Evaluating an Agent-Based Model:
Evaluation Practice Meets Research on Evaluation

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Large-Scale Agent-Based Simulation of Complex Educational Systems

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What are we up to?
model development process
Model 1
Visual representation of score assignment

- Red = Low Ability/Score
- Yellow = Medium Ability/Score
- Green = High Ability/Score
- Black = Teacher
- Grey = Student

Student X

Grade 1 Test

Grade 2 Test

Grade 3 Test

Grade 4 Test
Student score function

- **Score Assignment Notation**
  - $X^g_k = $ Score for student $k$ at grade level $g$
  - $A_k = $ Baseline ability for student $k$ to learn the material
  - $T = $ Baseline ability for the teacher to teach the material
  - $N = $ Number of students in the classroom
  - $w_i = $ Calibration Weights

\[
X^g_k = \frac{1}{4} \left[ w_1 A_k + w_2 T + w_3 \frac{1}{N} \sum_{j=1}^{N} A_j + w_4 X^{g-1}_k \right]
\]

For the first iteration, we only average over first three terms.
Model 2
Abilities (True Scores) versus Observed Test Score
\[ \theta_{ijkl} = w_1 \theta_{ijk(t-1)} + w_2 \theta_{ijk(t=0)} + w_3 \bar{\theta}_{jkt} + w_4 \alpha_{jkt} + w_5 \beta_{kt} \]
\[ \theta_{ijkt} = w_1 \theta_{ijk(t-1)} + w_2 \theta_{ijk(t=0)} + w_3 \bar{\theta}_{jkt} + w_4 \alpha_{jkt} + w_5 \beta_{kt} \]

\[ w_1 = [1-(\text{grade level} /12)] \times \text{Constant} \]
\[ w_2 = (\text{grade level} /12) \times \text{Constant} \]
\[ w_3 = \text{Constant} \]
\[ w_4 = \text{Constant} \]
\[ w_5 = \text{Constant} \]
Exaggerated Model
Exaggerated Model (Observed Test Scores)
Systems Models Informed by Data
Used a variety of multi-level models (HLMs) to estimate a variety of parameters.
Proportion of Variance in Test Scores at Each Level

<table>
<thead>
<tr>
<th>Level</th>
<th>“Start” of School Year</th>
<th>“End” of School Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>School</td>
<td>0.27</td>
<td>0.27</td>
</tr>
<tr>
<td>Teacher</td>
<td>0.06</td>
<td>0.09</td>
</tr>
<tr>
<td>Student</td>
<td>0.67</td>
<td>0.64</td>
</tr>
</tbody>
</table>
Teacher
VA
School
VA
Student
VA
VA for ELA
High & Low Groups

• averaged ELA scores over all years

• LOW ELA = bottom 1/3 of students

• HIGH ELA = top 2/3 of students
Mean Math Scores Over Time
(Standardized M=0, SD=1)

Grade Level

High ELA

Low ELA
Matching Students with Teachers

<table>
<thead>
<tr>
<th>Fixed Effect</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>T-ratio</th>
<th>d.f.</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>For LOWELA slope, P1</td>
<td></td>
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<td></td>
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<tr>
<td>For INTRCPT2, B10</td>
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<tr>
<td>INTRCPT3, G100</td>
<td>-0.118530</td>
<td>0.012738</td>
<td>-9.305</td>
<td>39</td>
<td>0.000</td>
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<td>For VALO33, B11</td>
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<tr>
<td>INTRCPT3, G110</td>
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<td>0.015701</td>
<td>22.615</td>
<td>1023</td>
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<tr>
<td>For HIELA slope, P2</td>
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<tr>
<td>For INTRCPT2, B20</td>
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<tr>
<td>INTRCPT3, G200</td>
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<td>0.023128</td>
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<td>For VAHI33, B21</td>
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<tr>
<td>INTRCPT3, G210</td>
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<td>0.016493</td>
<td>22.897</td>
<td>1023</td>
<td>0.000</td>
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</tbody>
</table>
Evaluating Utility
Professional Development for Teachers

Which teachers receive it?
- weakest teachers
- any teacher

Percent of all teachers who receive it?
- 30%

Matching

Percentage
- Students matched to teachers: 90%
- Students matched to students: 60%

Results
Simulation 1: 19%
Professional Development for Teachers

Which teachers receive it?
- weakest teachers
- any teacher

Percent of all teachers who receive it?
- Simulation 1: 19%
- Simulation 2: 47%

Results

Matching

- Percentage
  - Students matched to teachers: 90%
  - Students matched to students: 60%
Thank You