Matching Algorithms for Blood Donation

Donor blood is a **scarce resource:**

- every 2 seconds, someone in the US needs blood
- shortages especially impact developing countries, and in particular, children and women facing complications during childbirth
- donation rates are correlated with a country's wealth; high-income countries have median donation rate of 31.5 donations per 1000 people, while low-income countries have a median of 5.0 donations per 1000 people.

facebook

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* : median donation rates

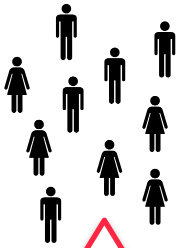
Statistics and quotes from the American Red Cross (ARC) and the World Health Organization (WHO)

Donor Coordination & Recruitment

In our setting, blood donors and recipients use a **web application** to connect with one another.

The web app can send **notifications** to donors, about a particular donation opportunity. These notifications are sent automatically, by a **notification policy.**

Potential blood *donors*

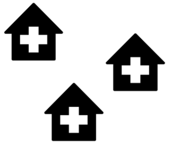


- Browse opportunities
- receive **notifications**

Web app

Notify donors using a **notification policy**

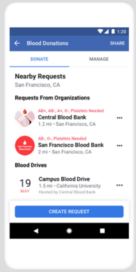
Donation *opportunities* ("recipients")



- State a need
- Reach out to donors

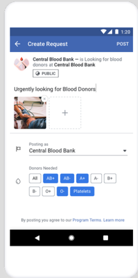
Taking the perspective of the web app, we study the **Facebook Blood Donation Tool**, which connects donors with opportunities to donate in several countries around the world, with ~70 million registered donors.*

Blood donors can find donation opportunities, and can choose to receive notifications about opportunities



Blood recipients can state their need & availability

- Individuals
- Hospitals
- Blood drives



* : As of June 2020 https://socialgood.fb.com/health/blood-donations/

Matching Model

We formalize an *online matching model* for this setting, which differs from standard online matching in several key ways

Standard Online Matching / Adwords	Blood Donor Matching	Same?
U entirely offline	*U* entirely offline	✓
Fixed time horizon *T*	Fixed time horizon *T*	✓
U removed when matched	*U* return after ***K days***	✗
V have capacity 1	*V* have **unlimited capacity**	✗
V arrive one-by-one	*V* arrive in **batches**, and some are offline	✗
|*V*| >> |*U*|	|*V*| << |*U*|	✗

Donors $u \in U$

- *offline*, but *rate limited*: donors can only be matched once every ***K* days**

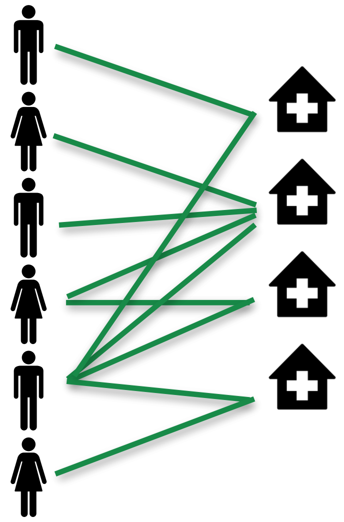
Edges (potential recipients) $e = (u, v) \in E$

- *potential notifications*, which may depend on distance or donor/recipient preferences
- Edge *weights* $w_{et} \in [0, 1]$ (likelihood of MA)

Recipients $v \in V$

- Both *offline* recipients (always available), and *online* recipients (sometimes available)
- Probability $p_{vt} \in [0, 1]$ that *v* is available at time *t*

Finite time horizon (days): $t \in \{1, \ldots, T\}$

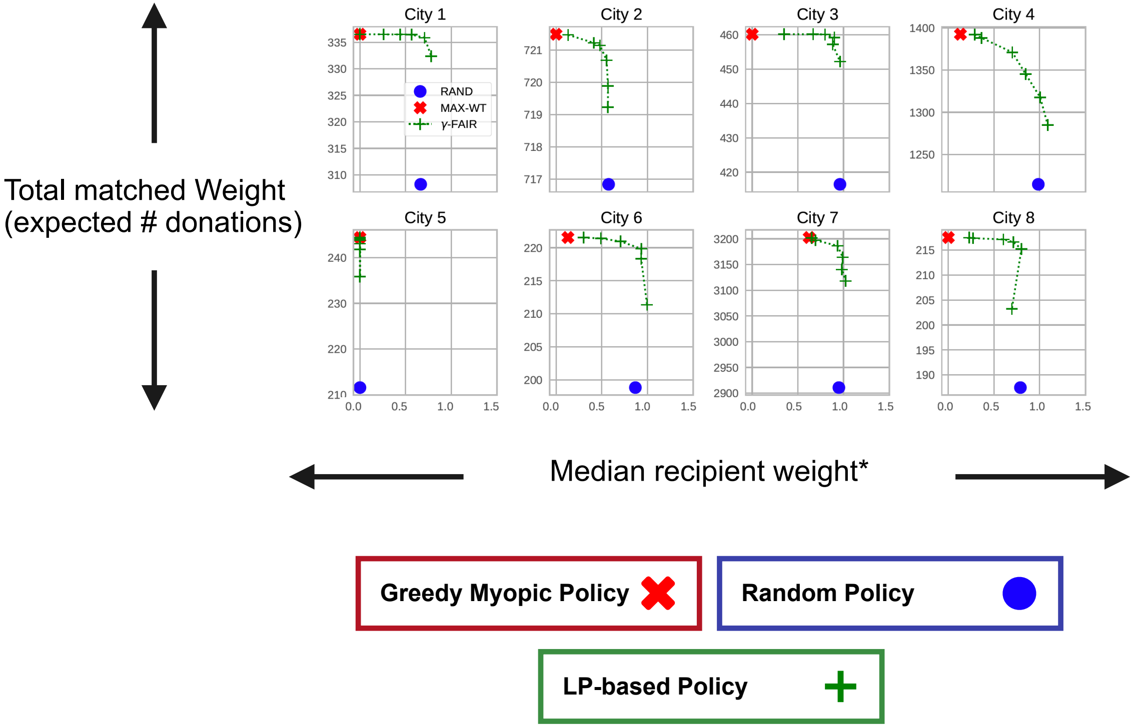


Initial Results

In **simulations** we find that a greedy policy (which maximizes edge weight) increases overall matching weight by 5-20%.

This comes at a cost of ignoring some recipients, which are not well-connected, or have low edge weights.

In online **experiments**, using 1.3 million donors, we find that notifications which maximize (estimated) edge weight also increase overall donor action rate by about 5% (*p*<<0.001).



* : normalized by expected weight assigned by the random policy