GENETIC PROGRAMMING OF AUTONOMOUS AGENTS

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GPAA

- Genetic Programming (GP)
- Project Description
- Results
- Conclusion

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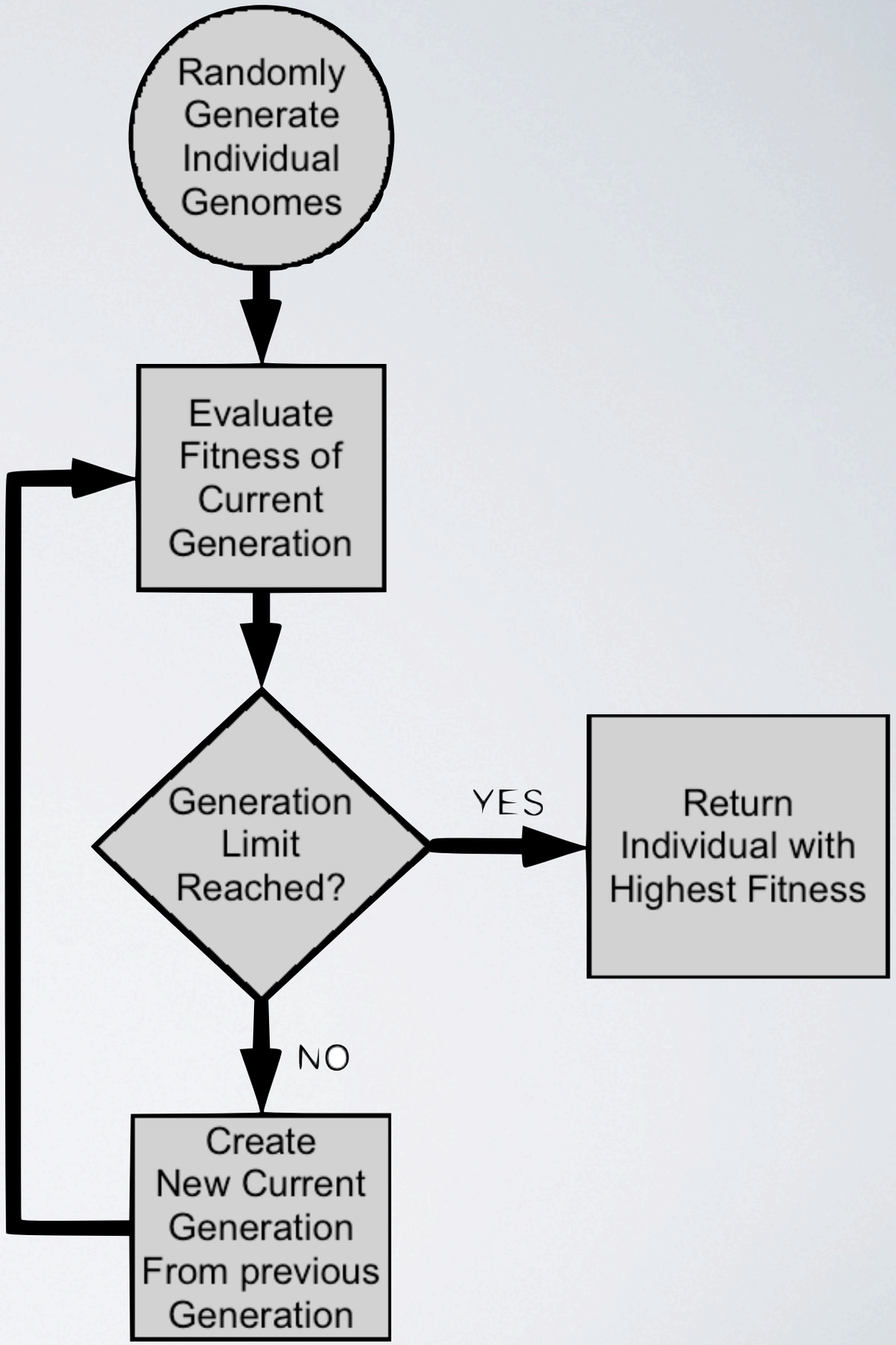
PRACTICAL GENETIC PROGRAMMING

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



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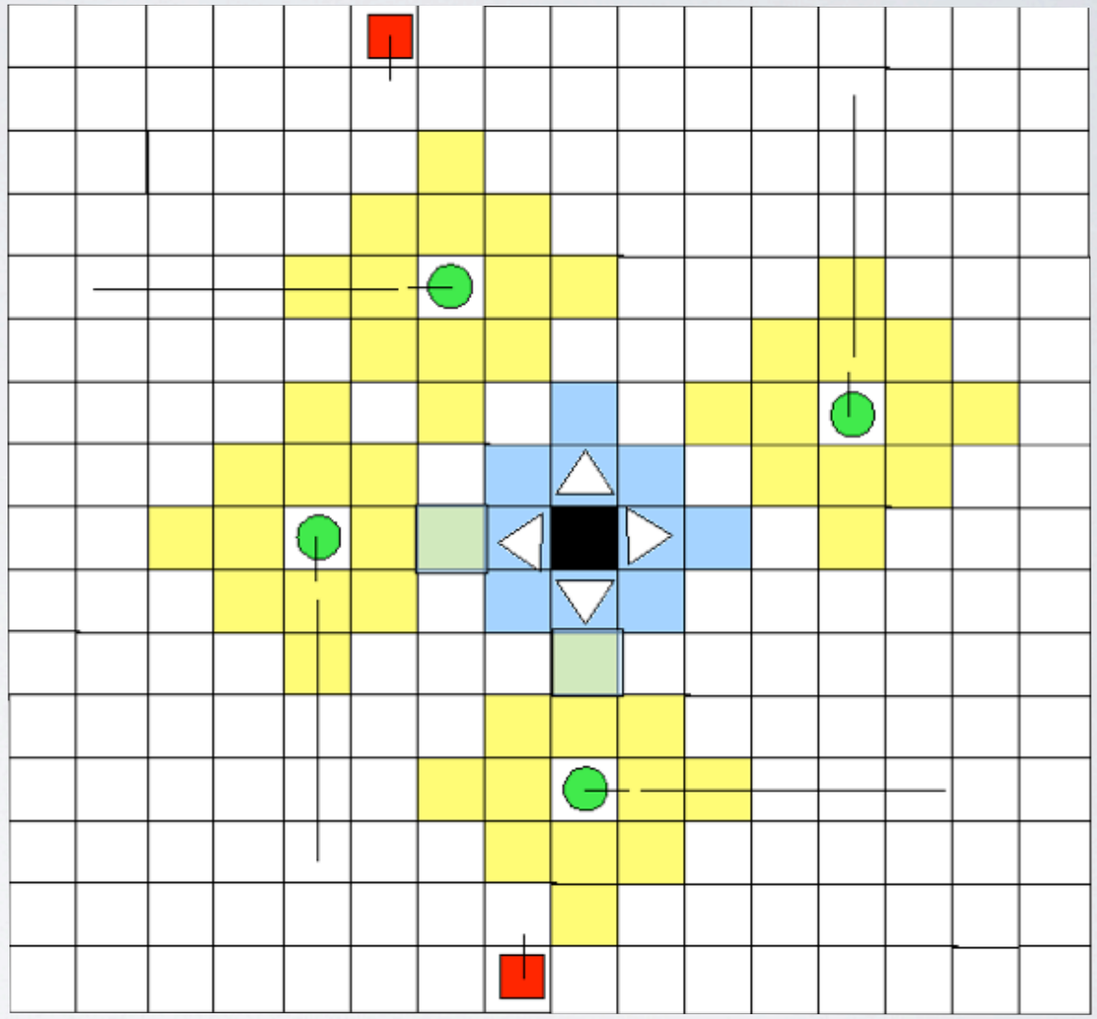
TRADITIONAL METHODS

1. Grid Domain

   - Movement is unrealistic
   - Space is warped

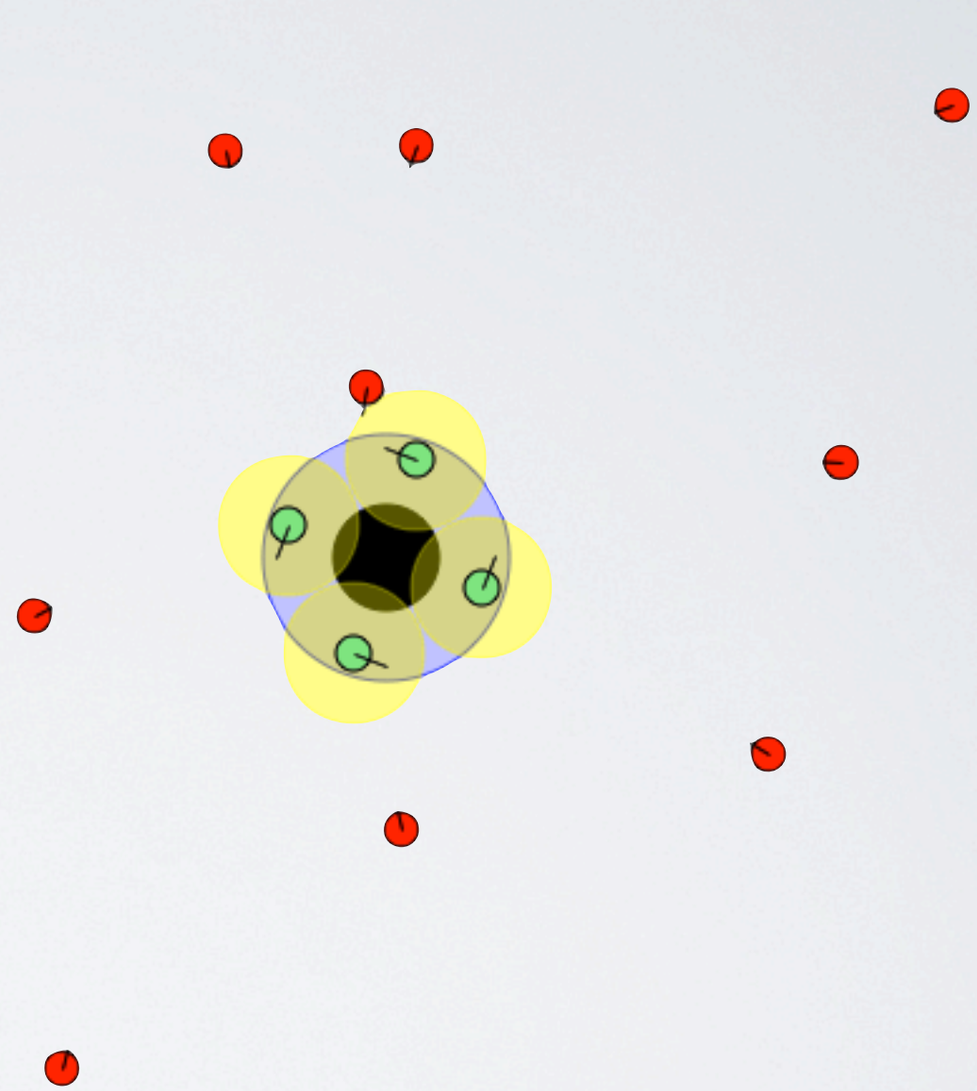
2. Complex Primitive Set

   - 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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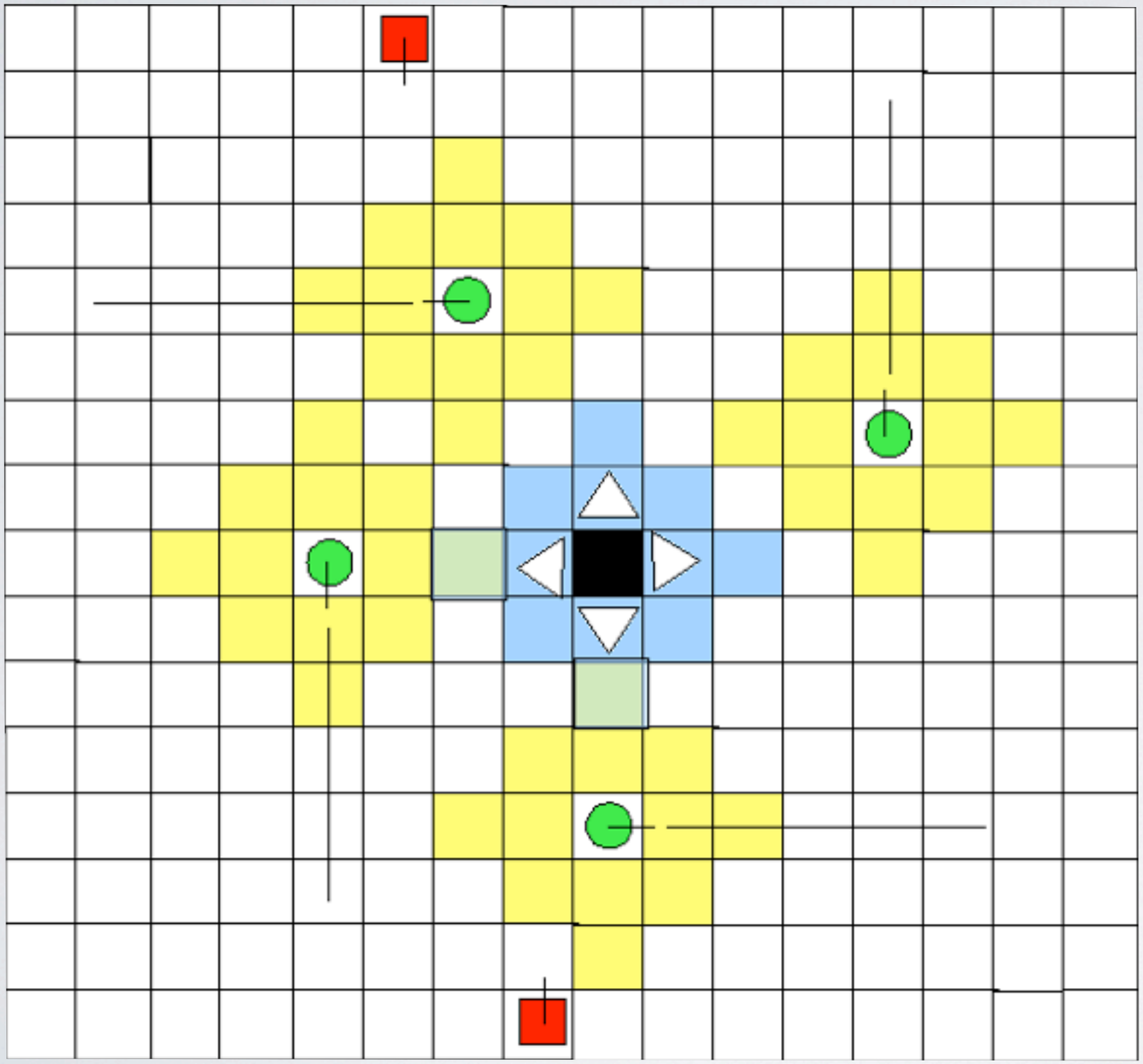
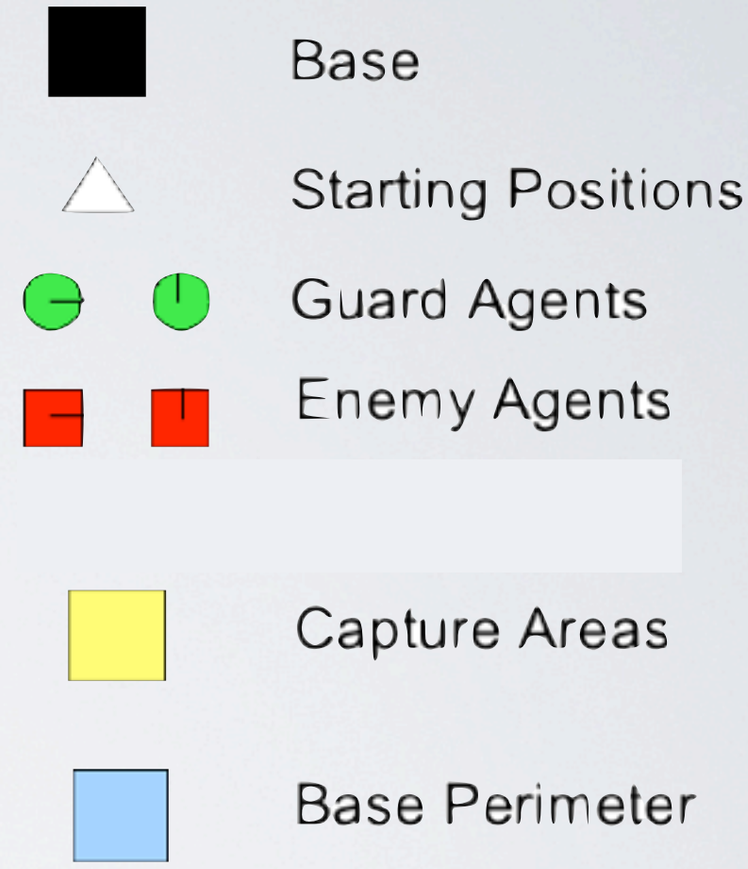
GRID-BASED SIMULATIONS

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

GRID-BASED SIMULATIONS





GRID-BASED SIMULATIONS

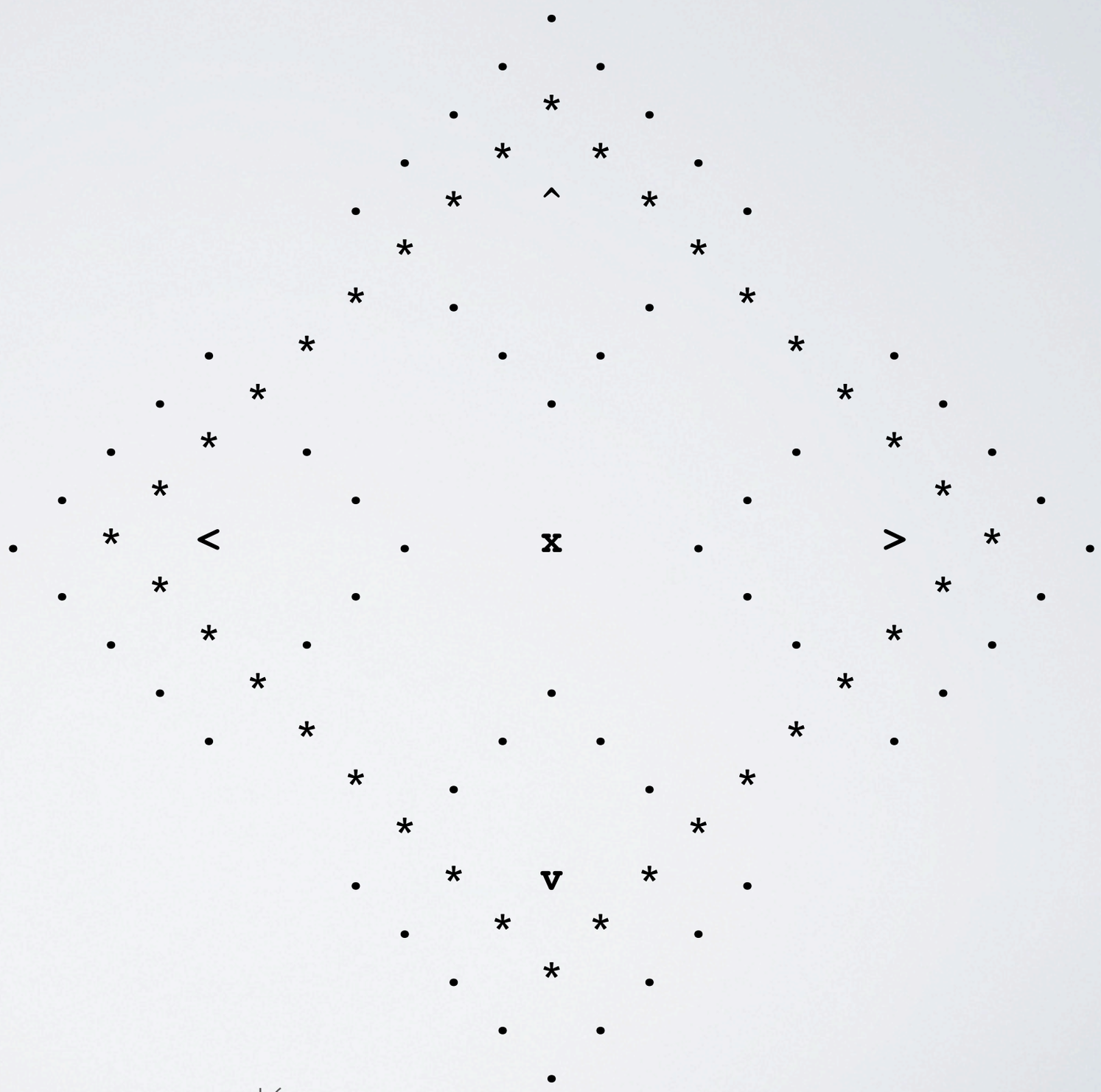
- Primitive Set
- Forward, Left, Right
- Distance from base
- Arithmetic: +, -, *, /, %
- if (a > b) then (c) else (d)

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

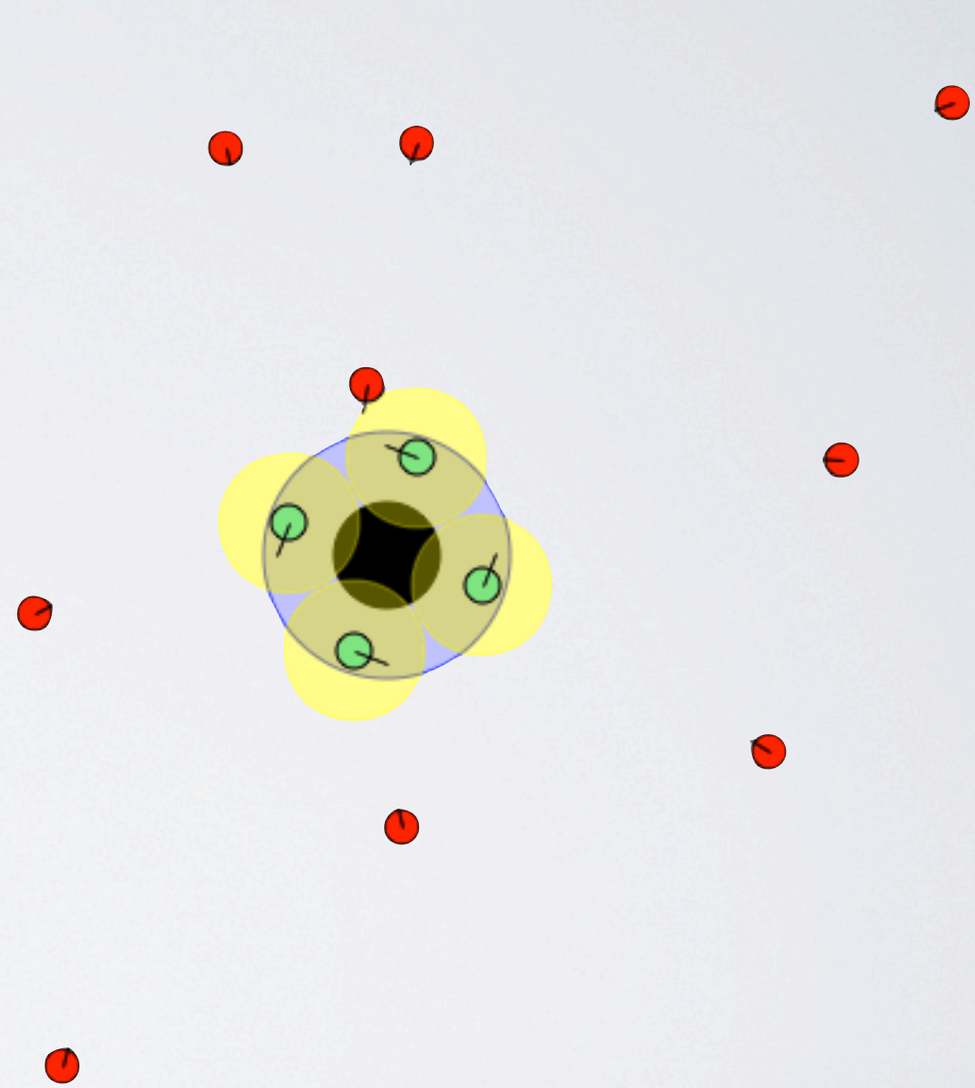
- Homogenous Guards
- Base Perimeter: 7

GRID BASED SIMULATIONS

- Software works
- Exploits grid domain
- Results are not practical

CONTINUOUS SIMULATIONS

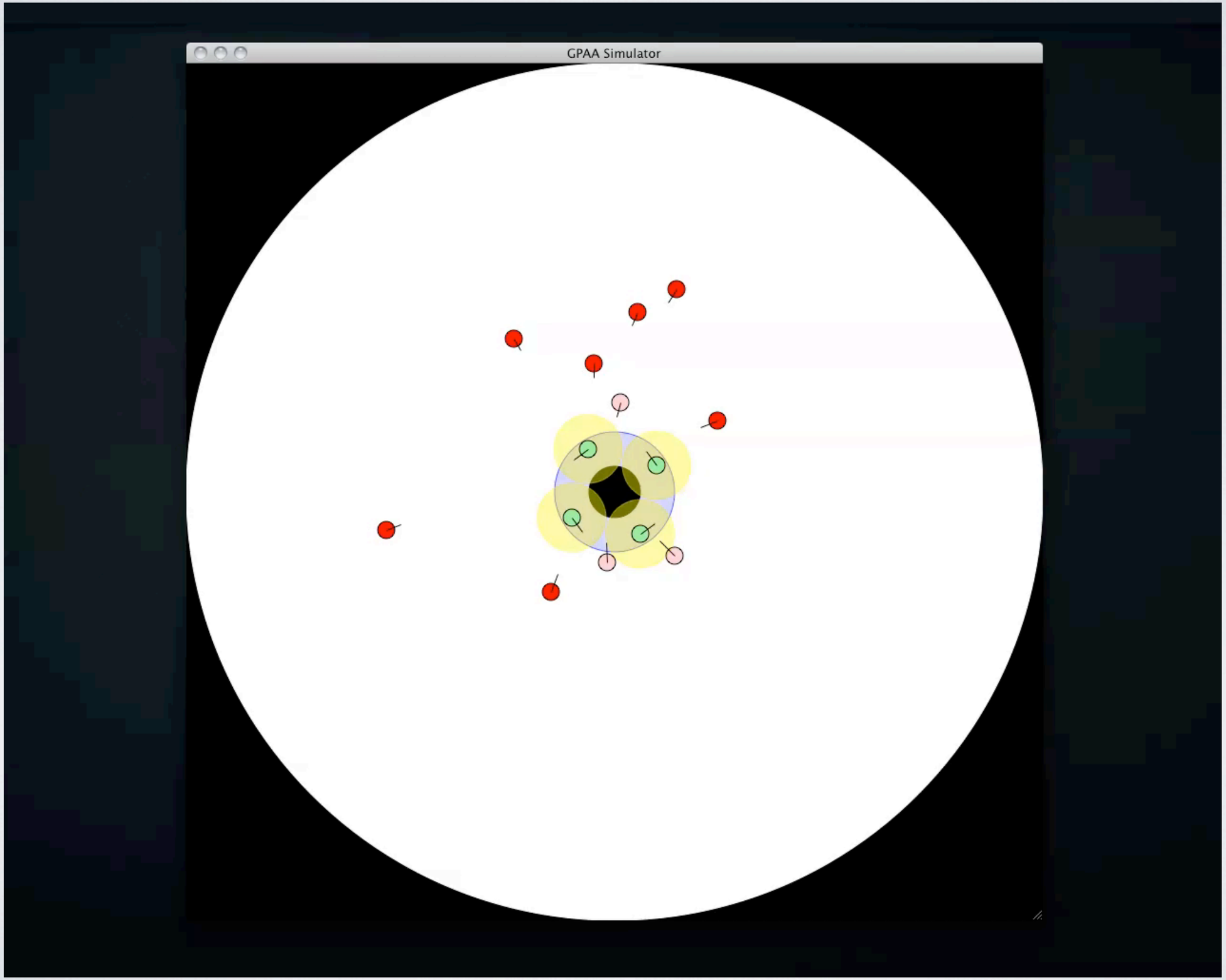
- Eliminates warping
- Realistic movement
- 4 guards
- Guard sensor range: 4 units
- Perimeter around base: 7 units



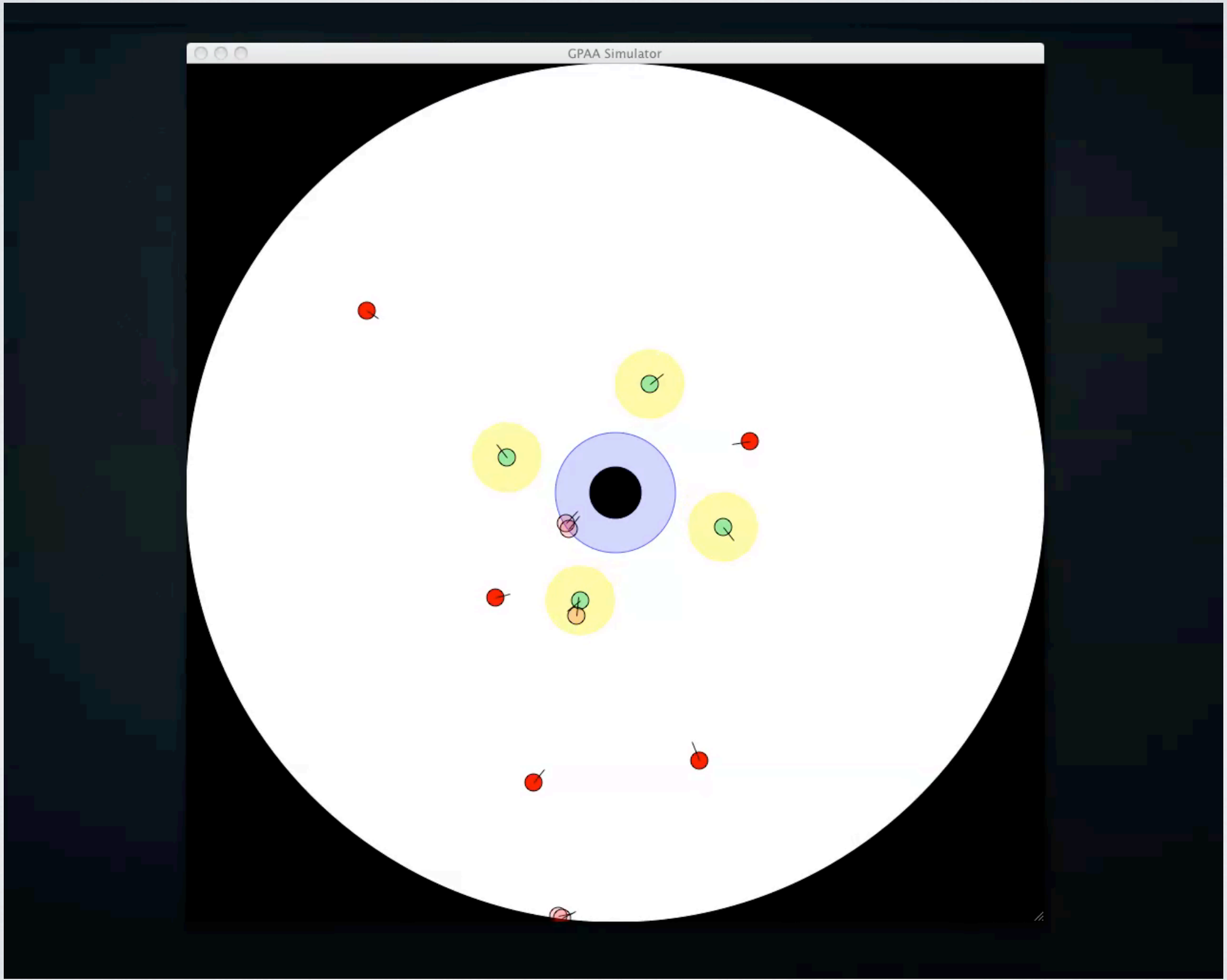
CONTINUOUS SIMULATIONS

- 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



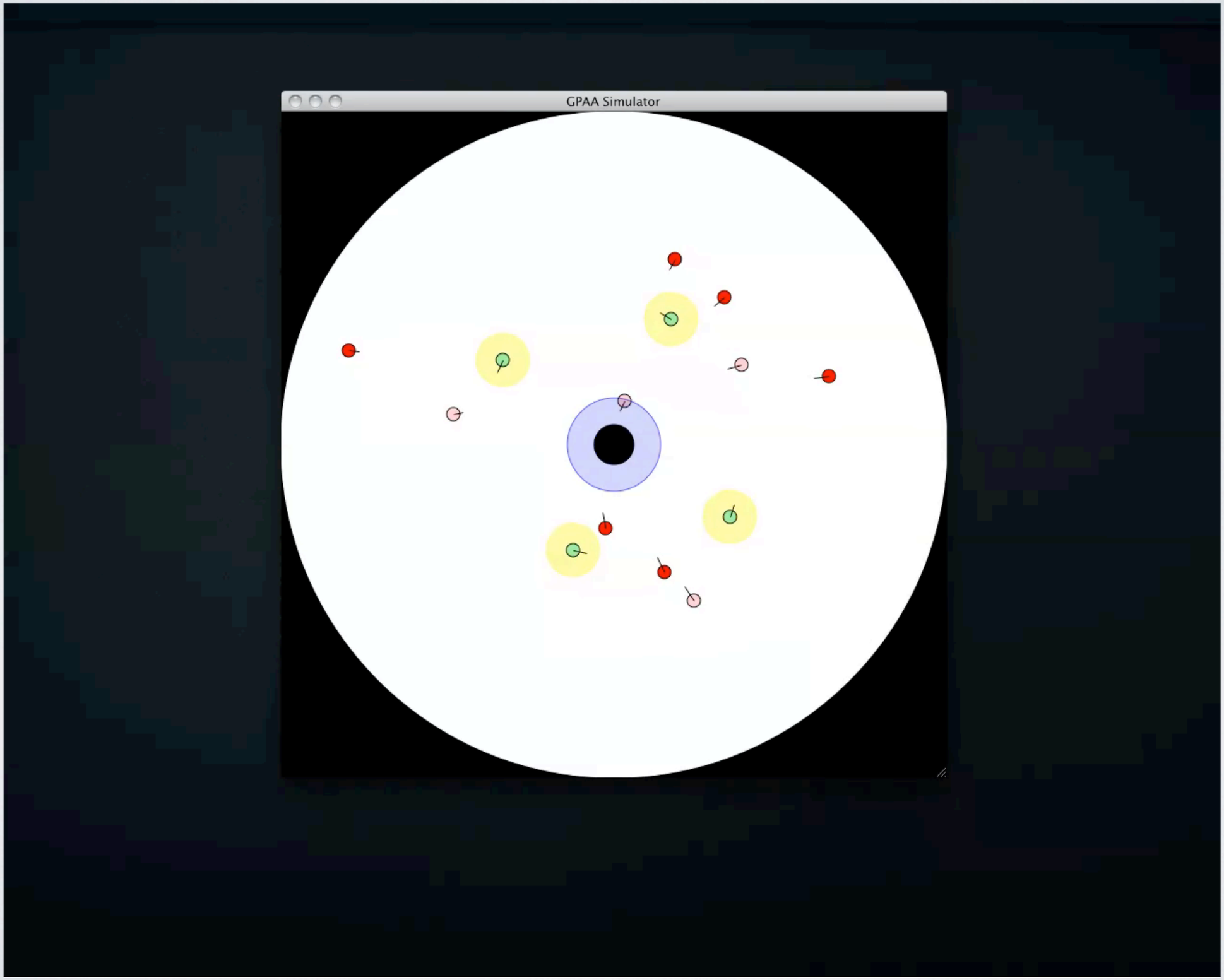
CONTINUOUS SIMULATIONS

- 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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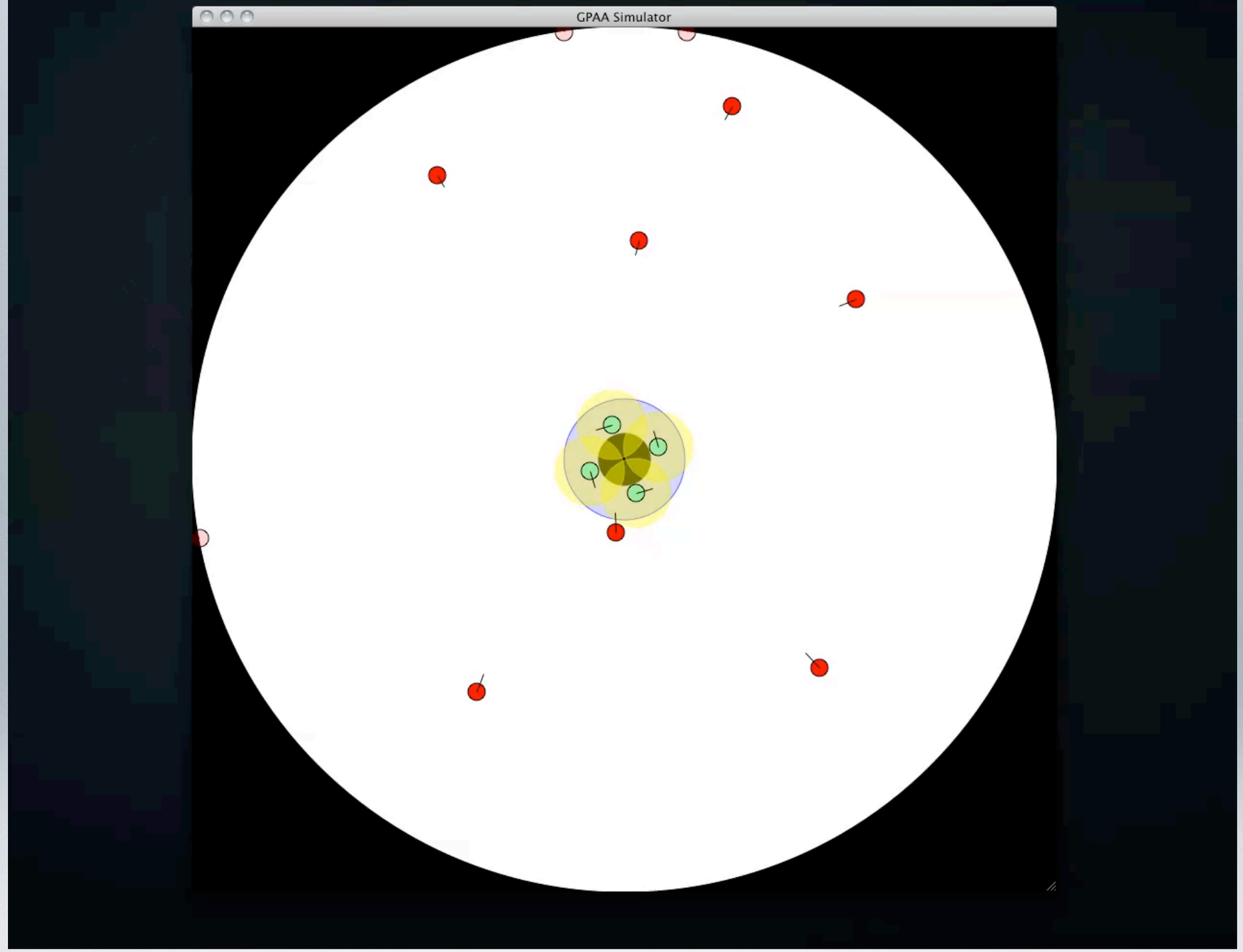
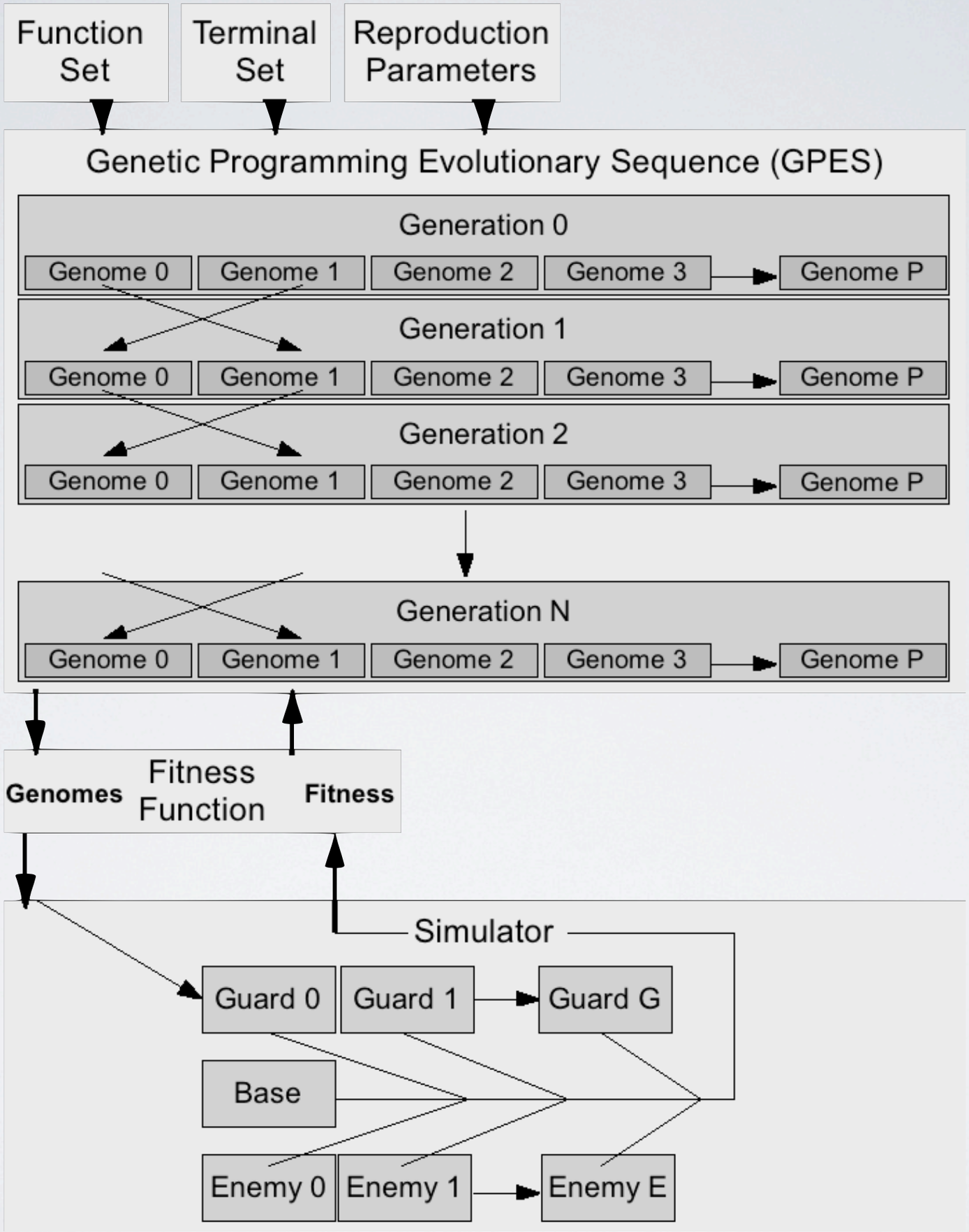
PRACTICAL GENETIC PROGRAMMING

FUTURE WORK

- Autonomous agent platform
- Accurately model noise
- Test on physical agent



QUESTIONS


Function Set
Terminal Set
Reproduction Parameters
Genetic Programming Evolutionary Sequence (GPES)
Generation 0
Genome 0
Genome 1
Genome 2
Genome 3
Genome P
Generation 1
Genome 0
Genome 1
Genome 2
Genome 3
Genome P
Generation 2
Genome 0
Genome 1
Genome 2
Genome 3
Genome P
Generation N
Genome 0
Genome 1
Genome 2
Genome 3
Genome P
Genomes
Fitness Function
Fitness
Simulator
Guard 0
Guard 1
Guard G
Base
Enemy 0
Enemy 1
Enemy E

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