
AWS
re:Invent

AIM204

Get rolling with machine learning on AWS DeepRacer

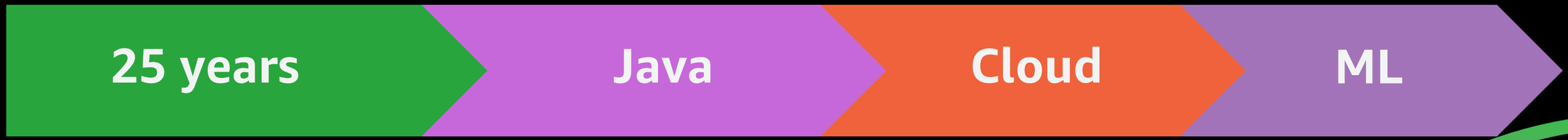
Kesha Williams

AWS Machine Learning Hero and
Senior AWS Training Architect,
A Cloud Guru

AWS re:Invent

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About Me



Teaching and sharing lessons learned

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Agenda

Machine learning on AWS

Introducing the AWS DeepRacer

Introduction to reinforcement learning

AWS DeepRacer Console

New for 2021 in the AWS DeepRacer League



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Machine learning on AWS



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The Amazon ML stack

Broadest and most complete set of machine learning capabilities

AI SERVICES

VISION
- Amazon Rekognition

SPEECH
- Amazon Polly
- Amazon Transcribe *+Medical*

TEXT
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- Amazon Translate
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DEVELOPMENT
- Amazon CodeGuru

CONTACT CENTERS
- Contact Lens *For Amazon Connect*

AMAZON ML SERVICES

- Amazon SageMaker
  - SageMaker Studio IDE
    - Built-in algorithms
    - Notebooks
    - Experiments
    - Processing
    - Model training & tuning
    - Debugger
    - Autopilot
    - Model hosting
    - Model Monitor
  - Ground Truth
  - AWS Marketplace for ML
  - Neo
  - Augmented AI

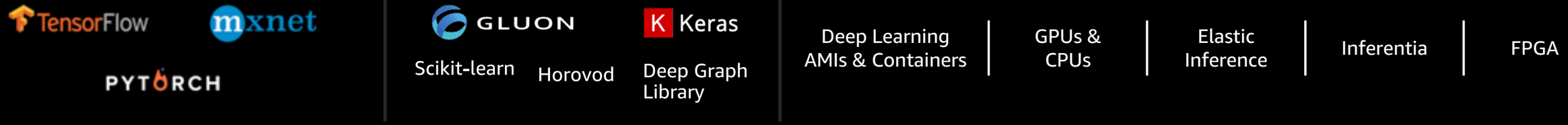
AMAZON ML FRAMEWORKS AND INFRASTRUCTURE

- TensorFlow
- mxnet
- PYTORCH
- GLUON
- Keras
- Scikit-learn
- Horovod
- Deep Graph Library
- Deep Learning AMIs & Containers
- GPUs & CPUs
- Elastic Inference
- Inferentia
- FPGA

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AMAZON ML SERVICES



Amazon SageMaker

Ground Truth

AWS Marketplace for ML

SageMaker Studio IDE

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Building your team's skills

HANDS-ON LEARNING



AWS DeepLens
Deep learning



AWS DeepRacer
Reinforcement learning



AWS DeepComposer
Generative AI

Introducing AWS DeepRacer



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

Literally



Under the hood

- 1:18 4WD scale car
- Intel Atom processor
- Intel distribution of OpenVINO toolkit
- Stereo Camera (4MP)
- 360-degree 12-meter scanning radius LIDAR sensor
- System memory: 4 GB RAM
- 802.11ac Wi-Fi
- Ubuntu 16.04.3 LTS
- ROS kinetic



OpenVINO™

Get hands-on experience with reinforcement learning



AWS DeepRacer
Evo

Get hands-on experience with reinforcement learning



AWS DeepRacer Evo



3D-racing simulator

Get hands-on experience with reinforcement learning



AWS DeepRacer Evo



3D-racing simulator



AWS DeepRacer League

Get hands-on experience with reinforcement learning



AWS DeepRacer Evo



3D-racing simulator



AWS DeepRacer League



Community races

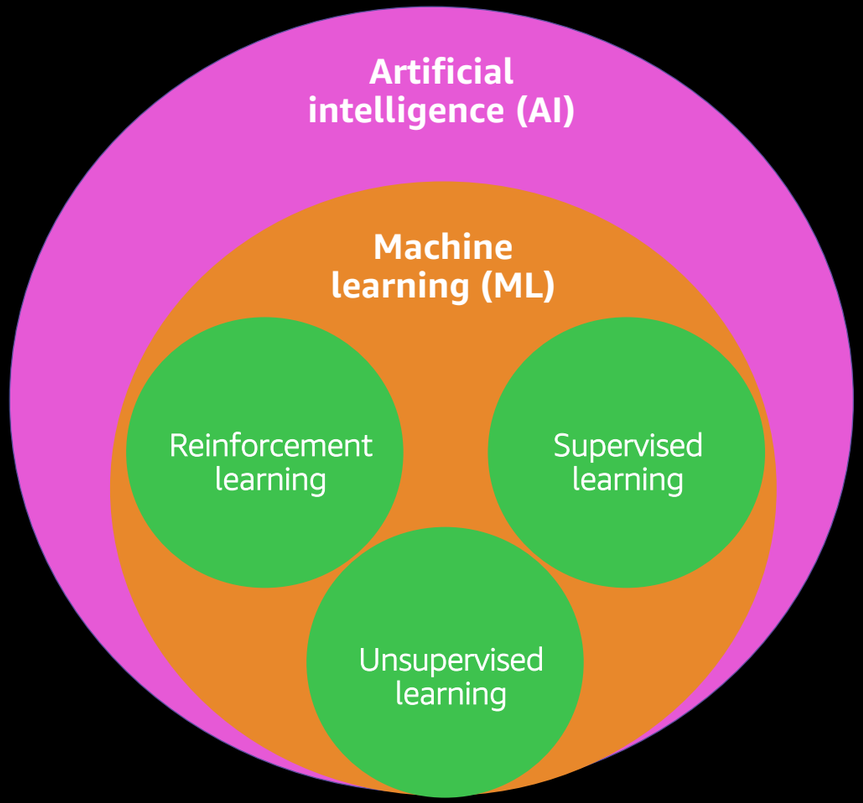
Reinforcement learning for the Sunday driver



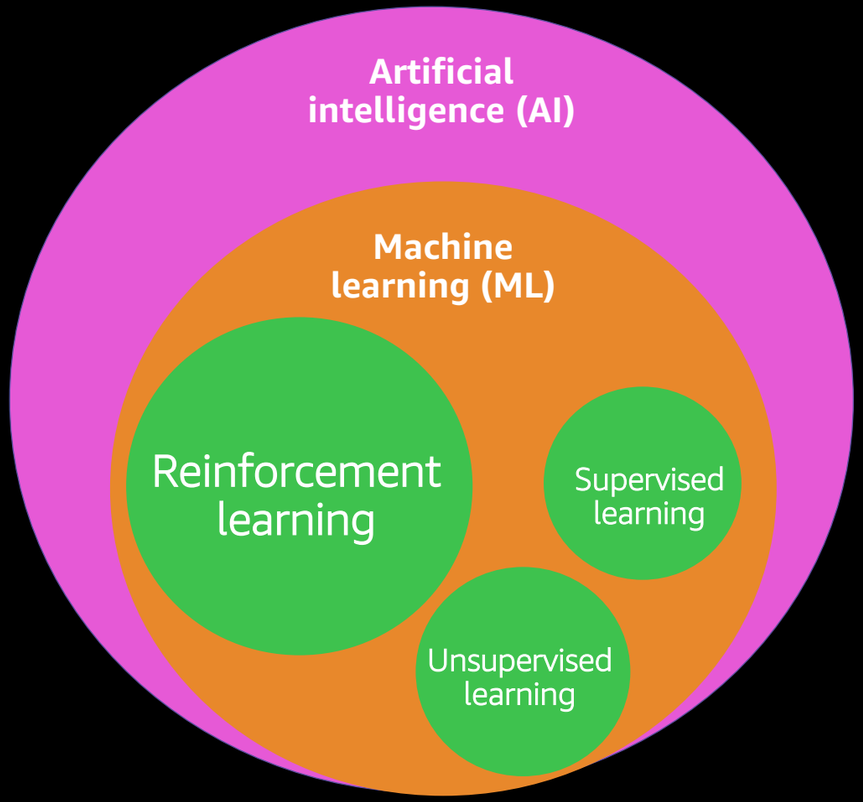
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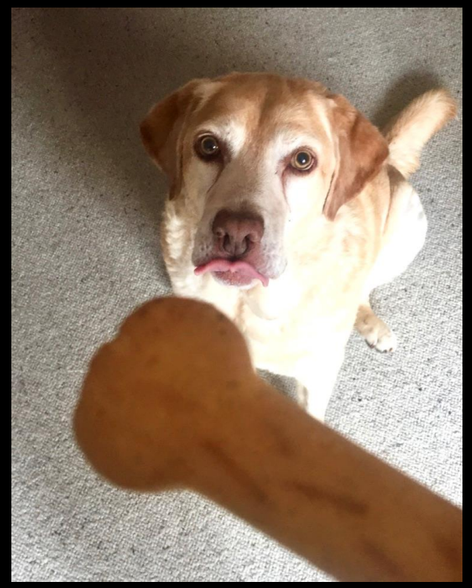
Reinforcement learning in the broad AI context



Reinforcement learning in the broad AI context



Reinforcement learning in the real world



Reward positive behavior

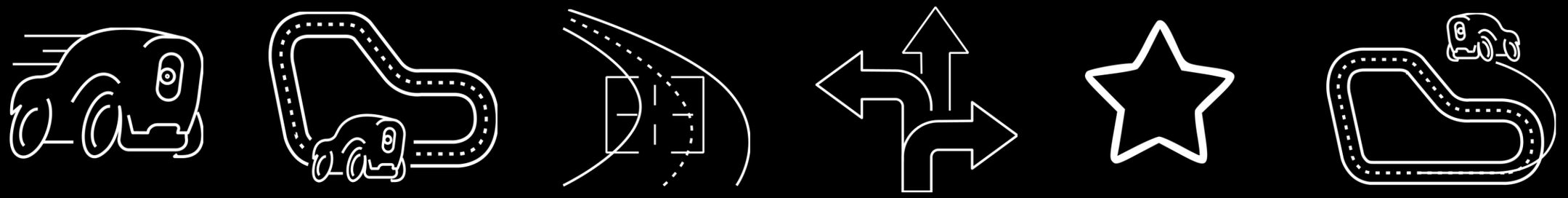


Don’t reward negative behavior



The result!

Reinforcement learning terms



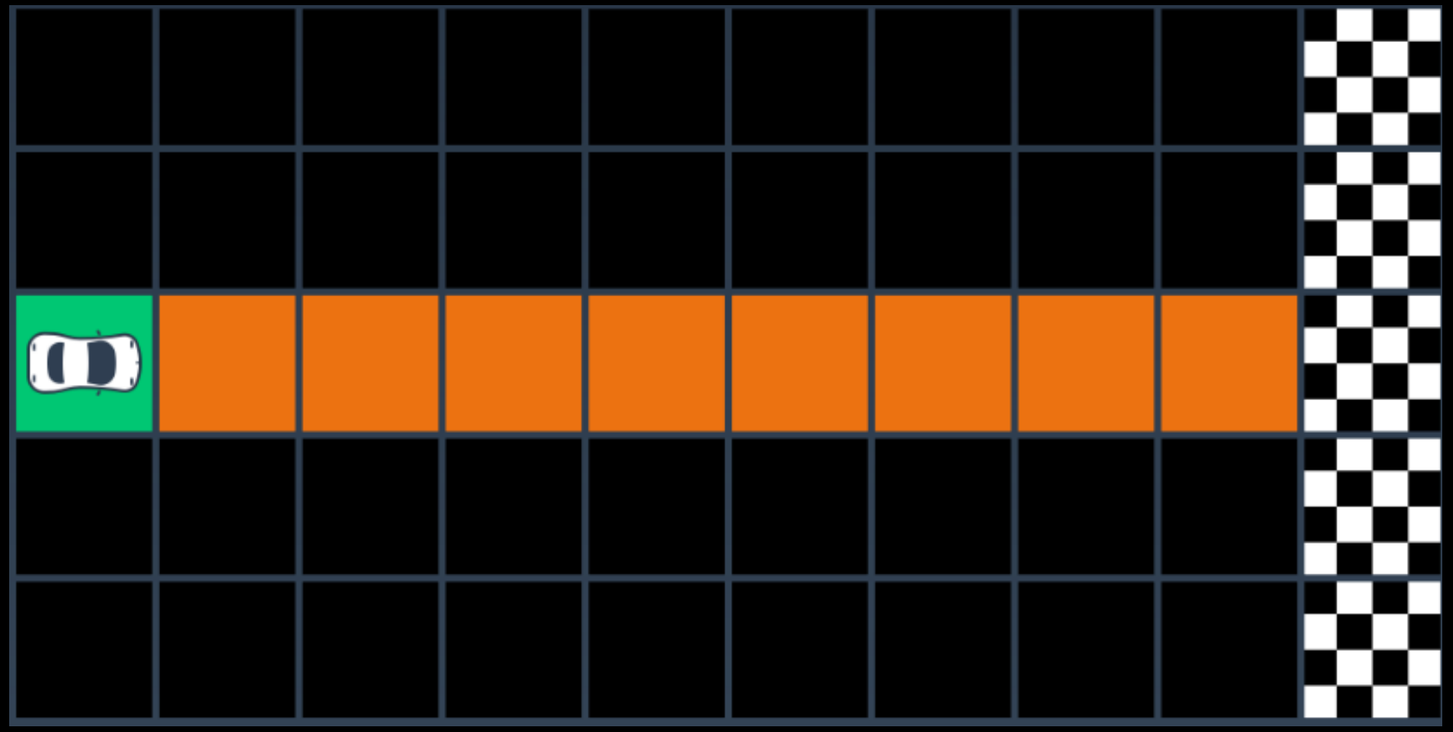
Agent | Environment | State | Action | Reward | Episode

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

The reward function in a grid race



Agent



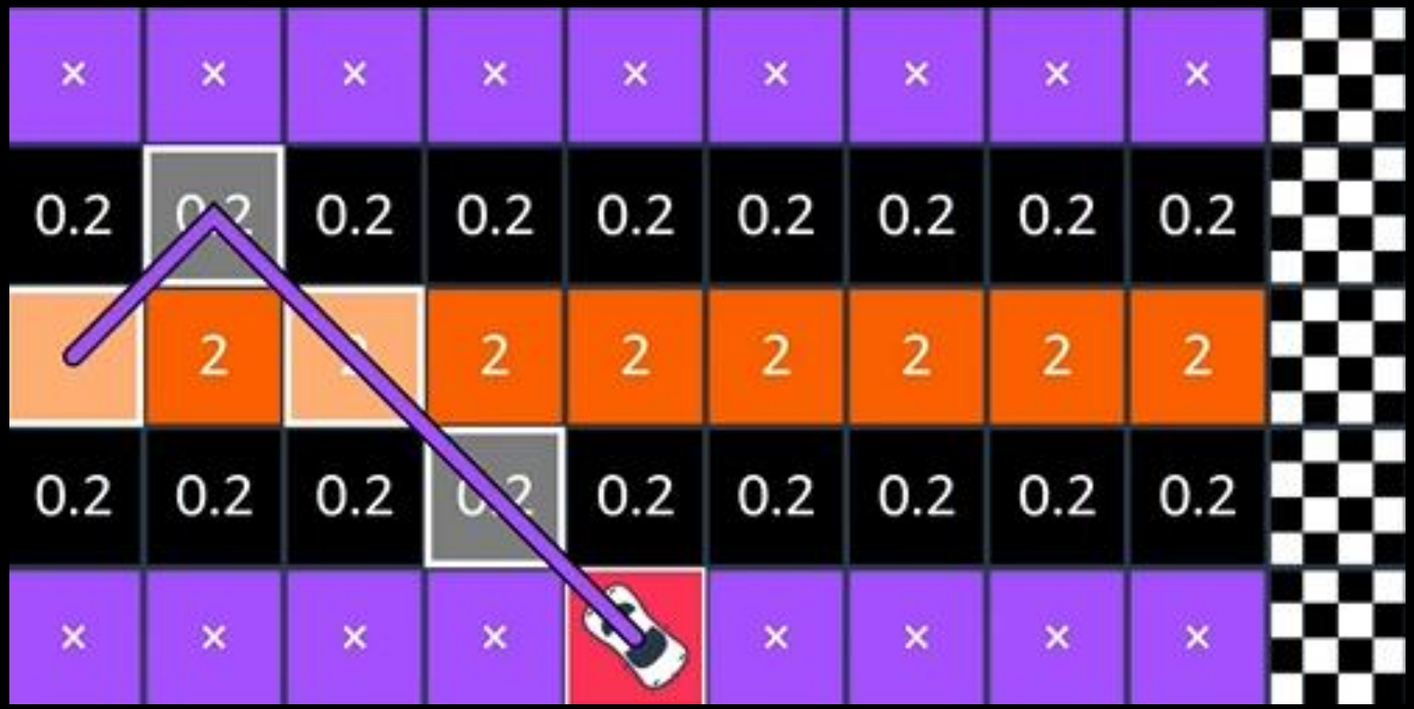


Goal

Rewards that incentivize center-line driving

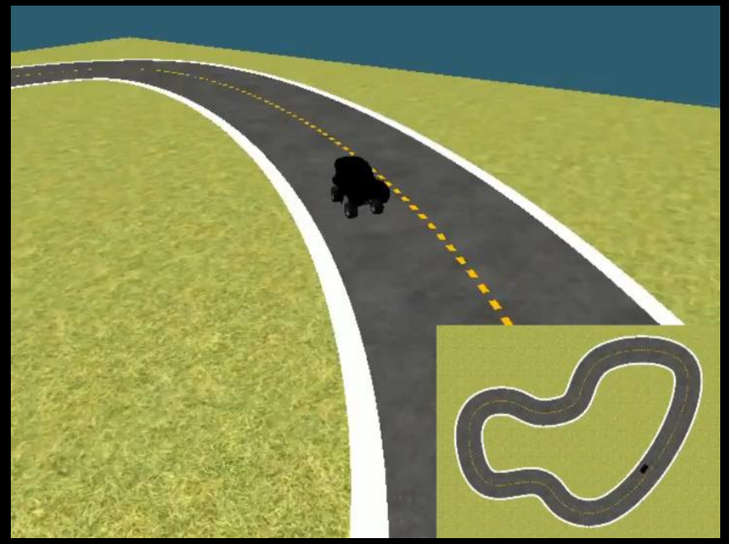


Iteration and convergence

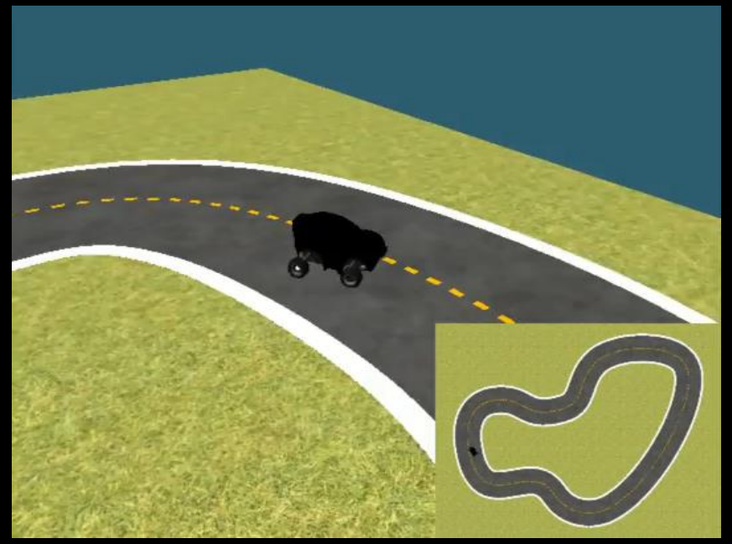


Exploration vs. exploitation

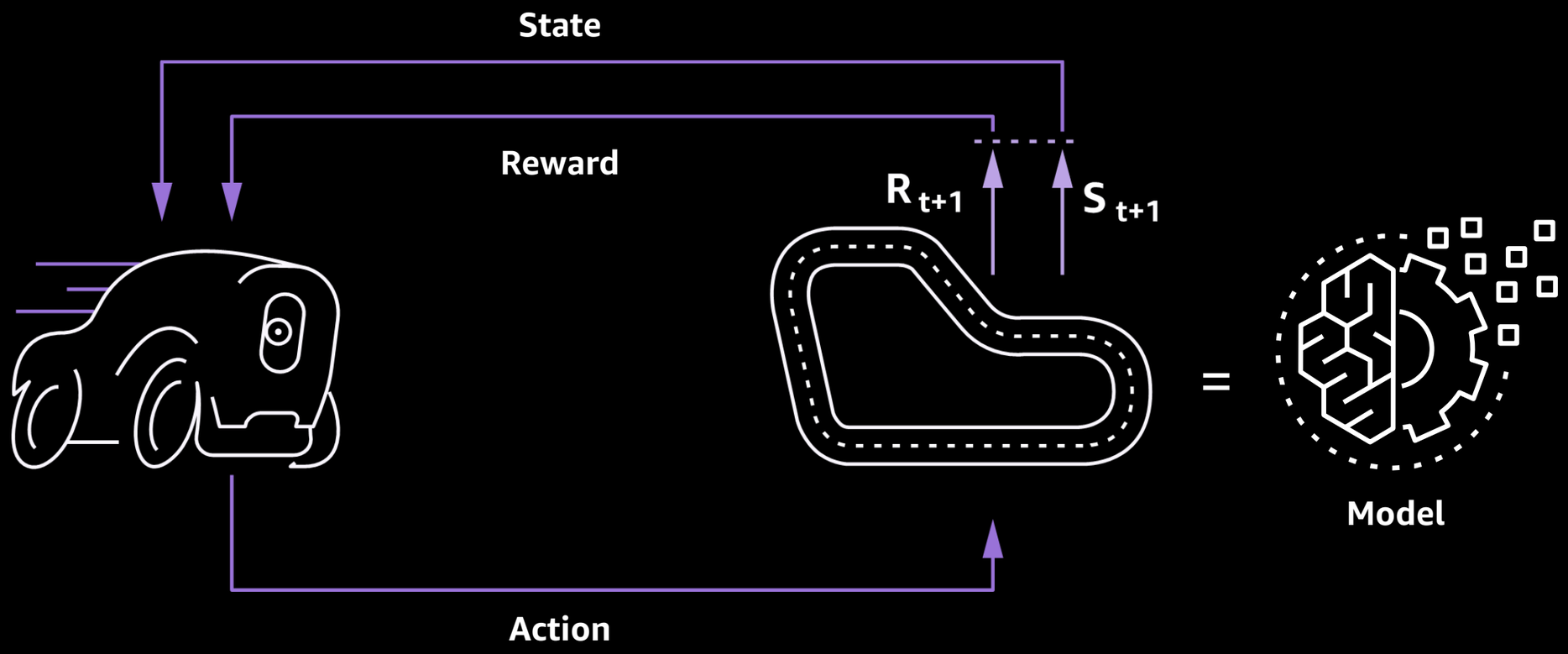
EXPLORATION



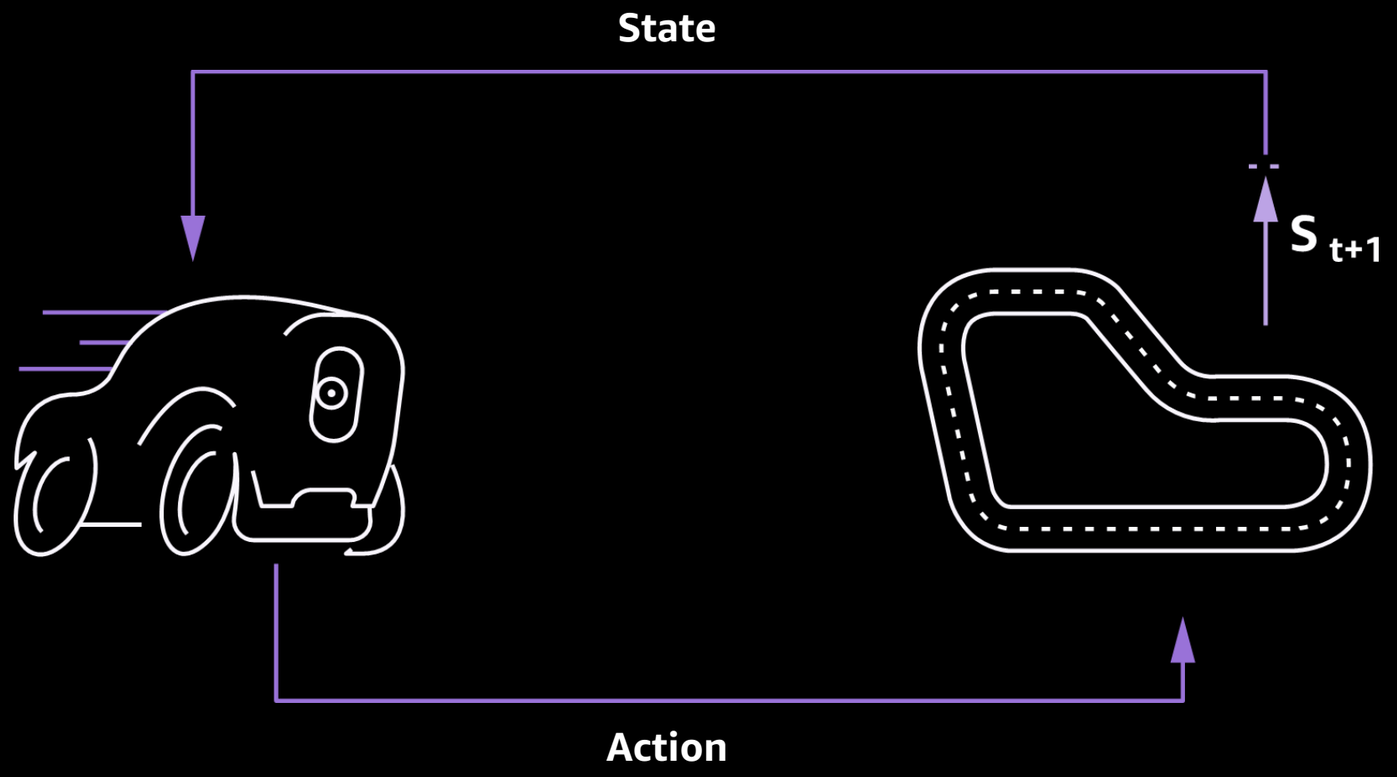
EXPLOITATION



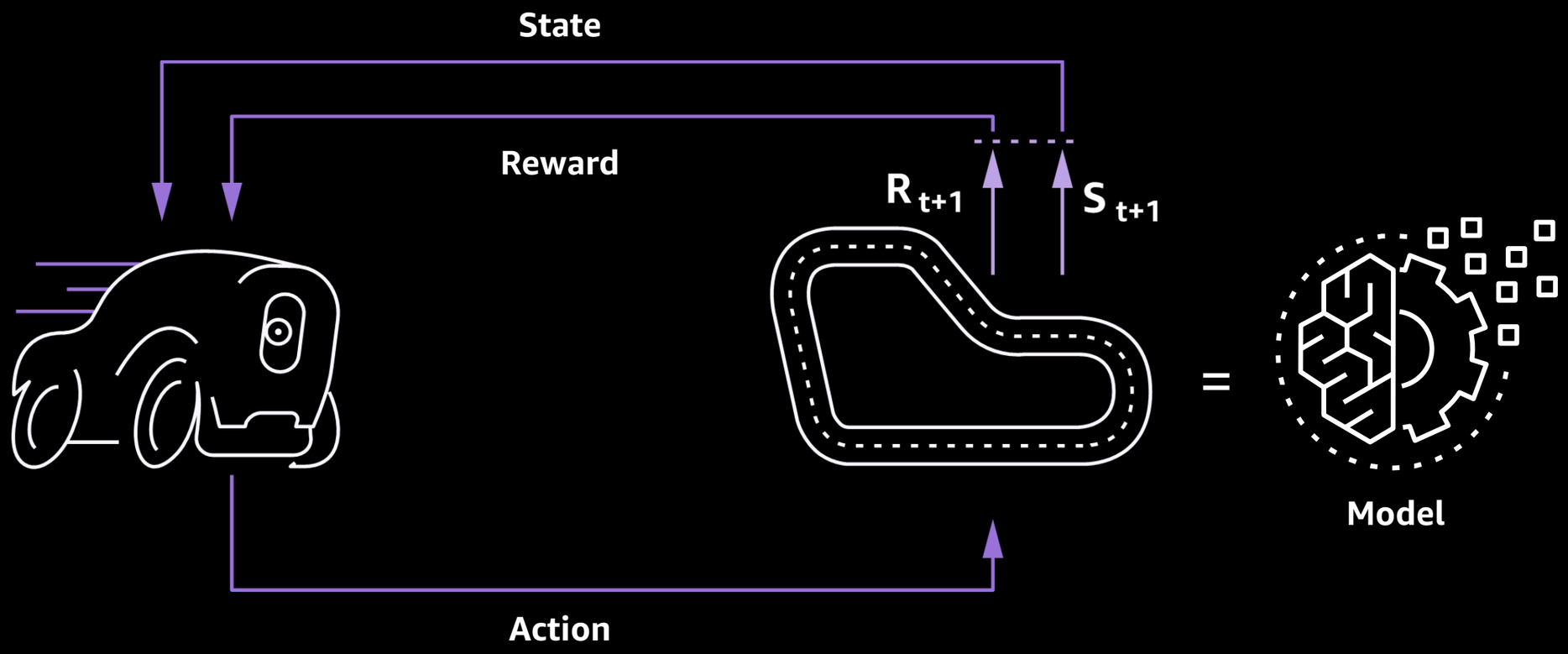
How does learning happen?



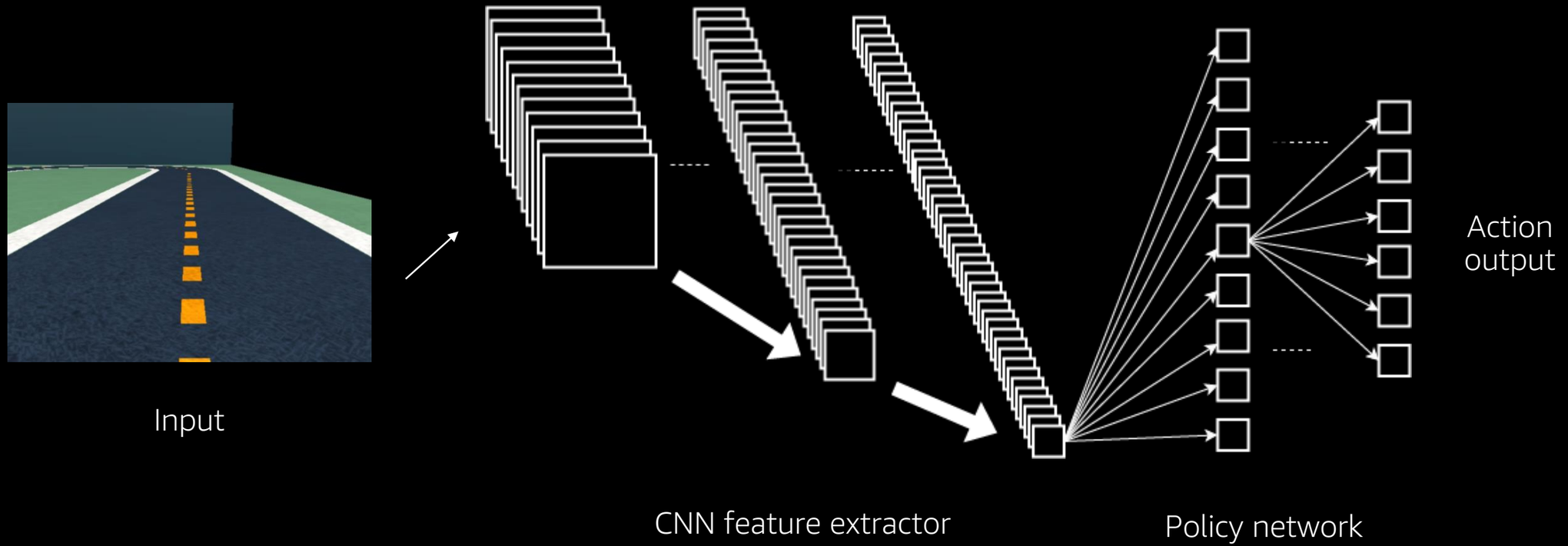
How does learning happen?



How does learning happen?



AWS DeepRacer neural network architecture



AWS DeepRacer neural network architecture

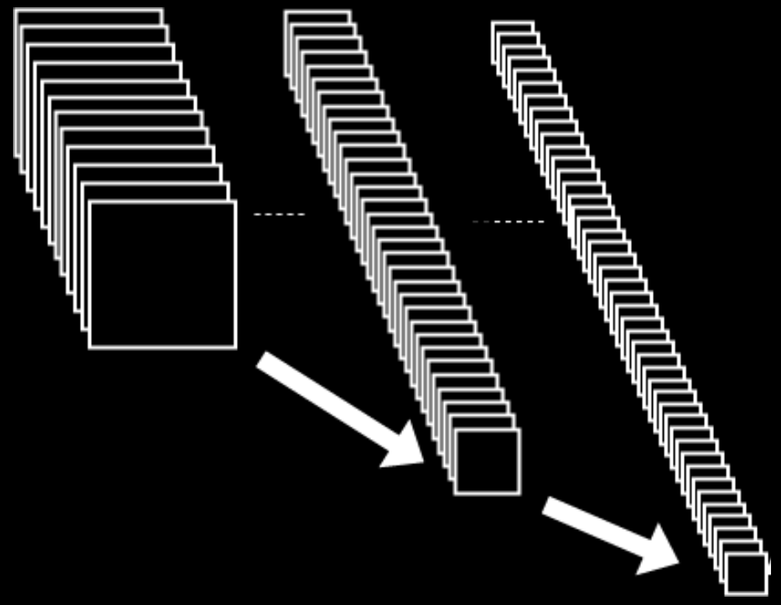


Input

AWS DeepRacer neural network architecture

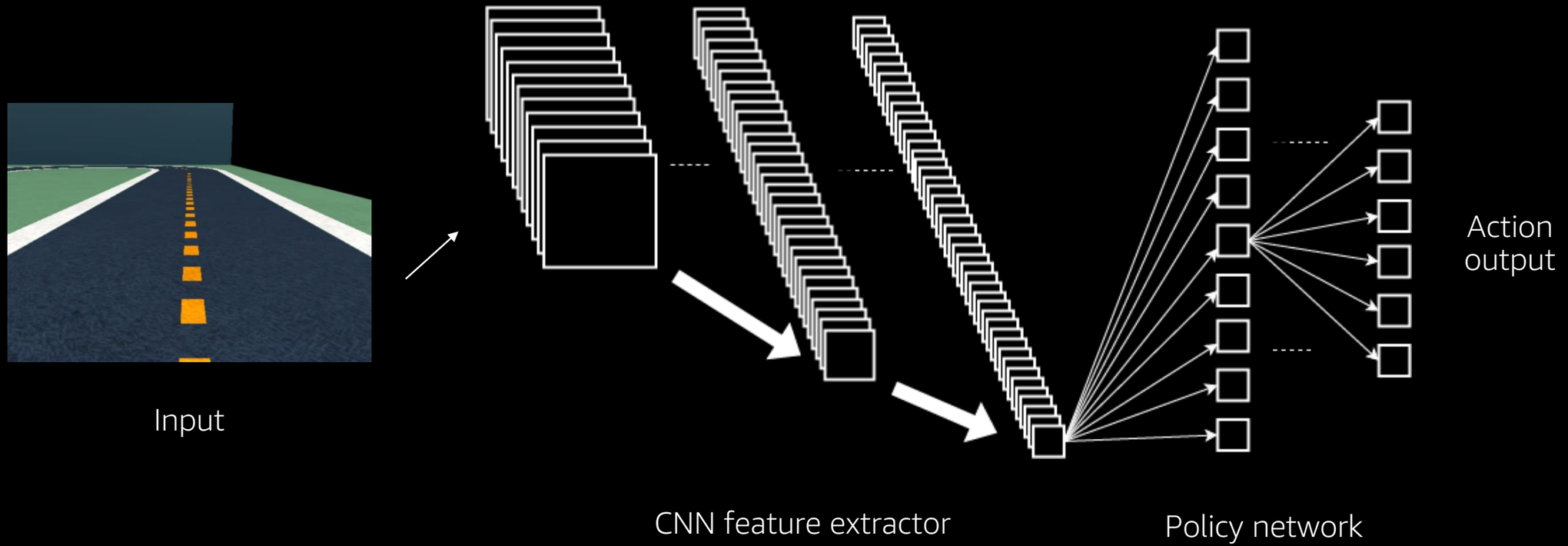


Input



CNN feature extractor

AWS DeepRacer neural network architecture



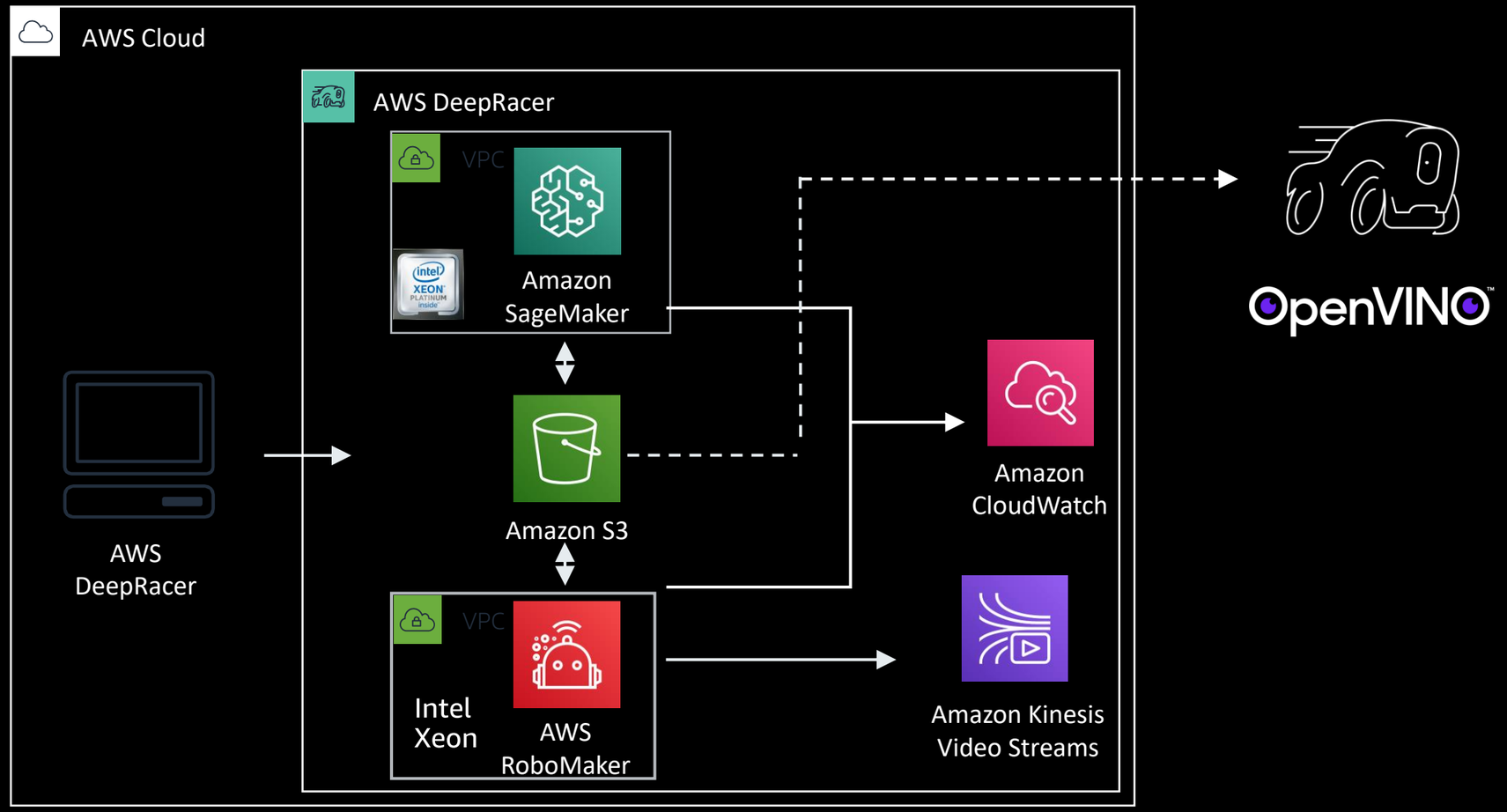
The AWS DeepRacer console



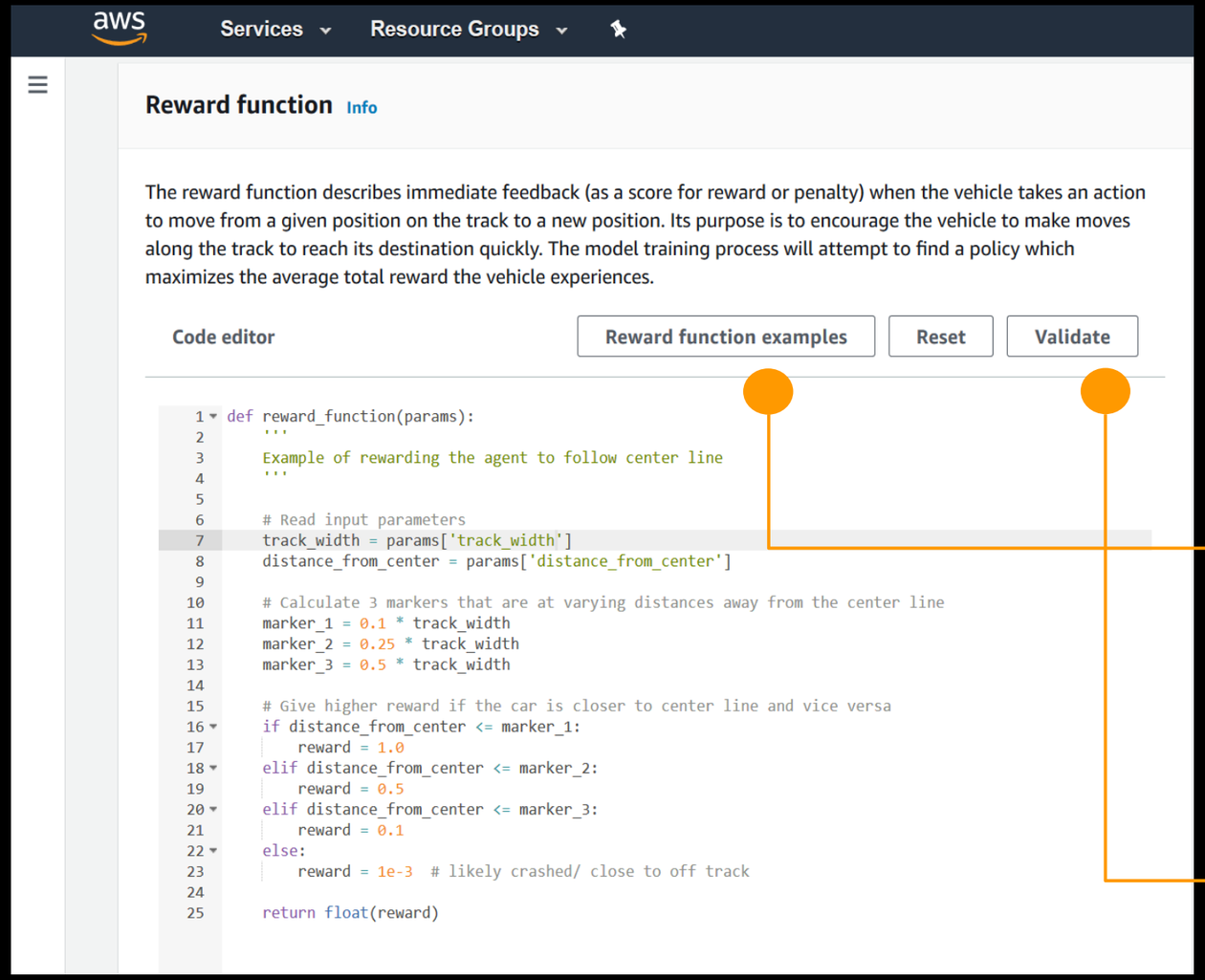
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AWS DeepRacer simulator architecture



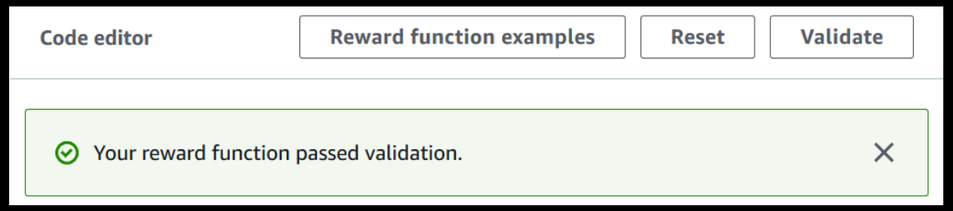
Programming your own reward function



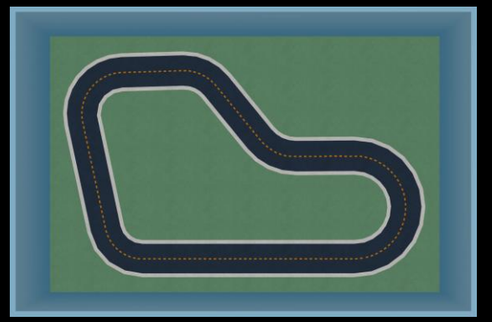
Code editor – Python 3 syntax

Three example reward functions

Code validation via AWS Lambda



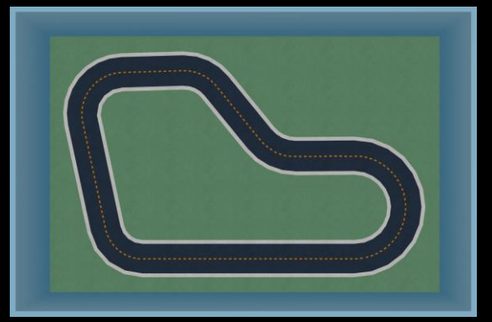
Track Components

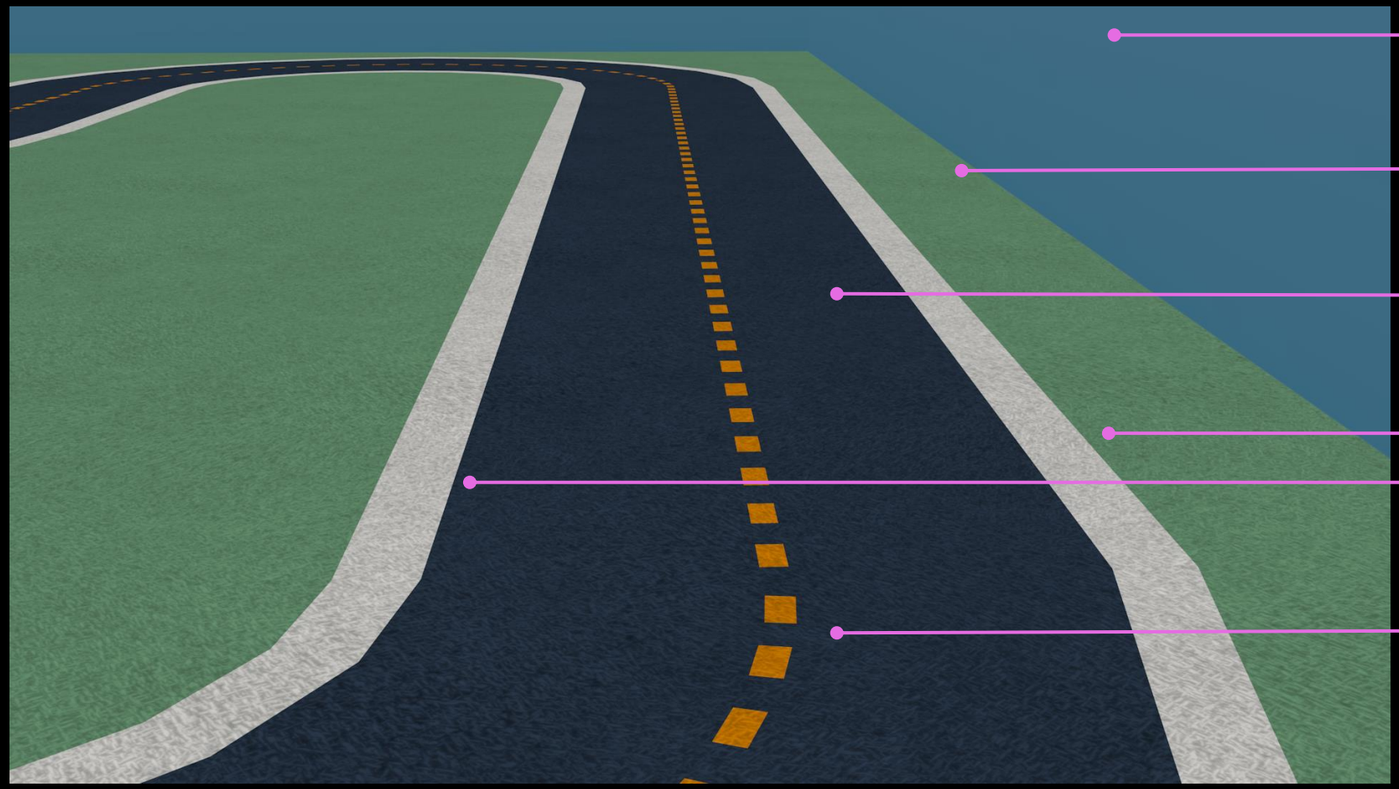




Track wall

Track Components





Track wall

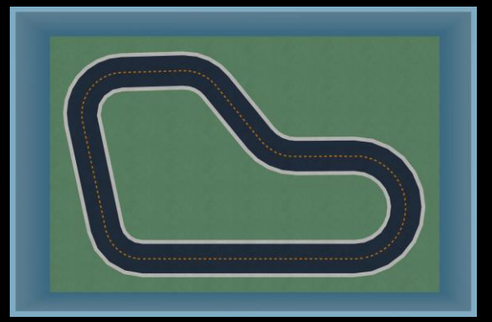
Field aka off-track

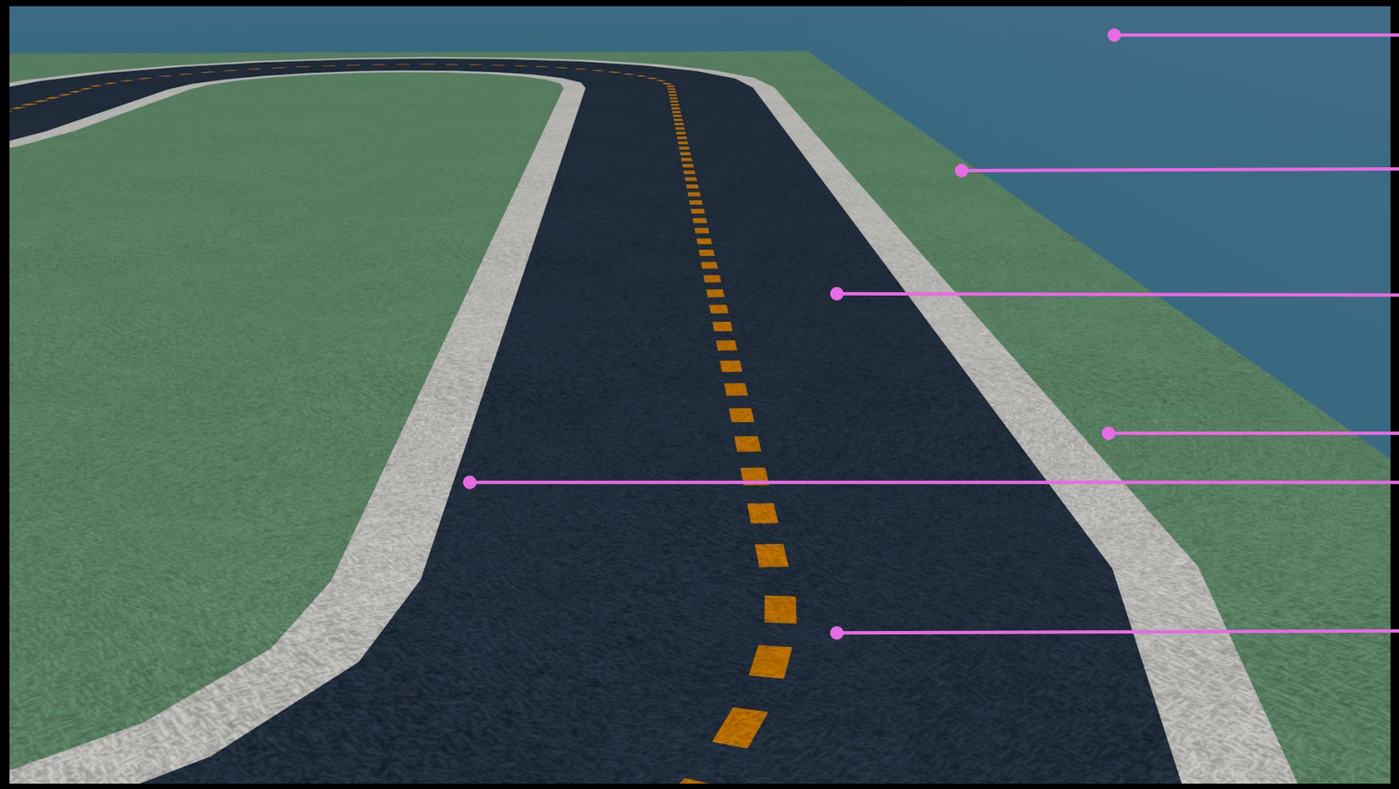
Track surface aka on-track

Track boundaries

Track center

Track Components





Track wall

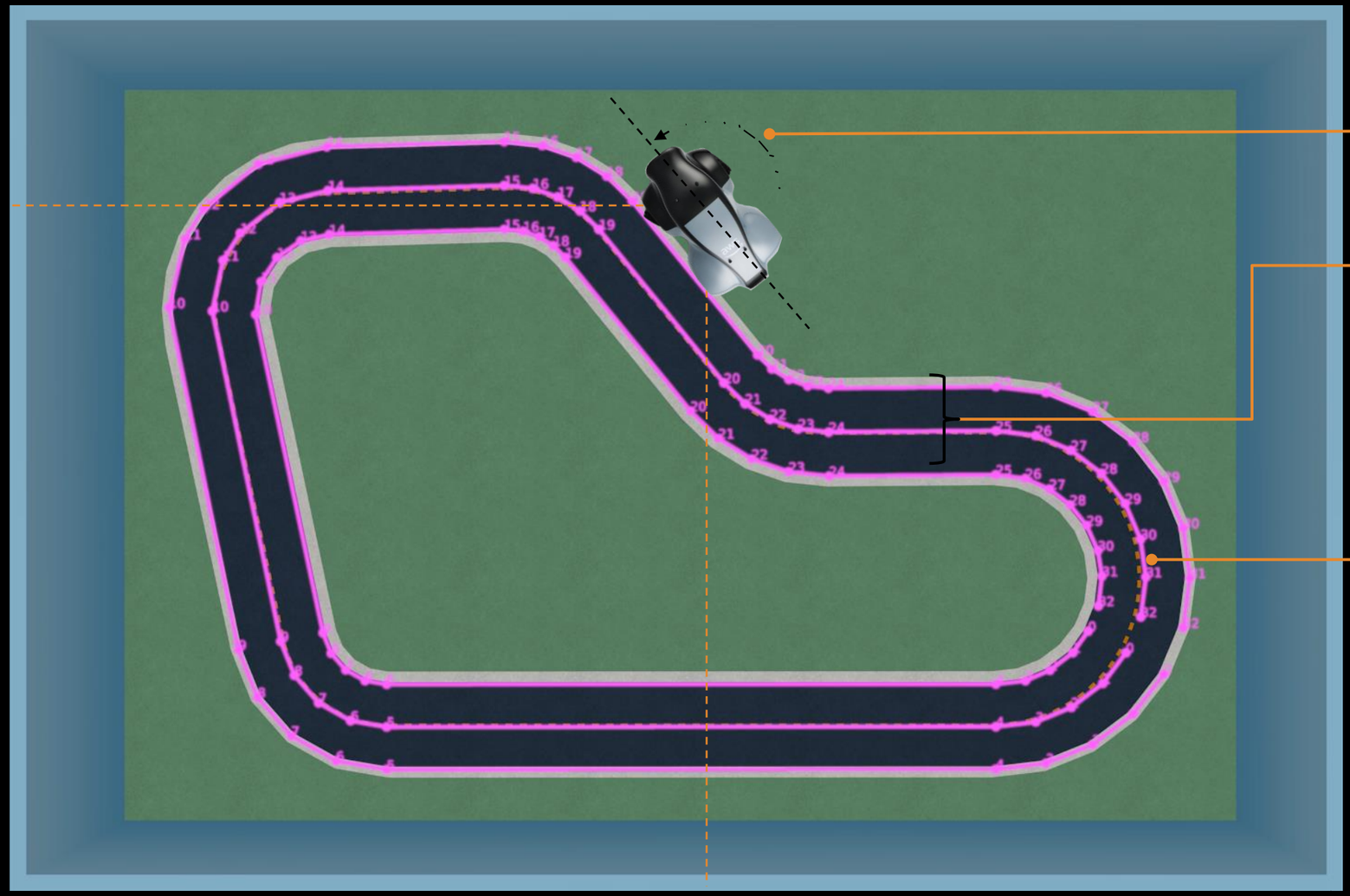
Field aka off-track

Track surface aka on-track

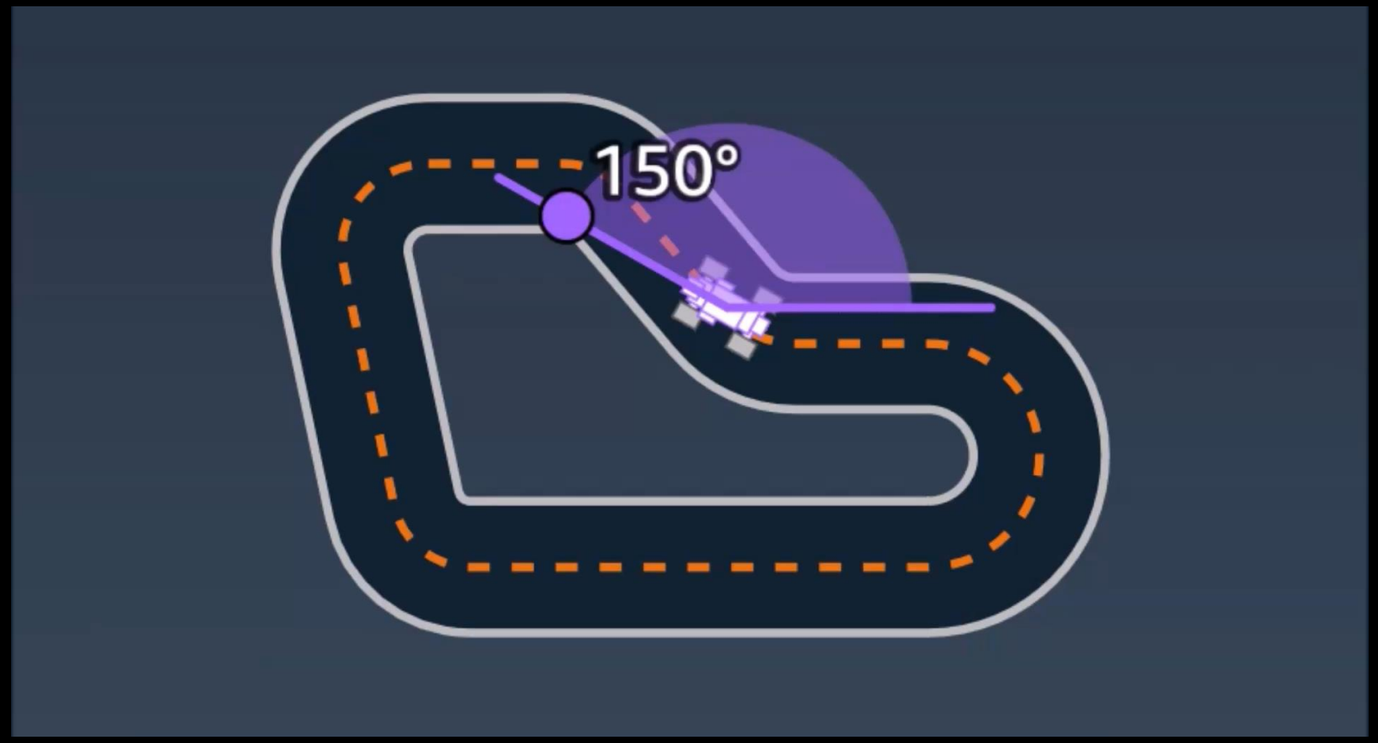
Track boundaries

Track center

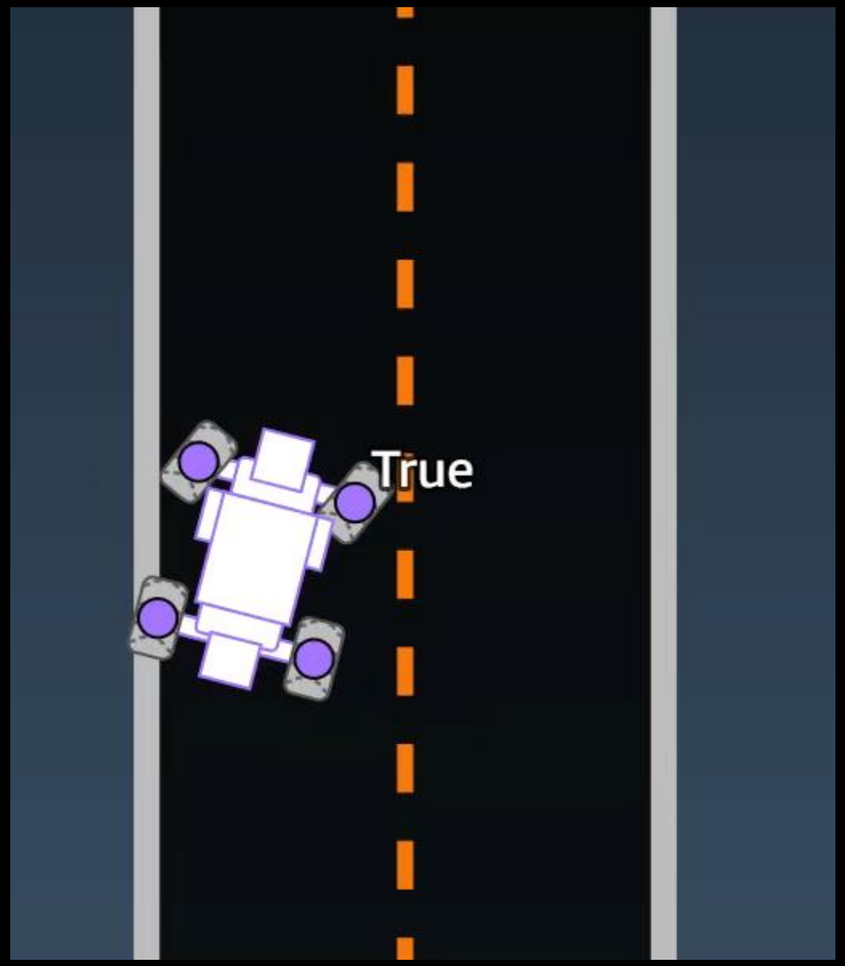
Coordinate system and track waypoints



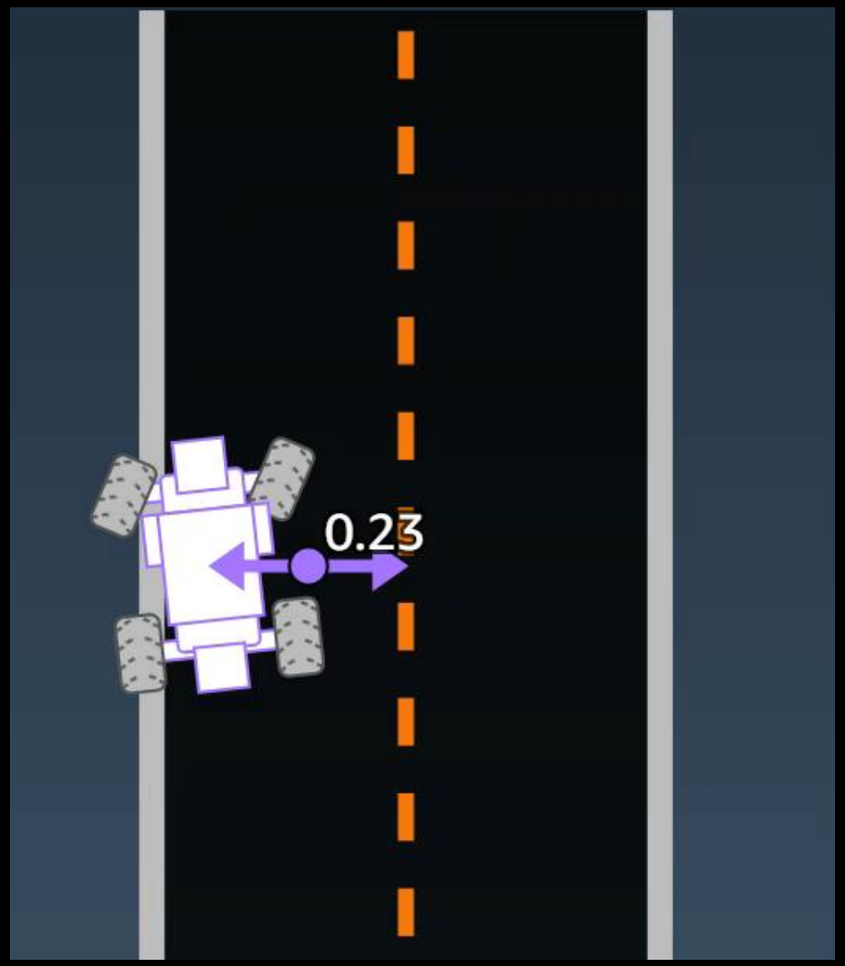
Example parameter – heading



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

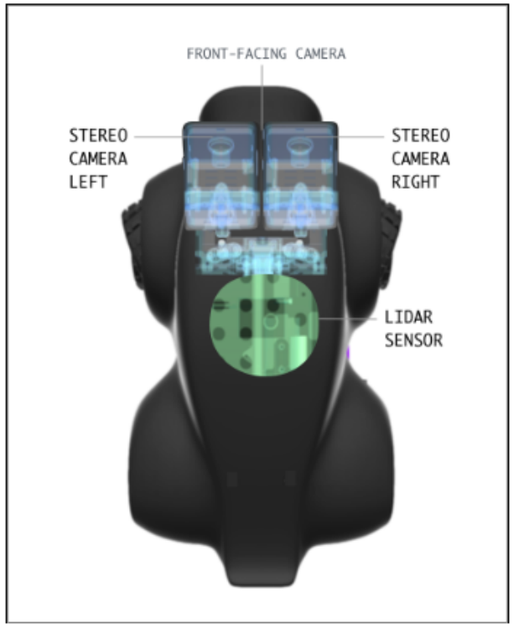
Mod specifications
The garage shows the DeepRacer vehicles that you can train models for. You can add vehicles by using the "build new vehicle button"

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

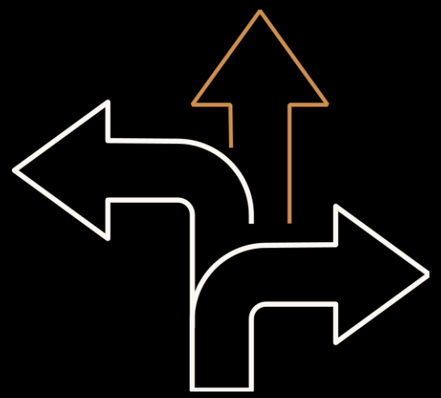
- ○ Front-facing camera
  Single camera that captures the images with sizes of 160 x 120 in front of the agent at 15 fps. The camera has 120 wide angle lens. The images are converted into grey scale before being fed to the neural network
  ▶ Benefits of the front-facing camera
- ◉ Stereo cameras (right/left) 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

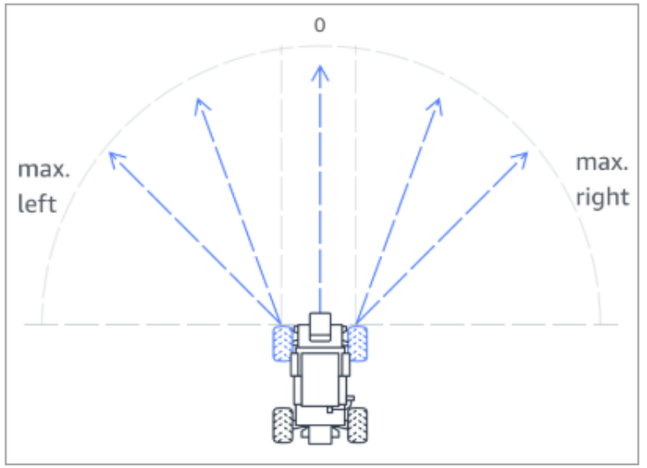
Maximum speed

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

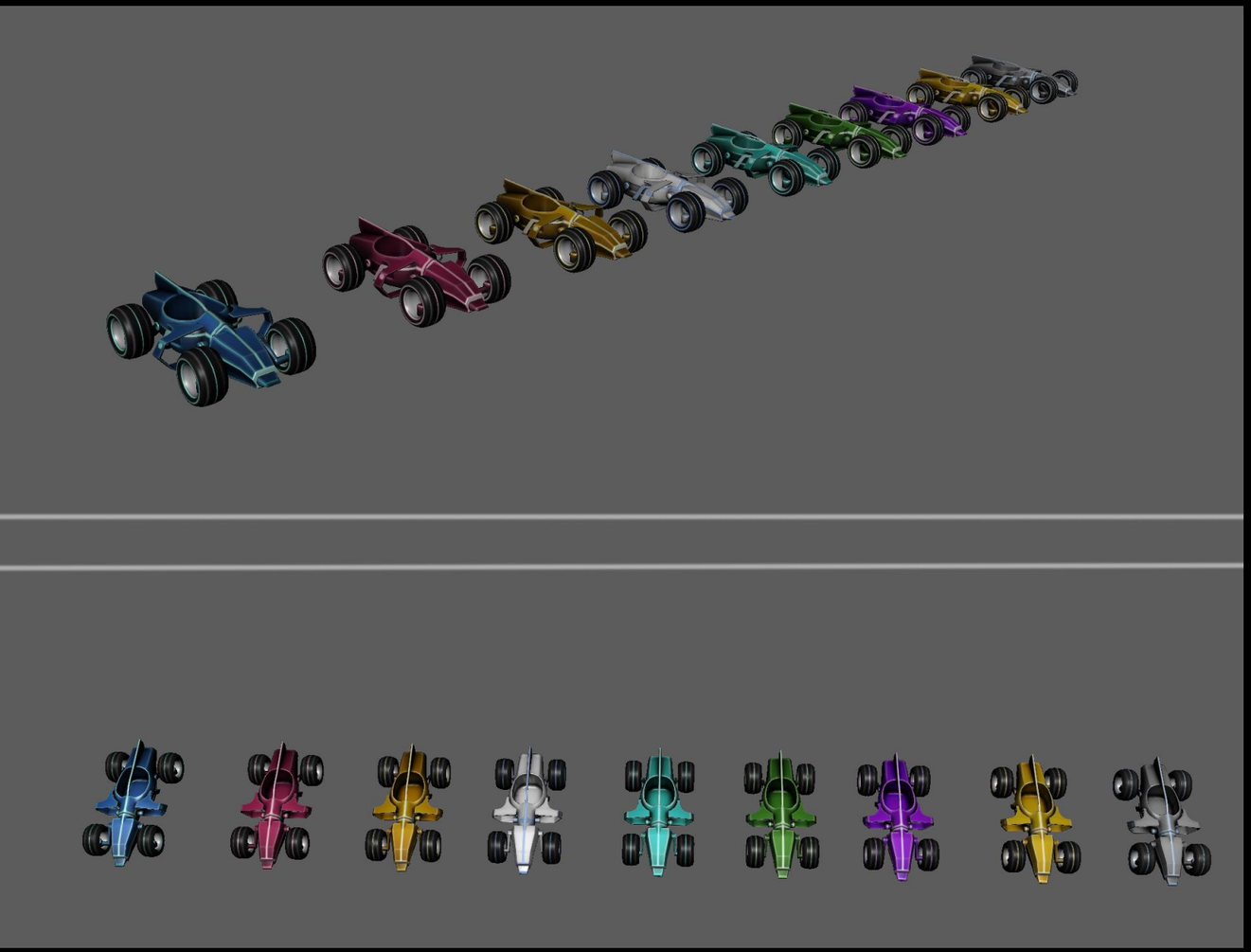
Announcing new 2021 League features



AWS DeepRacer
League

Open and ***Pro*** Divisions

Announcing new 2021 League features



Open and ***Pro*** Divisions

Digital Rewards in console

Announcing new 2021 League features



In Collaboration with F1™

Open and *Pro* Divisions

Digital Rewards in console

Special Sponsored events

Announcing new 2021 Community Leagues



Community
League races

Community League tools

Race admin tools

Live virtual races in console,
broadcasting to Twitch

Additional resources

AWS 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

AWS DeepRacer console



https://console.aws.amazon.com/deepracer/home?region=us-east-1#league

Thank you!

Kesha Williams

kesha.williams@acloud.guru

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