AWS re:Invent

NOV. 29 – DEC. 3, 2021 | LAS VEGAS, NV

DPR201-R2

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Get rolling with machine learning on AWS DeepRacer

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Principal Solutions Architect
AWS

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Agenda

Introducing AWS DeepRacer

Introduction to reinforcement learning

AWS DeepRacer console

New for 2022 in the AWS DeepRacer League

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Introducing AWS DeepRacer



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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™

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

Literally



Get hands-on experience with reinforcement learning



AWS DeepRacer Evo

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Get hands-on experience with reinforcement learning



AWS DeepRacer Evo



3D-racing simulator

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Get hands-on experience with reinforcement learning



AWS DeepRacer Evo



3D-racing simulator



AWS DeepRacer League

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Get hands-on experience with reinforcement learning



AWS DeepRacer Evo



3D-racing simulator

AWS DeepRacer League

Community races

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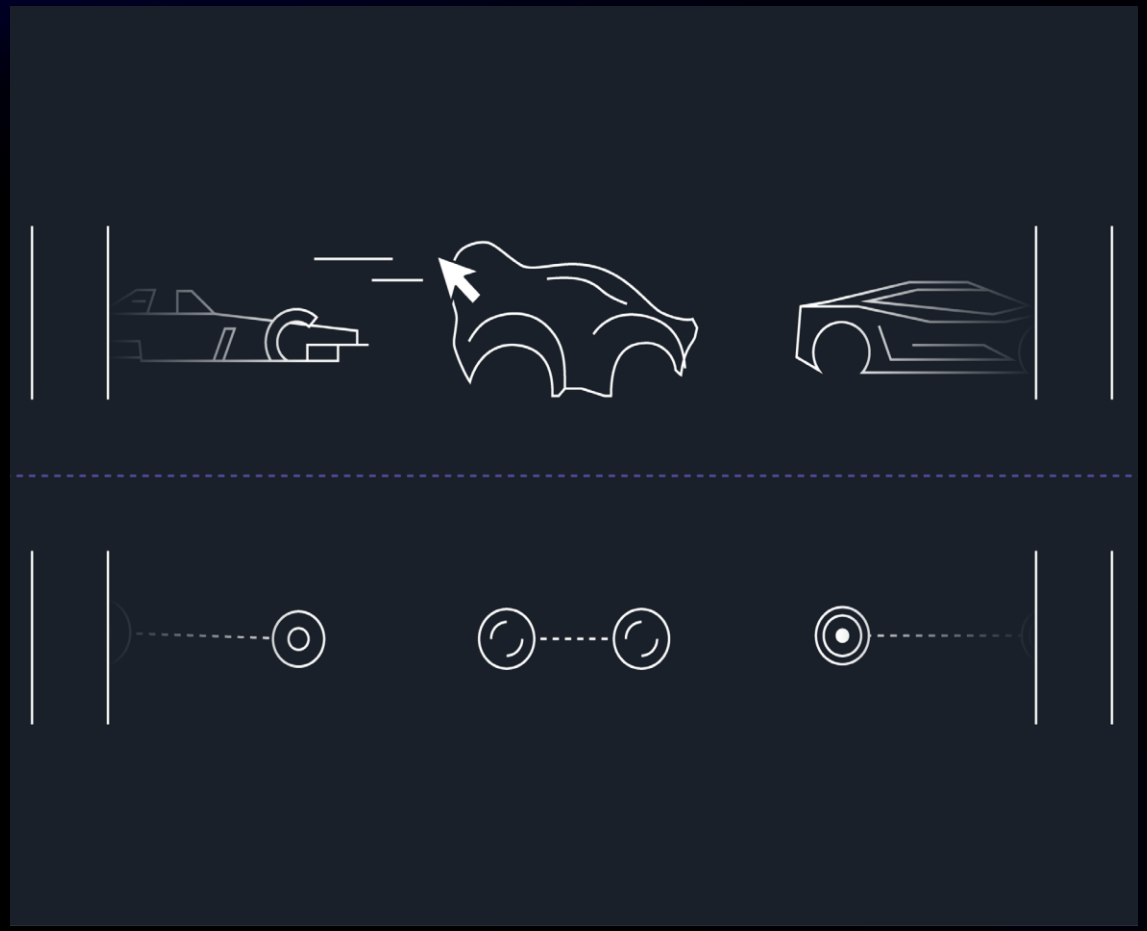
Join the 2022 League



COMPETE AGAINST RACERS FROM ALL OVER THE GLOBE

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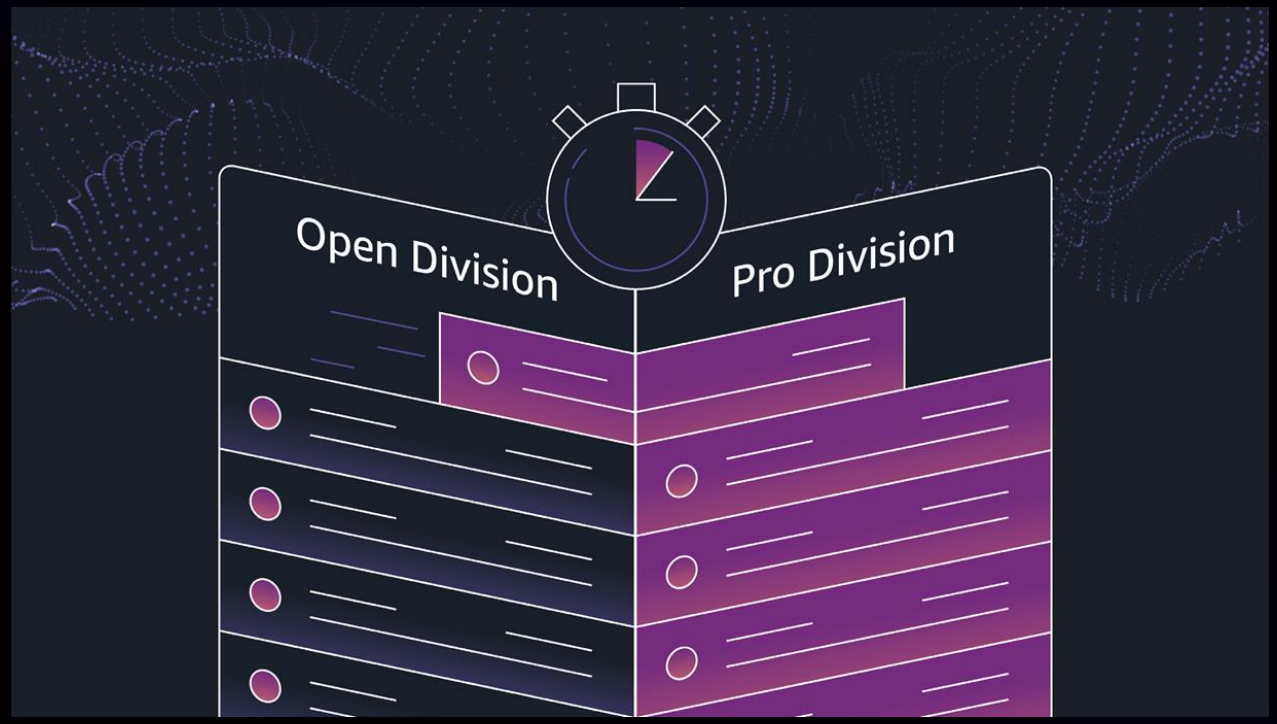
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EARN EXCLUSIVE DIGITAL REWARDS TO CUSTOMIZE YOUR CAR IN CONSOLE EACH MONTH

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Join the 2022 League



START IN OPEN DIVISION AND WORK YOUR WAY UP TO COMPETE AGAINST THE PROS

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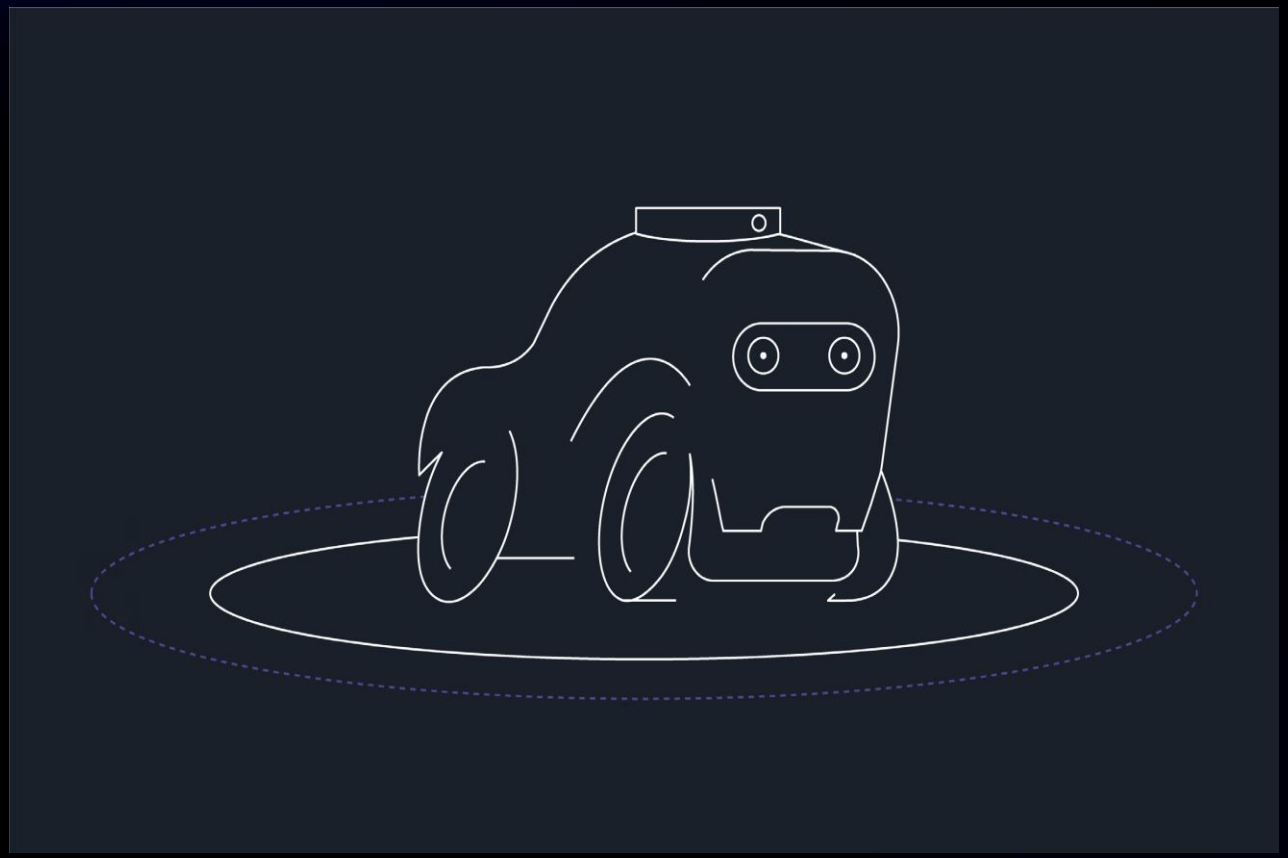
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WIN AWS DEEPRACER OFFICIAL MERCHANDISE

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Join the 2022 League



QUALIFY FOR THE MAIN EVENT IN THE PRO DIVISION TO WIN AN AWS DEEPRACER EVO

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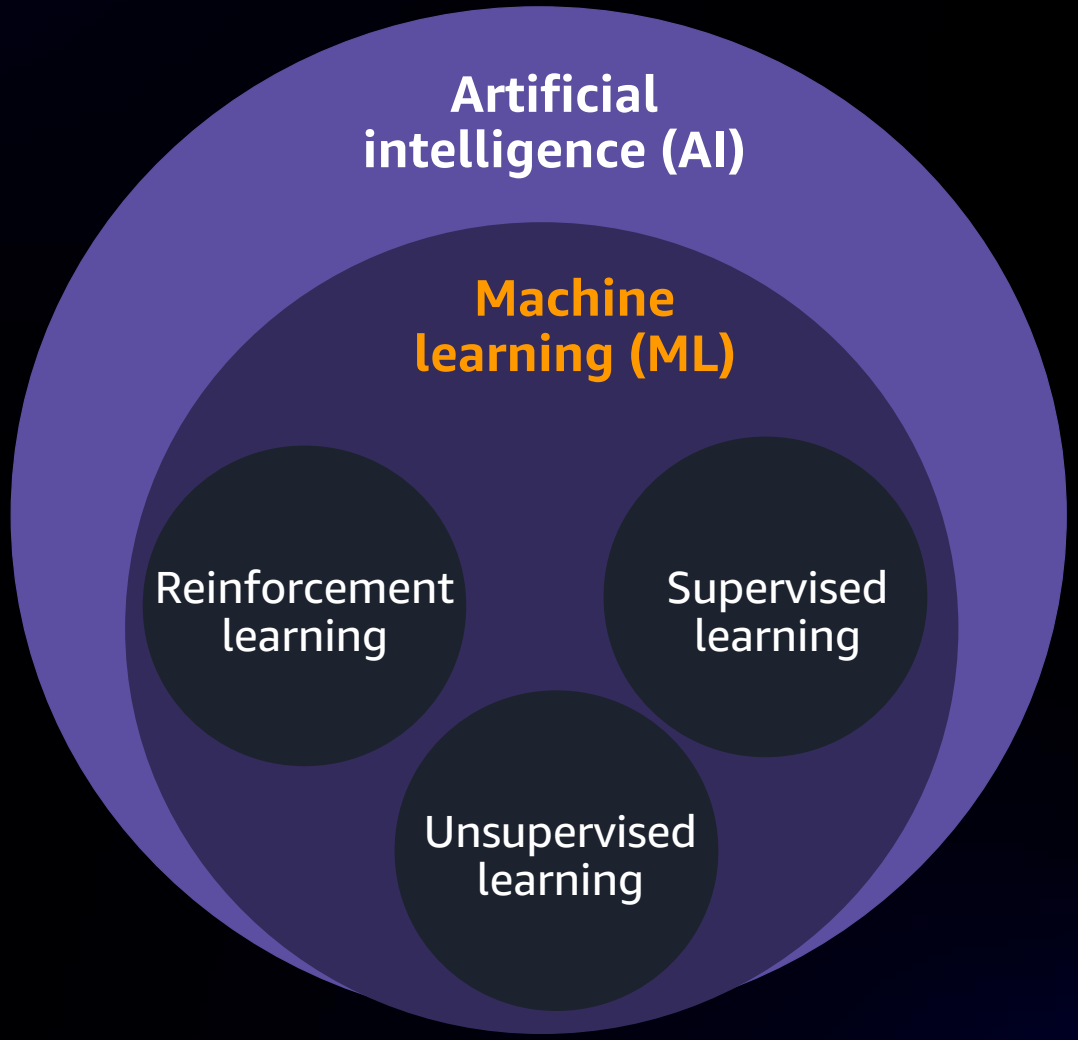
WIN A PRO DIVISION RACE AND YOU WILL RECEIVE A TRIP TO RE:INVENT TO COMPETE IN THE AWS DEEPRACER CHAMPIONSHIPS

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Reinforcement learning for the Sunday driver

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Reinforcement learning in the broad AI context



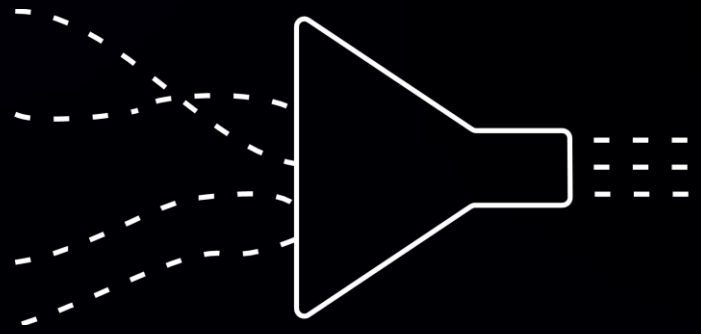
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Machine learning overview



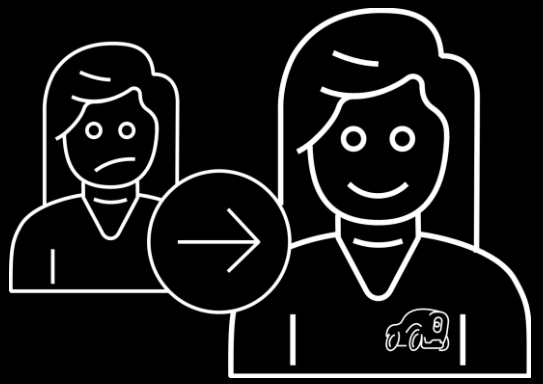
Supervised

Example-driven training; every datum has a corresponding label



Unsupervised

No labels for training data



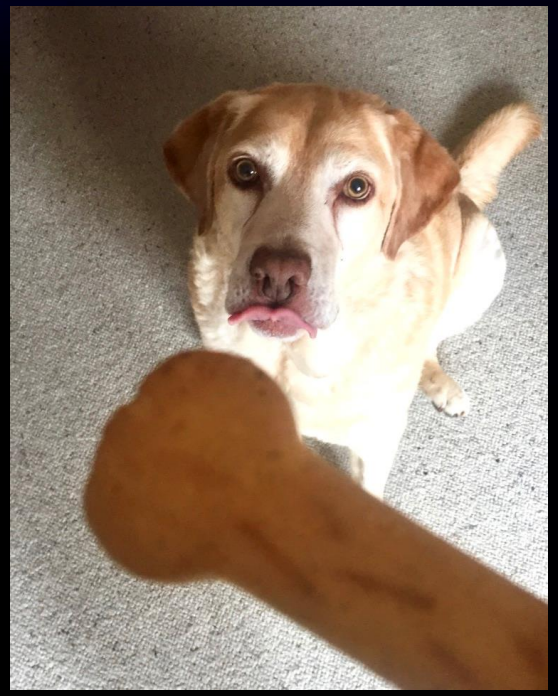
Reinforcement

Learns through consequences of actions in a specific environment

aws

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Reinforcement learning in the real world



Reward positive behavior



Don’t reward negative behavior



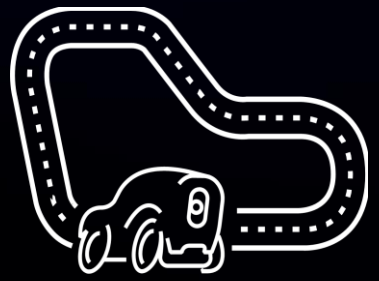
The result

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Reinforcement learning terms



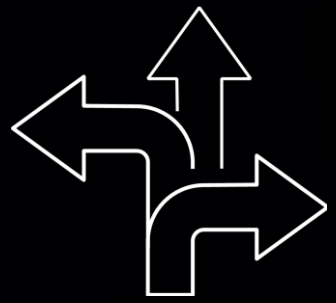
Agent



Environment



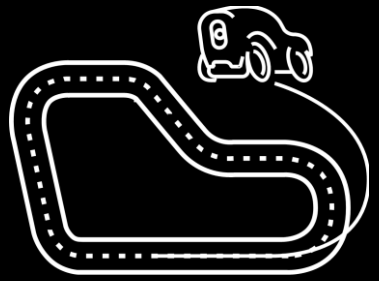
State



Action



Reward



Episode

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The reward function



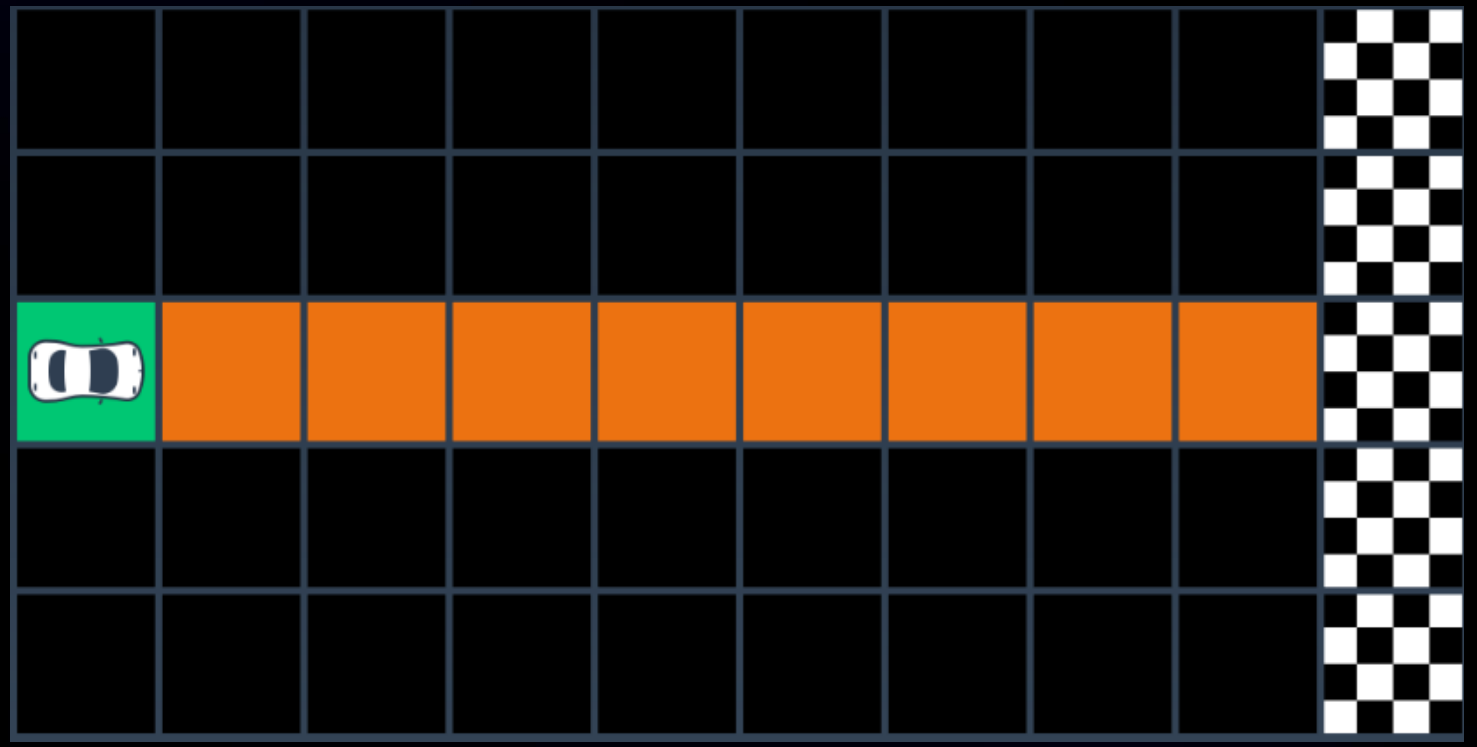
The reward function incentivizes particular behaviors and is at the core of reinforcement learning

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The reward function in a grid race



Agent





Goal

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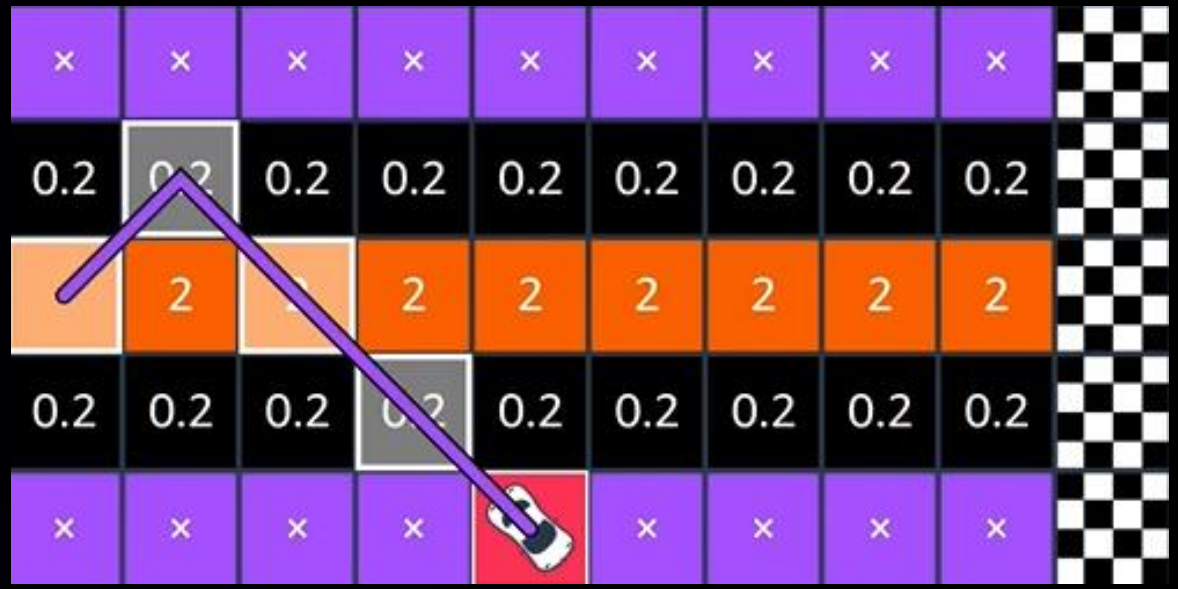
Rewards that incentivize center-line driving



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Iteration and convergence

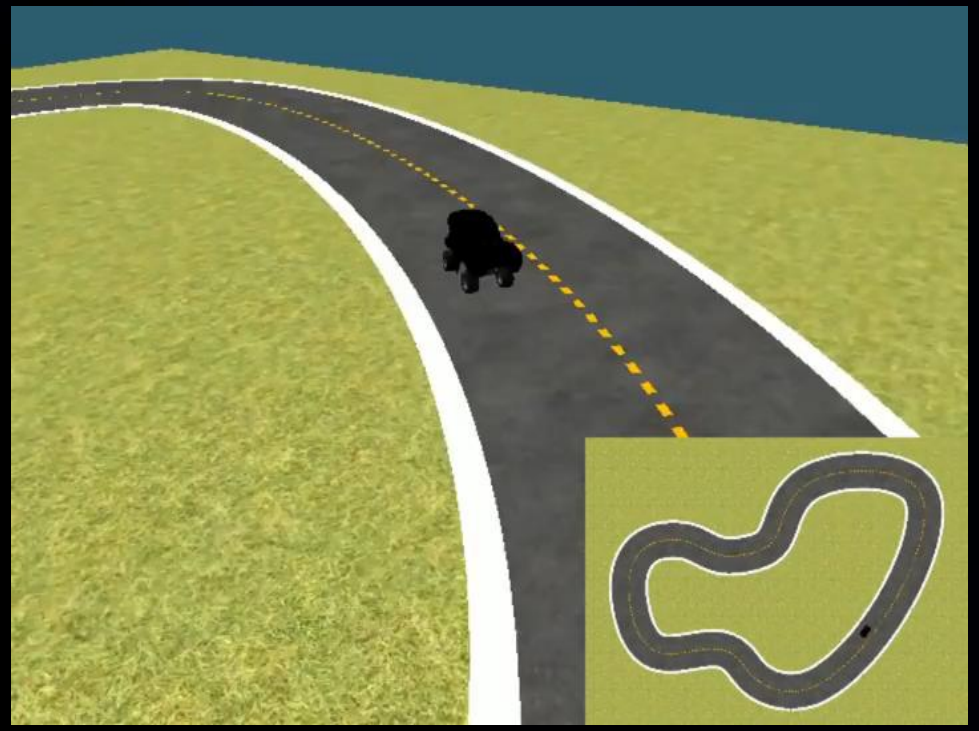




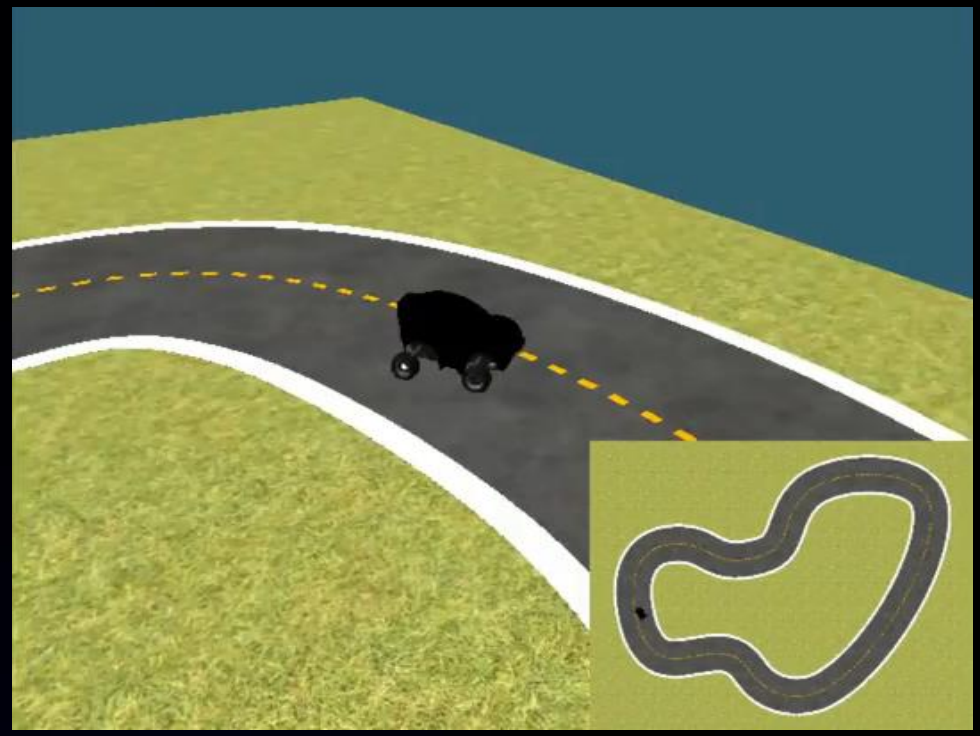
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Exploration versus exploitation

Exploration

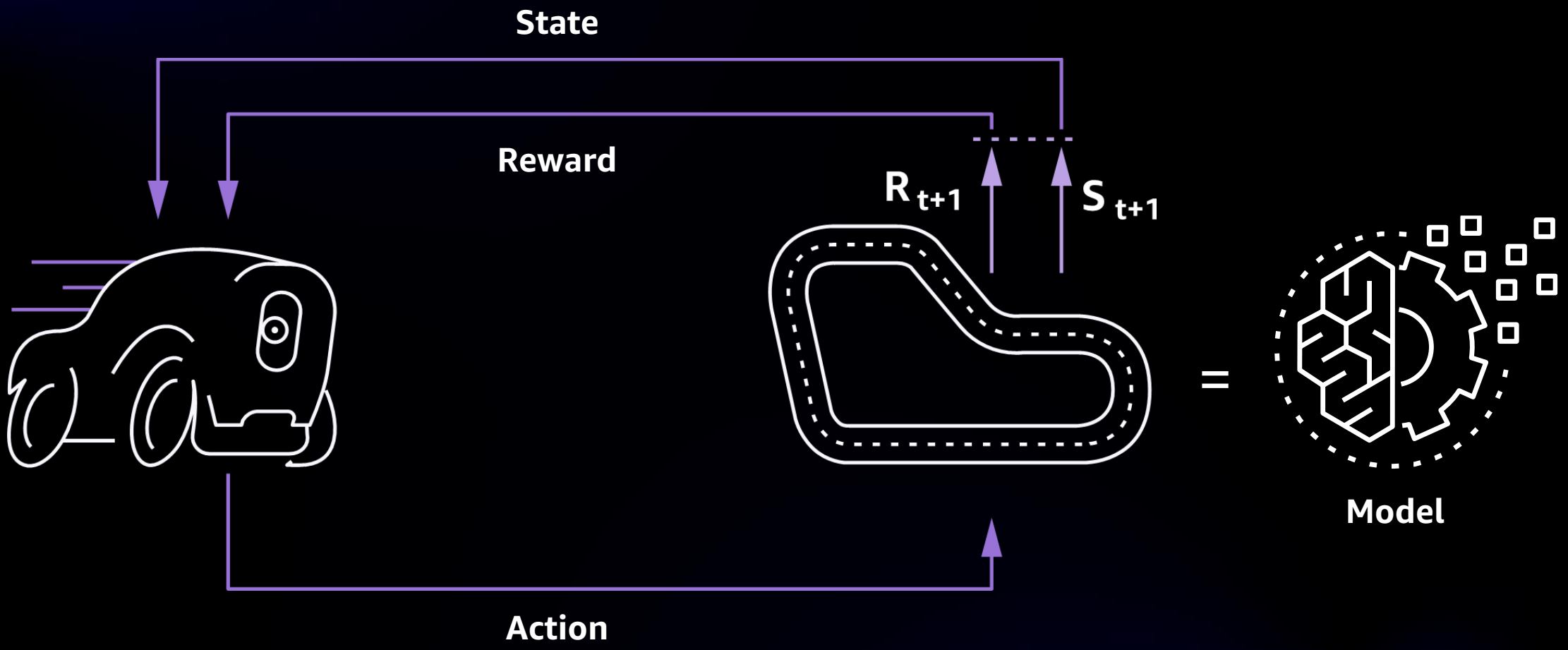


Exploitation



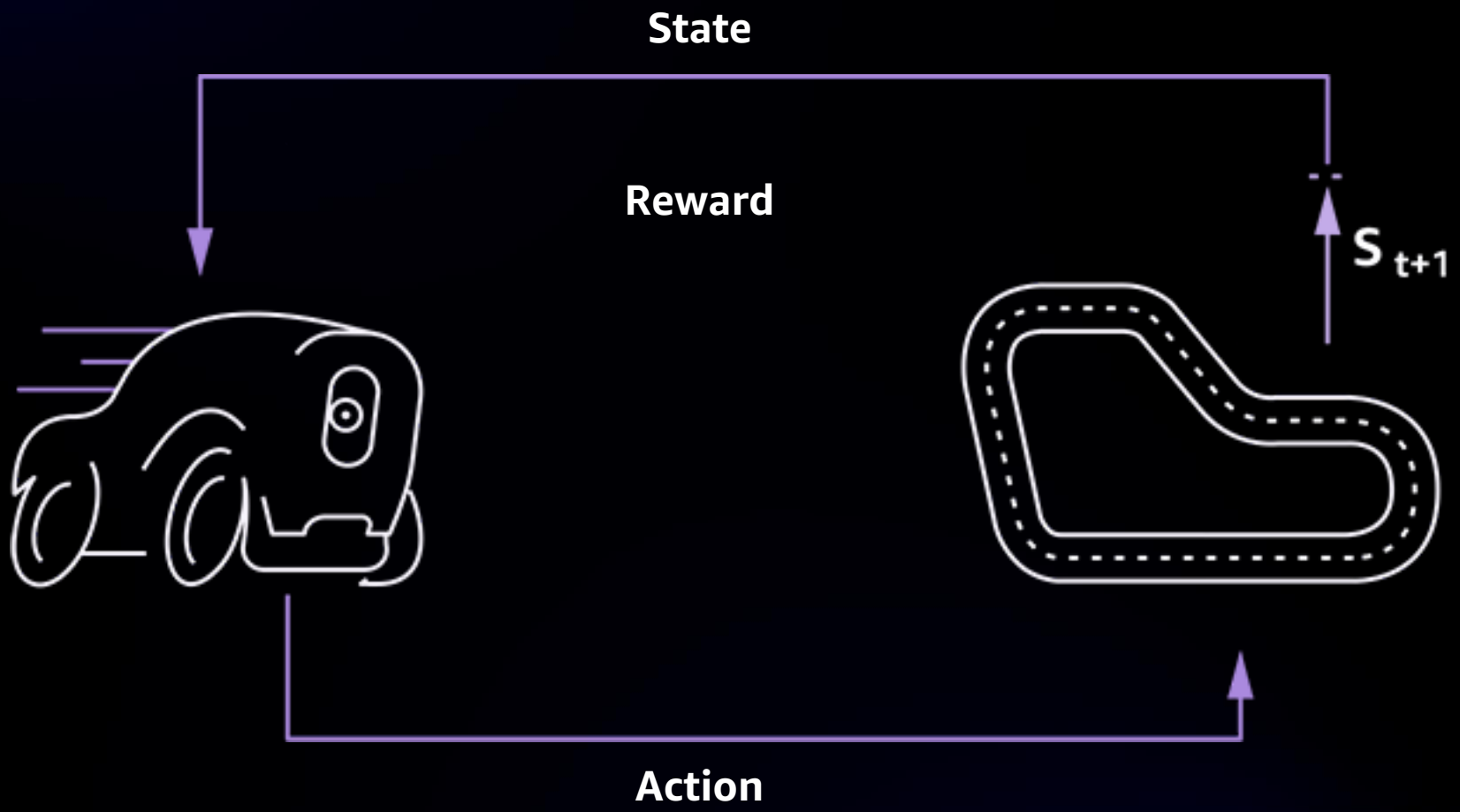
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How does learning happen?



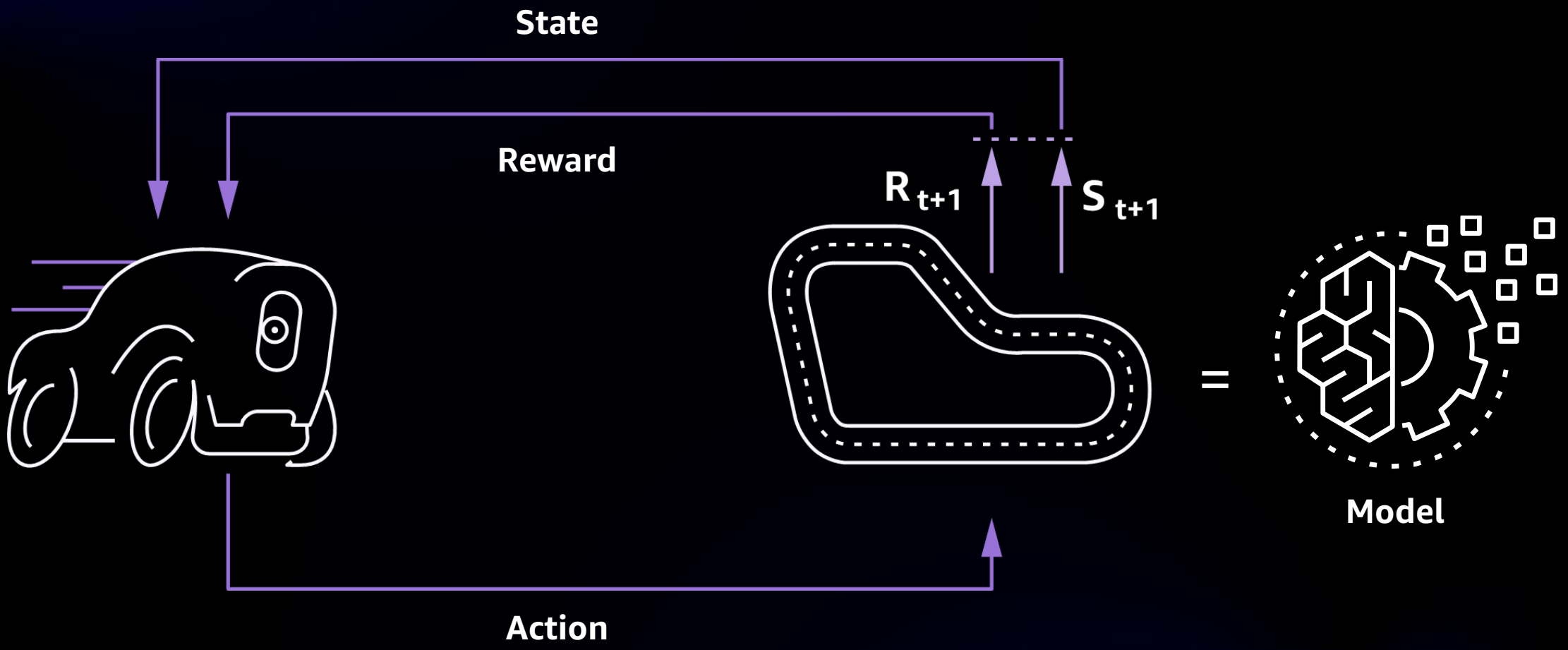
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How does learning happen?



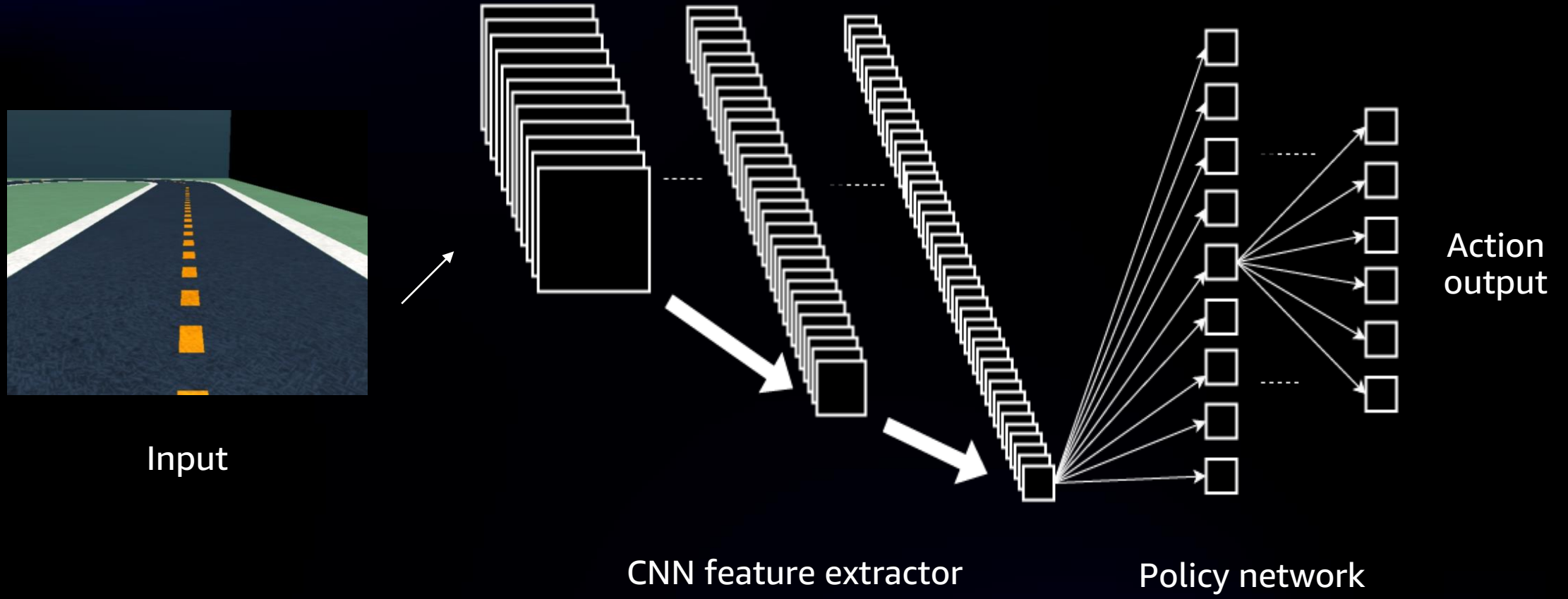
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How does learning happen?



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AWS DeepRacer neural network architecture



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AWS DeepRacer neural network architecture



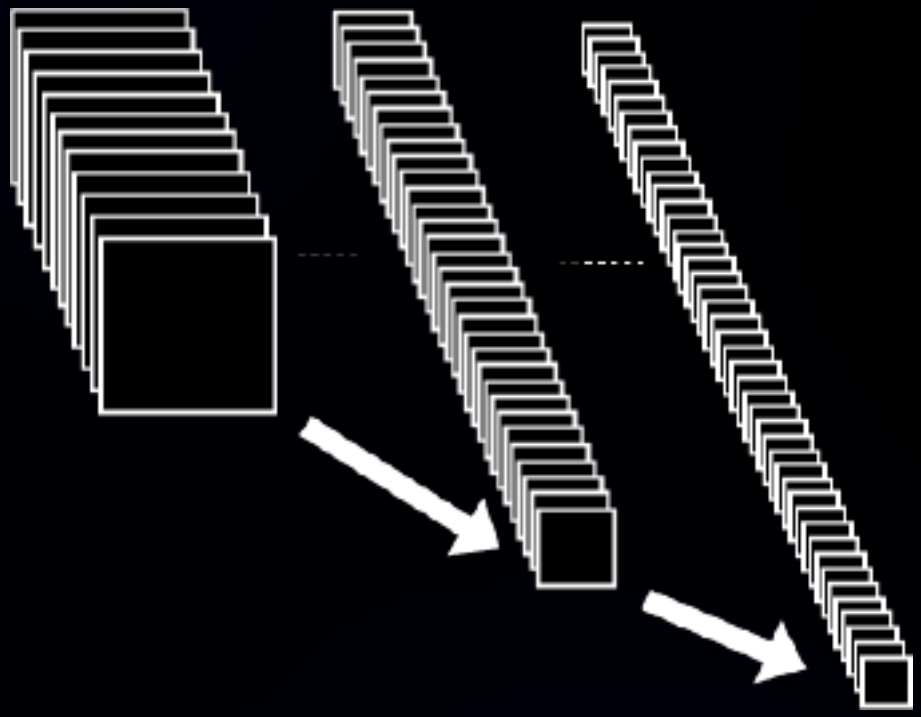
Input

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AWS DeepRacer neural network architecture



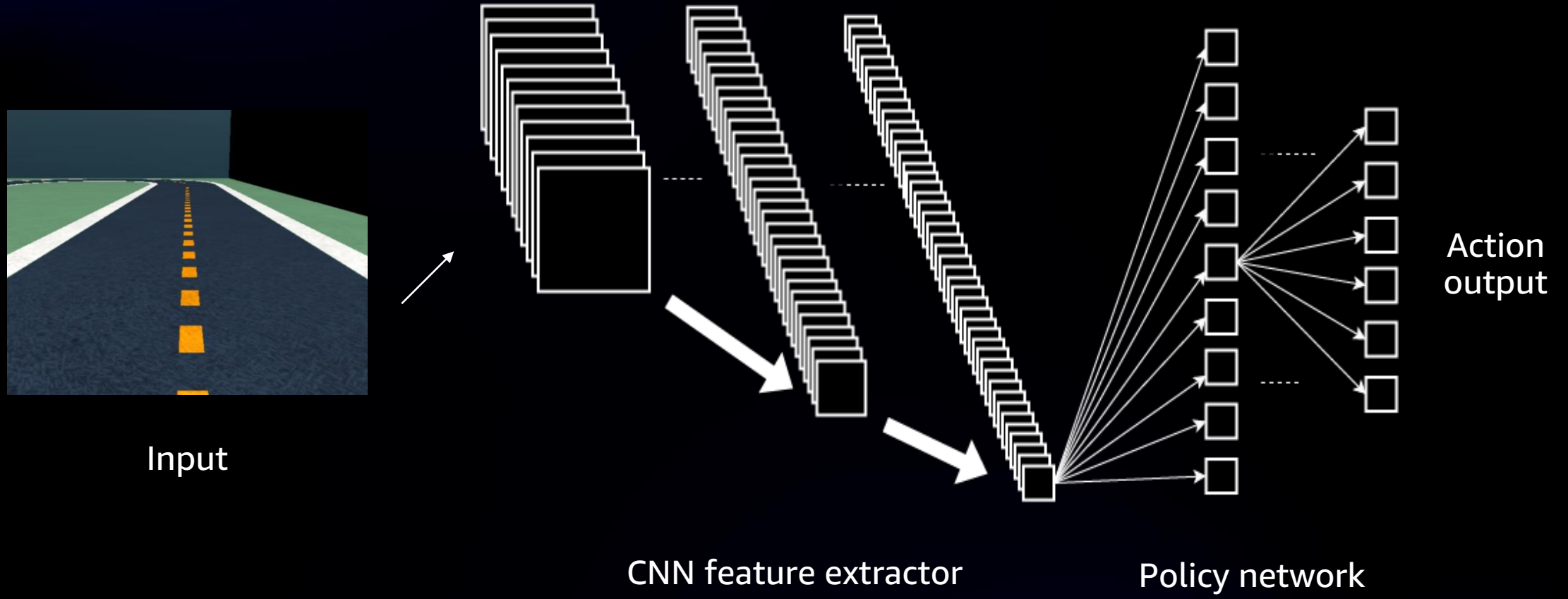
Input



CNN feature extractor

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AWS DeepRacer neural network architecture

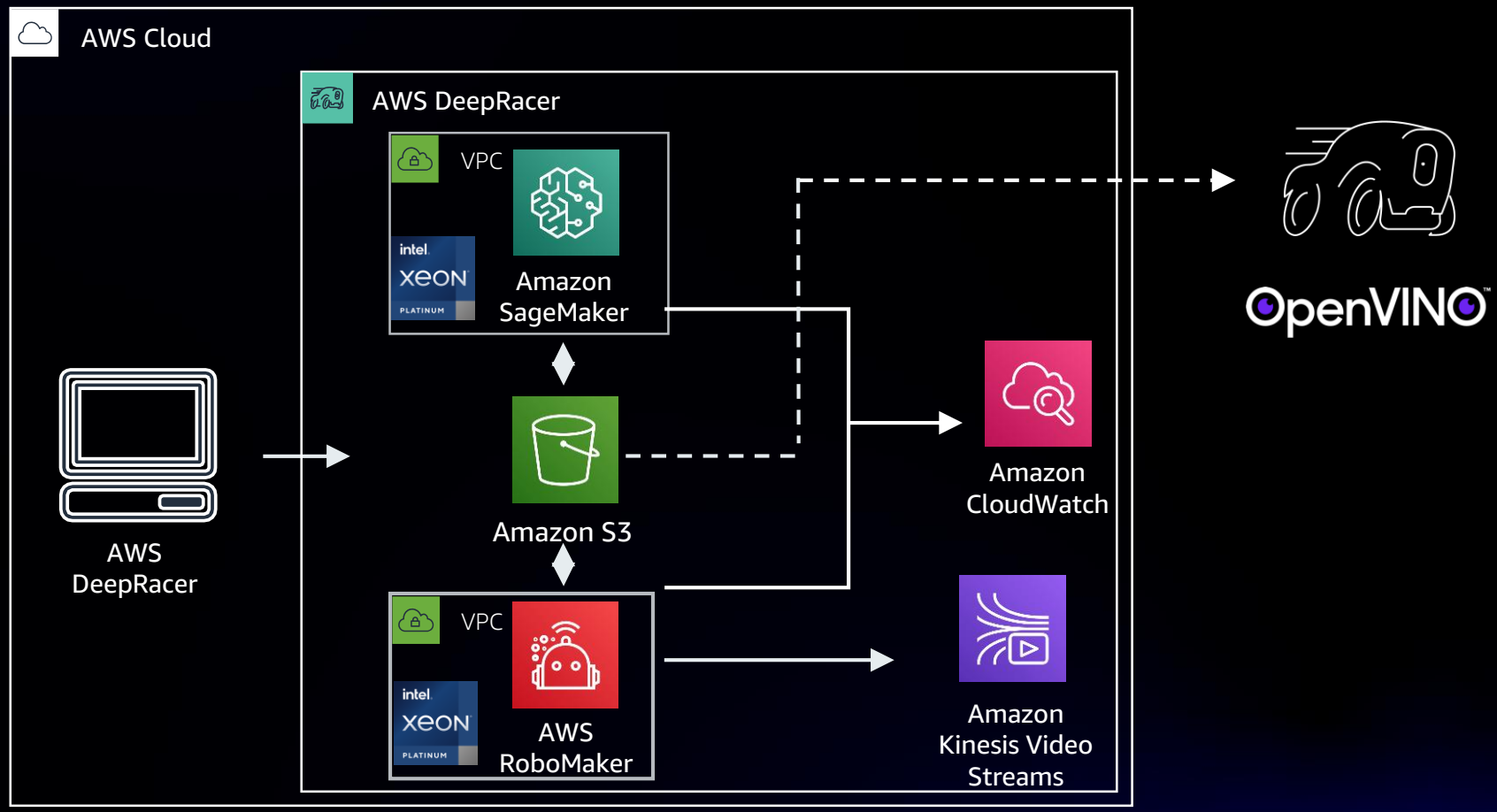


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The AWS DeepRacer console

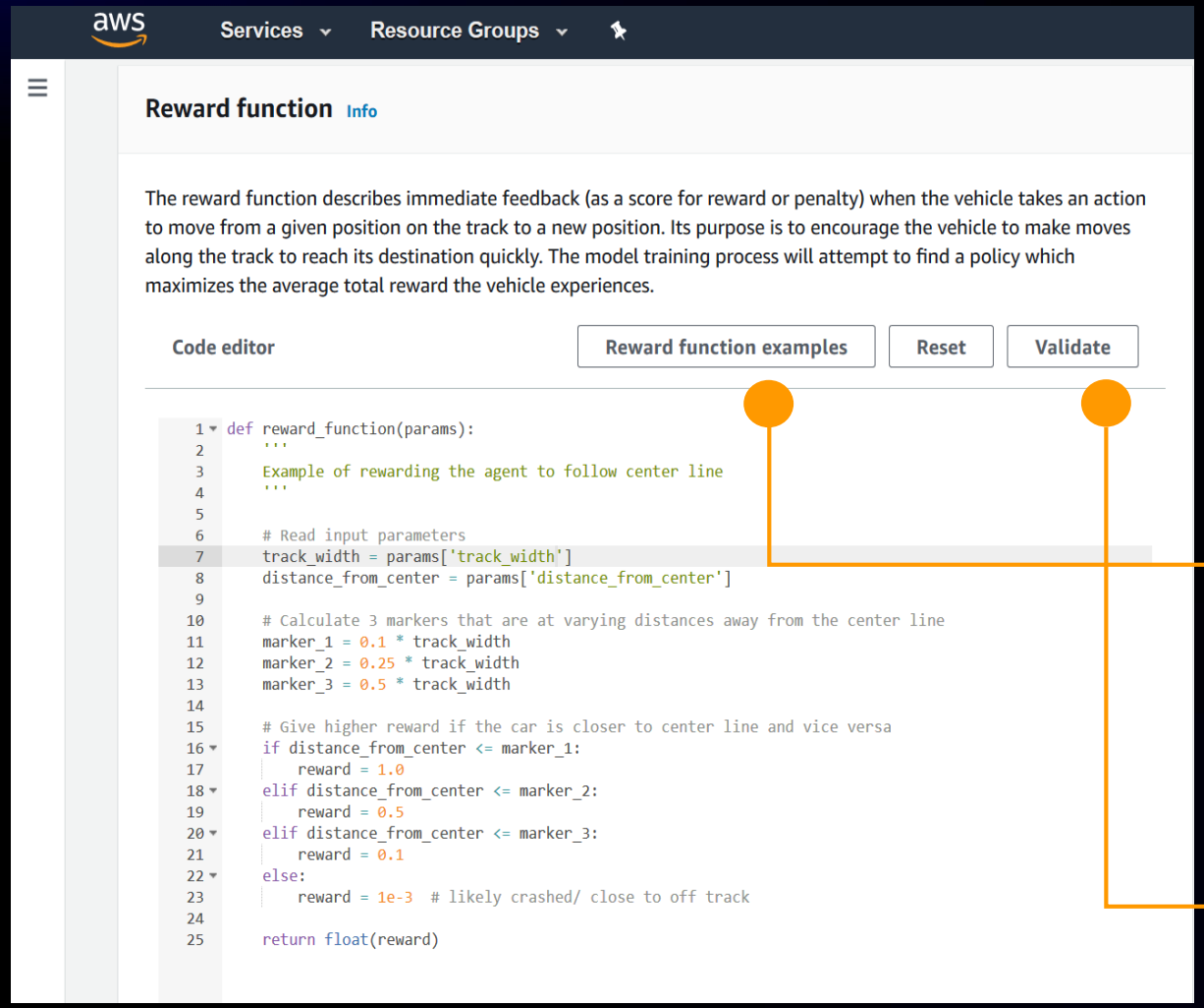
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AWS DeepRacer simulator architecture



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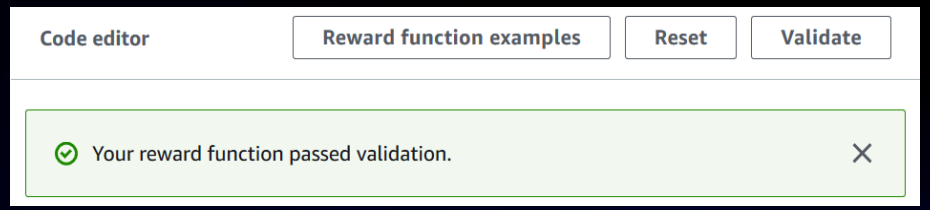
Programming your own reward function



Code editor: Python 3 syntax

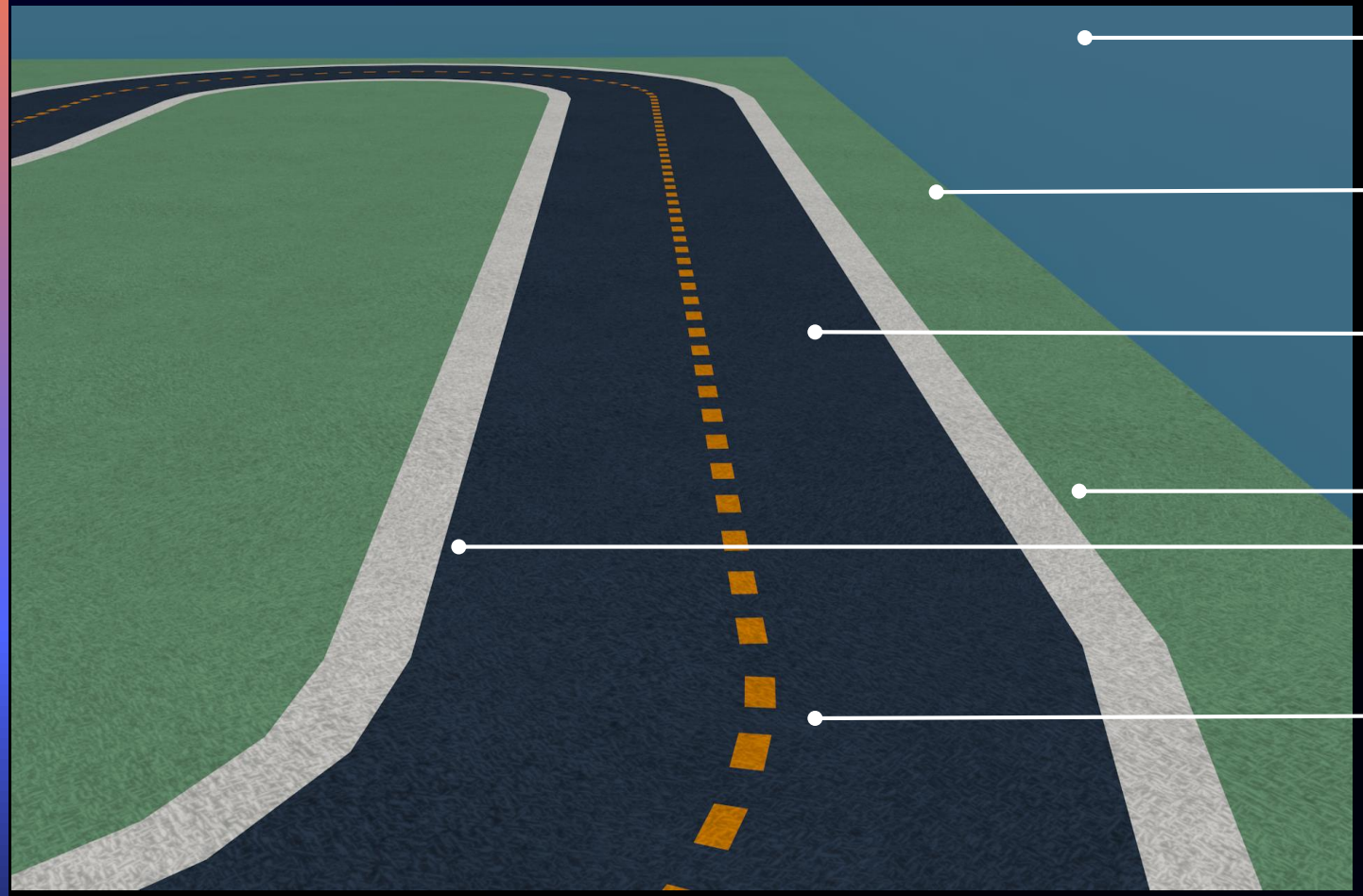
Three example reward functions

Code validation via AWS Lambda



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Track components



Track wall

Field, aka off-track

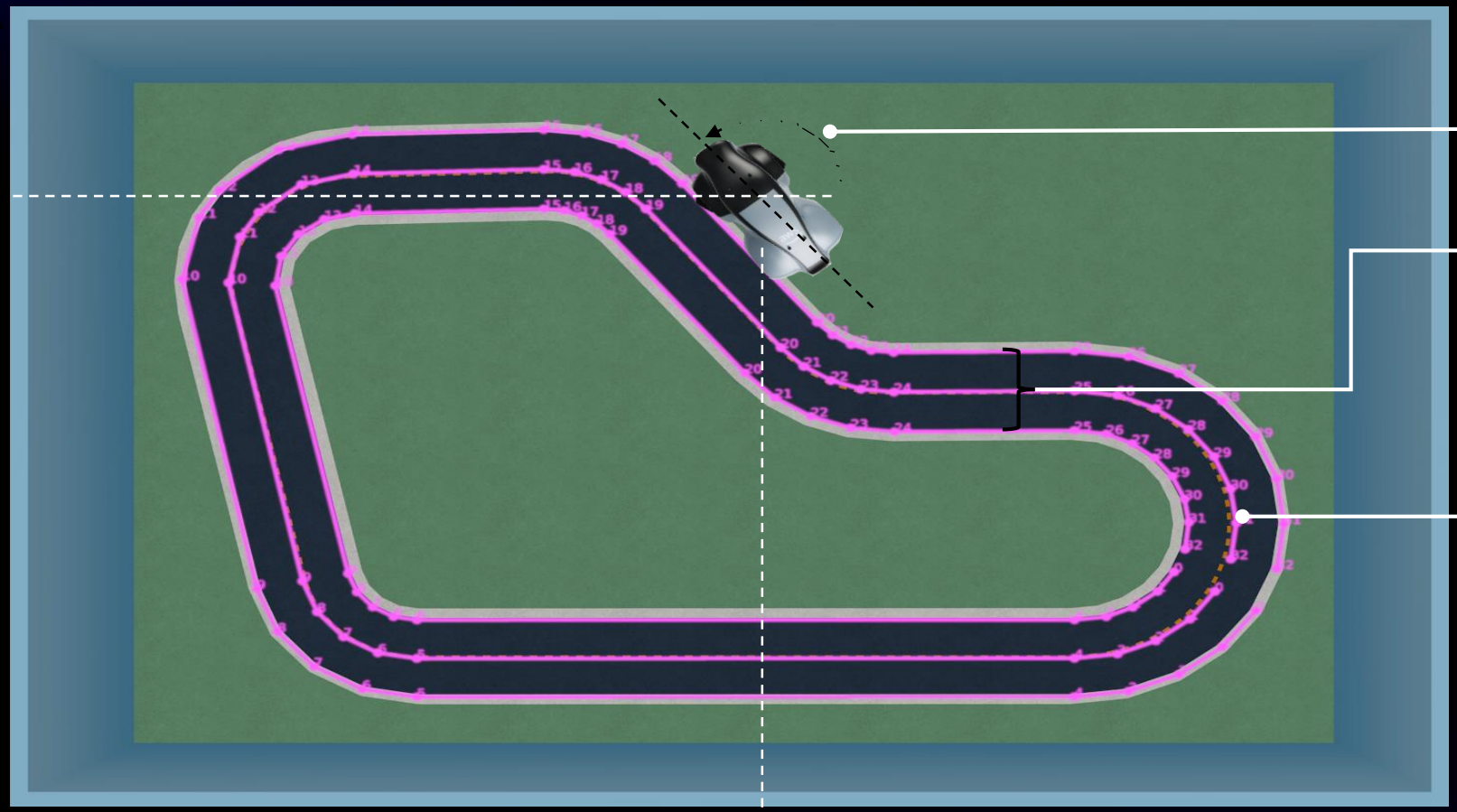
Track surface, aka on-track

Track boundaries

Track center

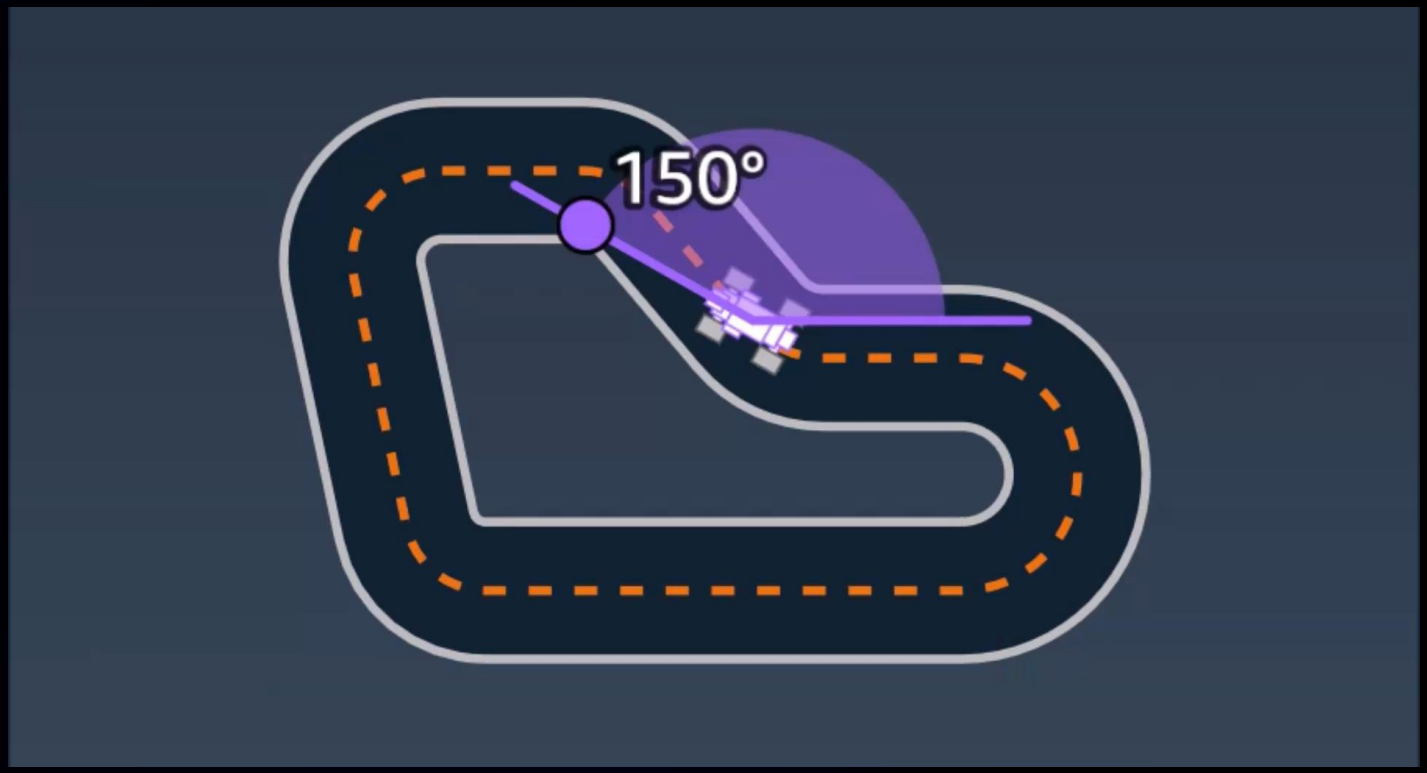
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Coordinate system and track waypoints



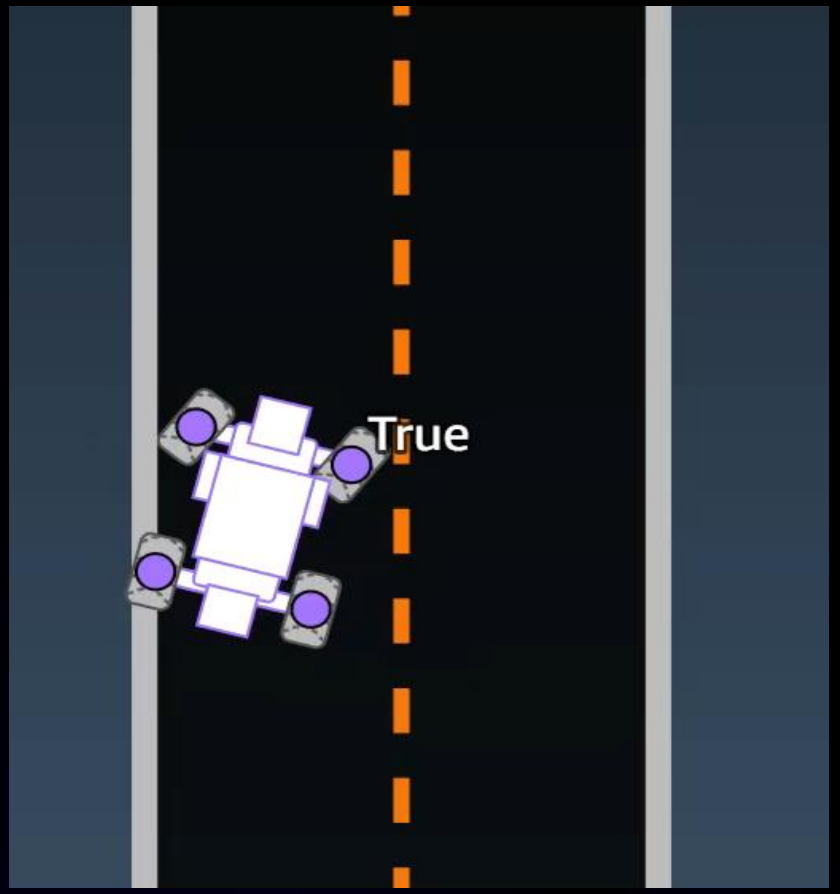
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Example parameter: heading



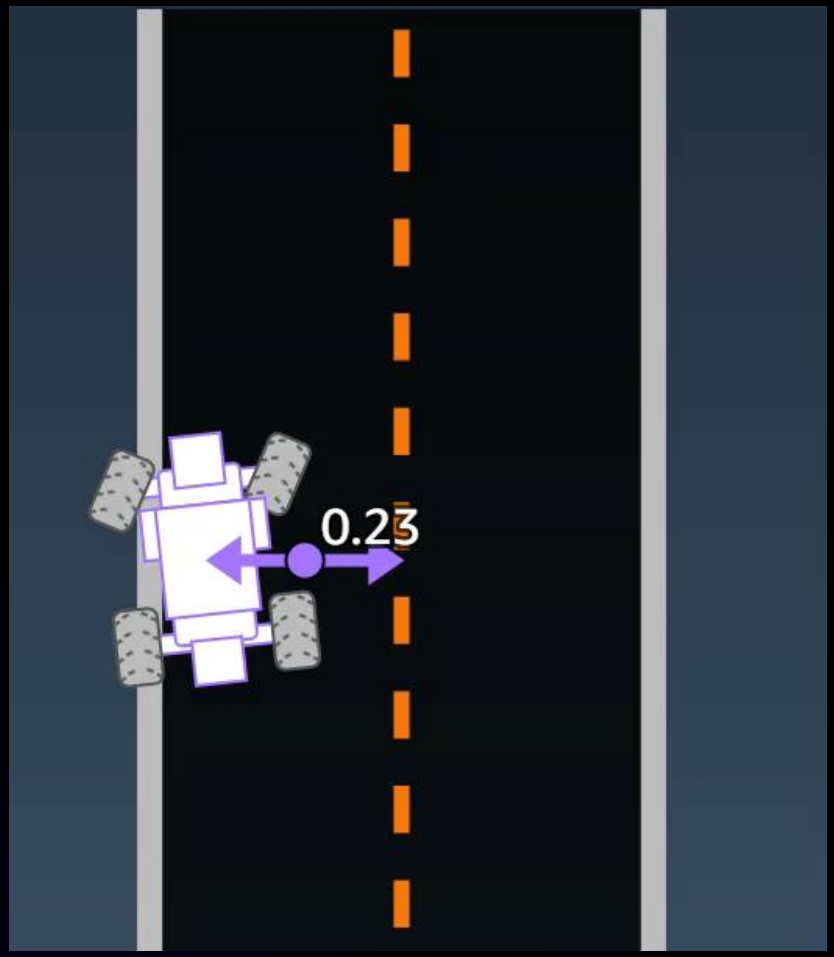
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Example parameter:
all_wheels_ on_track



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Example parameter:
distance_ from_center



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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

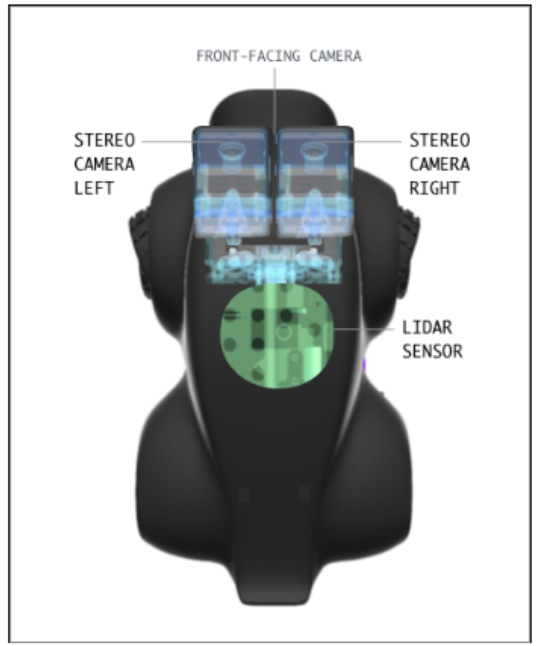
Mod specifications
The garage shows the DeepRacer vehicles that you can train models for. You can add vehicles by using the "build new vehicle button"

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

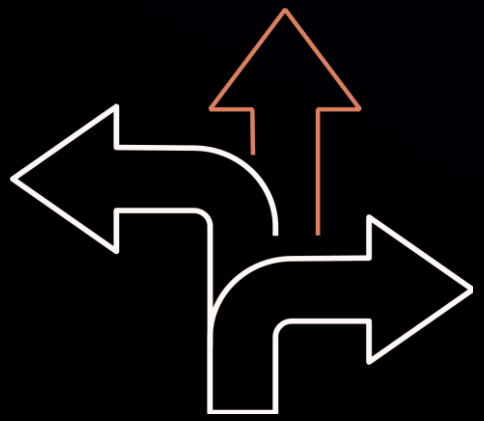
Add-on sensors

- ☑ 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



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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

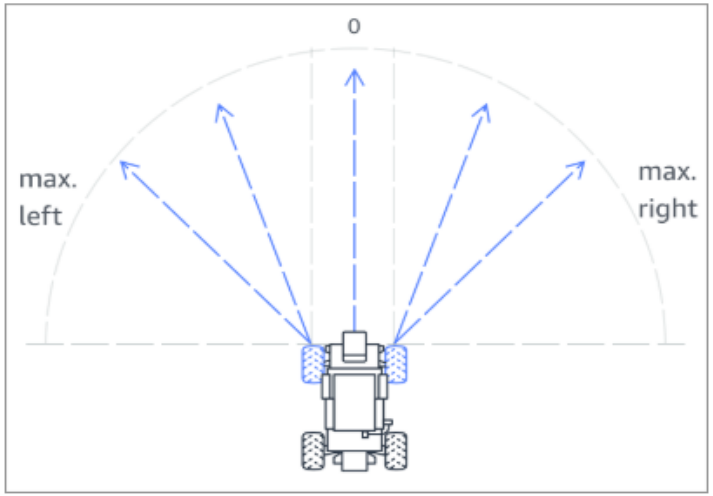
Maximum speed

4 m/s

Select values between 0.1 and 4.

Speed granularity

1

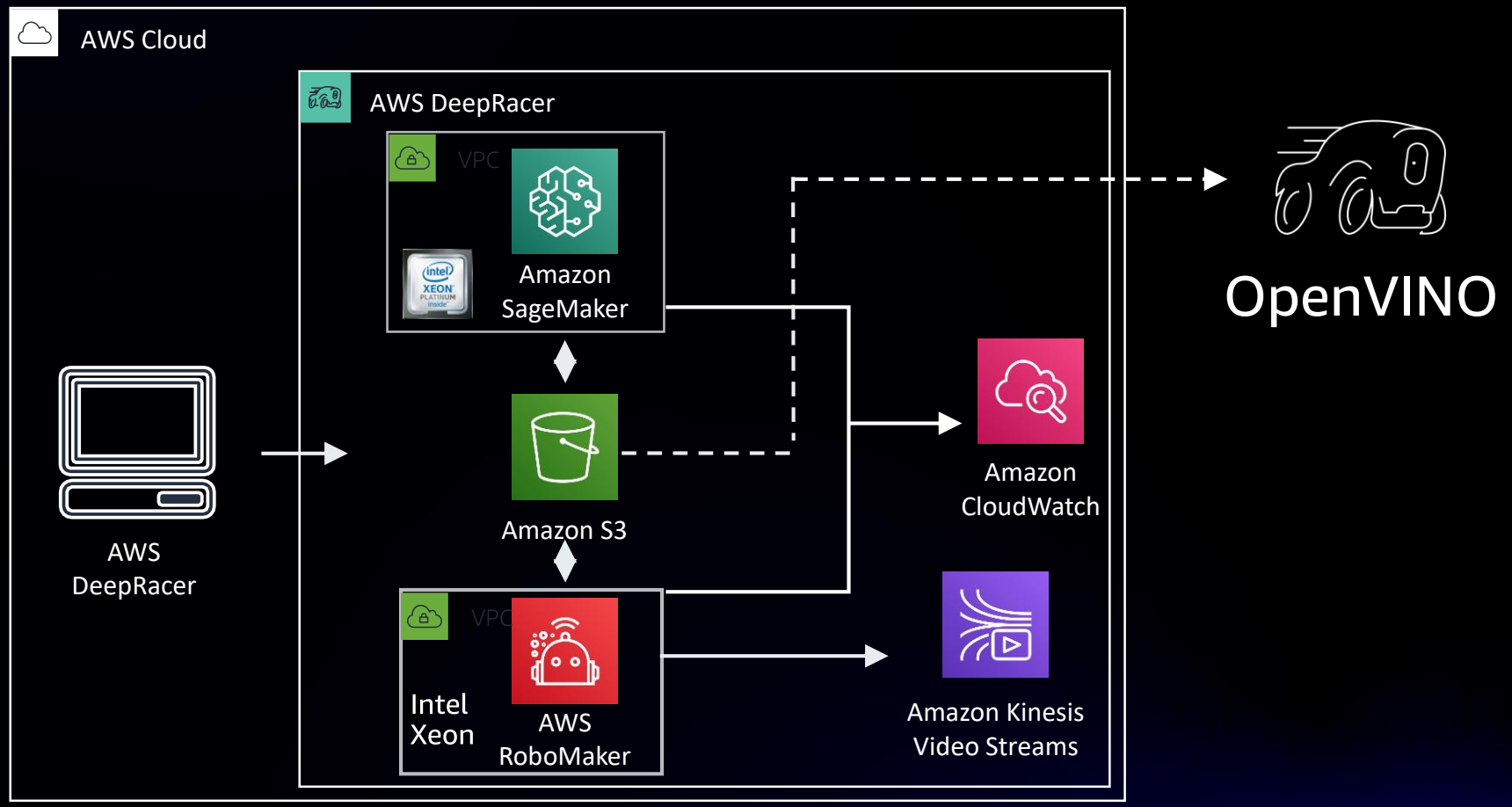


Action list

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

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AWS DeepRacer simulator architecture



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Additional resources

- AWS DeepRacer Slack community: http://join.deepracing.io/
- GitHub: https://github.com/aws-samples/aws-deepracer-workshops/
- No-cost 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://intel.ly/3Frn174

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AWS DeepRacer console



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

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Access the AWS Events app



https://onelink.to/4y9ve4

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Thank you!

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