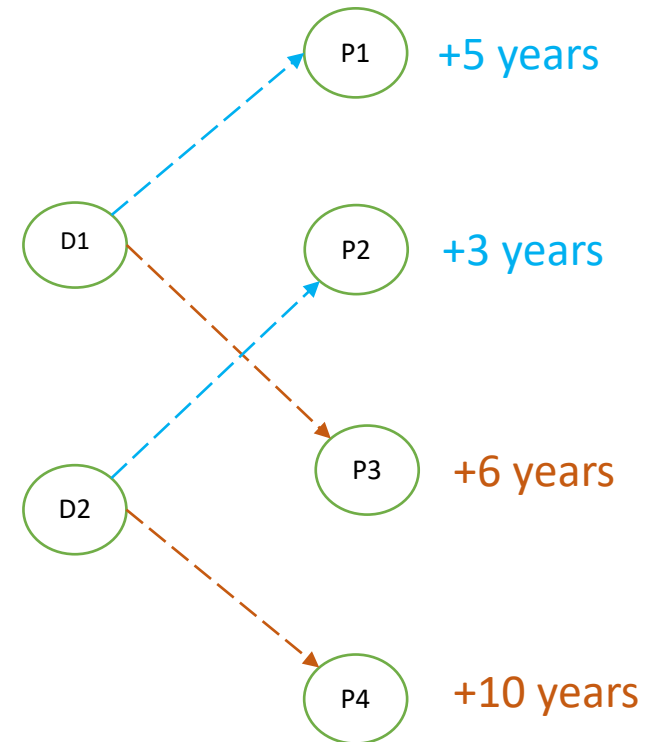
- Waiting time
- Donor/recipient immune system compatibility (CPRA score)
- Prior living donor
- Distance from donor hospital
- Survival benefit
- Pediatric status

Utilitarian Approach

- Utilitarianism: an ethical theory which says that the right thing to do is always the thing that maximizes the greatest total welfare.
- Kidney matching:
 - Match donors to patients in a way that maximizes the greatest total welfare.
- What is the greatest total welfare in the kidney case?
 - One option: total life years gained.

Maximization

- (3 min) With the person next to you, discuss which pairing we should choose according to the maximization principle:
 - [D1 and P1, D2 and P2]or
 - [D1 and P3, D2 and P4]
- The maximization principle dictates that we choose [D1 and P3, D2 and P4] because it maximizes total life years gained.



Problems with Maximization

- In this scenario, P1 and P2 don't end up receiving kidneys because the total number of life years they are expected to gain is not as high as the total number of life years that P3 and P4 are expected to gain.
- With a partner: why might it be *unfair* that P1 and P2 are passed over in favor of patients with better expected outcomes? What are some possible reasons that P1 and P2 have lower expected outcomes? (5 min).

Problems with Maximization (cont.)

- Why might P1 and P2 have lower expected outcomes in the first place?
 - Age
 - More severe disease
 - Time on transplant list
 - Socioeconomic inequality in healthcare
 - Racial inequality in healthcare

Needs-based Approach

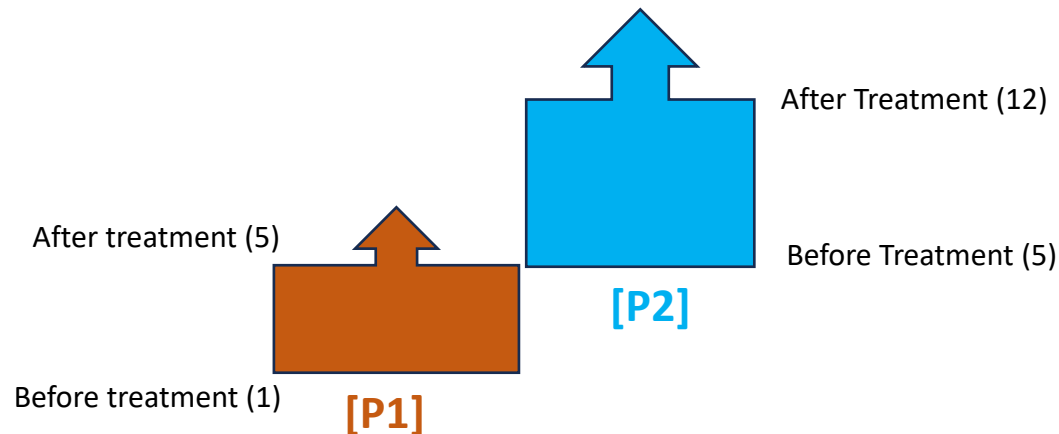
- Needs-based theory: scarce medical resources should go to those that need them the most.
- Maximin principle: pick the donor matches that help the least well-off people the most.

Least well-off?

- How do we determine who is the least well-off?
- One standard way of doing this is through quality-adjusted life years (QALYs).
 - One year lived in perfect health = 1 QALY
 - Represents combination of two benefits of treatment: length of life and quality of life.
 - So, someone who has fewer QALYs is worse-off than someone who has more QALYs

Maximin Applied

(3 min) With the person next to you, discuss which of two compatible patients we should match a donor with, according to the maximin principle:



According to the maximin principle, we should choose [P1], because in doing so we help the least well-off patient the most, where the “least well-off” means fewest QALYs

Problems with Maximin?

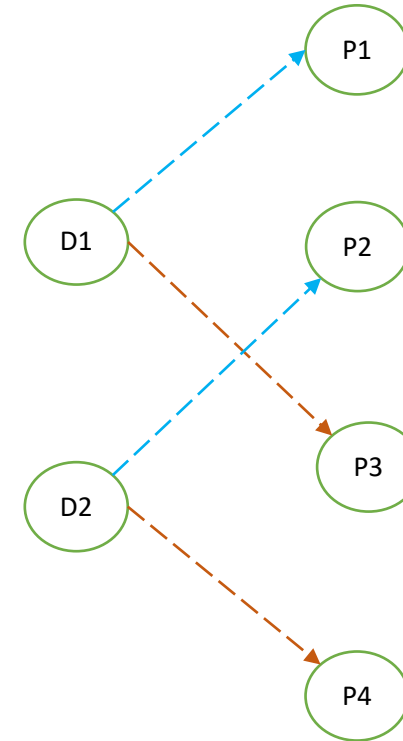
- In this scenario, P2 does not end up receiving a kidney because they start out better off than P1.
- With a partner: why might it be *unfair* P2 does not receive the kidney in this case? What are some possible issues with using a need-based approach in this case? (5 min).

Problems with Maximin (cont.)

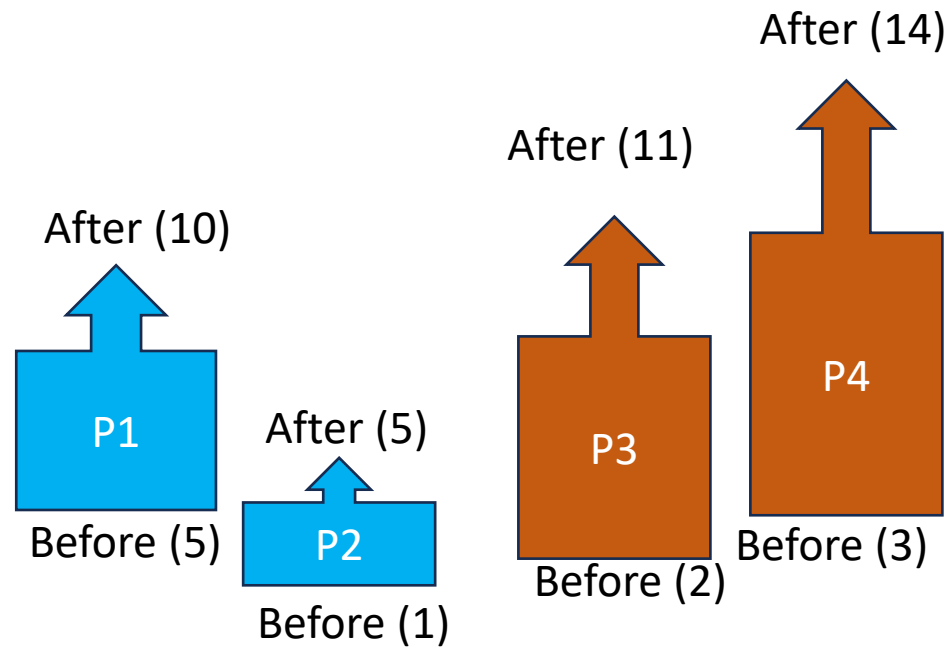
- Problems with a needs-based approach
 - What if the expected benefits to P2 are very large and the expected benefits for P1 are very small?
 - Use of QALYs to determine “least well-off” is flawed.

Activity (5 min)

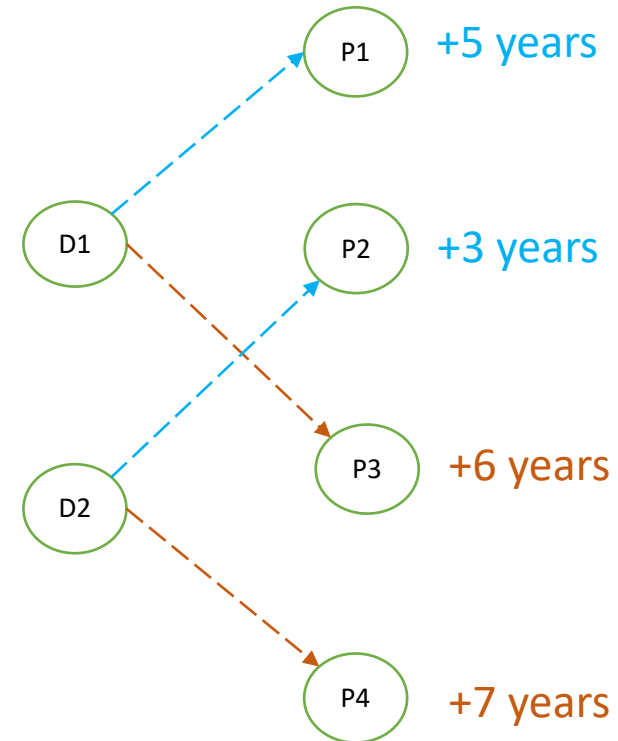
- Your side of the room will be assigned to argue for Maximin (needs-based) or Maximization (utilitarian).
- With your partners: come up with reasons in favor of your assigned position. Be ready to report back to the larger class.



QALY increase with treatment



Overall life years gained



Class Vote – use poll in canvas

Utilitarian Approach

- Maximization: maximize the greatest total good (greatest total life years gained).
- Moral intuition: do the most good with the resources you have.
- sensitive to scale
- not sensitive to starting point

Needs-based Approach

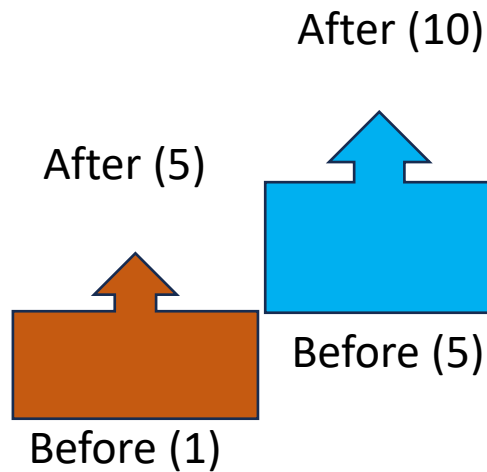
- Maximin: help the least well-off patients (lowest starting number of QALYs).
- Moral intuition: help those who need it most.
- sensitive to starting point
- not sensitive to scale.

Another option:

- Prioritarianism:
 - (1) the lower an individual person's level of well-being over the course of their life, the greater the moral value of a benefit to that individual.
 - (2) we should act so as to maximize moral value.
- Principle: prioritize getting benefits to those whose well-being is lower, but all benefits are taken into account (they will just be weighted differently).
- (5 min) With a partner: how would this work in the organ donation case?

Prioritarianism applied

- Case 1



- Case 2

