SYSTEMS ENGINEERING RESEARCH CENTER

8TH ANNUAL SERC DOCTORAL STUDENTS FORUM
SERC SPONSOR 12TH ANNUAL RESEARCH REVIEW
HOSTED VIRTUALLY ON : NOVEMBER 17-18, 2020

PURDUE UNIVERSITY

Game balance & Game breaking: A game theory approach

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RESEARCH OVERVIEW

Game balance is the measure of favorable-ness of a given player over the other(s) in a particular game scenario or an entire game. A balanced game is unbiased to its player irrespective to their attributes.

There have been a handful of game balancing techniques outside the manual labor-intensive play testing methods. Simple solutions, like restrictive game play, are limited because of their inability to provide insight on interdependencies among the mechanisms in the game. On the other hand, techniques framed around using Machine Learning algorithms are limited by computational budgets and/or cognition inability to assess human actions.

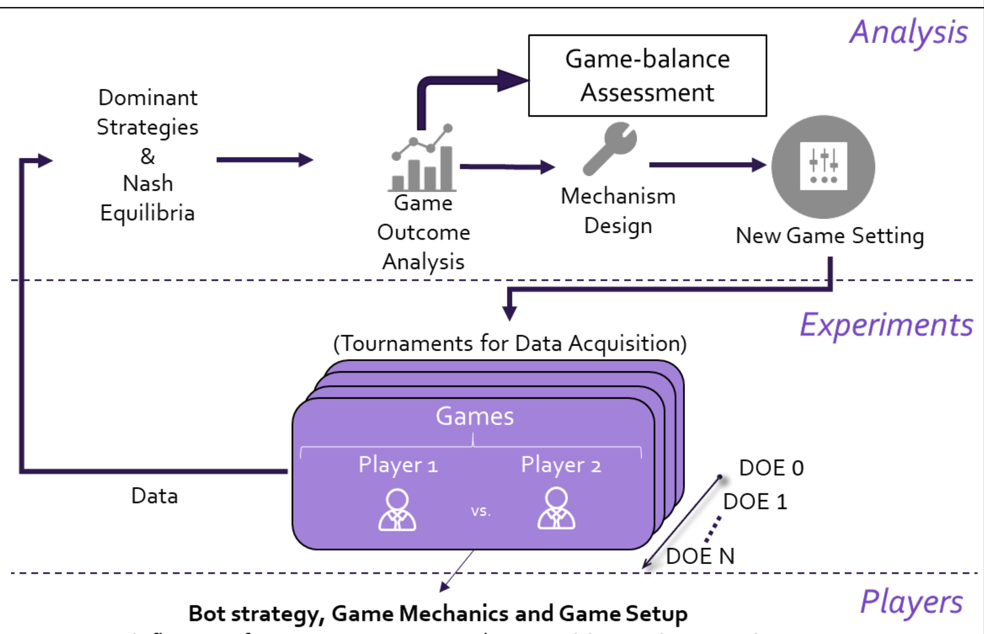
We believe game theory provides an effective middle ground to these methods and investigate its applicability and extent. This knowledge about player decisions, strategies and, game balance can be leveraged to shift game balance as desired. In other words, break the game.

METHODOLOGY

microRTS is a small implementation of an Real Time Strategy (RTS) game, primarily designed to perform AI research and test theoretical ideas, is used to test our hypothesis.

The image below depicts our framework to use game theory in assessing game balance. Game mechanics like resources, player strategy, player position and many others are independently varied to form a single generation of **Design of Experiments (DOE)**. Multiple DOEs are then generated with combinations of these mechanics. Game data in form of player actions and strategies is analyzed using the game theory lens. This provides us an understanding which actions affected the game outcome and vice-versa.

Based on the interpretations, a new set of changes via mechanism design are introduced into the next generation of DOE. This is repeated to increase the accuracy of the assessment and also to cover all game mechanisms.



In our current investigation, 5 out of the 11 mechanics in microRTS are tested:

- Influence of Player Strategy
- Influence of Resource Quantity
- Influence of Resources Location
- Influence of Starting Position
- Influence of Starting Resources

The DOE consists of independent symmetric games and combination of the above mechanics.

RESEARCH QUESTIONS

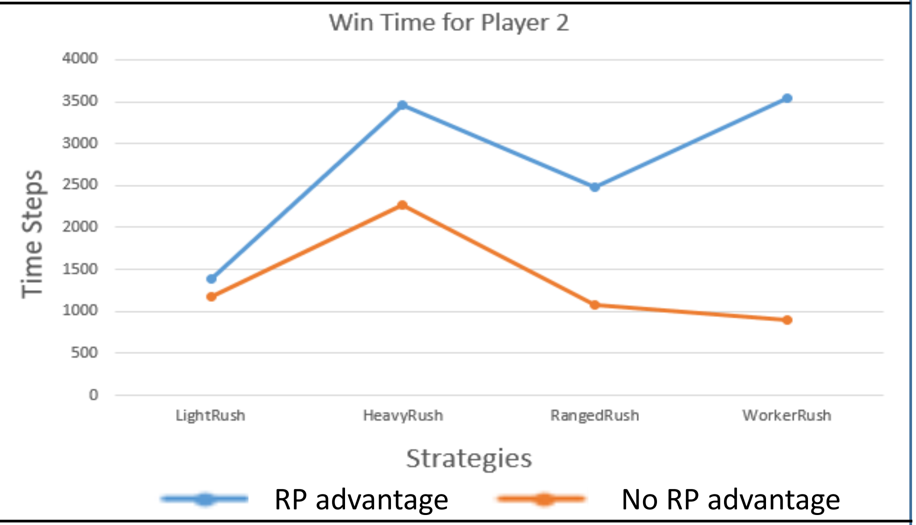
- Is game theory a feasible analytical tool to detect and evaluate game balance?
- Can game theory be applied to an RTS game, where the number of decision trees and game states are large?

DATA & ANALYSIS

Presenting insights from 2 DOE generations as a sample:

Effect of **Resource Quantity (RQ)** on game outcome was the most prevalent observation among all mechanics. Game outcome seemed to have the most sensitive reaction to a change in RQ. A player with a higher RQ always won the game when rest of the game settings were symmetric. However, when introducing player strategy into the DOE, we observed that some strategies were unaffected by a variation in RQ. Showing that there exists some dependencies between the two mechanics. Certain strategies faired well in higher RQ conditions.

When RQ was tested against **Resource Position (RP)** mechanic, we observe an RQ advantage outperforms an RP advantage. Interestingly however, a player with RQ advantage takes longer to win against a player RP advantage than usual, irrespective of player strategy.



Takeaways:

- In balanced games, there are two possibilities. Either all of a players' actions are dominant strategies or all action sets are weak Dominant Strategic Equilibria.
- Any deviation indicates an imbalance and the game theory lens points the direction of equilibrium shift.
- We detected that microRTS has an inherent imbalance proving the effectiveness of our methodology.
- Complex games with large number of mechanics will require large sets of data to be analysed. This affirms the need for automating mechanism design to reduce the size of DOEs and its subsequent generations.

FUTURE RESEARCH

- Including all 11 mechanics to provide a complete game balance assessment of microRTS.
- Explore automated Mechanism Design for setting up new Design of Experiments (instead of full factorial) – optimal learning.
- Use sophisticated bots to remove low fidelity issues in player behavior.
- Assess if game balance is beyond the win probability metric, and is this methodology still valid – like the time metric in the above example

CONTACTS

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