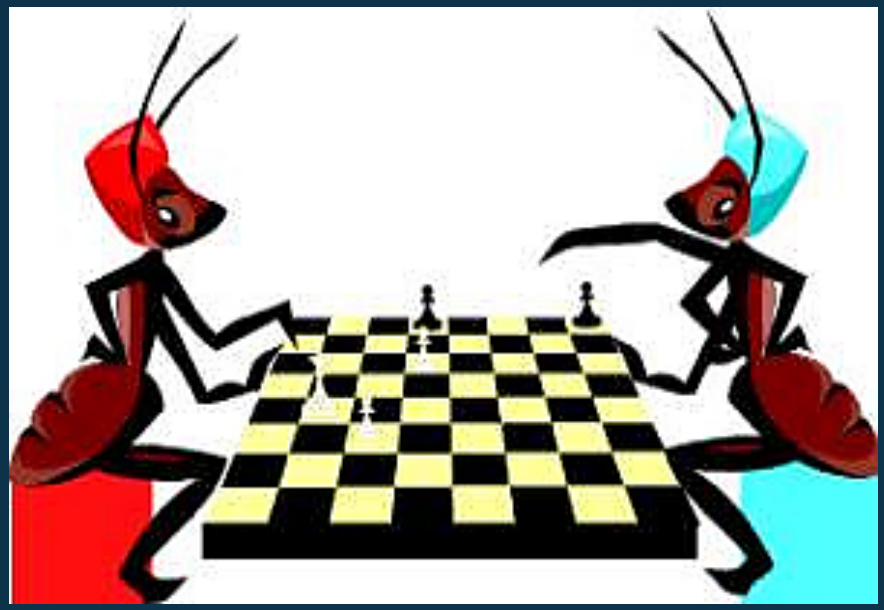
Discussion of Emergent Strategy

When Ants Play Chess



Mark Jenne and David Pick

Presentation Overview

- Introduction to strategy
- Previous work on emergent strategies
  - Pengi
  - N-puzzle
  - Sociogenesis in MANTA colonies
- Multi-agent reactive chess program
  - MARCH
  - Experiments
- Conclusions

Strategy

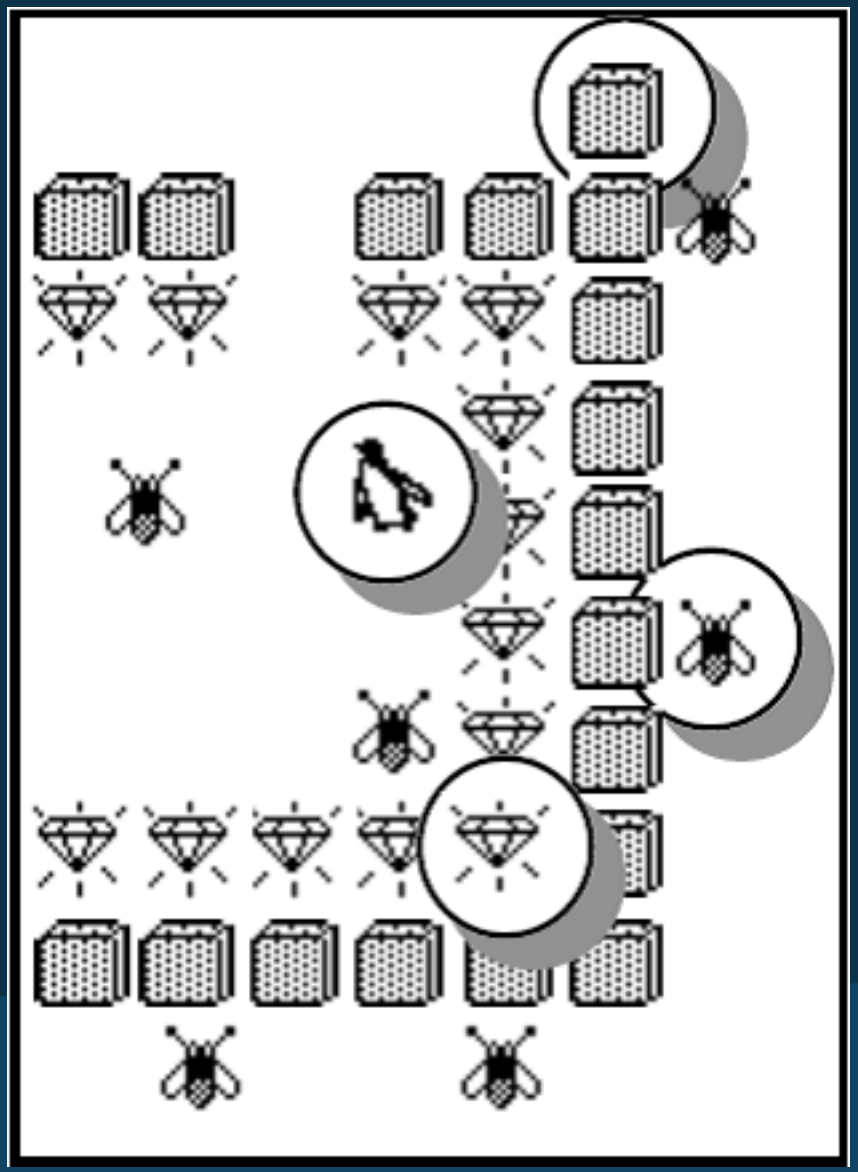
- Making plan of coordinated actions for reaching a goal
  - Often conflicting with goal of other agent
  - Different resources needed to reach it
- Relies on two strong assumptions
  - Having global view of current situation
  - Making sure resources perform as intended

Emergent Strategy

- Global strategy can sometimes end up not being useful
- Emergent Strategy, as seen by observer, arises from coordination of local behaviors that are not aware of their place in global strategy
- Some strategy can be viewed as the result of interactions between simple agents with only local information
- This approach can constitute a constructive lower bound for planning or search through consideration of local behavior

Pengi

- Based on game called Pengo
- Combination of simple rules for movement can create appearance of intelligent strategy from an omnipotent entity
- Pengi underlines three features of emergent strategies
  - Rarely find optimal solutions
  - Difficult to formalize from observation
  - Difficult to reuse



N-Puzzle

- Slide square tiles to reach goal configuration
- Each tile as own autonomous agent with own field of perception
- Simple rules for each piece leads to emergence of truly original strategies for solving problems within the puzzle
  - Placement of corner tiles
- Sub-optimal algorithm emerges overall, but much simpler than known strategies

Sociogenesis in MANTA Colonies

- Sociogenesis is the foundation process
- Modeling and simulation of social organization in ant colony
  - Each organism represented by behavior-specified agent
- Test hypotheses about emergence of social structures from behavior and interactions among individuals
- Observed a general strategy based on simple rules for best foundation of colony

MARCH

- Multi-Agent Reactive CHess Program
- Chess offers good testing grounds for strategy
  - Global strategy is viewed as essential for success
- Goal was to program a decent chess-playing program while remaining as simple as possible

Details of MARCH

- Each chess piece is an autonomous agent with its own behavior and field of perception
- Each space on chess board knows piece on it and two fields called *whiteStrength* and *blackStrength*
- A single turn consists of:
  - Asking each piece to determine pieces it threatens
  - Asking threatened pieces to propagate material value on spaces between self and threatening piece
  - Asking each piece to mark each place it could move to
  - Choosing randomly among pieces with greatest marks and moving it to related space

Experiments with MARCH

- Played 200 games against average human player
  - Won 57 times
  - Lost 83 times
  - Stalemate 60 times
- Most of loses occurred early in game, wins late in game
  - Bad at opening, but plays well once pieces deployed
- Played 50 games against GNU chess program
  - Much stronger player
  - Lost 47 times
  - Stalemate 3 times

Conclusions on MARCH

- Multi-agent reactive system can play chess with skill equivalent to average human player
- Some emergent strategies can be observed, but remain partial and unlasting
- Cannot react in a coordinated way to strong opponent and gets trapped quickly
- Obtaining good opening move sequences is a primary challenge
  - Environment is open and multi-agent reactive system is not threatened enough to react intelligently

Conclusions on Reactive Systems and Emergent Strategy

- Limits of emergent strategies can be observed from interactions between reactive agents
- Possible to obtain long-term emergent strategies with reactive systems
  - Ant colony sociogenesis
- In many domains, global strategy could be advantageously replaced by set of local tactical behaviors leading to emergent strategy