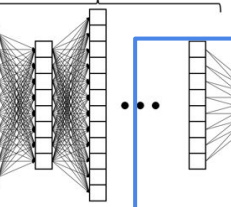


Assessing "Blind" Simulated Annealing in a racing sim.

Team members:

Zachary, S

Teodor, C

Repository

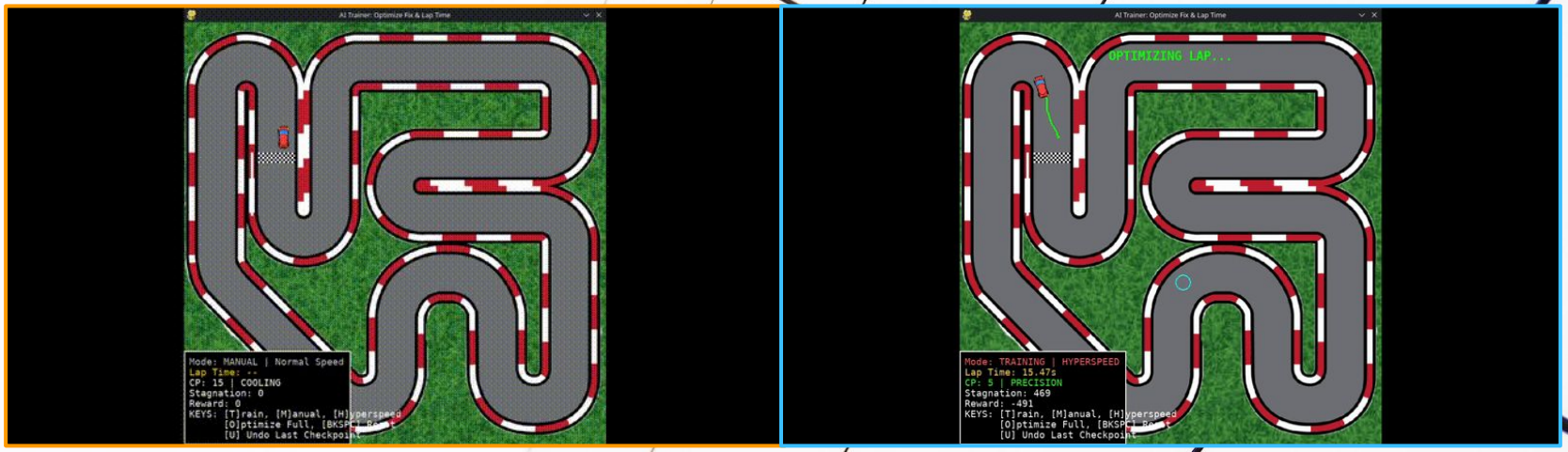
https://github.com/TEODORCRISTESCU/AI-Car-Simulated-Annealing

GOAL: To implement Artificial Intelligence logic from scratch (no pre-made AI libraries) to solve a navigation track.

One of our points of comparison throughout this project was other suitable methods. Notably Genetic Mutation though some other deep-learning models were also examined.

Foundation:
Physics/Rendering:Adapted from Pygame-Car-Racer (Techwithtim).
Theoretical Basis: Standard SA principles (GeeksforGeeks).
Benchmark: Compared against GeneticCars (MikeOfZen), which uses Genetic Algorithms + Raycasts.

DEMO


AI Trainer: Optimize Fix & Lap Time
Mode: MANUAL | Normal Speed
Lap Time: --
CP: 15 | COOLING
Stagnation: 0
Reward: 0
KEYS: [T]rain, [M]anual, [H]yperspeed
[O]ptimize Full, [BKSP] Re
[U] Undo Last Checkpoint
AI Trainer: Optimize Fix & Lap Time
OPTIMIZING LAP...
Mode: TRAINING | HYPERSPEED
Lap Time: 15.47s
CP: 5 | PRECISION
Stagnation: 469
Reward: -491
KEYS: [T]rain, [M]anual, [H]yperspeed
[O]ptimize Full, [BKSP] Re
[U] Undo Last Checkpoint

Approach:

Architecture:

Input: Frame count (Time).

Output: Action Sequence (e.g., Frame 10: Turn Left, Frame 11: Accelerate).

Constraint: The agent is Blind. It does not know where the walls are; it only knows if it has crashed (Game Over).

The Logic: We treat the entire run as a mathematical function to be optimized.

State: The list of all steering/throttle inputs.

Energy/Cost: Negative distance traveled + Penalty for bad angles and crashes.

Neighbor: A slight random mutation of the current input list.

Details and struggles:

The "Horizon Problem": Initially, the car would speed to a checkpoint but end up facing a wall, making the next section impossible.

Fix: We adjusted the scoring function to prioritize Car Angle over raw speed + tuning temperature.

Cooling Schedule: We implemented a dynamic "State Machine" to handle cooling:

Standard Learning: Normal exploration.

Fine-Tuning: Very low T, making tiny adjustments to perfect a turn.

Panic Mode: If the car gets stuck in a local minimum (no improvement for X iterations), we spike the Temperature T to force a drastic change.

Annealing vs Genetic / others

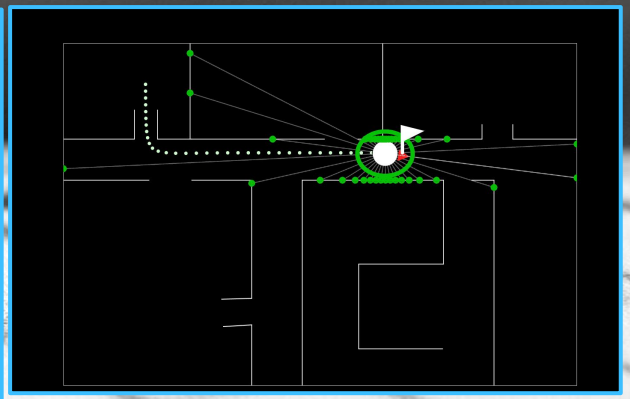
Sensory Input vs. Memorization:

Genetic Algs / deep learning: Sees the wall → Turns.

Annealing: Memorizes "Turn at Frame 100."

Failure Mode: If the car starts 1 pixel to the left, "Turn at Frame 100" causes a crash. The script is brittle.

Genetic View:



Annealing View:

Questions?