AWS re:Invent

AIM207-R3

Get started with AWS DeepRacer

Speaker Name
Job Title

Speaker Name
Job Title

AWS re:Invent

aws

Agenda

AWS DeepRacer

AWS DeepRacer League

Reinforcement learning for the Sunday driver

AWS DeepRacer virtual simulator

Under the hood

AWS DeepRacer hands-on lab

AWS DeepRacer at re:Invent 2019

AWS DeepRacer

Introducing AWS DeepRacer Evo

How can we put reinforcement learning in the hands of all developers? Literally.

Get hands-on experience with reinforcement learning

AWS DeepRacer Evo

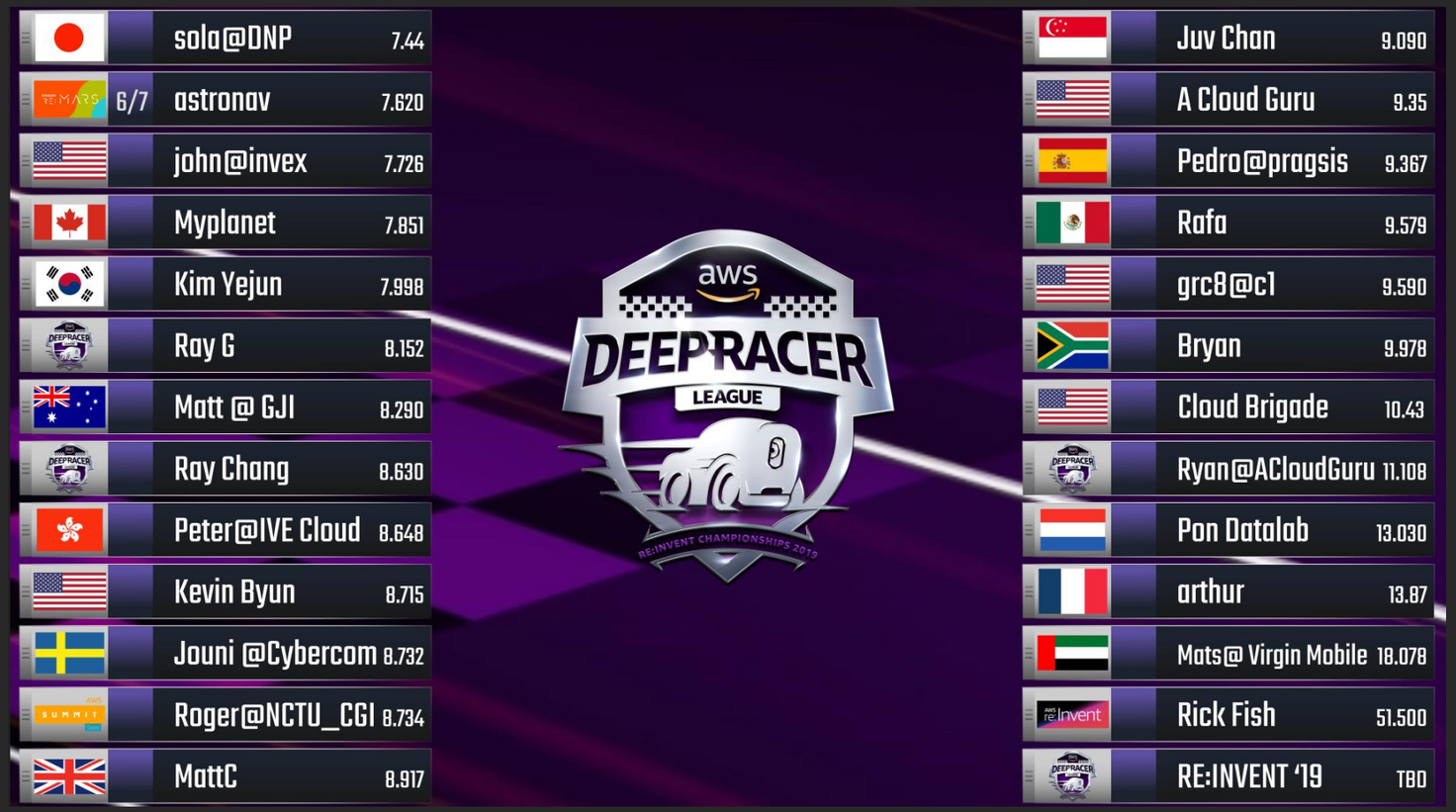
3D racing simulator

2020 AWS DeepRacer League

Community Races

AWS DeepRacer League

AWS DeepRacer League 2019: Summit Circuit



21 races, 17 countries, thousands of developers of all skill levels, and a world record of 7.44 seconds

www.deepracerleague.com

AWS DeepRacer League 2019: Virtual Circuit

6 virtual race winners and 18 top point-getters

http://join.deepracing.io/

AWS DeepRacer League will return in 2020!

2 ways to race	3 race formats	Prizes!
Online Virtual Circuit	Time trial	Paid trip to re:Invent!
In-person Summit Circuit	Object Avoidance	Win DeepRacer cars
	Head-to-head	

www.deepracerleague.com

RL for the Sunday driver

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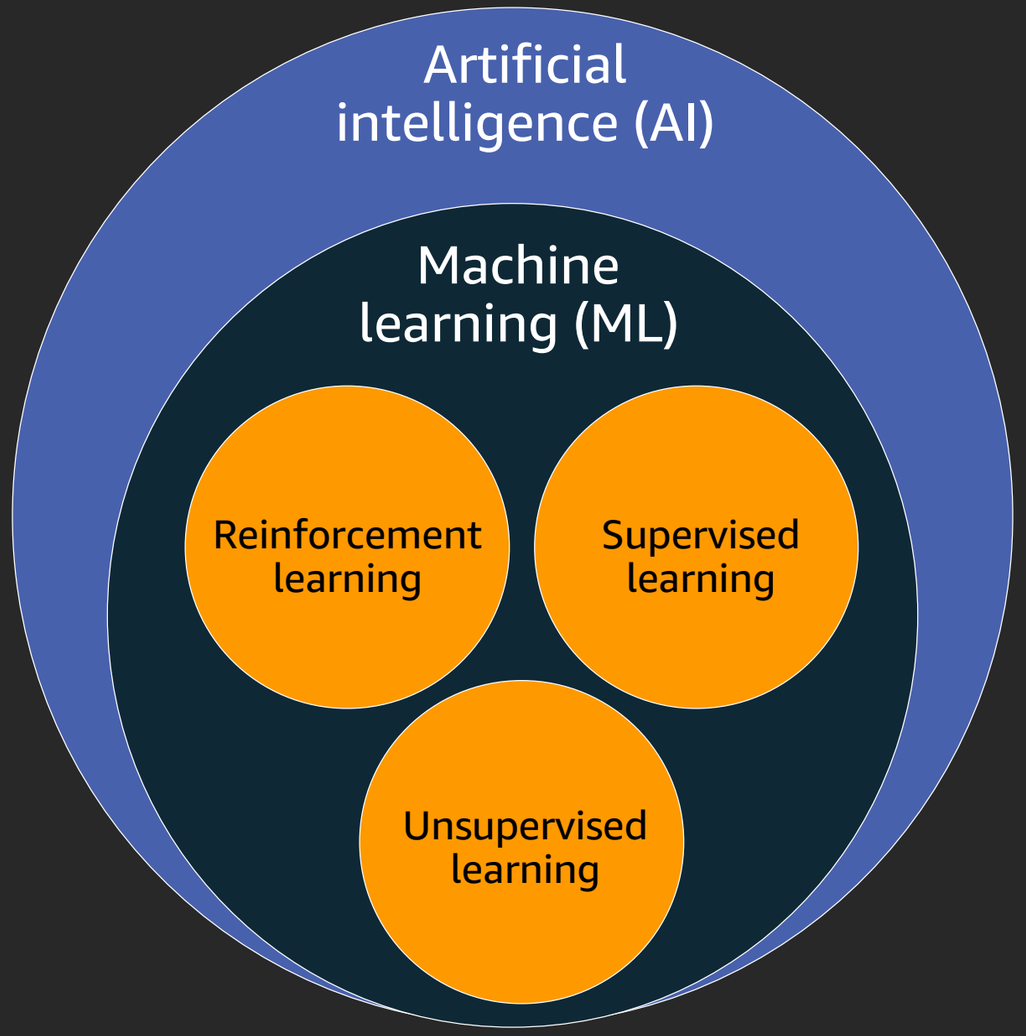
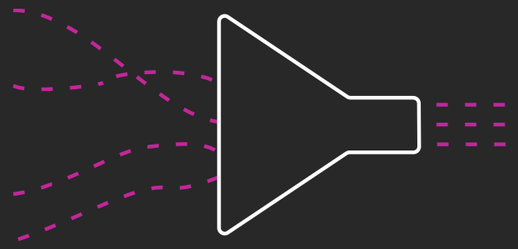
Reinforcement learning in the broader AI context



ML overview

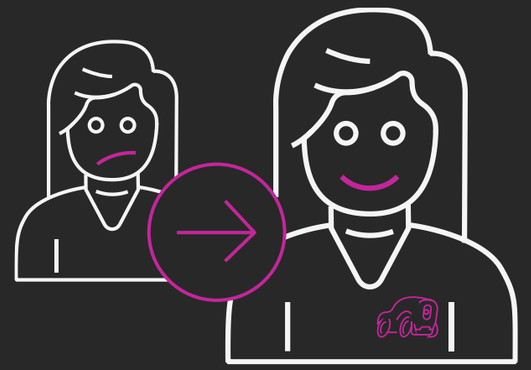
Supervised

Example-driven training; every datum has a corresponding label



Unsupervised

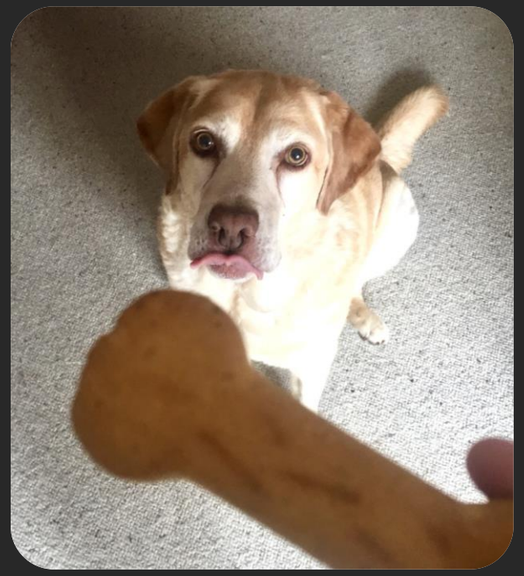
No labels for training data



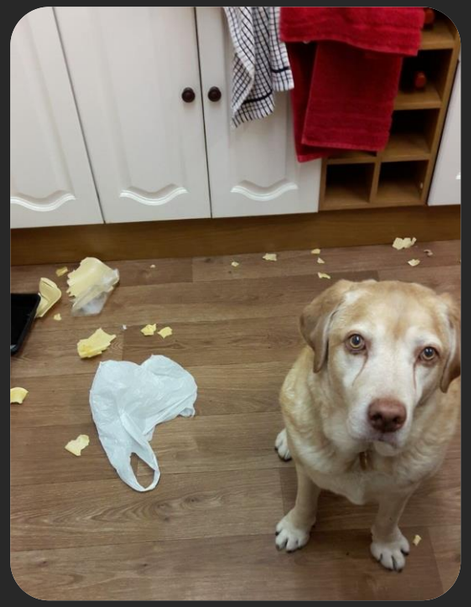
Reinforcement

Learns through consequences of actions in a specific environment

RL in the real world



Reward positive behavior

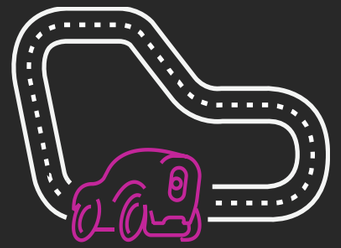


Don’t reward negative behavior

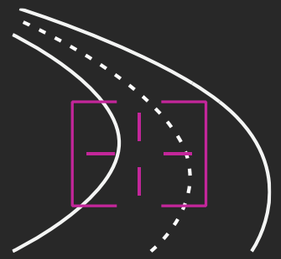
The result!

Reinforcement learning terms

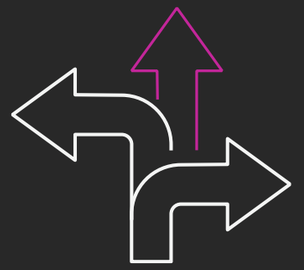
Agent



Environment

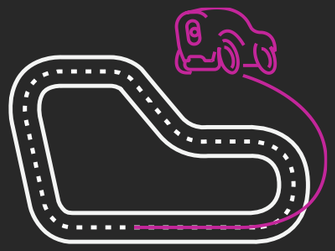


State



Action

Reward

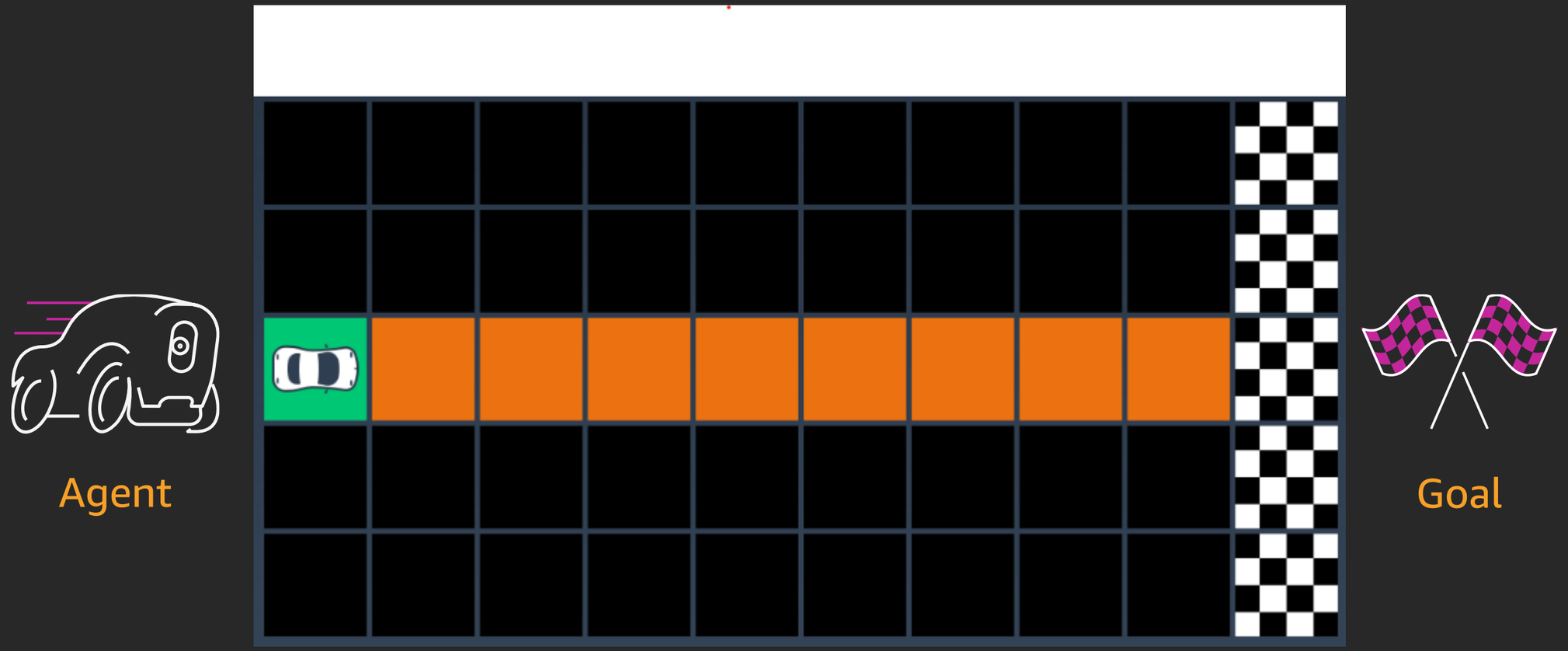


Episode

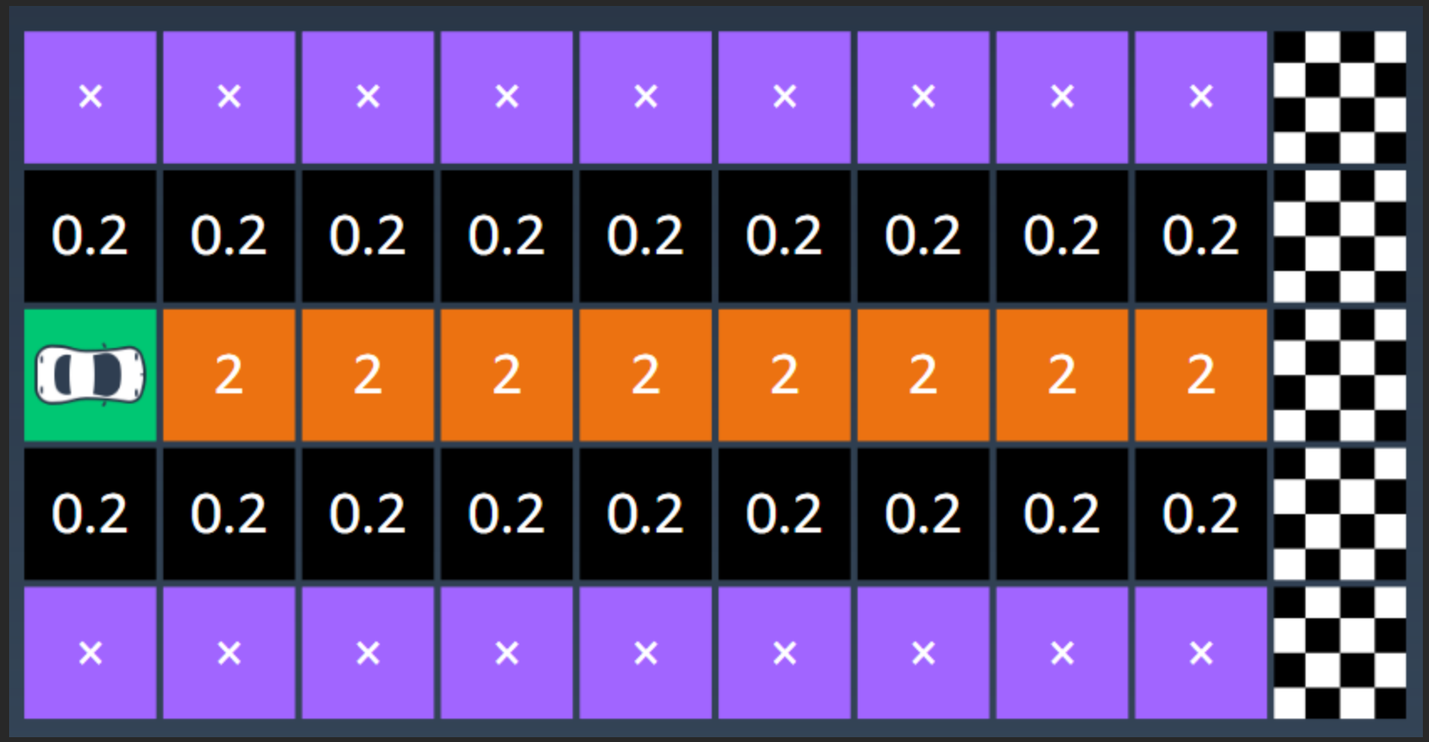
The reward function

The reward function incentivizes particular behaviors and is at the core of reinforcement learning

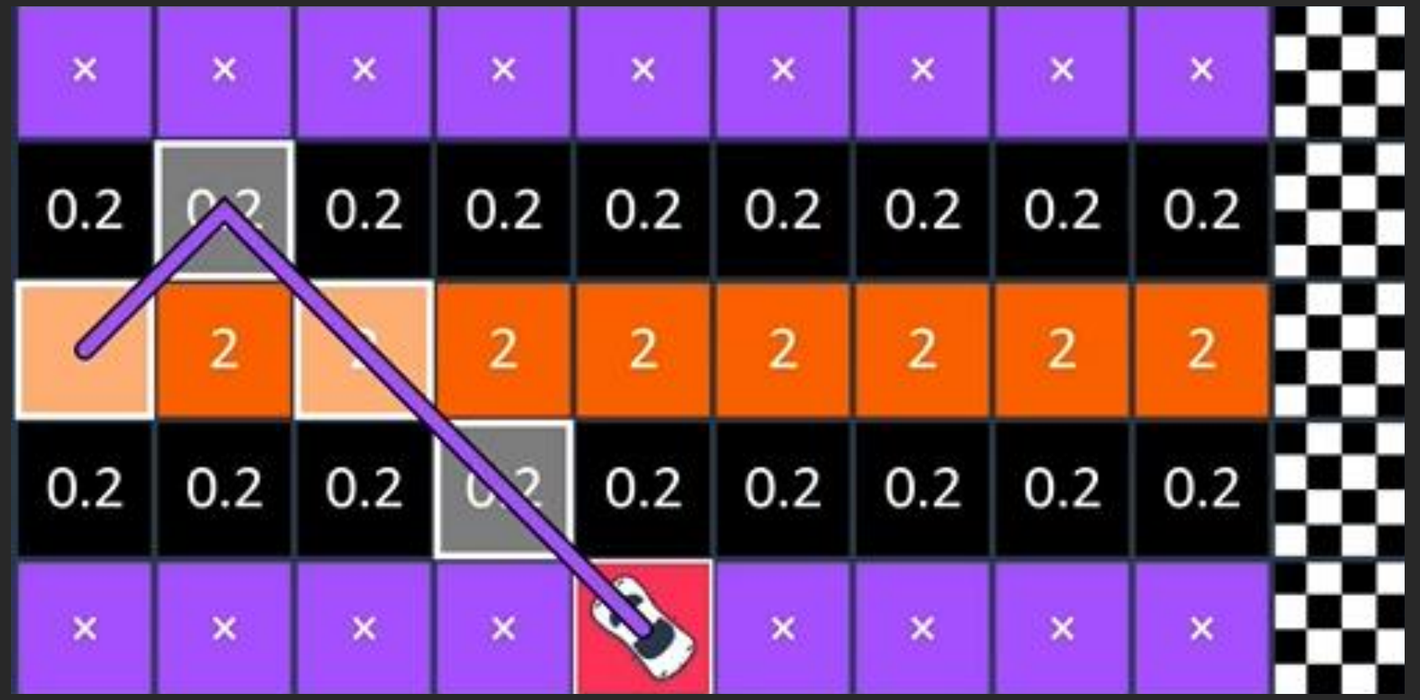
The reward function in a grid race



Rewards that incentivize center line driving



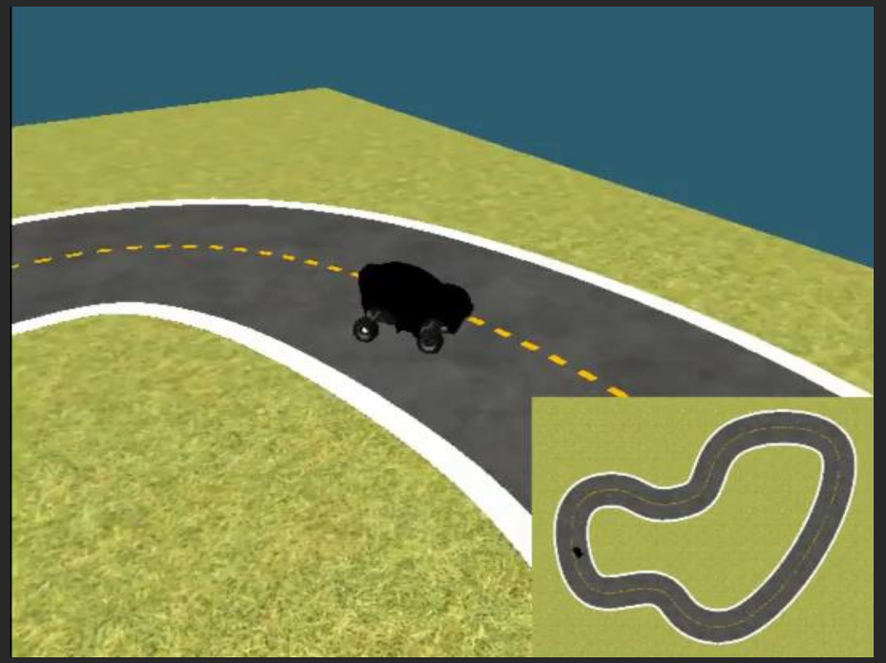
Iteration and convergence



Exploration versus exploitation

Exploration

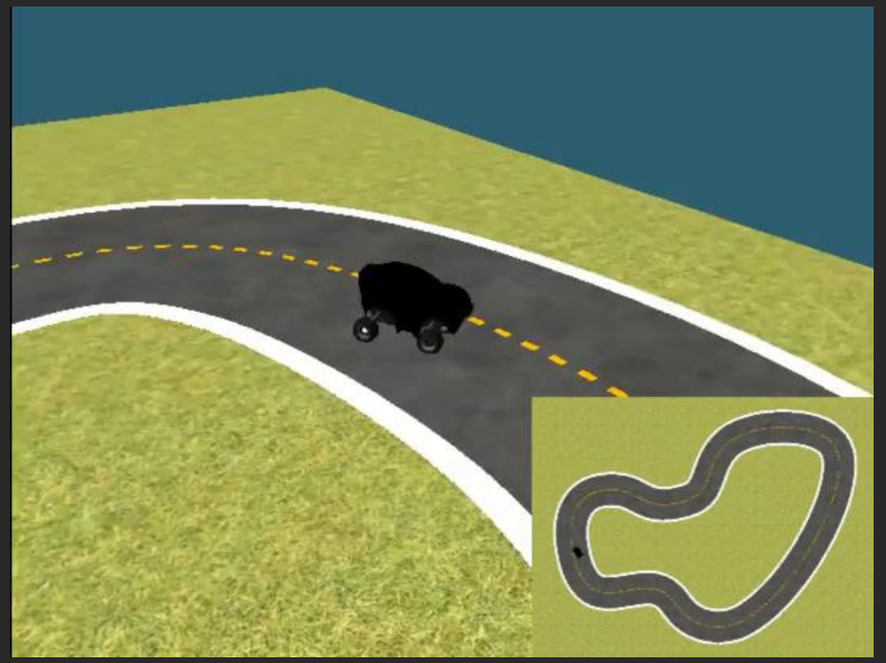
Exploitation



Exploration versus exploitation

Exploration

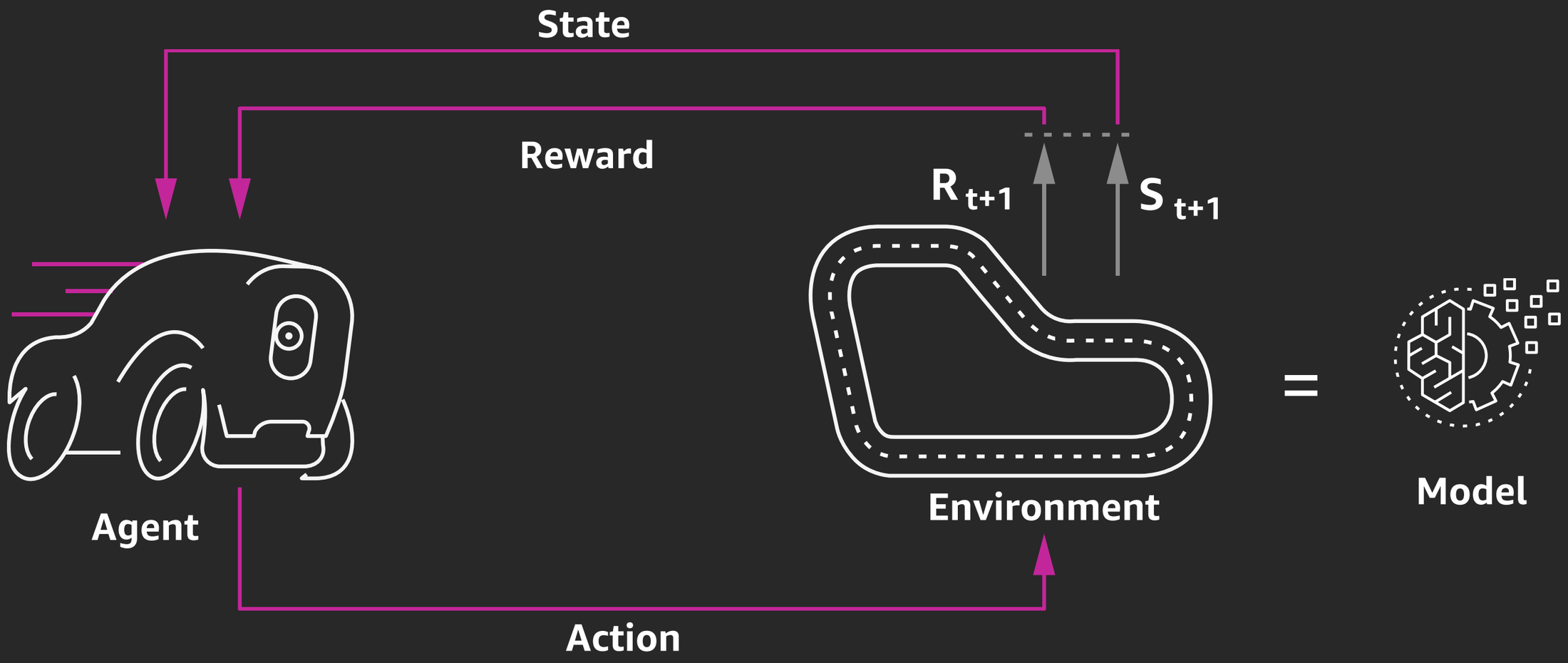
Exploitation



Recap before we continue

Reinforcement learning

How does learning happen?



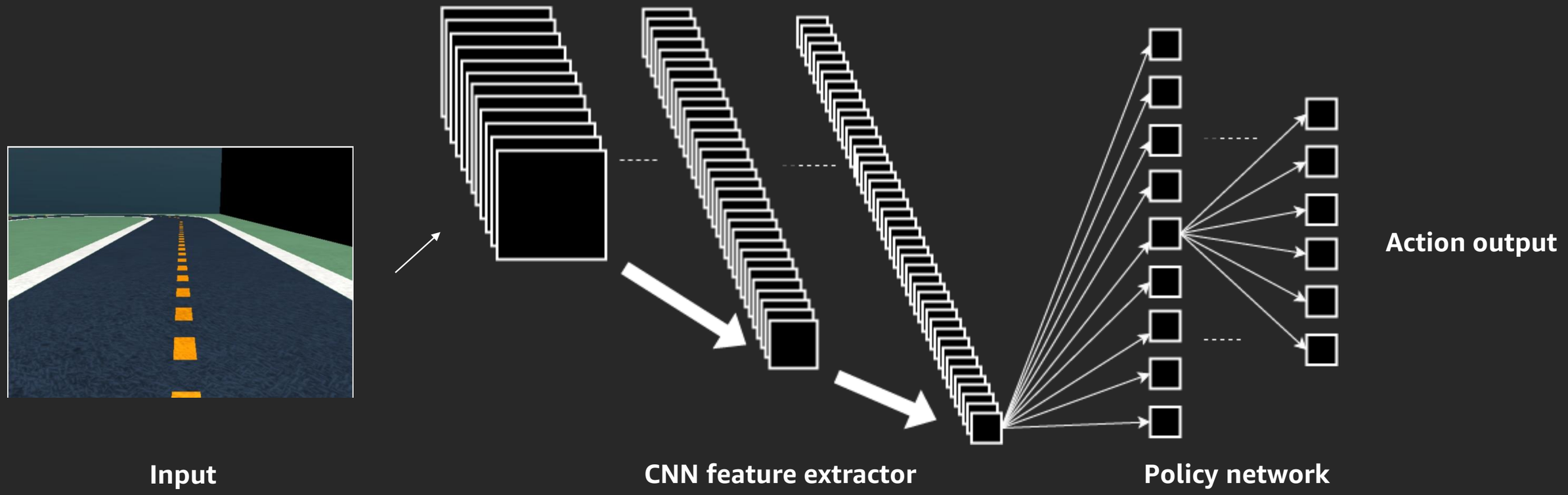
RL algorithms: Vanilla policy gradient

Gather episode using current policy

Calculate the gradient of est. cumulative reward

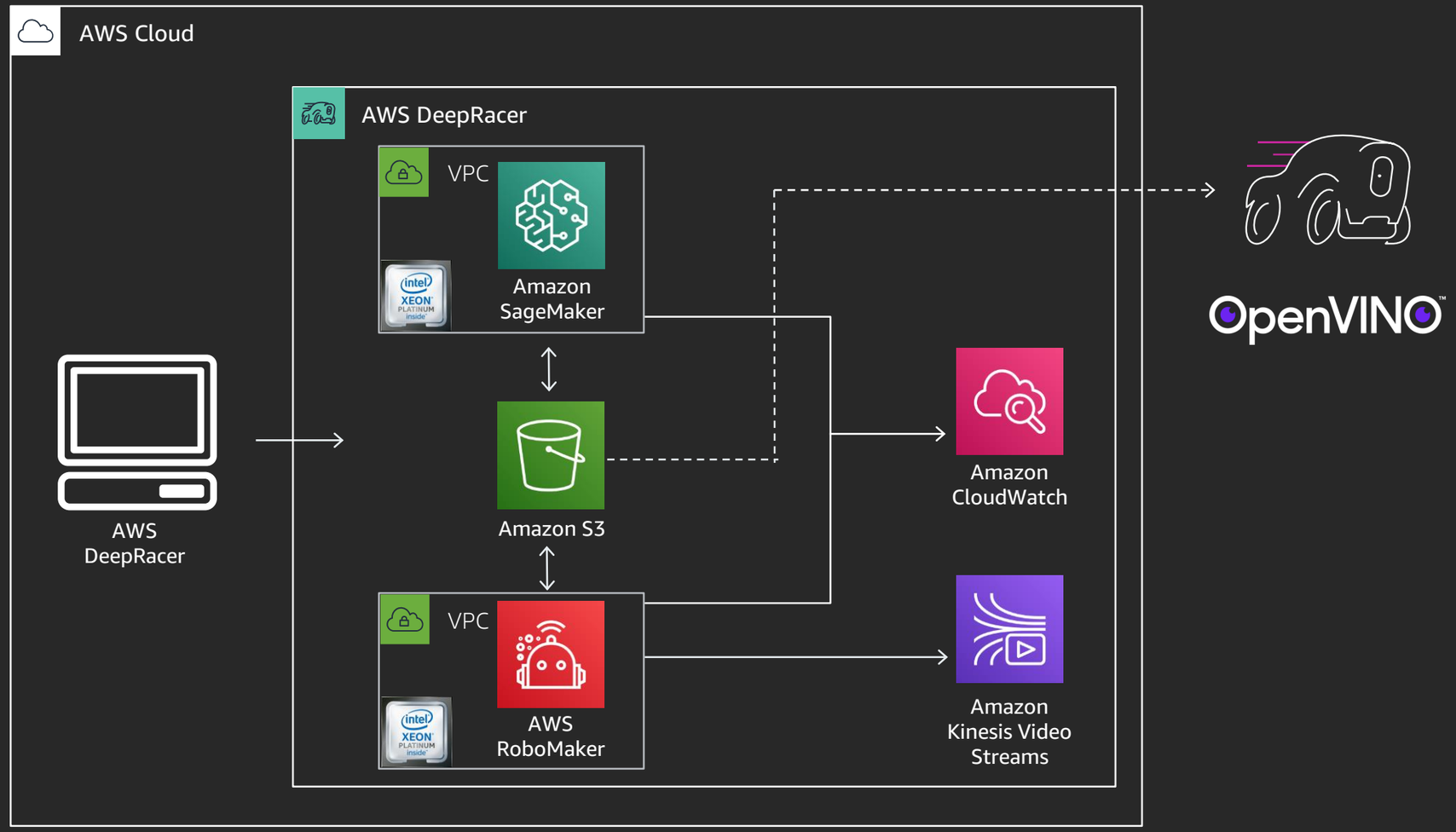
Update the policy for gradient ascent

AWS DeepRacer neural network architecture

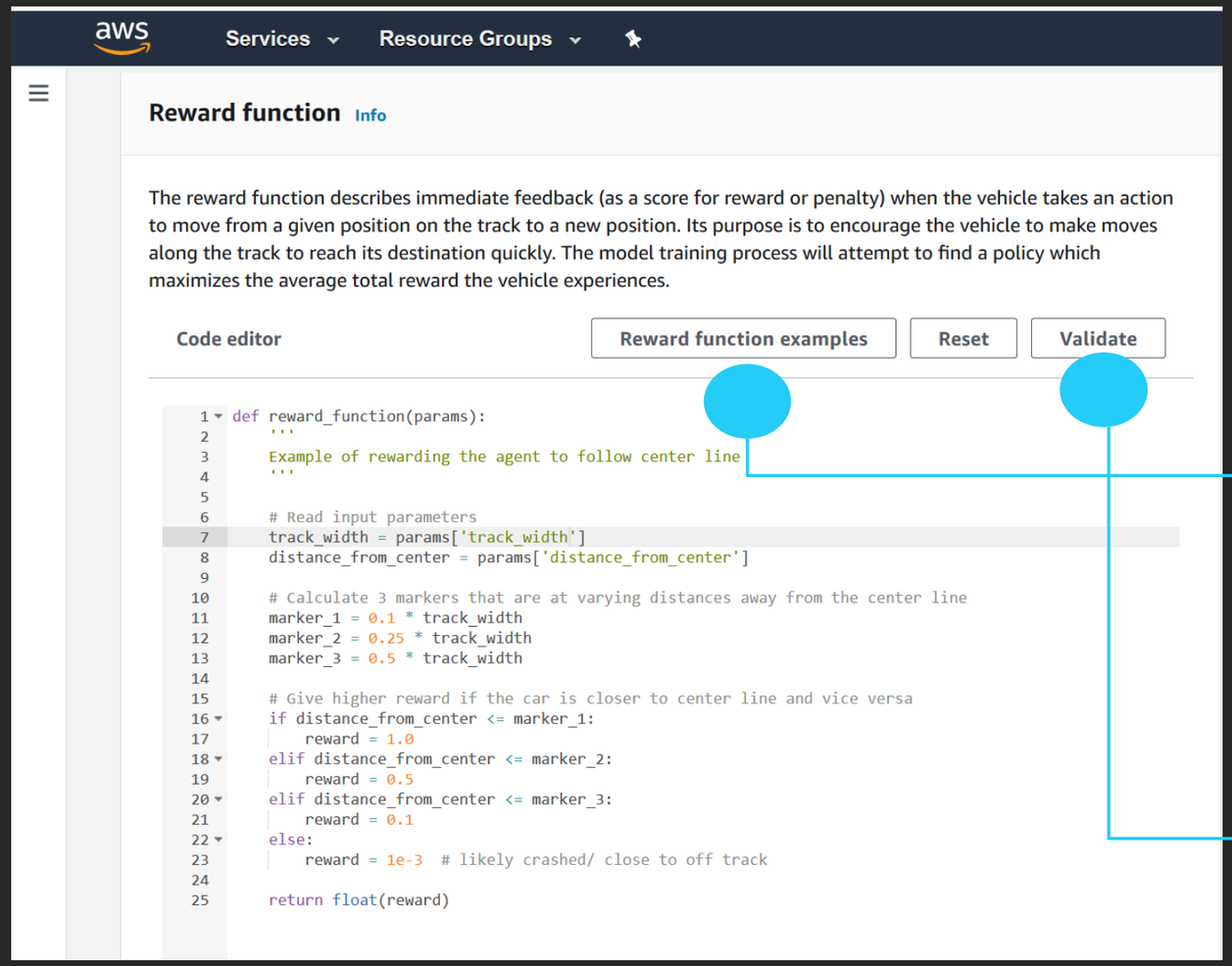


Virtual simulator

AWS DeepRacer simulator architecture



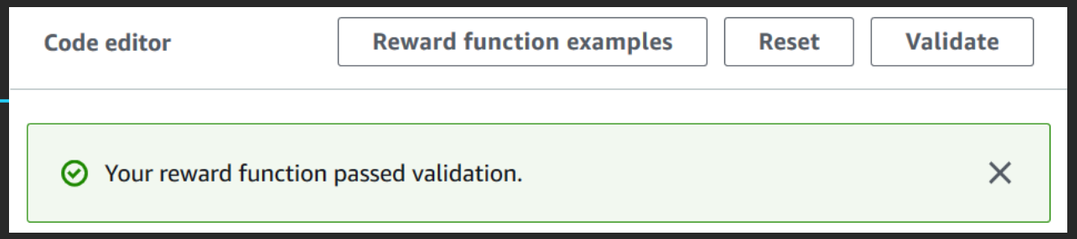
Programming your own reward function



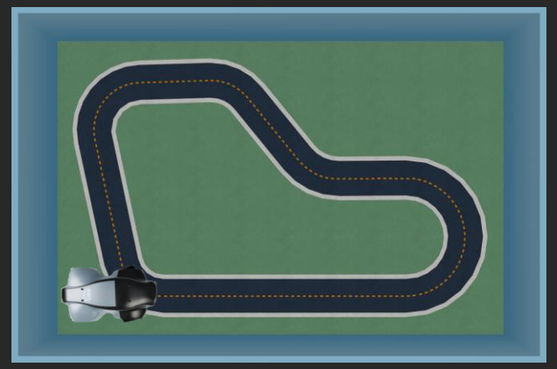
Code editor: Python 3 syntax

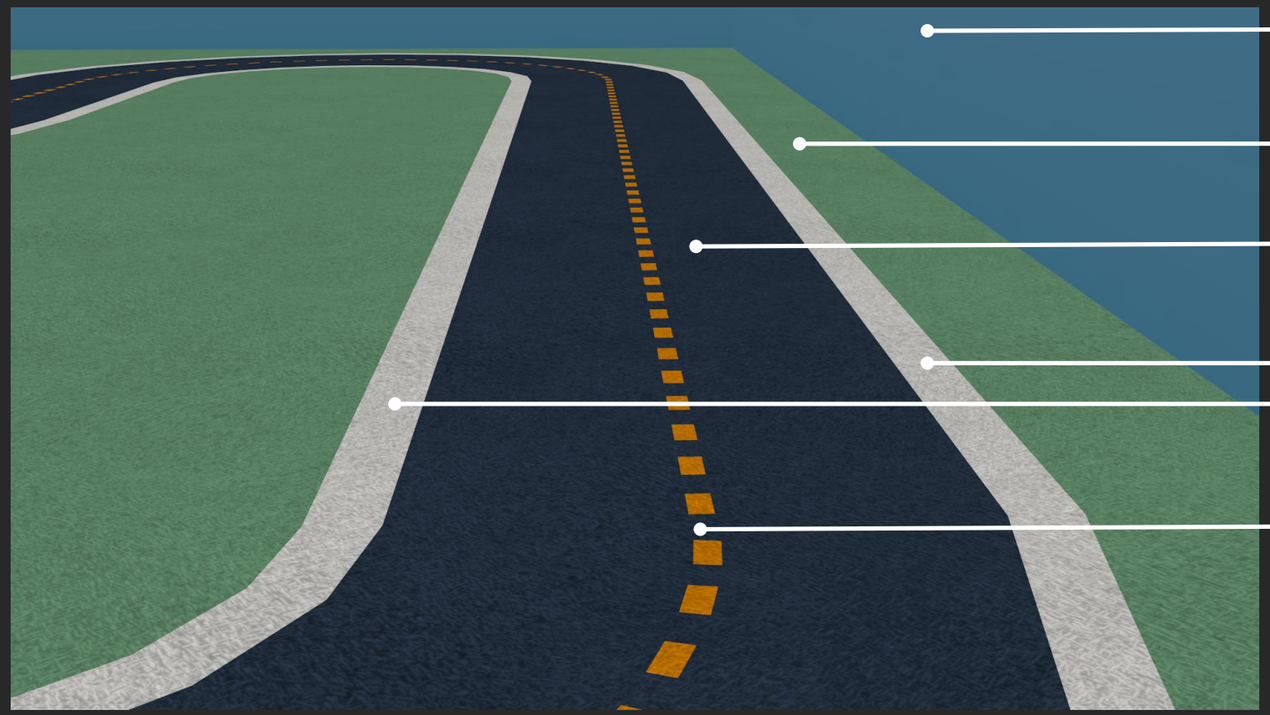
Three example reward functions

Code validation via AWS Lambda



Track components





Track wall

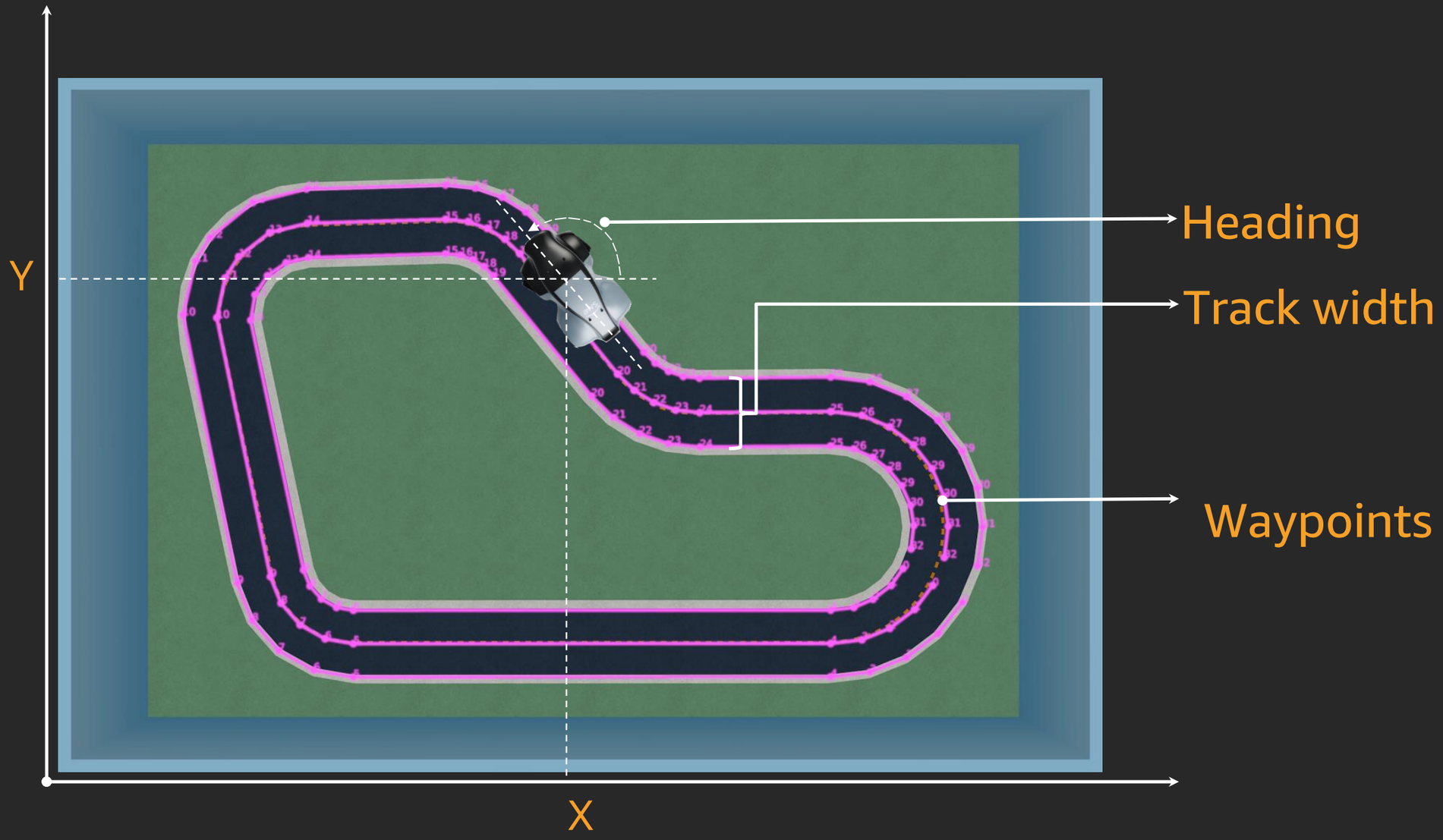
Field aka off-track

Track surface aka on-track

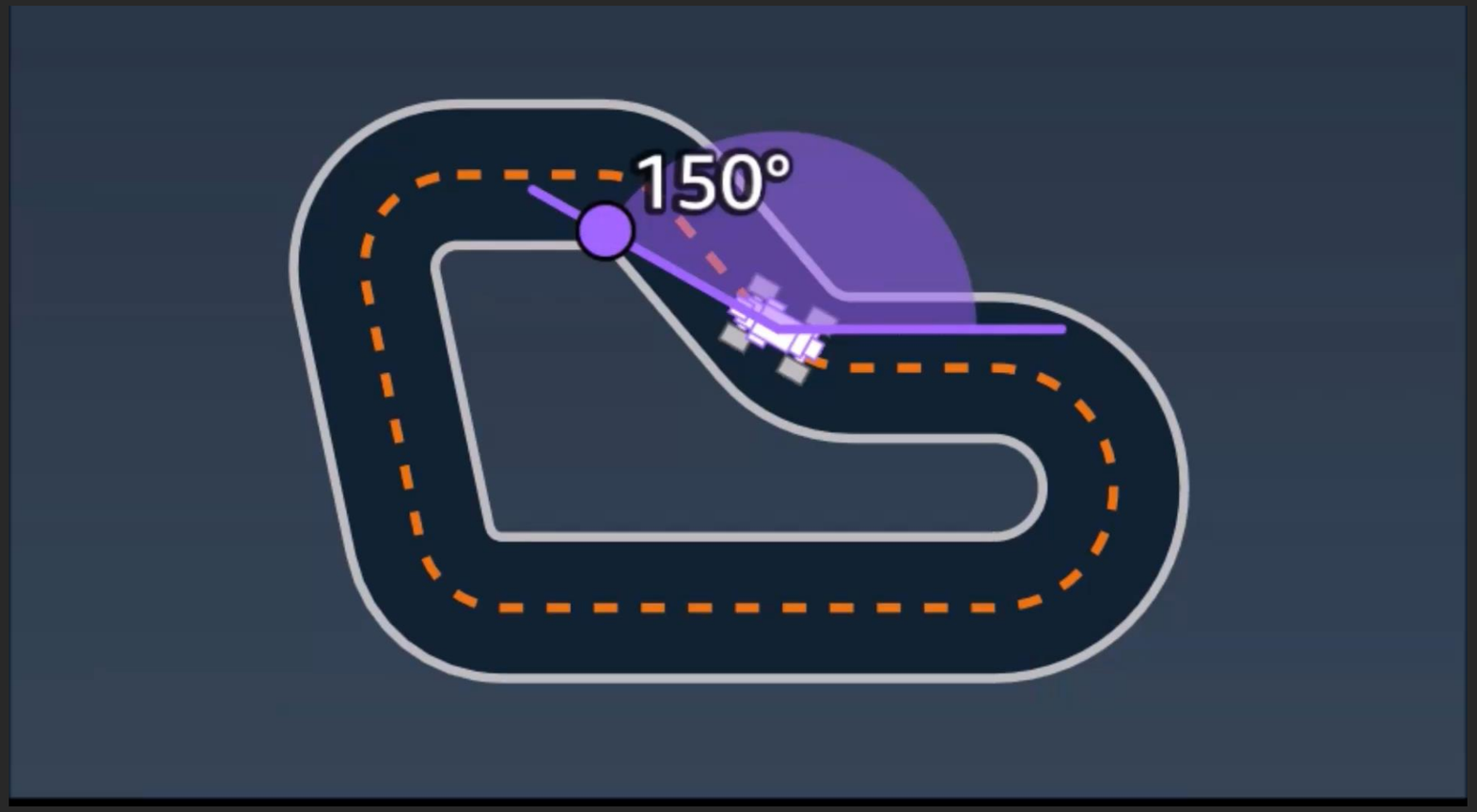
Track boundaries

Track center

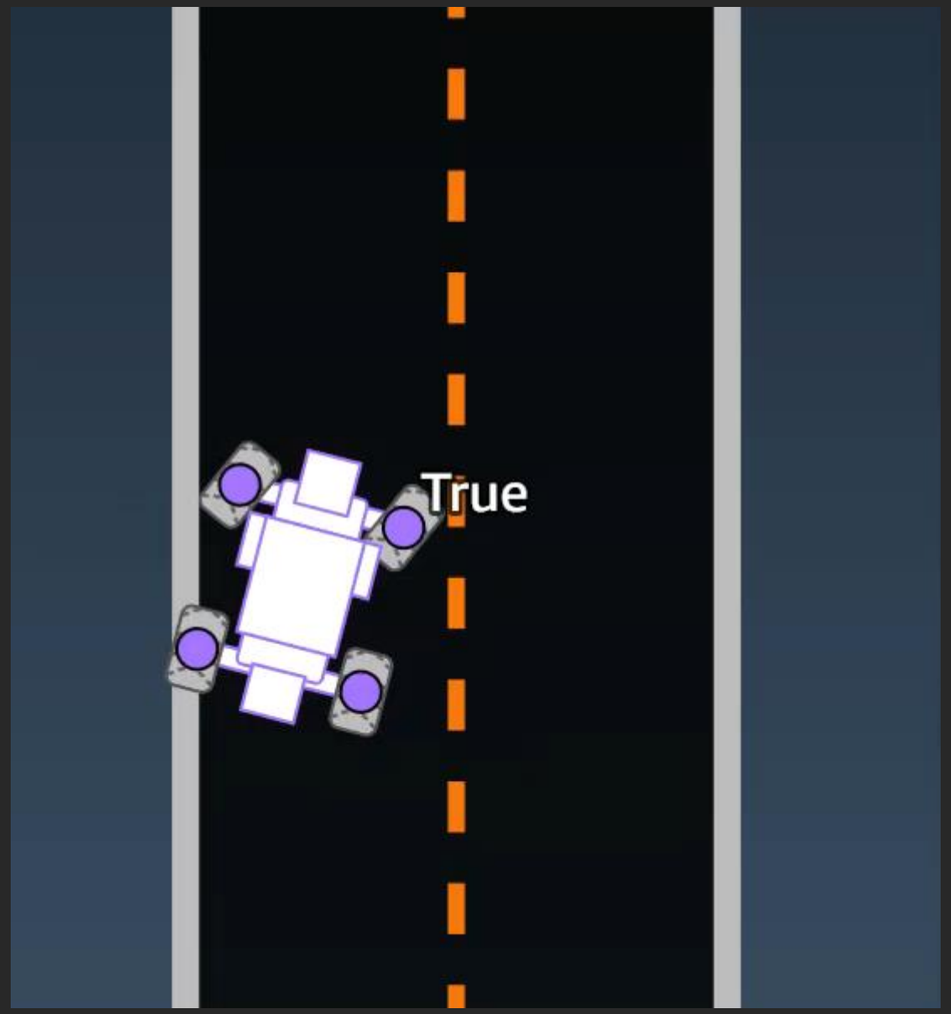
Coordinate system and track waypoints



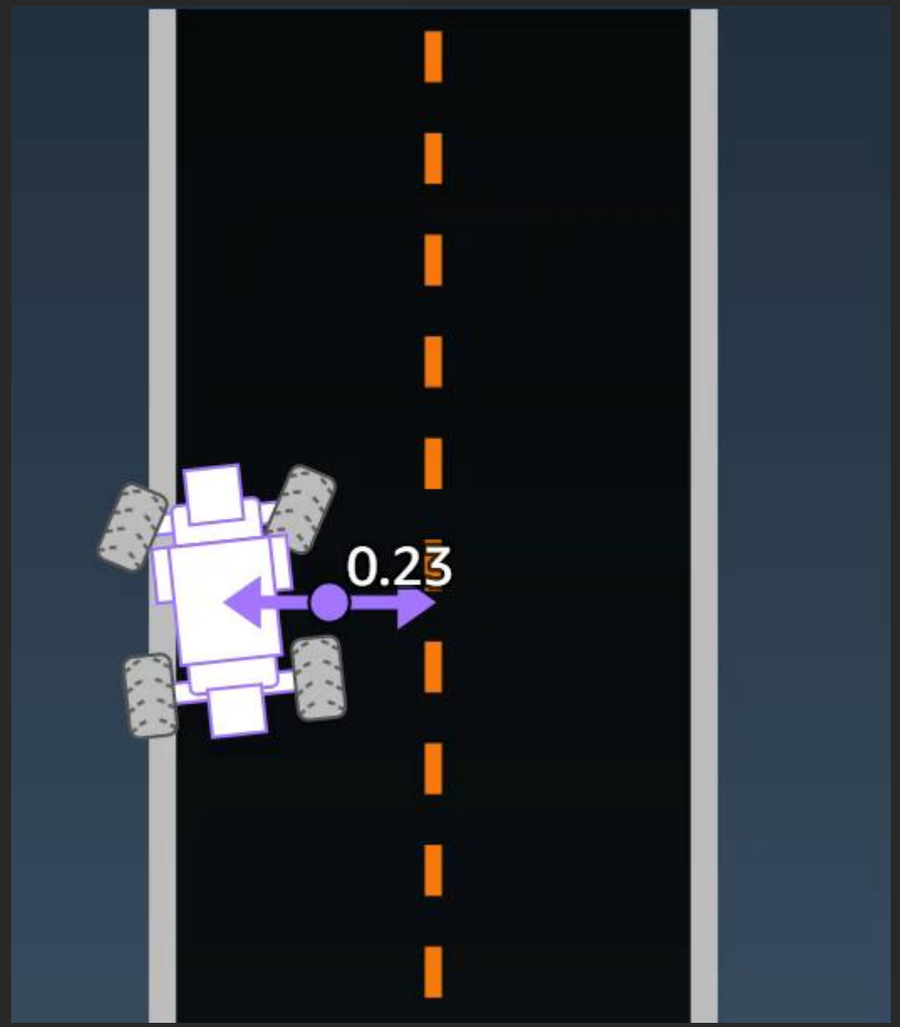
Example parameter: heading



Example parameter: all_wheels_on_track



Example parameter: distance_from_center



Customize your agent's sensors in the Garage

AWS DeepRacer > Reinforcement learning > Garage

Garage

Create model | Build new vehicle

The garage shows the DeepRacer vehicles that you can train models for. You can add vehicles by using the "build new vehicle button"

Evo — Mod vehicle

Sensor
Lidar
Stereo cameras

Neural network topology
DCN Shallow

Action space
Speed: 4 m/s Steering Angle: 30°

Mod your own vehicle

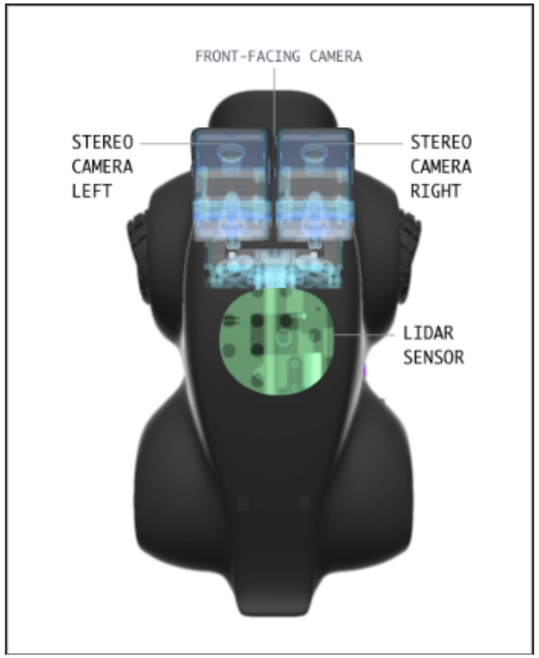
Mod specifications
The garage shows the DeepRacer vehicles that you can train models for. You can add vehicles by using the "build new vehicle button"

Sensor modification
Swap sensors to improve your DeepRacer's racing performance

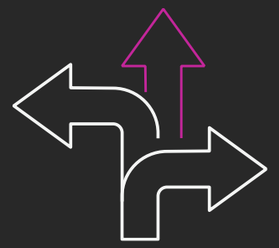
- ○ Front-facing camera
  Single camera that captures the images with sizes of 160 x 120 in front of the agent at 15 fps. The camera has 120 wide angle lens. The images are converted into grey scale before being fed to the neural network
  ▶ Benefits of the front-facing camera
- ◉ Stereo cameras (right/left) sensor
  Composed of two front-facing cameras, stereo cameras can generate depth information of the objects in front of the agent and thus be used to detect and avoid obstacles on the track. The cameras capture images with the same resolution and frequency. Images from both cameras are converted into grey scale, stacked and then fed into the neural network.
  ▶ Benefits of the stereo camera

Add-on sensors

- ☑ LIDAR sensor
  LIDAR is a surveying method that measures a distance to a target by illuminating the target with laser light and measuring the reflected light with a sensor.
  ▶ How LIDAR works with autonomous driving



Action space



Action space Info

Action space defines the specifc actions an agent can take in both the simulator and physical world. While a real vehicle can choose from a continuum of actions, AWS DeepRacer simplifies the agent's decision-making process by reducing that space to a set of discrete actions.

Configure this discrete action space by setting the range and granularity for speed and steering angle. The system automatically generates an action space according to that specification. Note that your model will take longer to train under a larger action space.

Maximum steering angle

30 degrees

Max values are between 1 and 30.

Steering angle granularity

5

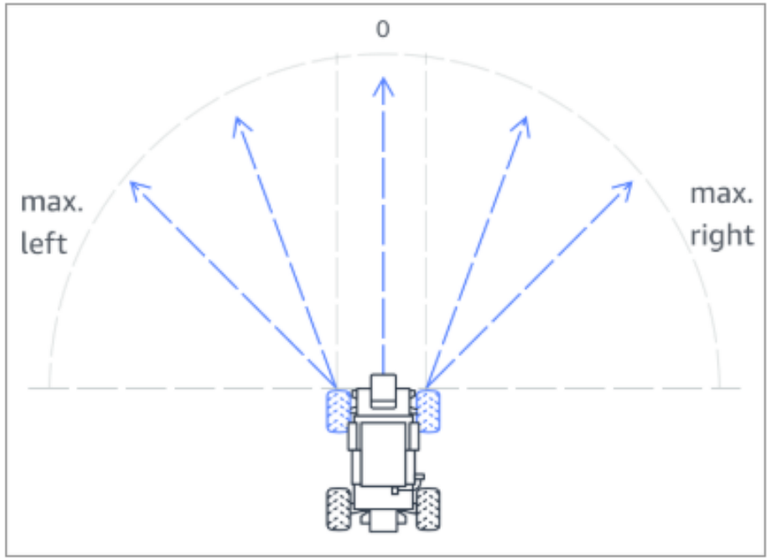
Maximum speed

4 m/s

Select values between 0.1 and 4.

Speed granularity

1



Action list

Action number	Steering	Speed
0	-30 degrees	4 m/s
1	-15 degrees	4 m/s
2	0 degrees	4 m/s
3	15 degrees	4 m/s
4	30 degrees	4 m/s

Under the hood

Under the hood

- 1:18 4WD scale car
- Intel Atom processor
- Intel distribution of OpenVINO toolkit
- Stereo Camera (4MP)
- 360 Degree 12 Meters Scanning Radius LIDAR Sensor
- System memory: 4 GB RAM
- 802.11ac Wi-Fi
- Ubuntu 16.04.3 LTS
- ROS Kinetic

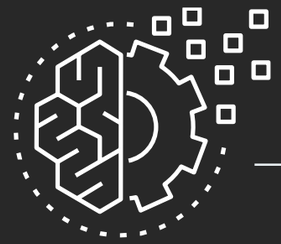
OpenVINO™

AWS DeepRacer software architecture

ROS nodes

ROS msg node

Stored file



Model

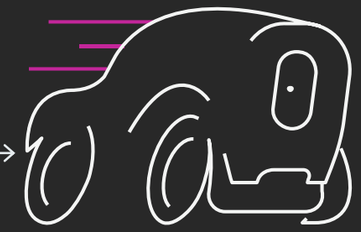
→ OpenVINO Model Optimizer → Optimized Model

Sensor

→ Media engine → Video M-JPEG → OpenVINO Inference engine → Inference Results → Navigation Node → Autonomous Drive → Control Node

Video M-JPEG → Web Server Video

Web Server Publisher → Manual Drive → Control Node



Servo & Motor

OpenVINO™

Optimizing and inferencing with OpenVINO™

Input data

OpenVINO™ optimized model

OpenVINO™ inference results

Racing

Free Download ▸ software.intel.com/openvino-toolkit
Open Source version ▸ 01.org/openvinotoolkit

AWS DeepRacer hands-on lab

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Additional resources

- DeepRacer Slack Community: http://join.deepracing.io/
- GitHub: https://github.com/aws-samples/aws-deepracer-workshops/
- Free video course: https://www.aws.training/Details/eLearning?id=32143
- Tips: https://aws.amazon.com/deepracer/racing-tips/
- Forum: https://forums.aws.amazon.com/forum.jspa?forumID=318
- Intel® Distribution of OpenVINO™ toolkit: https://software.intel.com/en-us/openvino-toolkit

Lab: AWS DeepRacer service

Objective: Build your first AWS DeepRacer Time-Trial model

1. Find the lab content here:

   https://github.com/aws-samples/aws-deepracer-workshops/

2. Navigate to:

   Workshops/2019-reInvent/Lab_200_AIM207

AWS DeepRacer at re:Invent 2019

AWS re:Invent

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Go race!

MGM Grand Garden

League Knockout Rounds

Race your model!

Experience DeepRacer Evo

Quad at Aria

DeepRacer Expert Boot camp

Venetian

Final, Thursday at 8am, Hall A or livestream

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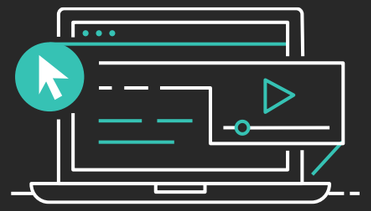
Role-based ML learning paths for developers, data scientists, data platform engineers, and business decision makers



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