

# Evolutionary Algorithms 101

NicApicella

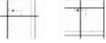
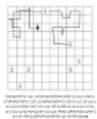
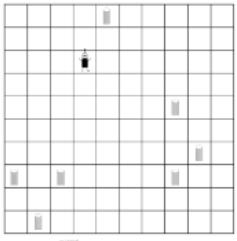
GPN II

24/Jun/2011

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# Pros and Cons

- + computational complexity is "irrelevant"
  - huge space (TSP)
    - many variables ("Curse of dimensionality")
    - no distinction of geno-/phenotype
    - no embryogenesis / nurture
    - stopping criteria?
    - how far / far along are we?
    - why are we here? how did we get here?
    - local optima
    - no guarantees on optimal (or even near-optimal) solution
    - + adaptation to (changing) environment
    - "no free lunch (in search & optimization)"



## Robby

10x10 environment

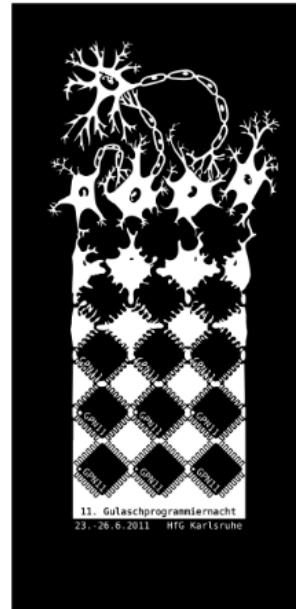
- walls all around
- each cell 50% chance of a can

Fitness function

- hit a wall: -5
- pick up nothing: -1
- pick up trash: +10

Trash-picking robot

- limited vision
- go N, S, E, W
- don't move
- pick up
- random move



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# Evolution

- Natural Selection
- Genetic drift
- Mutation
- Gene flow

# Computer Science

Artificial Intelligence



# Genetic Algorithm

0. Generate initial population
1. Perform selection (according to fitness function)
2. Reproduce (by applying genetic operators)
  - Crossover (recombination)
  - Mutation
3. GOTO 1

# Evolution

- Natural Selection  
"Survival of the Fittest"
- Genetic drift
- Mutation
- Gene flow

# evolution

## Natural Selection

"Survival of the Fittest"

## Genetic drift

# Computer Science

## Artificial Intelligence

Evolutionary Computation

### Evolutionary Algorithms

Genetic Algorithms  
Estimation of Distribution Algorithms  
Evolutionary Programming  
Evolutionary Strategies  
Imitation Learning

### Swarm Intelligence

Ant Colony Optimization  
Differential Evolution  
Bee Algorithms

other population-based  
metaheuristic methods

# Evolutionary Computation

# Artificial Intelligence

## Evolutionary Computation

### Evolutionary Algorithms

Genetic Algorithms  
Genetic Programming  
Evolutionary Programming  
Evolution Strategy  
Neuroevolution

### Swarm Intelligence

Ant Colony Optimization  
Particle Swarm Optimization  
Bees Algorithm

other population-based  
metaheuristic methods

# Evolutionary Computation

## Evolutionary Algorithms

Genetic Algorithms  
Genetic Programming  
Evolutionary Programming  
Evolution Strategy  
Neuroevolution

## Swarm Intelligence

Ant Colony Optimization  
Particle Swarm Optimization  
Bees Algorithm

other population-based  
metaheuristic methods

Genetic Algorithms  
Genetic Programming  
Evolutionary Programming  
Evolution Strategy  
Neuroevolution

# Swarm Intelligence

Ant Colony Optimization  
Particle Swarm Optimization  
Bees Algorithm

other population-based  
algorithms

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## Evolutionary Algorithms

Genetic Algorithms

Genetic Programming

Evolutionary Programming

Evolution Strategy

Neuroevolution

## Swarm Intelligence

Ant Colony Optimization

# Genetic Algorithm

0. Generate initial population
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# Robby

IOXIO environment

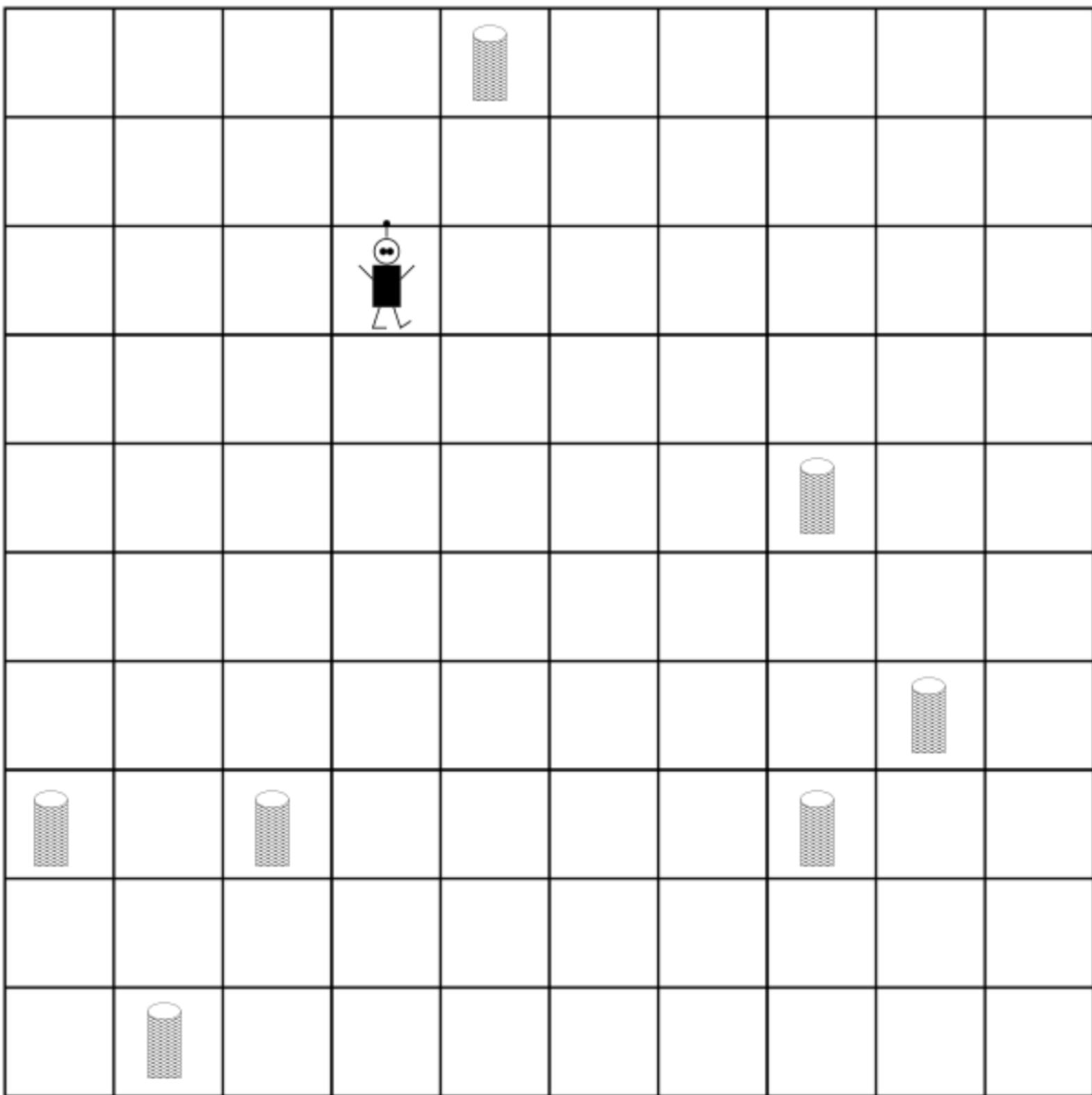
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...so, how do I make this "genetic"?

Candidate solution: "behaviour" of a Robby:

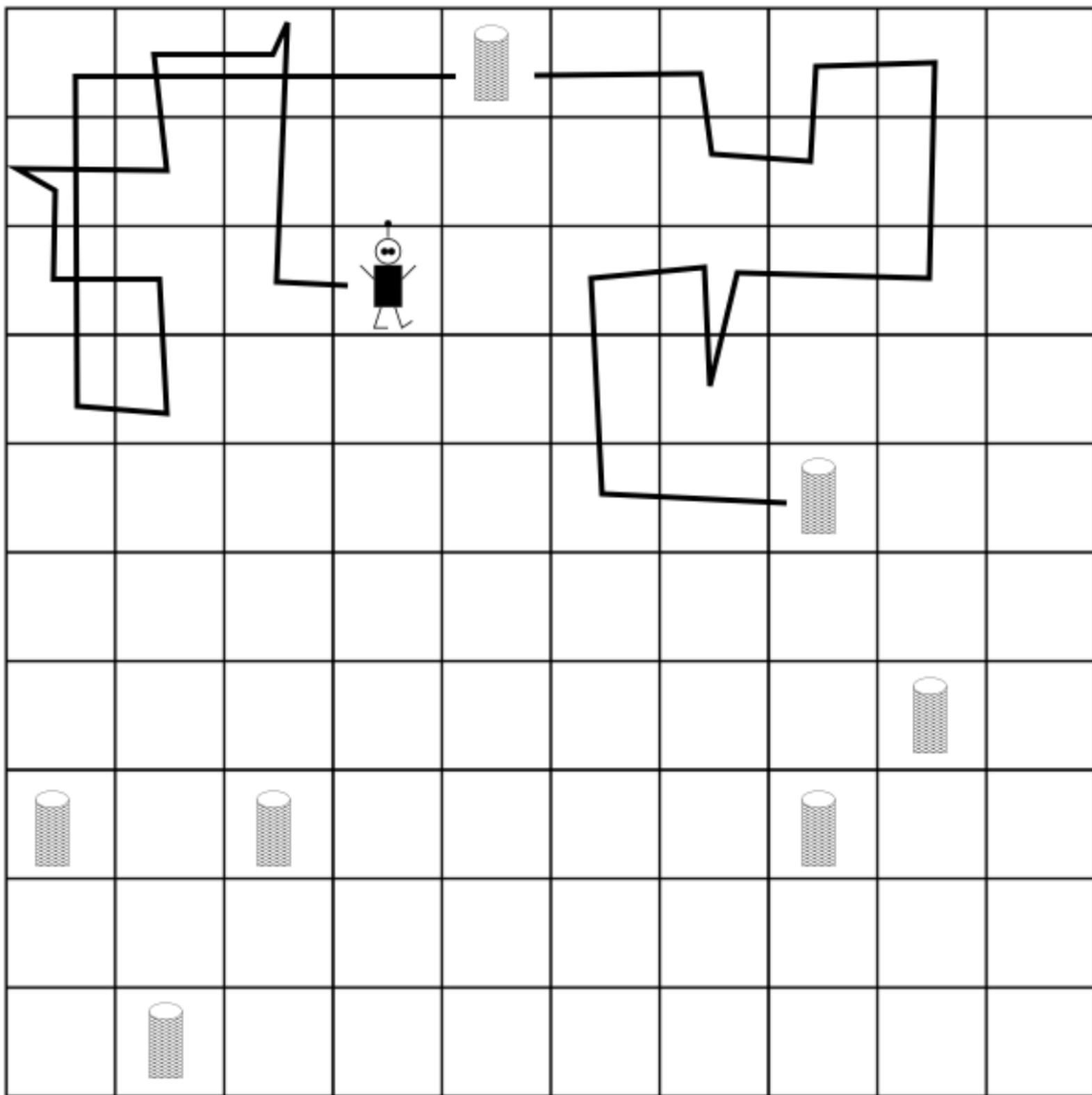
for each possible state, ...

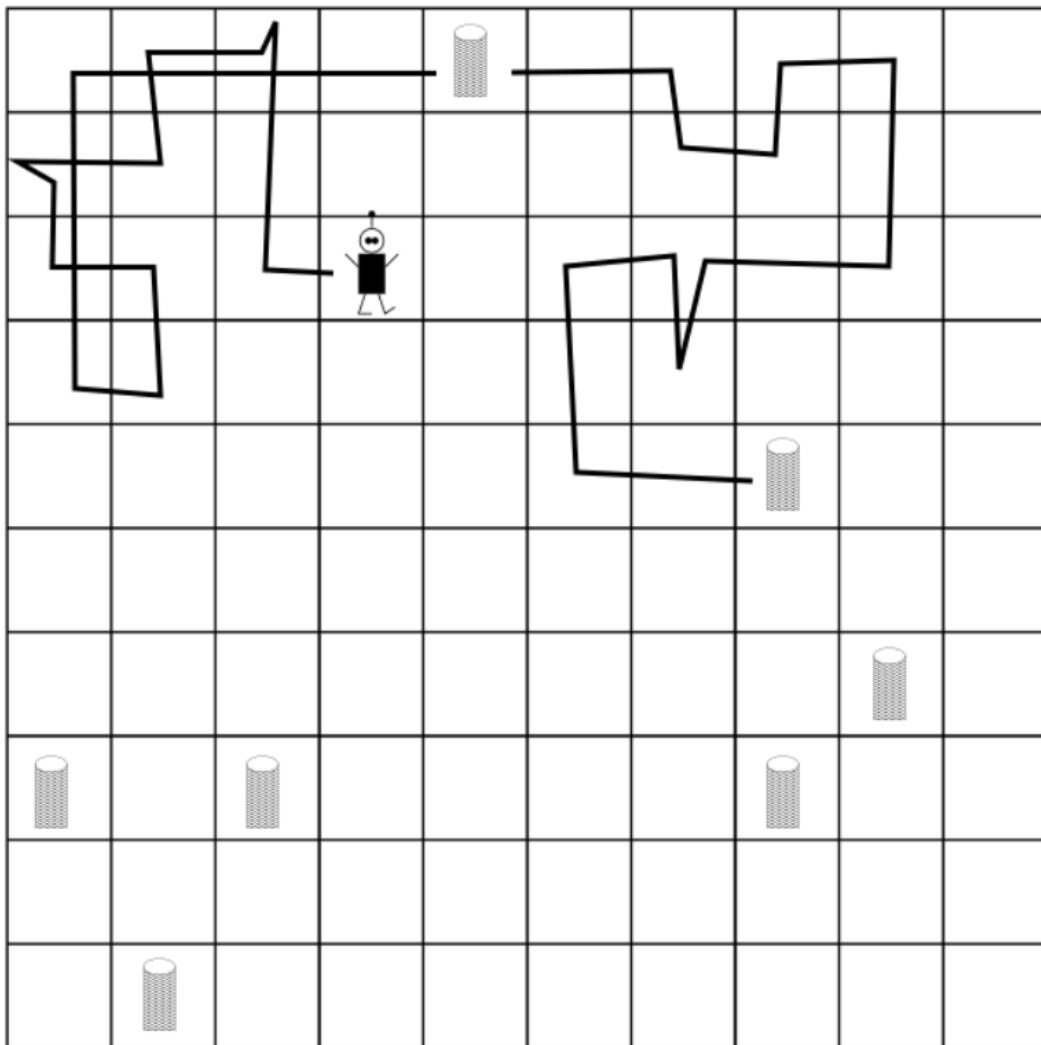
( $3^5 = 243$  states, as defined by cell-status & roddy's vision)

... execute one action

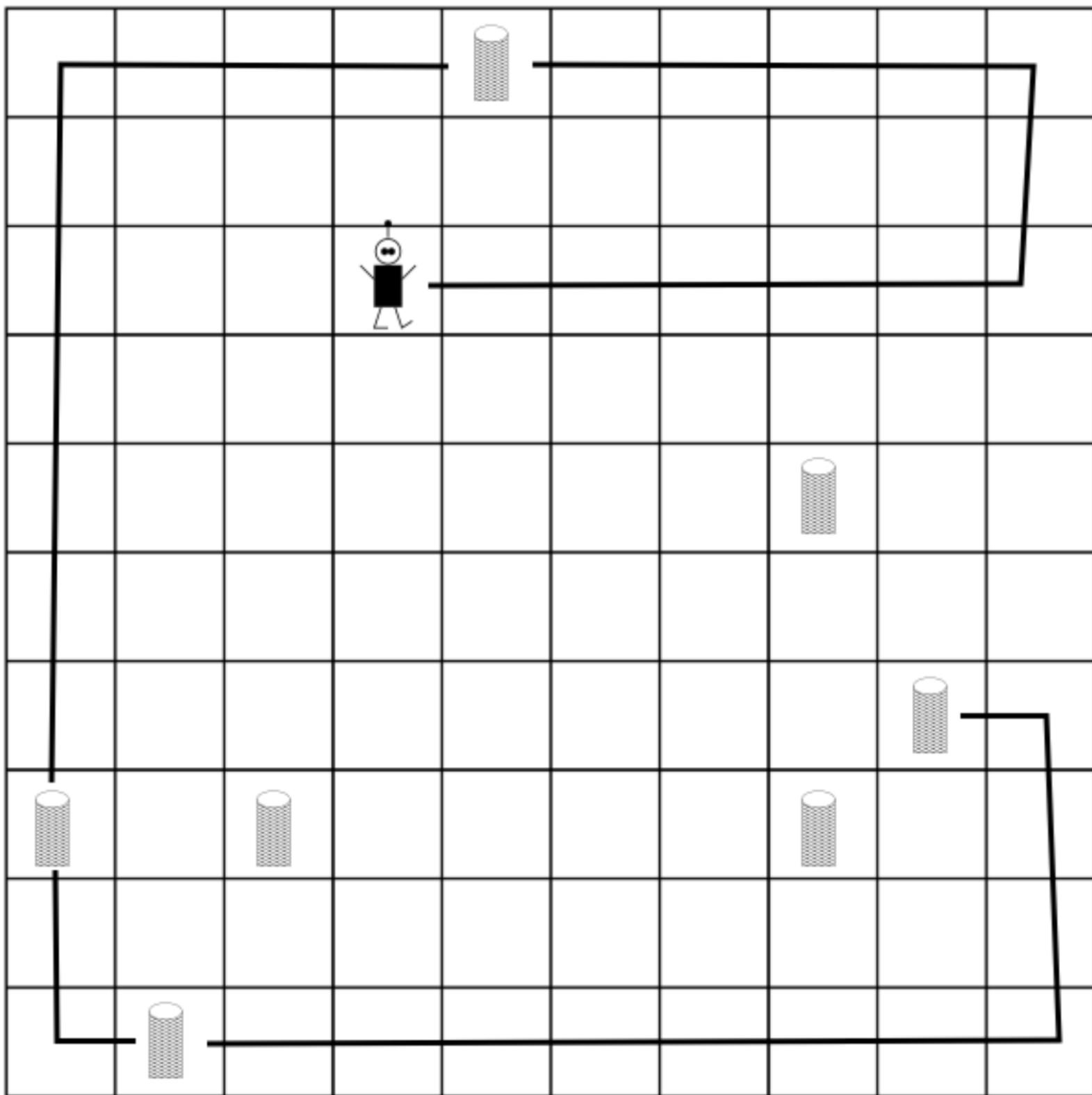
(one of 7)

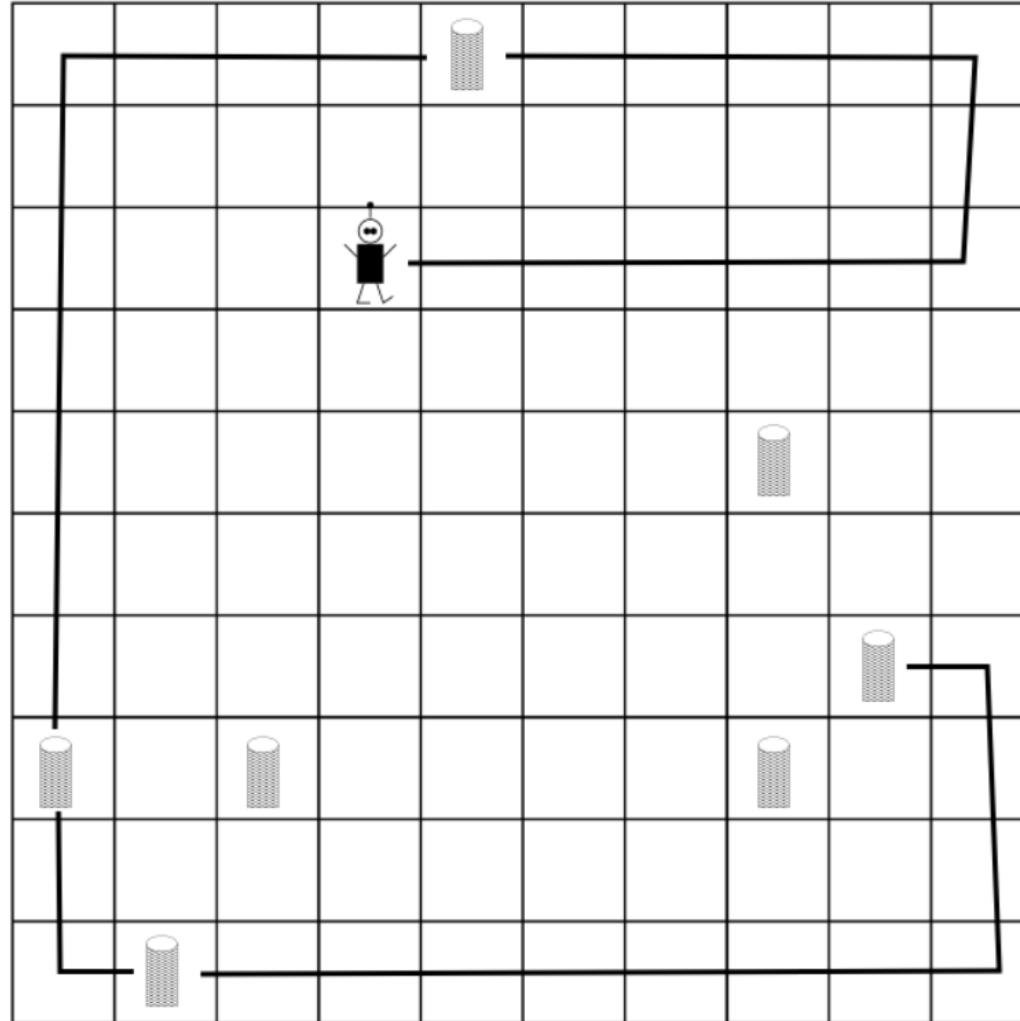
=> a "strategy" (or DNA) is a 243-long string of numbers 0..6



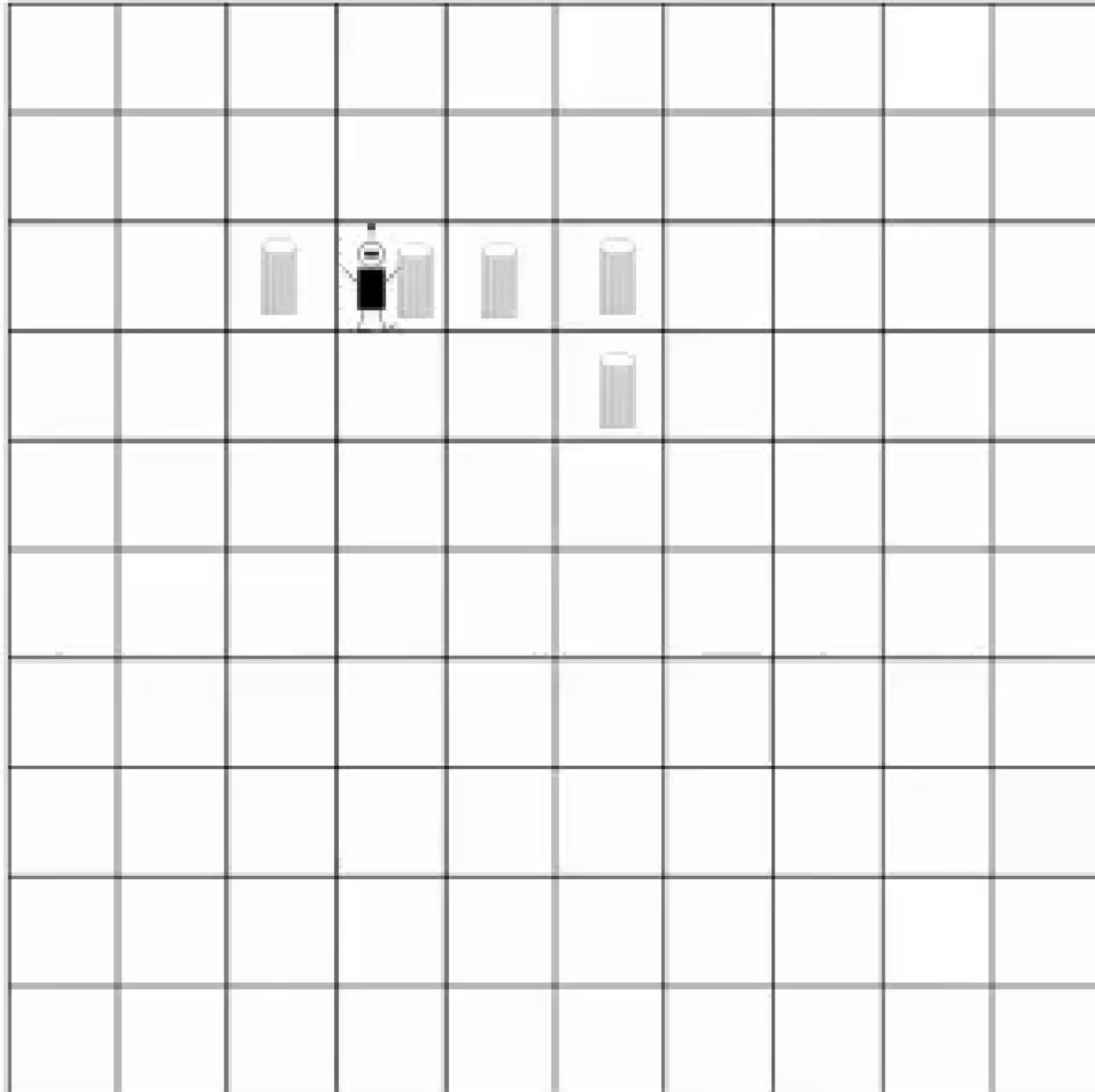


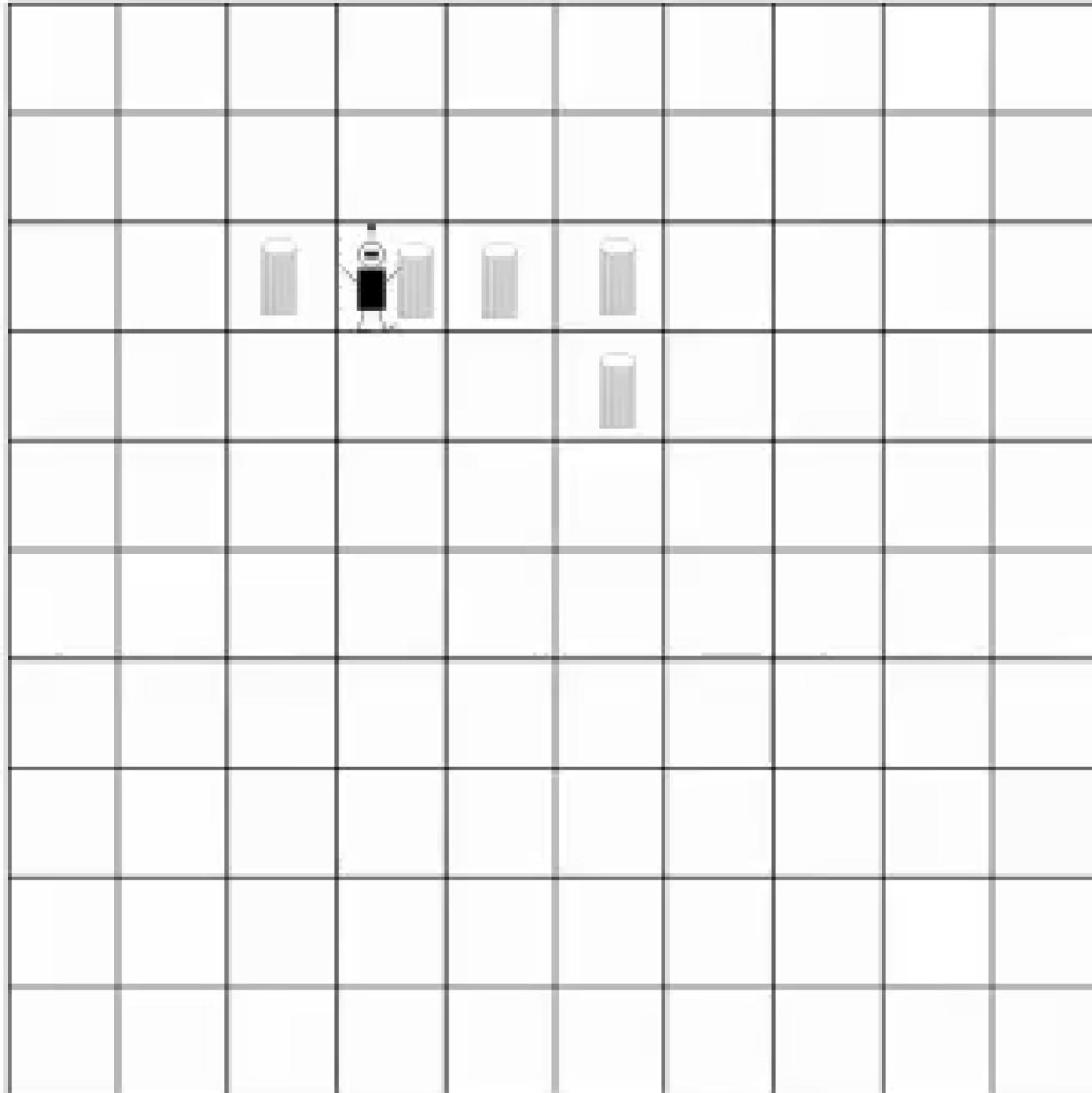
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25205035305065635356252353252656353665615135315125  
2353252151353151656353656252353252656353454





25435515325623525105635546115133615415103415611055  
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05435463240435033415325025325135235204515013015621  
3436252353223135051260513356201524514343432





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# Thank You!



Questions?