Neural Networks in Autonomous Vehicles

Based on "Driving Darwin" program

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Outline

What is a Neural Network?

Definition

A neural network is an artificial brain. And can be treated as a function $f_{NN}(IN) = OUT$

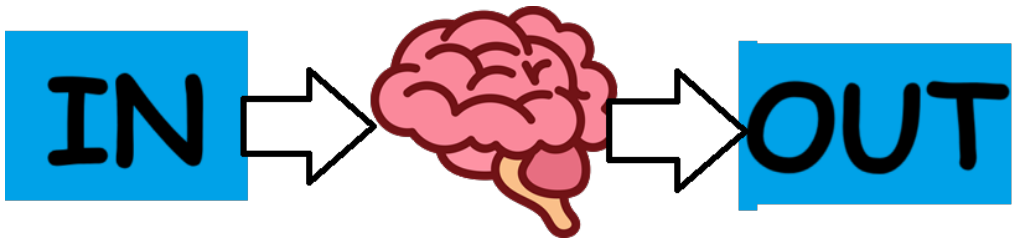


Figure: Artificial brain = Neural Network

- Get Some Data
- **Input** it to the artificial brain
- Read the **output**

What if we give a Neural Network to a car?

First we need to consider following things

- **Input to the Artificial Brain:** What information should be fed into the system to facilitate learning and decision-making?
- **Handling the Outcome:** Once the artificial brain processes the input, how should the outcomes be utilized or acted upon?

Input for the cars brain

Idea

- Cars navigate roads smoothly without hitting edges.
- Focus on car-to-road-edge distance.
- Check distance in various directions.
- Input them as an array to our Neural Network.

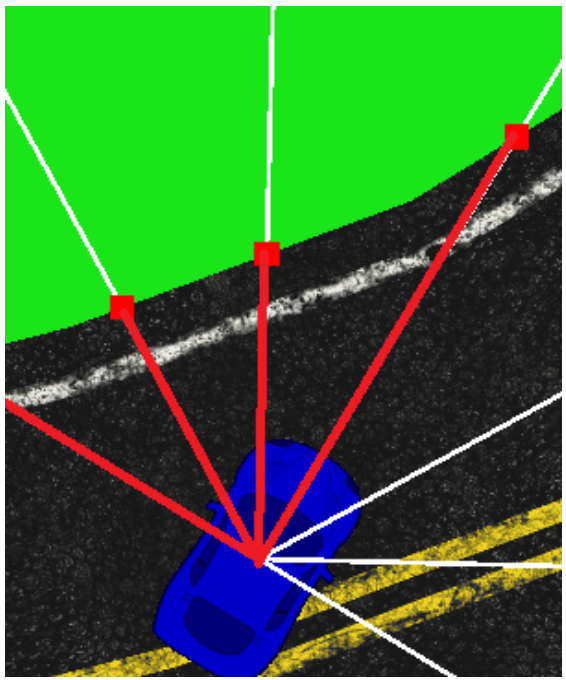


Figure: Distance to the edge of the road in directions(Red lines)

Output of the Network

- As the brain of our car "knows" about its surroundings
- Maybe its good idea to let it steer the car
- Let the output of the network be the direction of movement and velocity

Example

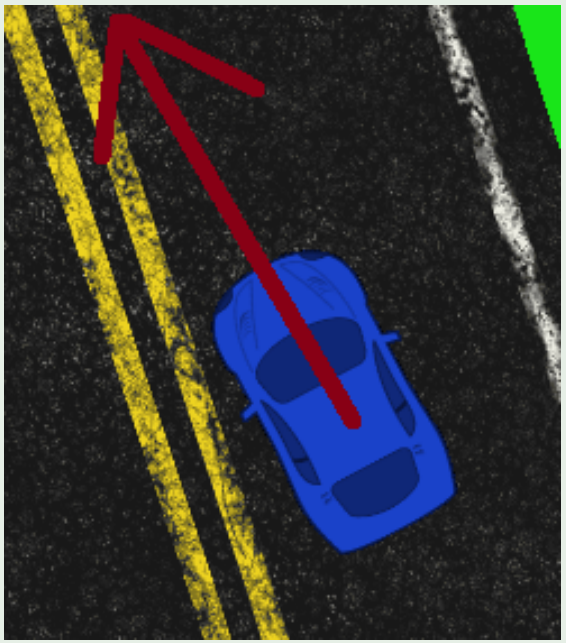


Figure: Cars brain choses direction and velocity

Let's finally give it a brain

Testing the idea

- Let's finally give it a brain a plug everything in
- Put it on the road and...
- It bumps into to the edge of the road. **Why?**
- Its brain is very primitive.It needs to learn and evolve

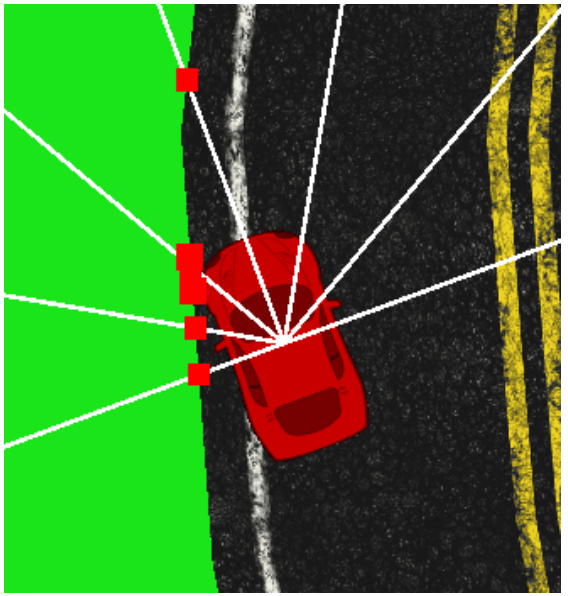
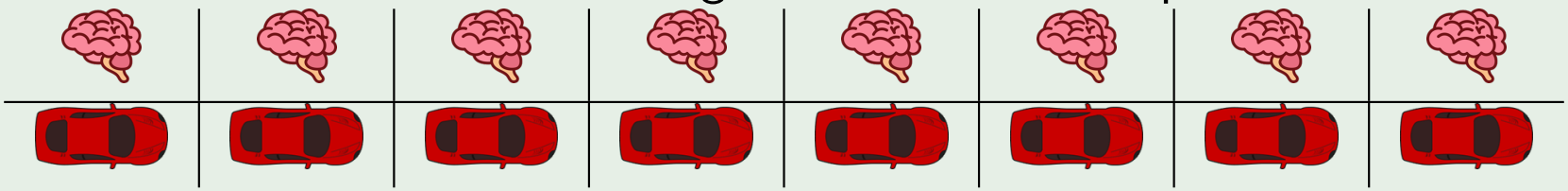


Figure: Our Car is not very clever for now

How to make it smarter?

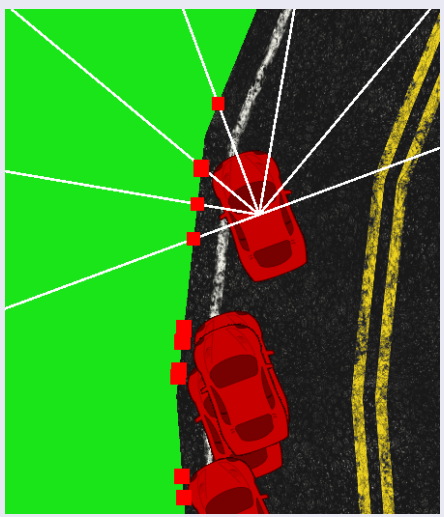
Simple Idea

Let's take a bunch of cars and give each one an unique random brain.



Maybe at least one of them will show some inteligence

Testing the idea

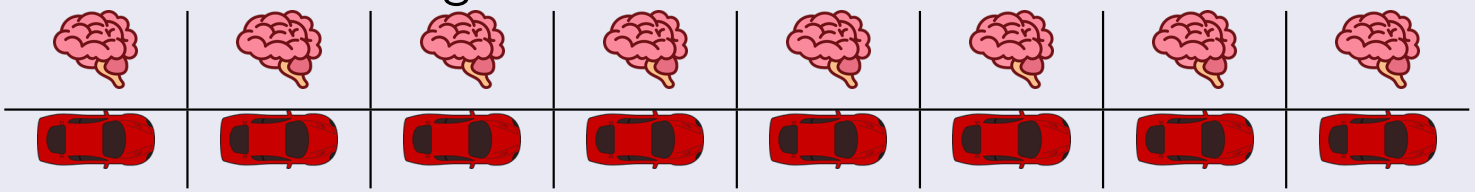


- Well they still bump into the edge of the road
- **However** One of them managed to travel Further than others
- That means its brain was the **smartest**
- Let's see what we can do with the best car

Evolution

New Generation

Let's create a new generation of cars.



1. **However** this time we will give each new car slightly modified version of the best brain from the previous generation.
2. In that way the new generation will "learn" from the previous one

Testing the idea

- We can repeat process described above over and over again
- That way each new generation will learn from its predecessors
- and stack its knowledge, until...
- eventually, we will get a car that is able to drive on its own

Progress over Generation

Each generation makes progress

Generation	Distance
1	12
2	34
3	52
4	54
5	61
6	91
7	inf

Figure: Data collected on 21.12.2023 using "DrivingDarwin" program

- Each generation gets better score than the previous
- Until generation 7 is able to fully drive on the road

Further Reading

Project links

Project page*	https://github.com/stachurski2k/DrivingDarwin

Sources

Inspiration	https://youtu.be/hfMk-kjRv4c?si=KWKiRY9hVDP_R-bV
Neural Networks	https://youtu.be/aircAruvnKk?si=-pxO5wa7qVt-1eHh
Road Generation	https://youtu.be/RF04Fi9OCPc?si=GgaL0ujYB1aqEibW

* "Driving Darwin" was fully developed by the author of this presentation, it covers much more advanced concepts than presented such as implementation of Neural Network from scratch and generator of bezier curves. Their description can be found in the documentation of the project.

Thank You for Your Attention

Any Questions?

by Stanisław Deja