2D Racing Simulation

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Abstract

This project will focus on a 2D Racing game, in which the system will continuously improve driving performance. We will train a convolutional neural network to drive a 2D car through a track without going off track.

1 Project Scope

This project will consider a single car on a flat continuous track. The car will always be on the track, if it drives off the track it will be counted as a failed trial.

1.1 Input/Output behavior

The input will be the current 96x96 RGB state of the game. This input will be fed into a convolutional neural network that will output a 4x1 array to be used as the next action.

1.2 Evaluation Metrics

The car can not violate track limits.

A possible modification to the race track can be checkpoints, that the car must reach in a specific order.

One important evaluation metric will be the time needed to complete a lap of the track, measure by the number of frames used.

2 Baseline

2.1 A2C

We achieved a baseline performance evaluation using the Advantage Actor-Critic (A2C) reinforcement learning algorithm. The results of the first 5000 timesteps are shown in the table below.

	eplenmean	eprewmean	explained_variance	fps	nupdates	policy_entropy	total_timesteps	value_loss
0	NaN	NaN	-8.095860e-02	27	1	4.256815	5	10.168140
1	NaN	NaN	1.132488e-06	49	100	4.257540	500	0.076601
2	1000.0	-49.218750	0.000000e+00	49	200	4.260181	1000	2.447494
3	1000.0	-49.218750	0.000000e+00	48	300	4.263363	1500	0.060290
4	1000.0	-48.392147	1.192093e-07	46	400	4.264649	2000	7.623740
5	1000.0	-48.392147	0.000000e+00	46	500	4.272092	2500	0.039670
6	1000.0	-49.413535	-8.344650e-07	46	600	4.277479	3000	21.306206
7	1000.0	-49.413535	0.000000e+00	46	700	4.282452	3500	0.016945
8	1000.0	-48.115928	-8.344650e-07	47	800	4.286417	4000	44.772968
9	1000.0	-48.115928	0.000000e+00	47	900	4.291824	4500	0.006022
10	1000.0	-49.738534	-8.344650e-07	47	1000	4.294659	5000	47.653221

3 Literature Review

Article Title: Game AI: Simulating Car Racing Games by Applying Pathfinding Algorithms

Article Source: http://www.ijmlc.org/papers/82-A1090.pdf

This paper explores techniques for creating realistic racing game AI through classical pathfinding algorithms, namely A*. The researchers use black and white 2d images to represent the environment. Black pixels correspond to the tarmac and white pixels are the runoff areas off track. The images are 1280x782 pixels. Each image is translated into a 2d matrix representing the search space. Each pixel represents a node. The group applied A* and two modified A* implementations to the dataset. From this, they proposed their own dynamic pathfinding algorithm. When applying A*, the AI behaves correctly, but generates a lot of Nodes which takes up precious CPU cycles. It is not optimal for large tracks with multiple AI running simultaneously. The two modified versions of A* seek to improve efficiency by generating and exploring fewer states. The first version reduced frontier states by using a system of precalculated waypoints. This produced fewer states and used few CPU cycles while running, but has the overhead of precalculating an optimal path. The second version combines A* with a line of sight algorithm to limit frontier states to those in direct viewing distance of the vehicle. The final algorithm presented in the paper is a dynamic pathfinding algorithm which combines techniques from the previous results with logic for random collision avoidance. This algorithm produces the most natural driving behavior of all the algorithms. While its result was considered most favorable of the three, it does not generate the fewest states and produce the fastest lap time. This paper provides a good baseline for weighing different approaches to our problem. Race car AI can be solved by applying data driven machine learning models, or more classical search and pathfinding approaches like those outlined here.

References

[1] Wang, Jung-Ying, and Yong-Bin Lin. *Game AI: Simulating Car Racing Games by Applying Pathfinding Algorithms*. International Journal of Machine Learning and Computing, 1 Feb. 2012, http://www.ijmlc.org/papers/82-A1090.pdf.