Learning to Navigate

A Genetic Approach Optimal Control

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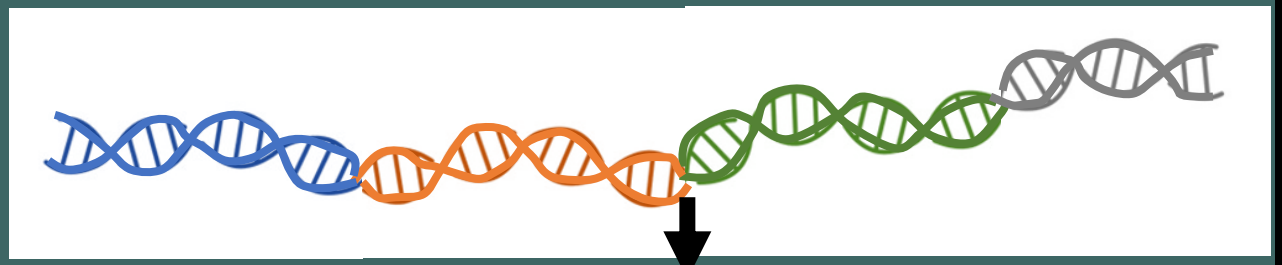
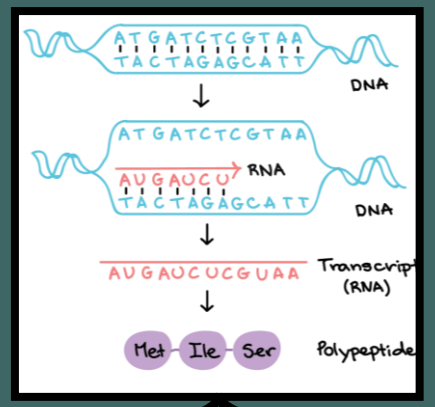
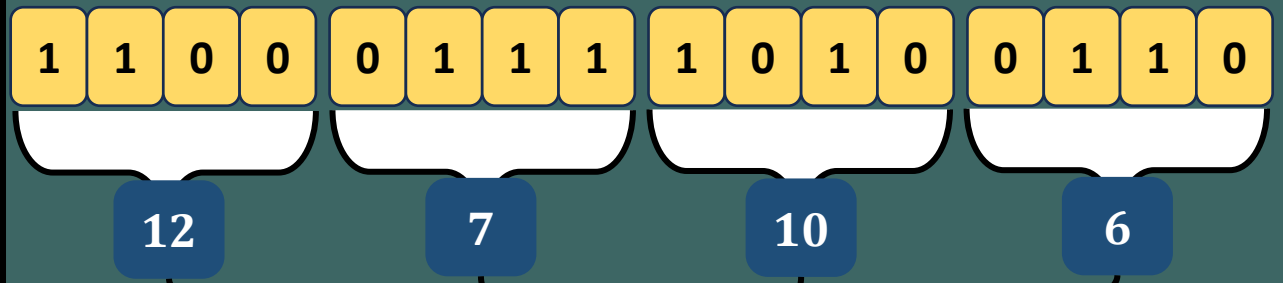
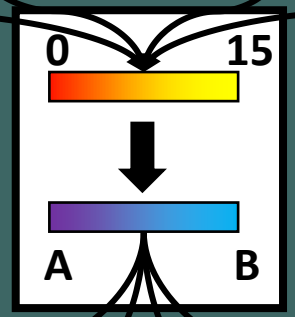
- Optimization by natural selection.
- Candidates represented as chromosomes.
- Randomly initialized chromosomes undergo selection, crossover, and mutation.
- Next generation is randomly sampled from a fitness-dependent probability distribution.
- Repeated iterations converge to near-optimal solutions.

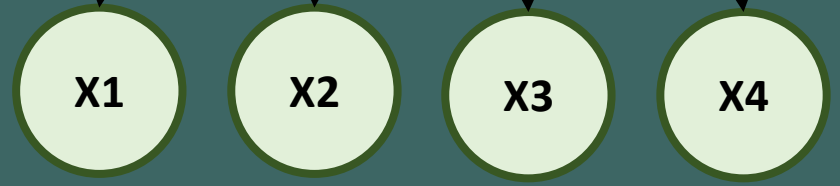


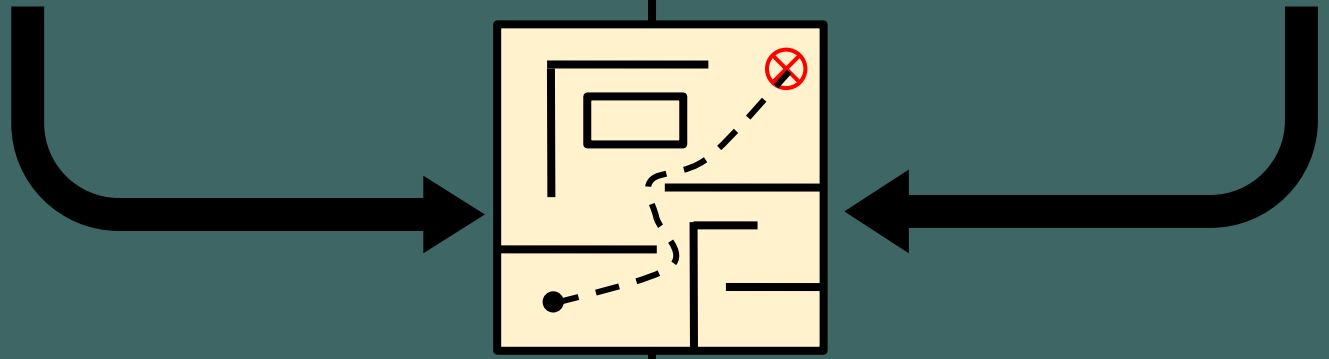

ATGATCTCGTAA
TACTAGAGCATT
DNA
ATGATCTCGTAA
AUGAUCU
RNA
TACTAGAGCATT
DNA
AUGAUCUCGUAA
Transcript
(RNA)
Met
Ile
Ser
Polypeptide


X1
X2
X3
X4


1 1 0 0 0 1 1 1 1 0 1 0 0 1 1 0
12
7
10
6

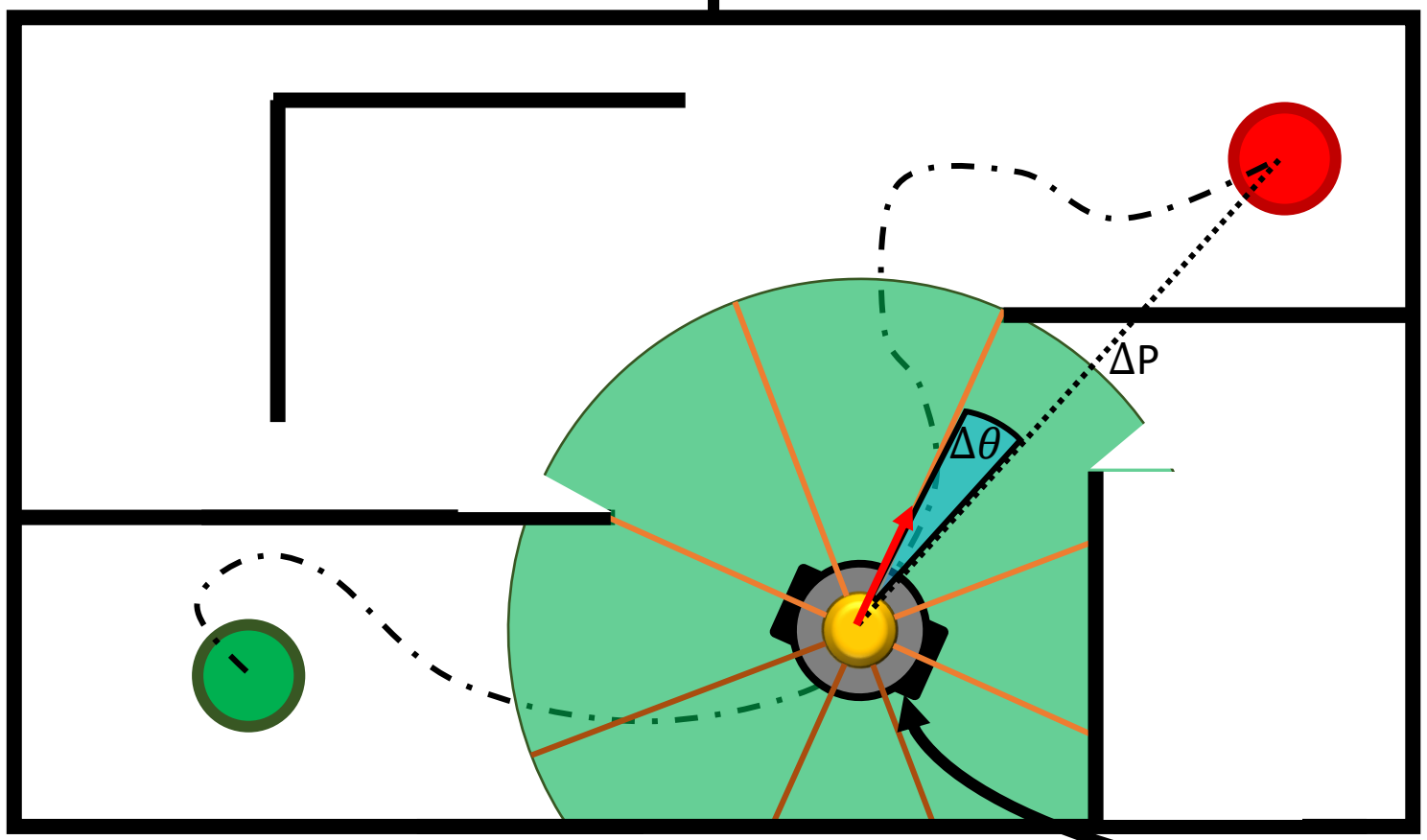

0
15
A
B


X1
X2
X3
X4

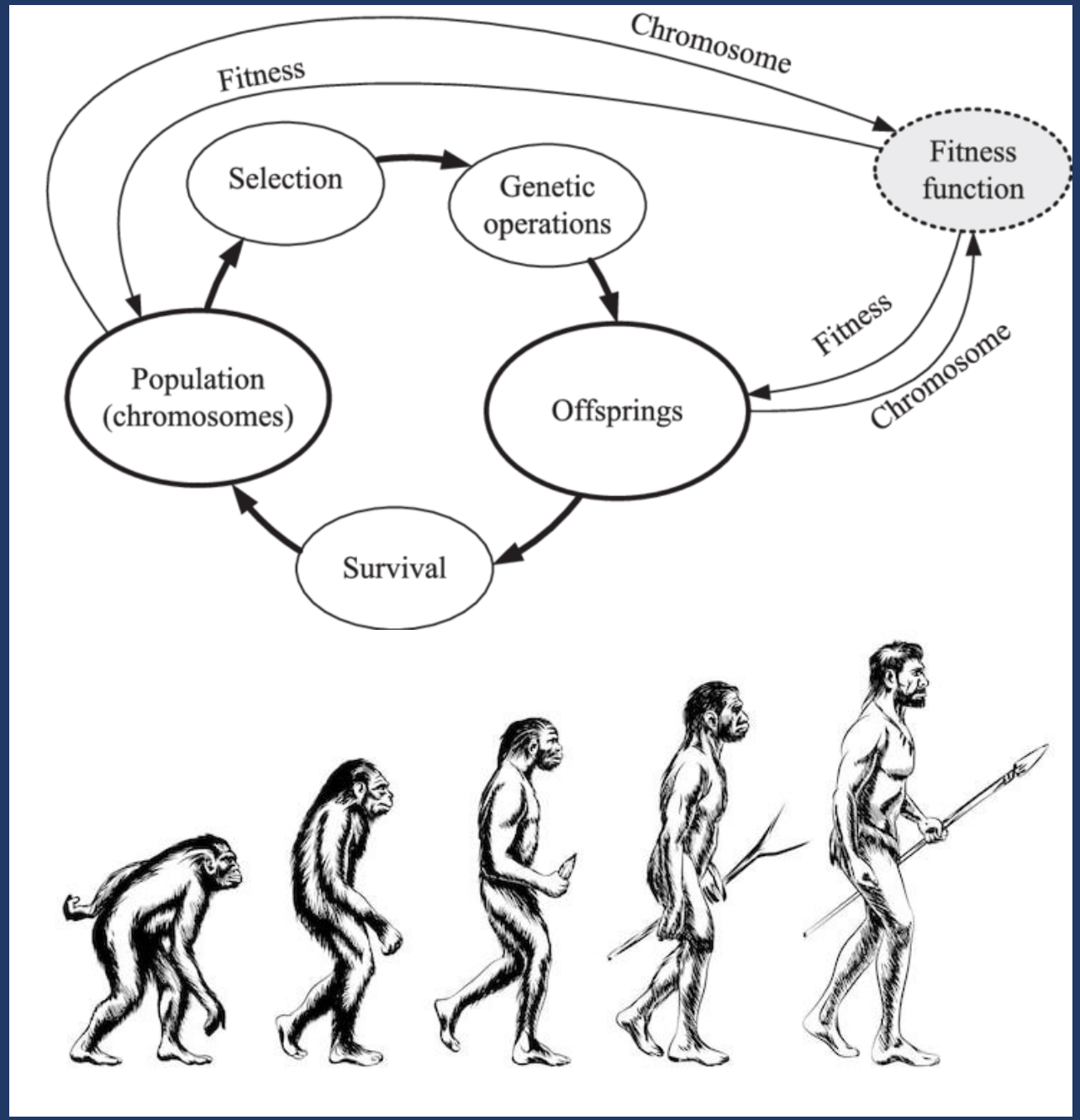


LIDAR 1
LIDAR 2
LIDAR 3
LIDAR 4
LIDAR 5
ΔP
$\Delta \theta$

	K_P	K_I	K_D
	L1	L1	L1
	L2	L2	L2
	L3	L3	L3
	- L2	- L2	- L2
	- L1	- L1	- L1
	ΔP	ΔP	ΔP
	$\Delta \theta$	$\Delta \theta$	$\Delta \theta$



V
W

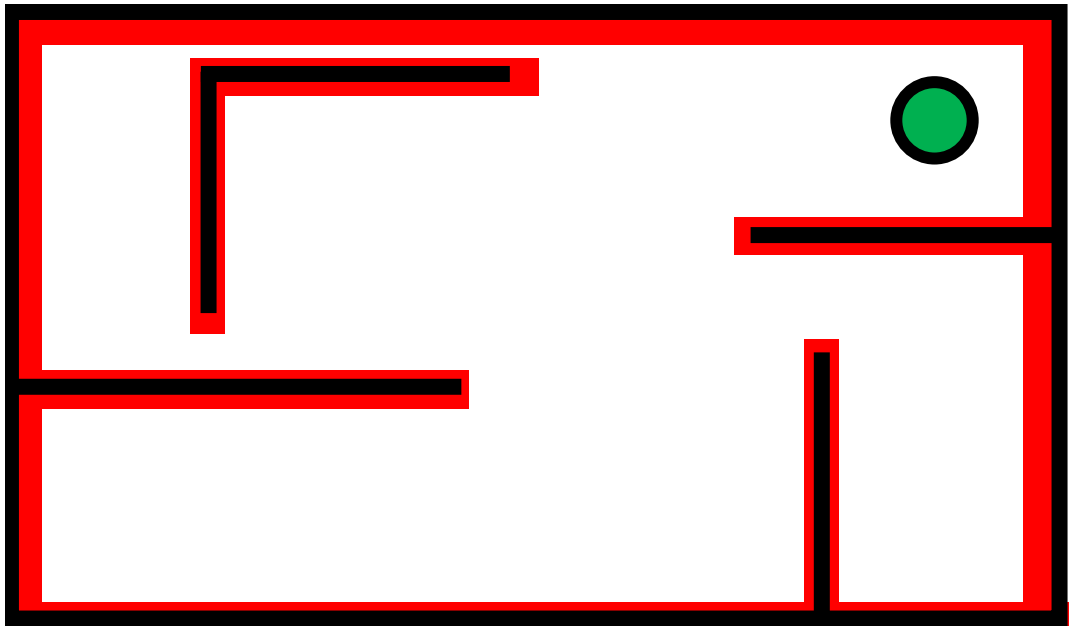


How does it learn?

- Mutation:
  - Random Bits in the Chromosome are flipped.
- Crossover:
  - Random bits of two parents are swapped.
  - Blocks corresponding to variables are swapped instead of bits.

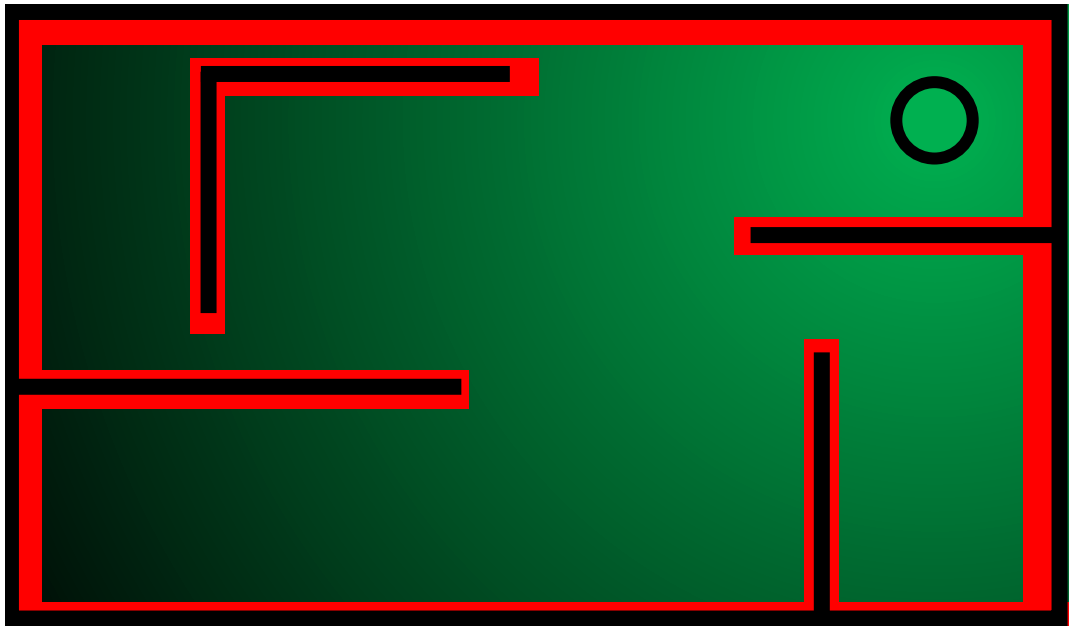
Fitness Function

- **Collision:**
  Large penalty (-ve reward) assigned if bot gets too close to walls/obstacles.
- **Completion:**
  Large bonus (+ve reward) assigned if bot gets close to final target.



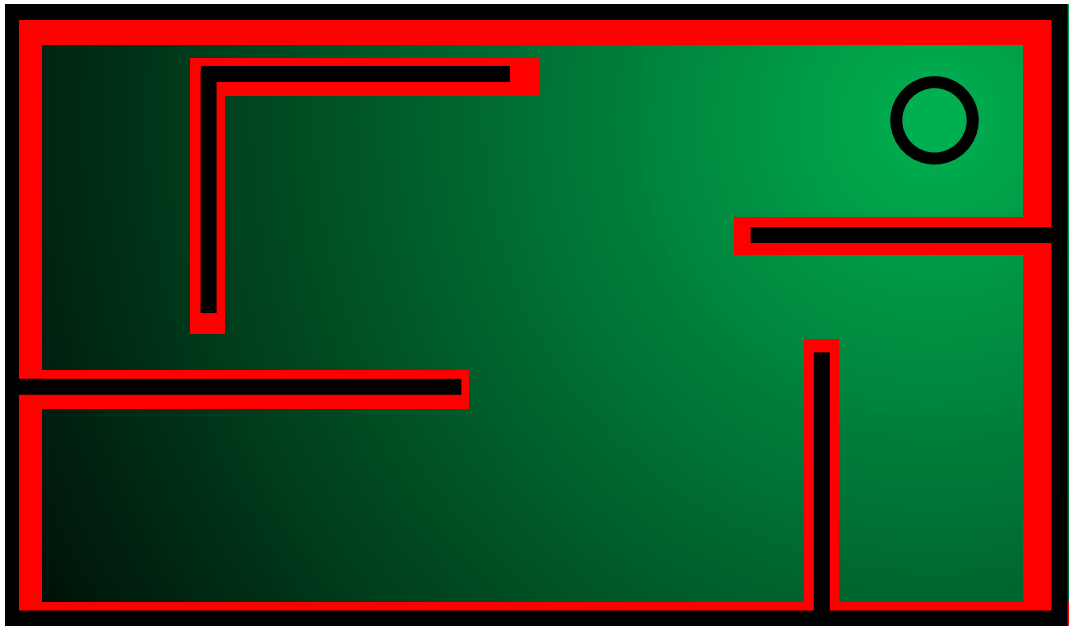
Fitness Function –v1

- Collision:
- Completion:
- Heuristic:
  Added penalty proportional to the final distance of bot from the target.



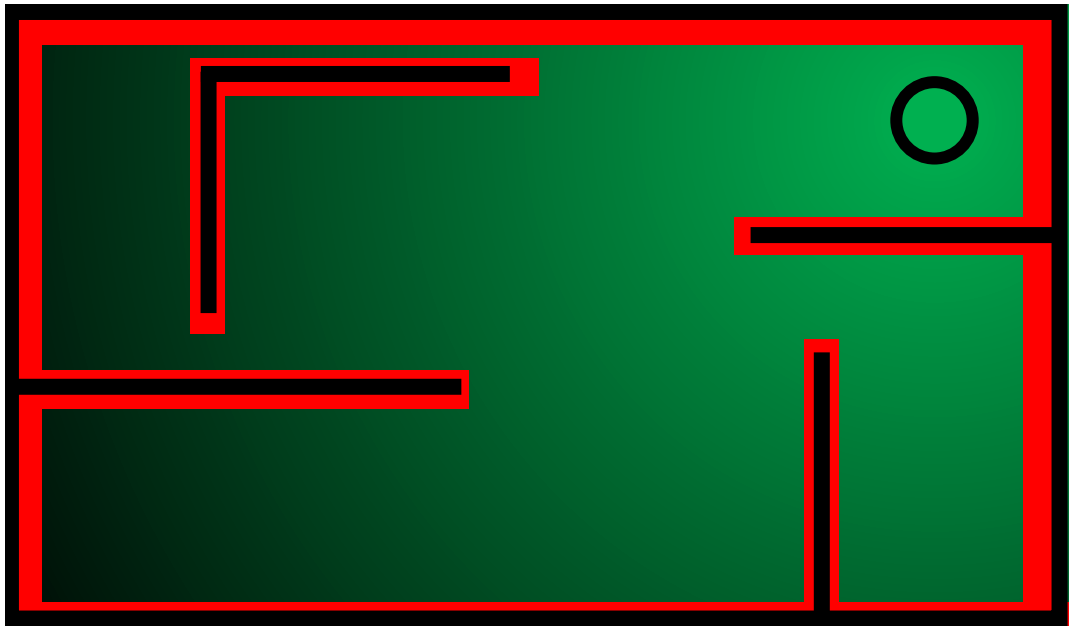
Fitness Function –v1(Final)

- Collision:
- Completion:
- Heuristic:
- Pace:
  Added penalty proportional to time spent.



Fitness Function –v2 (Definitely the Final One!)

- Collision:
- Completion:
- Heuristic:
- Pace:
- Deviation:
- Pace Condition:
  Time penalty added only if game was not ended by collision.



The Origins...

“Instead of trying to produce a programme to simulate the adult mind, why not rather try to produce one which simulates the child’s? If this were then subjected to an appropriate course of education one would obtain the adult brain.”

ALAN TURING, 1950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Interpretability

Inspired by natural phenomenon of genetic evolution, thereby providing intuitive insights into the learning mechanism.