Experimental Wargaming: Introducing the Project on Nuclear Gaming’s SIGNAL Framework

PRESENTED BY
Andrew Reddie, University of California, Berkeley
The Project on Nuclear Gaming is supported by the CCNY International Peace and Security Program.

$500K funding over two years

“…assess the implications for global strategic stability of advances in technologies…”

Eight Grants to Address Emerging Threats in Nuclear Security

$3 million in new grants to advance the field’s understanding of technology-driven challenges.

New technologies in a volatile world could create a new nuclear arms race and increase the risk of nuclear use. To better understand these emerging threats, Carnegie Corporation of New York today announced eight new grants aimed at reducing the risk of nuclear disaster.
The Project on Nuclear Gaming is a consortium.

- UC Berkeley Goldman School of Public Policy
- Nuclear Science and Security Consortium, an NNSA-sponsored program to develop new generation of laboratory-integrated nuclear experts
- Systems Analysis and Engineering experience
- Support application of Sandia experimental and serious game technology & subject matter expertise
- Mentoring and hosting of student interns
- Center for Global Security Research
- Providing expertise in weapons effects and international security
- Mentoring and hosting of student interns
- Organizing and hosting project workshops
The Project on Nuclear Gaming

Research Questions:
- How can experimental wargames be used to examine real-world problems?
- What impact might varying weapon capabilities have on deterrence and strategic stability?

Partnering and Mentoring Objectives:
- Strengthen and leverage existing partnerships between National Labs and Universities
- Engage the next generation of scientists, analysts, and researchers on nuclear matters
Substantive Research Questions:

▪ Do weapon effects change the dynamics of conflict escalation?

▪ Do they alter the nuclear threshold (morally, tactically, or otherwise)?
Research Design: How Should We Study Nuclear Deterrence?

Traditional Approaches:
- Empirical data
- Formal models
- Computer-based models
- Survey Experiments

Our Contribution:
- Experimental Gaming

SIGNAL
Wargaming has a long history...

Seminar and Scenario-based Wargaming

• Designing around identified policy challenges
  • Useful for policy-oriented inquiry
• “Open-ended” design with large game staffs and in-depth preparation
  • Blue, Red, and White Cell games
• Engaging high-level policy-makers
  • Training, education, and strategy

• Ex. Deterrence and Escalation Game and Review (DEGRE)

PoNG’s SIGNAL TTX at LLNL, May 2018
... And some limitations

Existing wargaming methods do not provide for outcome-oriented inference:

• Generalizable insights require data to perform large-\(n\) analysis.
• Experiments have standards with regard to replication and reproducability
  • Often, existing games vary on the basis of how they are presented, the identity of the players, and actions taken within the adjudication cell.
• Few games split their player populations into treatment and control groups to test a variable of interest.
• Sponsor bias
Experimental wargaming aims to be...

Replicable and Reproducible
   ◦ Strengthen our conclusions and address human variability by replicating a set of initial conditions and capturing significant quantities of data.

Controllability
   ◦ Allow for variable manipulation in initial conditions as well as in-game manipulation.

Clear Instrumentation
   ◦ Capture clear data about when a player chooses to perform actions in the game.

Neutral
   ◦ Researchers uninvolved with the actual data gathering, reducing bias.

Fidelity/Complexity
   ◦ Creating a simulation that captures the key features of the world surrounding the research question.
SIGNAL represents our PoNG’s first experimental gaming platform...

Incorporates “elements” of deterrence
- Military
- Economic
- Political/diplomatic

Incorporates “dynamics” of deterrence
- Bargaining
- Signaling
- Uncertainty
The Project on Nuclear Gaming uses controlled experiments...

**SIGNAL Online**
- Highly structured scenarios
- Rules-based adjudication
- Structured player dynamics
- Quantitative data collection

**SIGNAL Board**
- Highly structured scenarios
- Rules-based adjudication
- Fluid conversation and over-the-table player dynamics
- Improved quantitative data collection
...and benchmarks

**SIGNAL TTX**
- Fluid exploration of scenario features, player concerns, and boundaries for outcomes
- Control team adjudication
- Qualitative and narrative data collection

**SIGNAL Survey Experiment**
- Questionnaires focused on evaluating subject responses to specific situations
- No dynamic interaction
- Serves as a control set
High-level statistics from different treatments have similarities and differences.

<table>
<thead>
<tr>
<th>Metric</th>
<th>All Rounds</th>
<th></th>
<th>Without Last Round</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Traditional</td>
<td>Tailored</td>
<td>Traditional</td>
<td>Tailored</td>
</tr>
<tr>
<td>Number of Games</td>
<td>19</td>
<td>27</td>
<td>19</td>
<td>27</td>
</tr>
<tr>
<td>Total Actions</td>
<td>757</td>
<td>1103</td>
<td>504</td>
<td>839</td>
</tr>
<tr>
<td>Average Actions Per Game</td>
<td>39.8</td>
<td>40.9</td>
<td>26.5</td>
<td>31.1</td>
</tr>
<tr>
<td>Conflict Actions</td>
<td>276 (36%)</td>
<td>385 (35%)</td>
<td>163 (32%)</td>
<td>290 (35%)</td>
</tr>
<tr>
<td>Conventional Actions</td>
<td>175 (23%)</td>
<td>203 (18%)</td>
<td>106 (21%)</td>
<td>157 (19%)</td>
</tr>
<tr>
<td>Nuclear Actions</td>
<td>44 (6%)</td>
<td>124 (11%)</td>
<td>21 (4%)</td>
<td>90 (11%)</td>
</tr>
<tr>
<td>Traditional Nuclear Actions</td>
<td>44 (6%)</td>
<td>105 (10%)</td>
<td>21 (4%)</td>
<td>77 (9%)</td>
</tr>
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NOTE: While based on real data, these results are preliminary, non-conclusive, and for illustration only.
This method allows us to... Illustrate trends in player behaviors and strategies
Explore escalation dynamics...

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Games that “went nuclear”
To analyze the likelihood of nuclear use...

Using probit regression models, the treatment condition in which player are given additional HPLY and EMP capabilities yields a higher predicted probability of nuclear use.

Table 1: The effect of the treatment variable (incl. EMP and HPLY capabilities in player arsenal) on nuclear first use.

<table>
<thead>
<tr>
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<th>Model 1</th>
<th>Model 2</th>
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<tbody>
<tr>
<td>Treatment</td>
<td>0.96 (.44)**</td>
<td>1.06 (.40)*****</td>
</tr>
<tr>
<td>N</td>
<td>44</td>
<td>44</td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>-22.11</td>
<td>-26.67</td>
</tr>
<tr>
<td>Constant</td>
<td>0.20 (.29)</td>
<td>-0.48 (.30)</td>
</tr>
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</table>

* * p < 0.10, ** p < 0.05, *** p < 0.01

*Model 1 includes all rounds of each game in analysis.
*Model 2 omits the final round of each game in analysis.

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And to explore differences in escalation dynamics over time...

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The Project on Nuclear Gaming is also part of a bigger vision for enhancing the study of conflict.
The Project on Nuclear Gaming:

- Michael Nacht (PI), Bethany Goldblum, Andrew Reddie, Manseok Lee, Camila Valenzuela, Soravis Prakkamakul, Roshan Kirshnan, Jake Tibbetts, Chris Zheng, Vamshi Balanaga, Roshni Iyer, Sarah Laderman, Janani Mohan

- Sheryl Hingorani (PI), Jason Reinhardt, Kiran Lakkaraju, Jonathan Whetzel, Laura Epifanovskaya, Joshua Letchford, Alexandra Valdez, Vamshi Balanaga

- Wes Spain (PI), Craig Wuest, Andrew Reddie, Jake Tibbetts
Wargames as experiments: The Project on Nuclear Gaming’s SIGNAL framework

By Bethany L. Goldblum, Andrew W. Reddie, Jason C. Reinhart, May 29, 2019

What can we learn from the Peloponnesian War that will help us deal with the notion of cyber and nuclear conflict? What does World War I teach us

Bethany L. Goldblum
Bethany L. Goldblum is an associate research engineer in the Department of Nuclear Engineering at the University of California, Berkeley and executive director of the Nuclear Science and S...

Andrew W. Reddie
Andrew Reddie is a doctoral candidate in the Charles and Louise Tresser Department of Political Science at the University of California, Berkeley. He currently serves as deputy director for ...

Jason C. Reinhart
Jason C. Reinhart is a national security systems analyst and distinguished member of technical staff at Sandia National Laboratories
Back-Up Slides
What does SIGNAL stand for?

Strategic Interaction Game between Nuclear Armed Lands
SIGNAL is designed for the research question and to minimize bias – the game IS the lab.

- Non-nuclear and Nuclear players both won games.
  - Non-nuclear player won game ~38% more times than nuclear.
  - Each Nuclear player wins at approximately the same rate

- Players are not giving up, and engaging throughout the game
  - All players executed roughly similar numbers of actions

NOTE: While based on real data, these results are preliminary, non-conclusive, and for illustration only.
To answer our research question, we contrast games played with and without tailored-effects weapons.

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High-level statistics from different treatments have similarities and differences.

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Correlations between the real world and games have been demonstrated in social science research:

### Individual Level
- **Real-World correlations with in-game behavior**
  - Second Life (Yee, 2011A)
  - World of Warcraft (Yee, 2011B)
  - The Sims (Griebel, 2006)
  - Chevaliers’ Romance 3 (Lu, 2014)

### Group Level
- **Real world demographic characteristics and in-game behavior**
  - EverQuest II (Huang, 2009)
  - Second Life (Foucault, 2009)

### Societal Level
- **Commodity Pricing**
  - EverQuest II (Castranova, 2009)
  - Covert Networks (Keegan, 2011)

### Scenario Level
- **Infectious diseases**
  - World of Warcraft (Lofgren, 2007)

Games are already used to study the real world