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"Strategic Data Farming: Verifying Wargame Adjudicators to support the Model-Gama-Model Analysis Technique"

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Date: 7 May 08

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# Strategic Data Farming

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Strategic Data Farming

Deborah Duong
Human Judgment in Analysis

• How can we take advantage of human judgment in a way that is good for analysis?
  – Human beings have such better understanding of human contexts than computers do
  – In analysis like irregular warfare that involves the human terrain, this is more important

• The DoD does not trust computer simulation in this domain, and employs wargaming
  – But it is difficult to get enough repetitions for statistical significance of human judgments
  – They have compromised by using computer wargame adjudicators of social phenomena.
    • PSOM, SEAS, COMPOEX, etc.
Is it a good idea to use a computer adjudicator for a wargame for analysis?

- You could get this worst of both worlds…
  - We are spending lots of money on the games and the software but,
  - You won’t have enough repetitions to get statistically significant results anyway
  - The computer are usually better at playing a game, on its own terms, than humans are!
    - The world champion at chess is a computer program

- Model-Game-Model Technique
  - Uses iteration between human and computer to gain the best of both worlds
  - Humans are used to improve the model, not replace it
Model-Game-Model Technique

- **Model Phase**
  - Explore how the environment in the game may be manipulated so that an agent (human or ABS) may achieve its goal
  - Bring ways to “game the game” are to the surface
  - Modelers and Subject Matter Experts (SMEs) may change the game so that players win in more realistic ways
- **Game Phase**
  - Players play the improved game
  - Players suggest outcomes that are more realistic
  - Modelers may change the game so that players win in more realistic ways
- **Model Phase**
  - After several iterations, realism increases to the point that human beings are not needed to win in a realistic fashion, at which point automation (and statistical significance) is possible
Strategic Data Farming

• Strategic Data Farming may be employed in the first phase of the iterative model-game-model process
  – Strategic Data Farming is a way to explore how a player or an agent may succeed in a wargame or an agent based simulation (ABS)
    • Ways to game the game are exposed
  
• Strategic Data Farming makes use of Game tree technology from Artificial Intelligence

• Strategic Data Farming looks at worse-case-scenarios first
  – Desirable for analysis
  – Game trees win by the exploration of the worse case
Why do ABS and Wargames need Strategic Data Farming?

• ABS and wargames are typically nonlinear
  – New combinations of parameters contain surprises
  – Traditional parameter sensitivity testing for VV&A is inadequate
• Traditional Data Farming does a thorough exploration of the state space
  – Seeks to explore every combination of parameters
  – Takes supercomputers and vast computational resources
• In Strategic Data Farming, the emphasis is on the game theory of moves rather than parameters
  – There are usually fewer parameters in strategic games
    • What makes a game unique is strategy
  – Assumption of goals narrows down what exploration
Questions Answered

• Traditional Data Farming answers the basic questions of Agent-Based VV&A
  – Is every model outcome possible in the real world?
  – Is every possible real world outcome realizable in the model?

• Strategic Data Farming answers the basic questions of strategic games
  – Do strategies that win in the simulation win in the real world?
  – Do strategies that win in the real world win in the simulation?

• For Strategic Data Farming, once the model is refined so that the answer is yes, the game may be automated
How Strategic Data Farming Works

• Replace a player or an agent of a wargame adjudicator or agent based simulation with an game tree agent
• The game tree agent needs 3 things
  – A board evaluation function: a way to tell how far the agent is from its goal for a particular state of the board
  – A list of all the legal moves that the player can make
    • If there are too many, they should be ranked according to their usefulness for a strategy
  – A list of all the changes that can be made in the agents environment
    • May include other moves of the players
    • If there are too many, they should be ranked according to how harmful they are to the agent’s strategy
• Invert the game
How Game Inversion Works

- Play the game as though there are only 2 strategists
  - The replaced agent
  - The rest of the simulation
- A game tree is created in which the rest of the simulation is pitted against the agent’s goals
  - The simulation itself is used to advance to the next move
  - The game is “branched”: For every move made, the top N moves of the opponents are tried
  - Alpha beta minimax quickens the search
  - A move is chosen when goal is reached or computational limits are reached
- Replace every agent in the simulation, or player in the game, in the same fashion
What Strategic Data Farming Makes Possible

• Increased fidelity of wargames and agent based simulations

• Replacing the players for full automation
  – Once it is impossible to “game the game” the computer can usually play the game better than a human can
  – Human creativity doesn’t matter to who wins game
    • Imagining meanings for chess moves never won the game
    • The player can not increase the ways to win the game, he can only eliminate consideration of non-human ways to win
  – If the problem is analysis, this will save human resources and make runs statistically significant
  – Only applicable to closed games (That only machines adjudicate)
Myths of Game Theory Techniques

- A game tree agent makes players act rationally while people are irrational in the real world
  - Game tree agents evaluate their environment according to their goals. These may be religious, or private
- Sometimes people just miss things or behave stupidly, but we are not exploring those instances
  - Game tree agents do not need to take poor moves into account in order to calculate how to win the game
- Game trees can not handle real world moves
  - Modern game tree technology can
    - Use heuristics to rank moves
    - Take into account simultaneous moves
    - Take perception into account
      - As in poker
    - Take probability into account
Summary

• Strategic Data Farming can perform validation and enable automation in agent based simulations and in wargame adjudicators
• Strategic Data Farming narrows the space of possibilities that need exploration in strategic games
• Strategic Data Farming does not limit human creativity in analysis anymore than the simulator itself does