Modeling Assumptions Clash with the Real World: Configuring Student Assignment Algorithms to Serve Community Needs

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MD4SG Workshop 2020

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Student Assignment

Students

Preferences over schools

Priorities over students

Matching algorithm

Best possible assignments for students subject to school priorities
What modeling assumptions are made about people and their intentions?

- Preferences over schools
- Priorities over students

Matching algorithm

Best possible assignments for students subject to school priorities
What modeling assumptions are made about people and their intentions?

...and how do these clash with the real world?
Case study: San Francisco Unified School District

1978: NAACP sues SFUSD and state of CA

1983: Consent decree with two primary goals: equity & diversity

1994: Families sue SFUSD for using race as a factor in school assignment

1999: Settlement prohibits using race in assignment

2011: Matching algorithm is first implemented

2018: Board passes Resolution to redesign the assignment system

2018-2020: Redesign in process

<table>
<thead>
<tr>
<th>Racial quotas, opt-in transfers</th>
<th>&quot;The Diversity Index&quot;</th>
<th>Top trading cycles (&quot;The Lottery&quot;)</th>
</tr>
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<tr>
<td>1983: Consent decree with two primary goals: equity &amp; diversity</td>
<td>1999: Settlement prohibits using race in assignment</td>
<td>2011: Matching algorithm is first implemented</td>
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Research Questions

- What are the goals of student assignment in SFUSD?
- Why *should* their assignment system meet those goals?
  - Theoretical properties of TTC
  - Modeling assumptions about families
- What went wrong?
  - How do those modeling assumptions *clash with the real world*?
Methods

● Qualitative content analysis
  ○ Semi-structured interviews with SF parents (n=7)
  ○ Online parent discussions on Reddit
  ○ SFUSD content (community feedback and official policies)

● Analysis of economics literature to understand theoretical promises

● Exploratory quantitative data analysis
  ○ 2017 Kindergarten preference and 3rd grade achievement data
What are the goals of student assignment in SFUSD?

- Transparency, Predictability, Simplicity
- Equity and diversity
- Quality schools
- Community & continuity
What modeling assumptions are made about people and their intentions?

...and how do these clash with the real world?
Clearly defined, explicit procedure

Matching algorithm

Best possible assignments for students subject to school priorities

Optimizes for student preferences

Students

Strategy-proof

True preferences over all schools

Priorities over students

Background

Contributions

Methods

Results

Discussion
I do think that there is a certain group of people who have enough affluence to benefit from the system and get their kids into a better place. (P1)

I’m not really that confident in their actual lottery system. It could be bingo in the background for all I know. (P4)
Equal access to all schools

- All students can participate
- True preferences over all schools
- Priorities over students

Matching algorithm

Best possible assignments for students subject to school priorities

Can prioritize underserved students
**Barriers to accessing schools**

- **Students**
  - True preferences over all schools
- **Schools**
  - Priorities over students

**Limited impact, Political tension, Can exacerbate stereotypes**

- **Matching algorithm**
  - Best possible assignments for students subject to school priorities

---

**So, you are telling me this school is [. . . ] three blocks uphill and we’re supposed to do that with a kindergartner and no car? (P1)**

---

**Background Contributions Methods Results Discussion**
VALUE: Transparency, predictability & simplicity

VALUE: Equity & Diversity

VALUE: Quality Schools

VALUE: Community & continuity

Background
Contributions
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Results
Discussion

Students

True preferences over all schools

Priorities over students

Matching algorithm

Best possible assignments for students subject to school priorities

Healthy competition between schools
Our current choice system creates unhealthy competition between schools, and can have a negative impact on schools’ ability to build robust and consistent enrollments. (SFUSD, 2019)
Can prioritize neighborhood students, siblings

Matching algorithm

Best possible assignments for students subject to school priorities

Students

True preferences over all schools

Priorities over students
VALUE: Transparency, predictability & simplicity

VALUE: Equity & Diversity

VALUE: Quality Schools

VALUE: Community & continuity

Students

True preferences over all schools

Priorities over students

Schools

Matching algorithm

Best possible assignments for students subject to school priorities

Capacity mismatch, conflict with diversity and equity goals

[The lottery is] great because people get more choices, but for people who just want their neighborhood schools [. . . ] it’s too stressful. (P4)
VALUE: Transparency, predictability & simplicity  
VALUE: Equity & Diversity  
VALUE: Quality Schools  
VALUE: Community & continuity

- All students can participate
- True preferences over all schools
- Strategy-proof
- Clearly defined, explicit procedure
- Matching algorithm
- Best possible assignments for students subject to school priorities
- Healthy competition between schools

- Equitable access to all schools; prioritize underserved students
- Priorities over students
- Can prioritize neighborhood students, siblings
- Can prioritize neighborhood students, siblings
VALUE: Transparency, predictability & simplicity
VALUE: Equity & Diversity
VALUE: Quality Schools
VALUE: Community & continuity

Barriers to accessing schools

- Priorities over students
- Capacity mismatch; Political tension

Barriers to participation

- True preferences over all schools
- Distrust → Strategy → perceived inequity

Competition driven by social signalling & stereotypes

- Best possible assignments for students subject to school priorities
- Difficult to direct resources to under-enrolled schools

Matching algorithm

- Difficult to explain & understand
Features of Successful Governance Institutions

- Provide congruent, necessary information
- Decentralize and distribute power
- Support and encourage informed deliberation
- Support low-cost conflict resolution
- Monitor and stay accountable to outcomes
- Encourage adaptation and change

(Dietz, Ostrom and Stern, 2003)
Recommendations

1. Provide accessible, relevant information
2. **Balance optimizing** for individual preferences and community-level goals
3. **Define community-level goals** in collaboration with stakeholders
4. Support **informed deliberation of trade-offs**
Thank you!
Questions?

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Extra slides
## Summary: Results

<table>
<thead>
<tr>
<th>School District Value</th>
<th>Algorithm’s Theoretical Promises</th>
<th>Algorithm’s Mental Model of the World</th>
<th>Real World Challenges</th>
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<tr>
<td>Transparency, predictability and simplicity</td>
<td>- Clearly defined and explainable procedure</td>
<td>- Families accept their assignment as fair and legitimate as long as the algorithm is explained</td>
<td>- Understanding the system and researching schools is time-consuming and hard</td>
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<tr>
<td></td>
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<td>- Information / explanation is available</td>
<td>- Some parents try to game the system</td>
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<td></td>
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<td>- Families truthfully report preferences</td>
<td>- Lack of trust: perceptions of randomness and unfairness</td>
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<td>Equity and diversity</td>
<td>- Any student can apply to any schools</td>
<td>- All families participate</td>
<td>- Time, language, economic barriers to participating</td>
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<tr>
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<td>- Priority for underserved students</td>
<td>- Everyone has identical opportunity to rank any school</td>
<td>- Transportation constraints</td>
</tr>
<tr>
<td>Quality schools</td>
<td>- Competition drives up overall quality</td>
<td>- Families accurately estimate school quality</td>
<td>- Competition driven by social signalling &amp; stereotypes</td>
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<td>- Schools can respond to competitive pressures</td>
<td>- Lack of resources to respond to pressure</td>
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<td>Community and continuity</td>
<td>- Priority for siblings and neighborhood</td>
<td>- Schools have space for siblings and neighborhood students</td>
<td>- Frustrating for those who can’t access local schools</td>
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## Summary: Discussion

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<th>Recommendation for Student Assignment Mechanism</th>
<th>Current Assignment Challenges in SFUSD</th>
<th>Features of Successful Governance Institutions</th>
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</table>
| Provide accessible, relevant information         | - Difficult to find information about system or schools  
|                                                 | - Distrust and perceived randomness    | - Make information accessible and congruent  
|                                                 |                                       | - Include sources of uncertainty               |
| Balance optimizing for individual preferences and community-level goals | - Assignments satisfy individual preferences  
|                                                 | - Limited ability to optimize for community-level goals | - Decentralize and distribute authority  
|                                                 |                                       | - Monitor and stay accountable to outcomes     |
| Define community-level goals in collaboration with stakeholders | - Diversity and equity goals contested but inflexible | - Involve stakeholders in informed deliberation  
|                                                 |                                       | - Monitor and stay accountable to outcomes     |
|                                                 |                                       | - Encourage adaptation and change              |
| Support informed deliberation of trade-offs      | - Priority categories cannot resolve complex political tensions | - Involve stakeholders in informed deliberation  
|                                                 |                                       | - Support low-cost conflict resolution         |
Are We Governing the Educational Commons?

- Hardin (1968) - The Tragedy of The Commons
  - Resource users are trapped in a commons dilemma
- Ostrom (1990) (and others)
  - Many social groups have managed resources & prevented degradation through self-governance
- Limited resource: Educational Opportunity
  - Everyone wants access; demand > capacity
  - Current arrangement allows certain groups privileged access to the resource
  - Unclear/unpredictable distribution rule → tension, dissatisfaction
  - Distribution requires:
    - Decision making under uncertainty
    - Trade-offs between conflicting human values/interests
General Principles for Robust Governance of Resources

- Provide congruent, necessary information
- Support and encourage **analytic deliberation** to deal with conflict
- Monitor usage and devise accountability mechanisms
- **Nested**, varied institutional authority
- Induce compliance/cooperation
  - Trust & buy-in
  - Social capital & communication

(Dietz, Ostrom & Stern, 2003)
# Framing the Challenges in SFUSD

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<td>Social learning → Stereotyping/Choice patterns</td>
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### Information

- **Background**
- **Contributions**
- **Methods**
- **Results**
- **Discussion**
Acknowledgements

I am very grateful for many helpful discussions with staff at Berkeley GSE, SFUSD, OUSD, and OaklandEnrolls.

- Norma Ming
- Henry O'Connell
- Susan Hsieh
- Moonhawk Kim
- Sonali Murarka
- Luis Rodriguez
- Julia Judge
- Lisa Gibesdegac
Results: Unaddressed needs

- Transparency, Predictability & Simplicity
- Barriers to participation
- Equity & Diversity
- Social signaling
- Choice patterns
- Stress, distrust, strategizing
- Quality schools
- Community & continuity
## Mechanism Design Will Fix Everything!

<table>
<thead>
<tr>
<th>Goal</th>
<th>Why is this difficult or important?</th>
<th>How is mechanism design going to help?</th>
</tr>
</thead>
</table>
| Transparency, predictability, simplicity | Disparities in access to information on schools and enrollment processes                               | Clearly defined procedure  
Strategy-proof                                                                                   |
| Equity & Diversity                | Residential segregation  
Disparities in school quality                                                                         | Everyone has access to all schools  
Schools can specify priorities or quotas                                                        |
| Quality schools                   | Limited funding & resources                                                                             | Competition should put pressure on underperforming schools to improve  
Demand data can help district to choose when to open/close schools                               |
| Community & Continuity            | Mismatch between capacity, neighborhood size, and demand  
Residential segregation  | Schools can specify priorities  
Transparent reasoning  
Stability                                                                                     |
...or not...

<table>
<thead>
<tr>
<th>How is mechanism design going to help?</th>
<th>Why didn’t this work?</th>
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<td>Clearly defined procedure</td>
<td>Everyone is confused about how it works. This is exacerbated by frequent changes to specifics and disparities in information access. The district lacks clear definitions of success and cannot link their goals directly to their mechanism.</td>
</tr>
<tr>
<td>Strategy-proof</td>
<td>Distrust in the system leads to strategizing, particularly among the more well-off who have the capacity to do this and tend to be vying for spots at more popular schools. This exacerbates distrust and perceived inequity.</td>
</tr>
<tr>
<td>Everyone has access to all schools</td>
<td>There are barriers to participation of all kinds: informational and transportation/financial are the biggies. Language may also be significant. For minority students, particularly Latinx and African American, they may face discrimination or isolation at majority White and/or Asian schools.</td>
</tr>
<tr>
<td>How is mechanism design going to help?</td>
<td>Why didn’t this work?</td>
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<td>---------------------------------------</td>
<td>------------------------</td>
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<tr>
<td>Schools can specify priorities or quotas</td>
<td>Quotas are legally difficult. Priorities are limited in their ability to achieve distributional goals (sibling priority makes sense, but CTIP1 priority is limited if CTIP1 parents only list schools close to home, for example).</td>
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<td>Competition should improve school quality and help target resources</td>
<td>Competition is often driven by social signaling and stereotyping rather than actual value-added. It can instead exacerbate stereotypes and harm underperforming schools. The district is concerned about helping under-enrolled schools, not closing them. Under-enrollment is correlated with racial demographics, so simply closing these schools is not an option.</td>
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<td>Stable outcomes</td>
<td>Unclear whether this is perceived as fair or not, or even perceived at all.</td>
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Glossary

- **SFUSD, the district** = San Francisco Unified School District
- **The lottery** = The process by which students or parents submit preferences and are assigned to schools. May refer to the whole process or the algorithm itself
- **Tie-breaker** = a priority category at a school (e.g. sibling, AA, CTIP1)
- **AA** = attendance area
- **CTIP1** = the areas of the city with schools in the lowest quintile of academic achievement, used as a proxy to give low income students priority
### A Brief History of Mechanism Design for School Choice

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
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<tbody>
<tr>
<td>2003</td>
<td>Abdulkadiroglu &amp; Sonmez propose MD for school choice. DA implemented for NYC High schools.</td>
</tr>
<tr>
<td>2005</td>
<td>DA replaces the Boston Mechanism, known for being gameable.</td>
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<tr>
<td>2012</td>
<td>New Orleans &amp; Denver Roth wins nobel prize for “the theory of stable allocations and the practice of market design.”</td>
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<td>2013</td>
<td>Washington DC 2005 DA replaces the Boston Mechanism, known for being gameable.</td>
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<td>2014</td>
<td>Newark 2012: New Orleans &amp; Denver Roth wins nobel prize for “the theory of stable allocations and the practice of market design.”</td>
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What are the current challenges?

Families:
- Barriers to participation
  - Information, time, language
- Demand > Capacity
- Stress & unpredictability → distrust, strategizing

The District:
- Segregated choice patterns
- Limited resources
  - Esp at under-enrolled schools
- Neighborhood size > Capacity
- What does success look like?
True preferences over all schools

Priorities over students

Matching algorithm

Best possible assignments for students subject to school priorities

Barriers to participation

Students

Distrust → Strategy → perceived inequity

Difficult to explain & understand

Perceived randomness & unpredictability

Competition driven by social signalling & stereotypes

Difficult to direct resources to under-enrolled schools

Information

Monitoring

Analytic Deliberation

Nested authority

Communication and social capital

Trust and buy-in

Students

Schools

Capacity mismatch, conflict with D&E goals

Segregated choice patterns

Political, limited impact, can exacerbate stereotypes

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- Monitoring
- Analytic Deliberation
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- Trust and buy-in
Open Questions

Informational Needs
- Accessible information about school choices
- Outreach & recruitment
- Focus on relevant algorithmic details: e.g. predictability/uncertainty

Optimization Needs
- Explicitly optimize district goals
- Clearly defined and flexible metrics of success
- Active deliberation of trade-offs (e.g. neighborhood vs. diversity; diversity vs equity) at low involvement cost

Community Needs
- Develop trust in District
- Combat harmful stereotypes of underserved students & schools
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What information? How?

What details are relevant? How to explain?

What optimization procedure? How to trade off district vs. individual preferences?
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How to design for low cost engagement?

How to engage stakeholders in algorithm design?