



Experimental wargaming and quantitative analysis

PRESENTED BY

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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

Research Design: How Do We Study Nuclear Issues?

Traditional Approaches:

- Empirical data
- Formal models
- Computer-based models
- Survey Experiments

Our Contribution:

- Experimental Wargaming



The Project on Nuclear Gaming

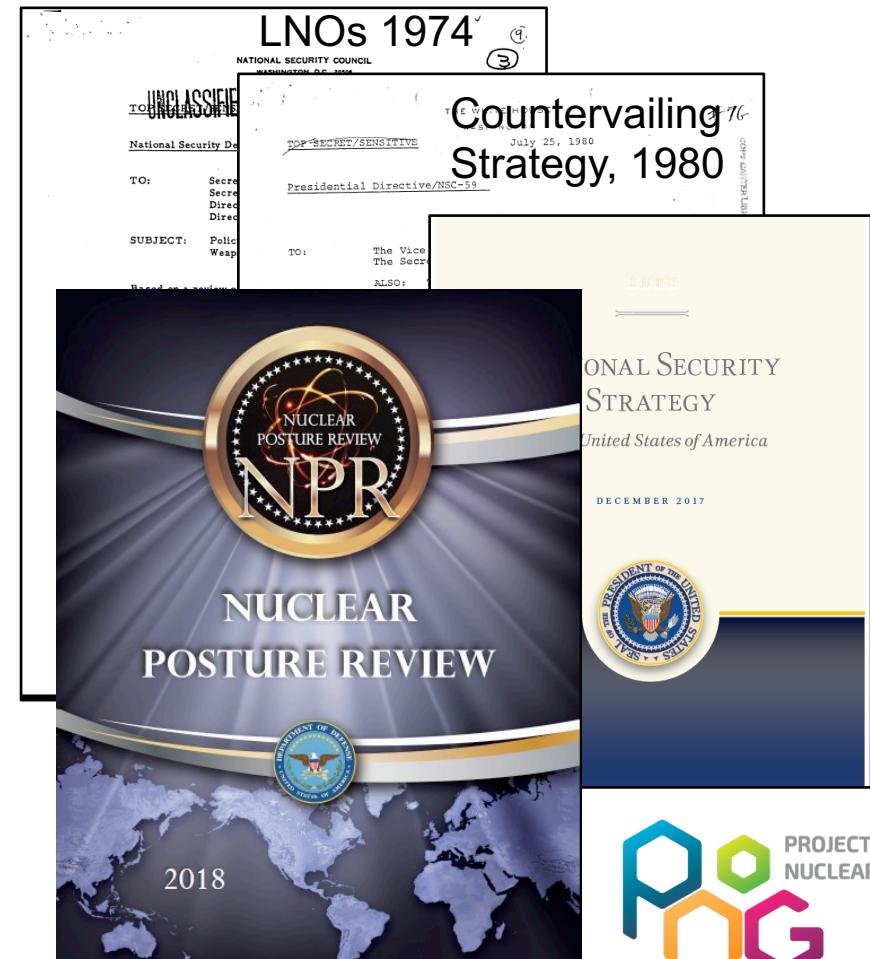
Research Questions:

- 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

PoNG is NOT making an assessment of any specific national policy or conflict scenario, but is informed by a long history of strategy and concepts.



In theory: What are the impacts of Tailored Effect NWs on deterrence and strategic stability?

Potential Costs of Tailored Effect NW:

- Breaking the nuclear taboo/Lowering threshold of nuclear use (Tannenwald 1999, Rovere and Robertson 2013, Doyle 2017)
- Lack of utility (Nelson 2010)
- Crisis instability
 - Blurring the distinction between conventional and nuclear weapons
 - Risk of inadvertent escalation if the adversary cannot discriminate between low- and high-yield attack (Sagan 1992, Posen 2013)
 - Inability to control escalation (Work 2015)
- Proliferation risk: Encouraging other countries to develop their own low-yield nuclear deterrent (Coyle and McKeon 2017, Gerstein 2018)

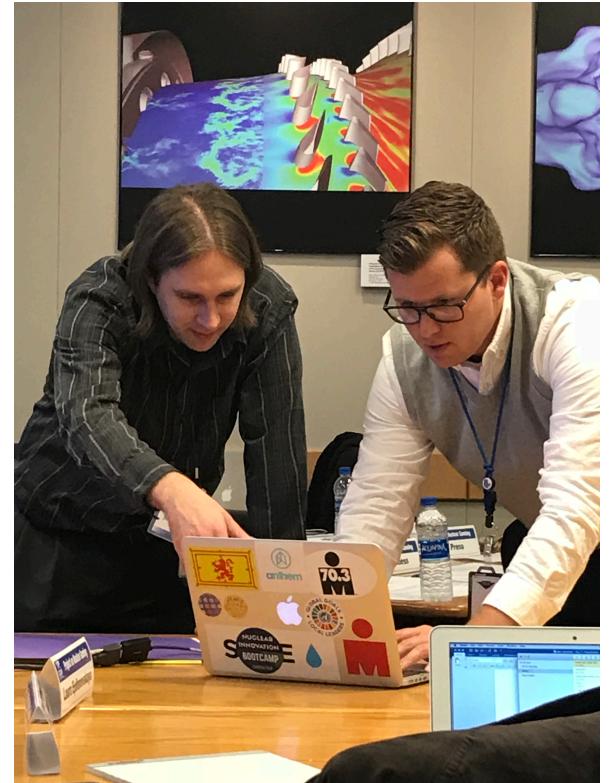
Potential Benefits of Tailored Effect NW :

- Tailored effect weapons less likely to lead to civilian deaths (Carpenter 2016)
- Increased probability of damage/kill for a given yield (Gen. Schwartz 2014)
- Providing a more credible nuclear deterrent for certain regional scenarios (Lieber and Press 2009)
- Raising the threshold for nuclear use (Williams and Lowther 2017)

Tailoring a long-standing method...

Seminar and Scenario-based Wargaming

- Analysis
 - Often designed around particular policy challenges
 - Used for national and military policy, planning, and decision-making
- Pedagogical Tool
- Design
 - “Open-ended” design with large game staff and in-depth preparation
 - Ex. Blue vs. Red cell with White cell adjudication
 - “Structured Exercises”
- Ex: Deterrence and Escalation Game and Review (DEGRE)



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 them against existing methods.

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

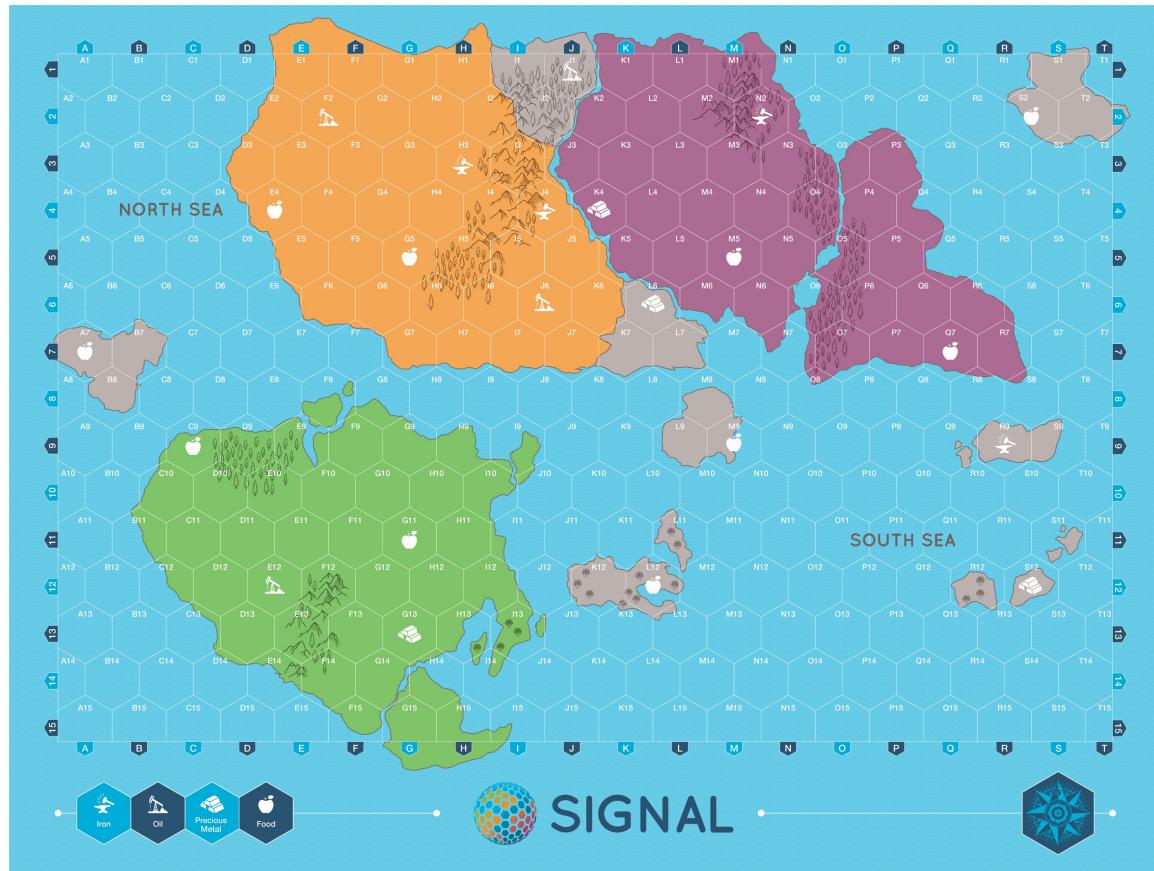
SIGNAL includes critical aspects of deterrence, escalation, and decision making.

Important elements and actions

- Military
- Economic
- Political/diplomatic

Important behaviors and mechanics

- Bargaining
- Signaling
- Uncertainty
- Cooperation
- Deterrence



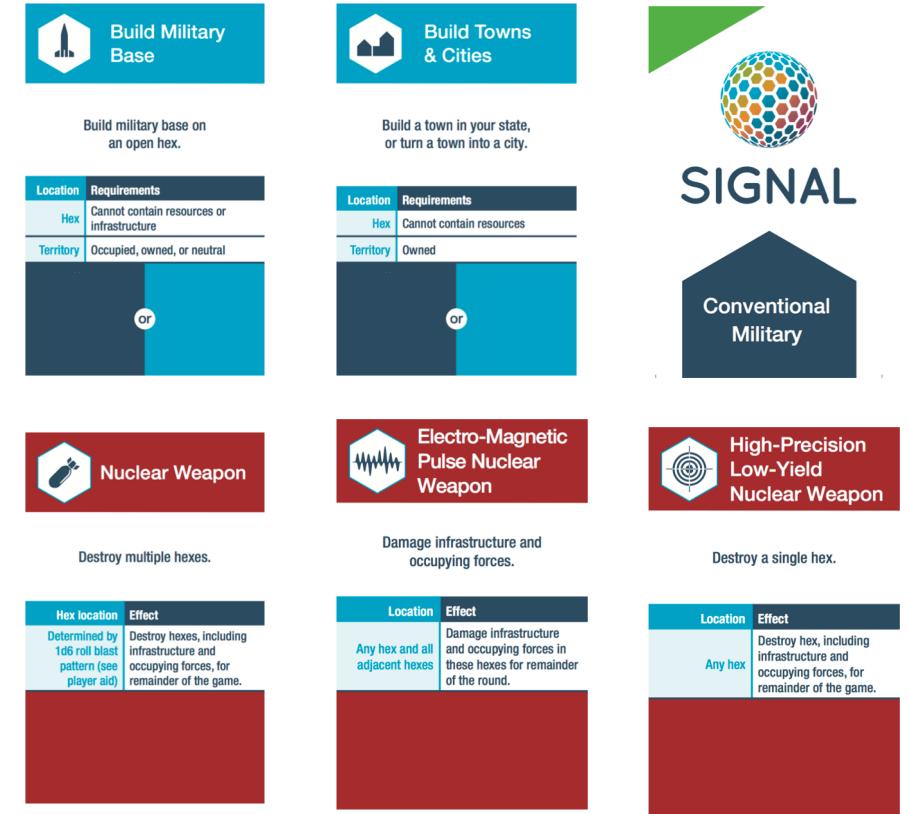
SIGNAL design enables exploration of a rich set of scenarios.

Military capabilities of players:

- Traditional NW
- High-Precision Low-Yield and EMP NW
- Conventional Forces
- Cyber Capabilities
- Defensive Capabilities

Executed via a series of rounds, each with three phases:

- *Signaling Phase for Diplomacy/Threats*
- *Action Phase for Making Moves*
- *Upkeep Phase for Accounting of Results*



SIGNAL is created using experimental design principles.

Two factor, between-subjects design:

- Two conditions, Treatment and Control that vary player capabilities.

Estimated time to play:

- SIGNAL Board: 2-4 hours
- SIGNAL Online: 1-1.5 hours

Key design elements:

- **Abstract Environment:** Abstract countries. Reduces impact of cultural stereotypes/role-playing.
- **Minimal Stochasticity:** Few actions are stochastic which increases controllability.
- **Multiple Avenues for Winning:** Players can succeed in multiple ways, allowing for diversity of play.
- **No white cell/adjudicator:** Rules are provided to players. Facilitators available to help in board game.



Experimental wargaming enables evidence-based conclusions.

Replicable and Reproducible

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

Controllable

- Allow for variable manipulation in initial conditions as well as systematic in-game manipulation to test hypotheses.

Clearly Instrumented

- Capture clear data on player actions & in-game communications.

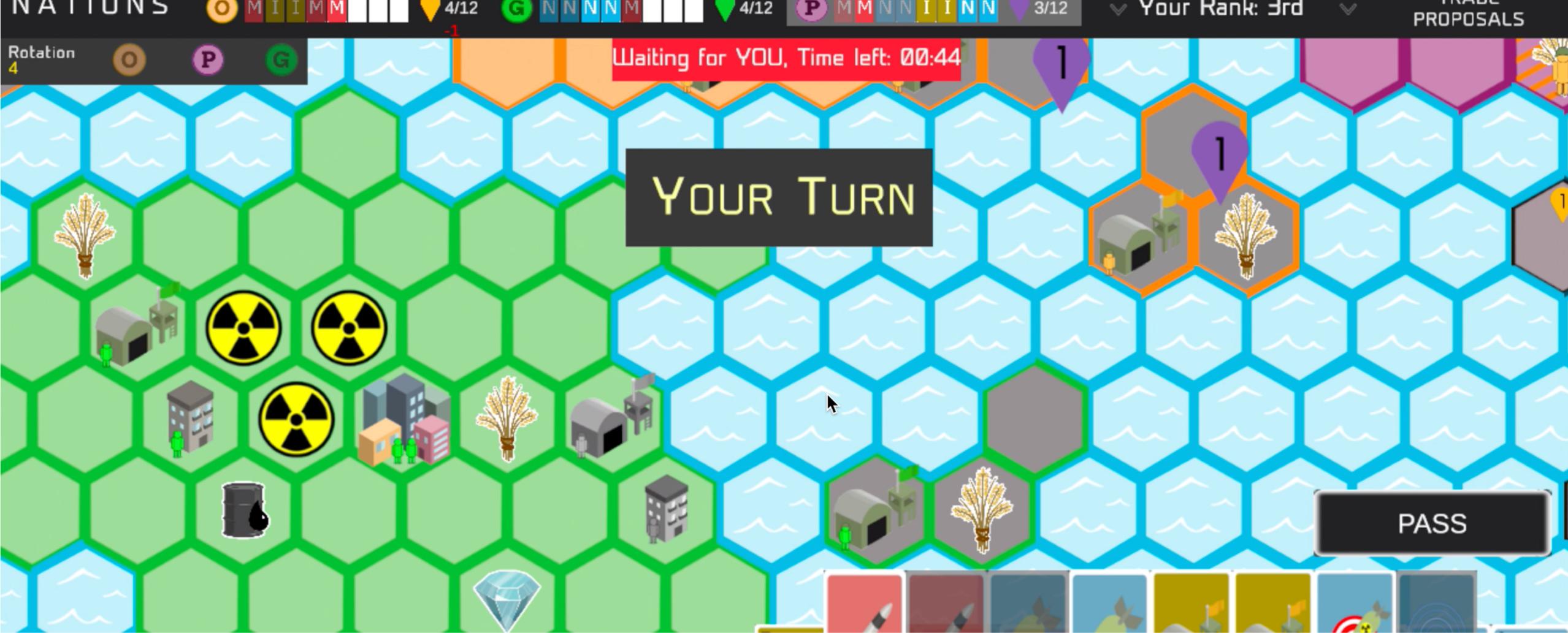
Neutral

- Researchers uninvolved with the experimental data collection, reducing bias.

Fidelity/Complexity

- Create an environment that captures the key features of the world surrounding the research question while simple enough to capture core strategic dynamics.





SIGNAL Online was released to the public in May 2019 and has already generated over 375 games with players from around the world.

SIGNAL Board data collection events are designed for replicability.



- Explanation of rules.
- Guided scenarios.
- Explore game play -- data not collected.
- Players randomly assigned to condition and other players.
- Play commences with data collection.

- **Exploration:** Players explore game before playing for real.
- **Rapporteurs:** Trained rapporteurs circulate to answer questions. Reduces player uncertainty in rules.
- **Player-led data collection:** Players take notes on moves, overseen by rapporteur.
 - Potential for mistaken collection of data, mitigated by rapporteurs oversight.

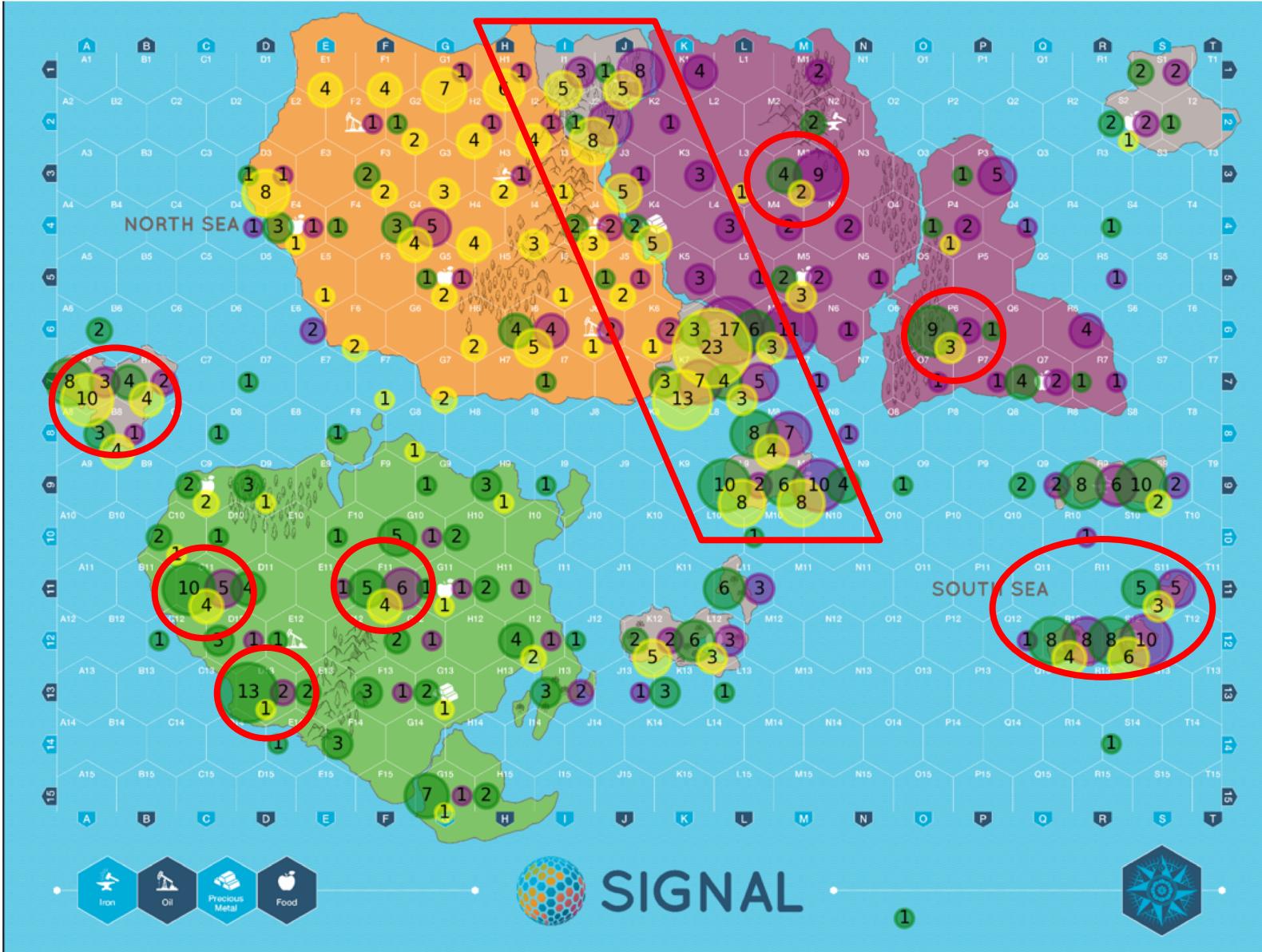
Upkeep Sheet	Game ---
<input type="checkbox"/> Step 1: Return all cards and signaling tokens to your hand.	<input type="checkbox"/> Purple <input type="checkbox"/> Green <input type="checkbox"/> Orange
<input type="checkbox"/> Step 2: Count your food:	
<input type="checkbox"/> Step 3: Count your population and support:	$\text{Support} = 3 + (3 \times \text{Population})$ $\text{Population} = \text{Support} - 2 \times \text{Food}$
<input type="checkbox"/> Step 4: Adjust your population until there is enough food to support them: IF: <input type="text"/> > <input type="text"/> THEN: Remove: OR Remove: OR Convert: TO	
<input type="checkbox"/> Step 5: Count your resources. Remember to count resources in allied states and resources from trade deals.	
<input type="checkbox"/> Step 6: Count your non-damaged infrastructure.	
<input type="checkbox"/> Step 7: Collect income - use infrastructure counts from Step 6.	$\text{Income} = 2 \times \text{Food} + 4 \times \text{Food} + 3 \times \text{Food}$
<input type="checkbox"/> Step 8: Repair damaged infrastructure and remove defense tokens.	

SIGNAL Board has been deployed in several data collection events.

- Dec. 3, 2018: UC Berkeley
 - Subjects: Students and faculty in related fields and professionals
 - **15 games**
- Dec. 5, 2018: Project on Nuclear Issues (Hosted by Rebecca Hersman)
 - Subjects: Members and affiliated professionals of the PONI program
 - **17 games**
- April 5, 2019: King's College, London (Hosted by the Wargaming Network at KCL)
 - Subjects: Students, faculty and professionals
 - **12 games**
- May 8, 2019: UC San Diego (Hosted by Erik Gartzke)
 - Subjects: Students in related fields
 - **6 games**



Visualization of game actions illustrate trends in player behaviors and strategies.

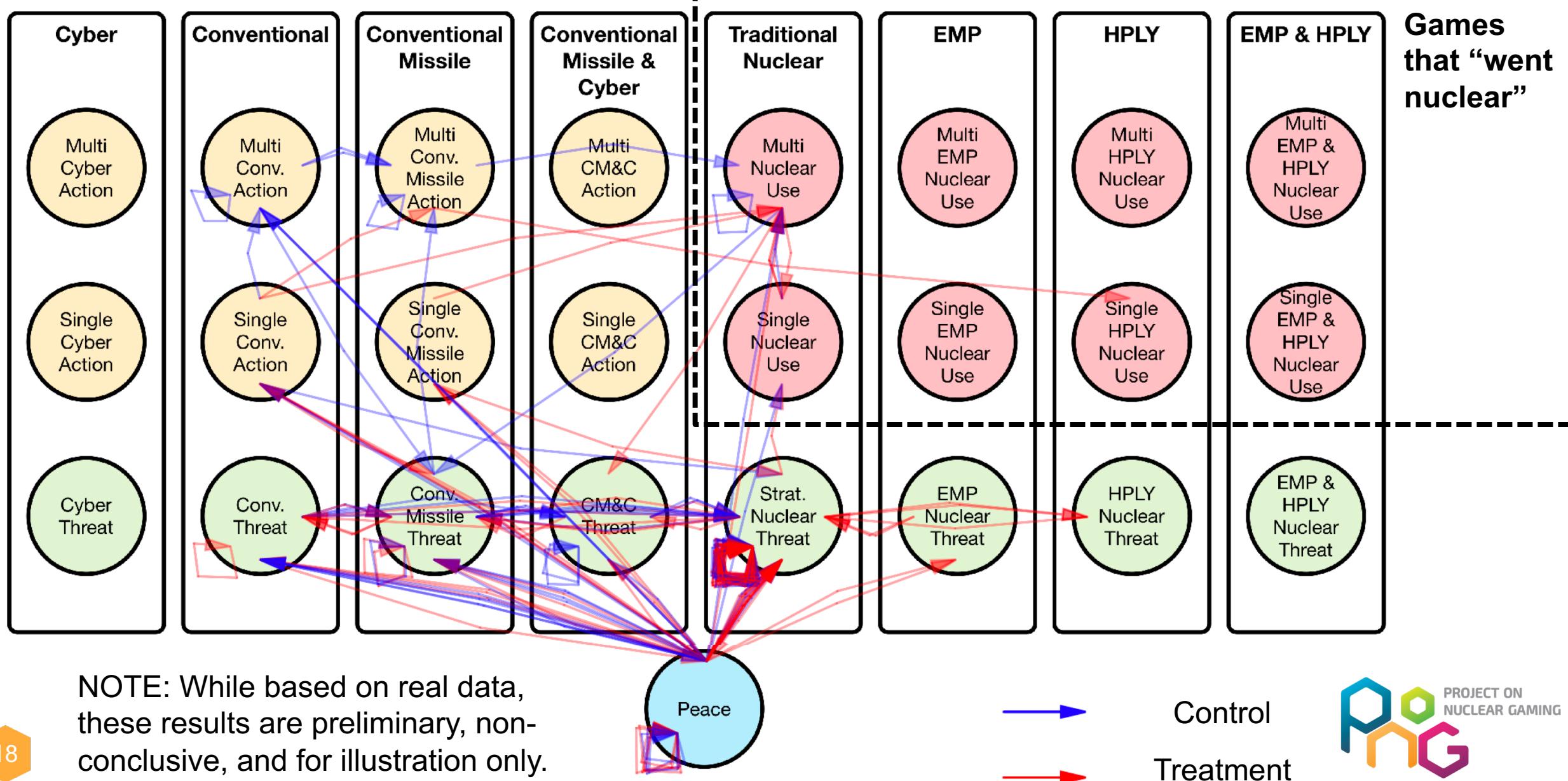


Overall strategic focus seems to be on:

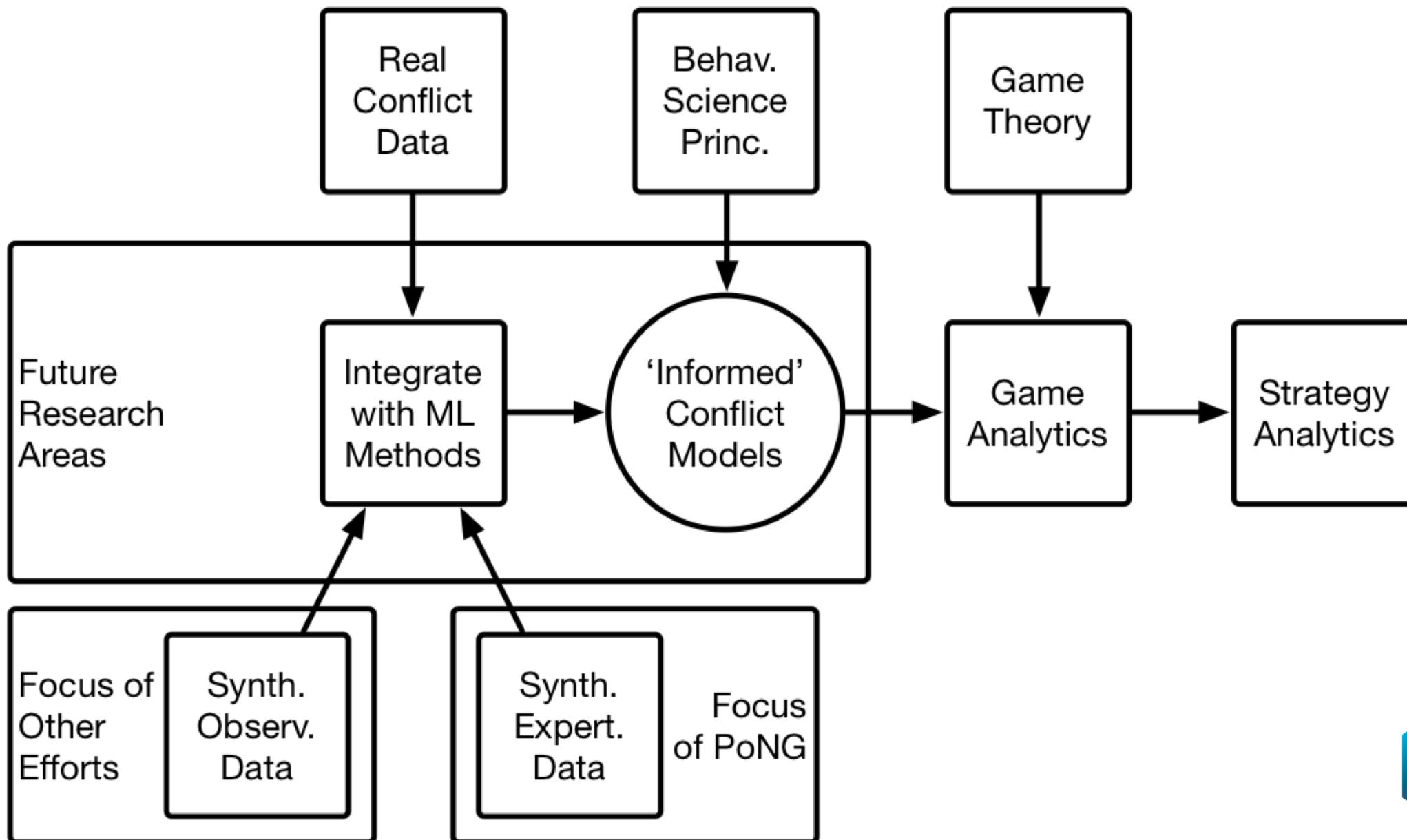
- Contiguous borders
- Adjacent minor states
- Military and ‘Value’ targets

* SIGNAL Board Data

Establishing Conflict Classes from raw data enables analysis of conflict escalation dynamics.



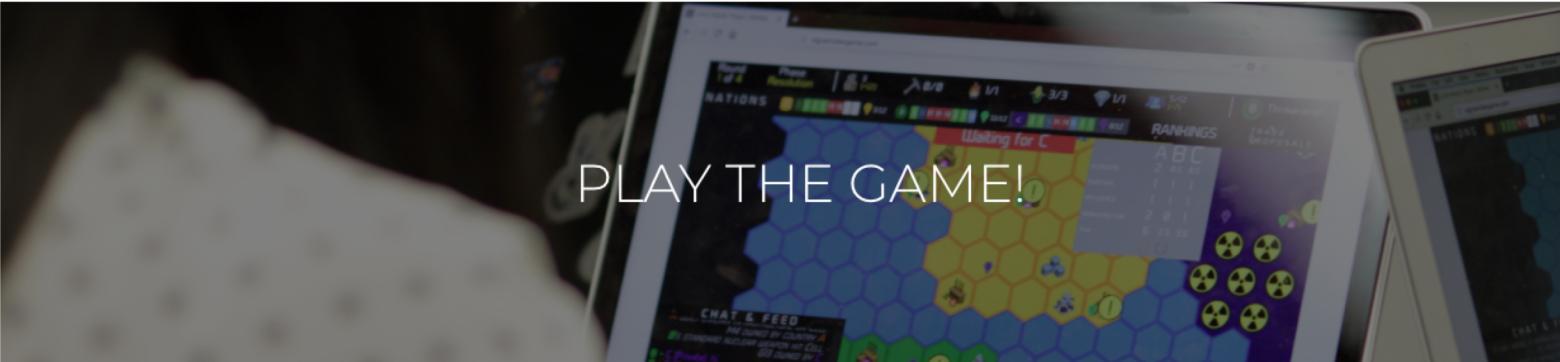
The Project on Nuclear Gaming is part of a bigger vision for enhancing the study of conflict.



Play the game!



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<https://pong.berkeley.edu/e-game>