GENETIC PROGRAMMING OF AUTONOMOUS AGENTS

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GPAA

- Genetic Programming (GP)
- Project Description
- Results
- Conclusion
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PRACTICAL GENETIC PROGRAMMING
INTRO TO GP

• Machine intelligence
• Theory of evolution
• What you want: fitness function
• How to get it: primitive set
• GP does the details
INTRO TO GP

Simulation of Evolution

1. Randomly Generate Individual Genomes
2. Evaluate Fitness of Current Generation
3. Generation Limit Reached?
   - YES: Return Individual with Highest Fitness
   - NO: Create New Current Generation From previous Generation
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TRADITIONAL METHODS

1. Grid Domain
   • Movement is unrealistic
   • Space is warped

2. Complex Primitive Set
   • Less creative
   • More work for designer
PERIMETER MAINTENANCE

- Military defense application
- Intrusion detection
- Spatial reasoning
SOFTWARE

• GP framework and simulator

• Written for project

• Ruby
  • quick development
  • easy interfacing
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GRID-BASED SIMULATIONS

- Verify software operation
- Develop fitness function
- 4 guards
- Guard sensor range: 4 units
- Perimeter around base: 7 units
GRID-BASED SIMULATIONS

- **Base**
- **Starting Positions**
- **Guard Agents**
- **Enemy Agents**
- **Capture Areas**
- **Base Perimeter**
GRID-BASED SIMULATIONS

• Primitive Set
  • Forward, Left, Right
  • Distance from base
  • Arithmetic: +, -, *, /, %
  • if (a > b) then (c) else (d)
GRID-BASED SIMULATIONS

- Fitness Function Simulation
  - Enemies randomly start at edge of grid
  - Move directly to base
  - Removed if guards sense them
  - Removed in base perimeter
- Fitness Score = Number of enemies detected
HOMOGENOUS TEAM

• All guards have same controller

• Optimal result
CO-EVOLUTION OF ENEMIES

• Homogenous Guards

• Base Perimeter: 7
GRID BASED SIMULATIONS

• Software works
• Exploits grid domain
• Results are not practical
CONTINUOUS SIMULATIONS

- Eliminates warping
- Realistic movement
- 4 guards
- Guard sensor range: 4 units
- Perimeter around base: 7 units
CONTINUOUS SIMULATIONS

- Primitive Set
  - Base and Direction vector
  - Store and Recall vectors
  - Vector arithmetic: +, -, *
  - Conditionals: vector magnitude and angle
- Controller returns vector; determines heading
HOMOGENOUS TEAM
CO-EVOLUTION OF ENEMIES
CONTINUOUS SIMULATIONS

• Successful strategies with vector arithmetic
• Realistic autonomous agent movement
• Unrealistically precise maneuvers
UNCERTAIN SIMULATIONS

• Generic noise to deal with uncertainty
• Develop cautious agents
HOMOGENOUS TEAM
NOISY SIMULATIONS

• GP can produce robust control programs
• Guards more cautious
• Basic strategy unchanged
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PRACTICAL GENETIC PROGRAMMING
FUTURE WORK

• Autonomous agent platform
• Accurately model noise
• Test on physical agent
QUESTIONS
NOISY SIMULATIONS

• Generic noise to deal with uncertainty
• Gaussian error added to sensors and movement
• Sensor: constant variance = size of guard
• Movement: variance = 1/10th of ideal movement