WARWICK
THE UNIVERSITY OF WARWICK

# The Mathematics of Reinforcement Learning and its Applications

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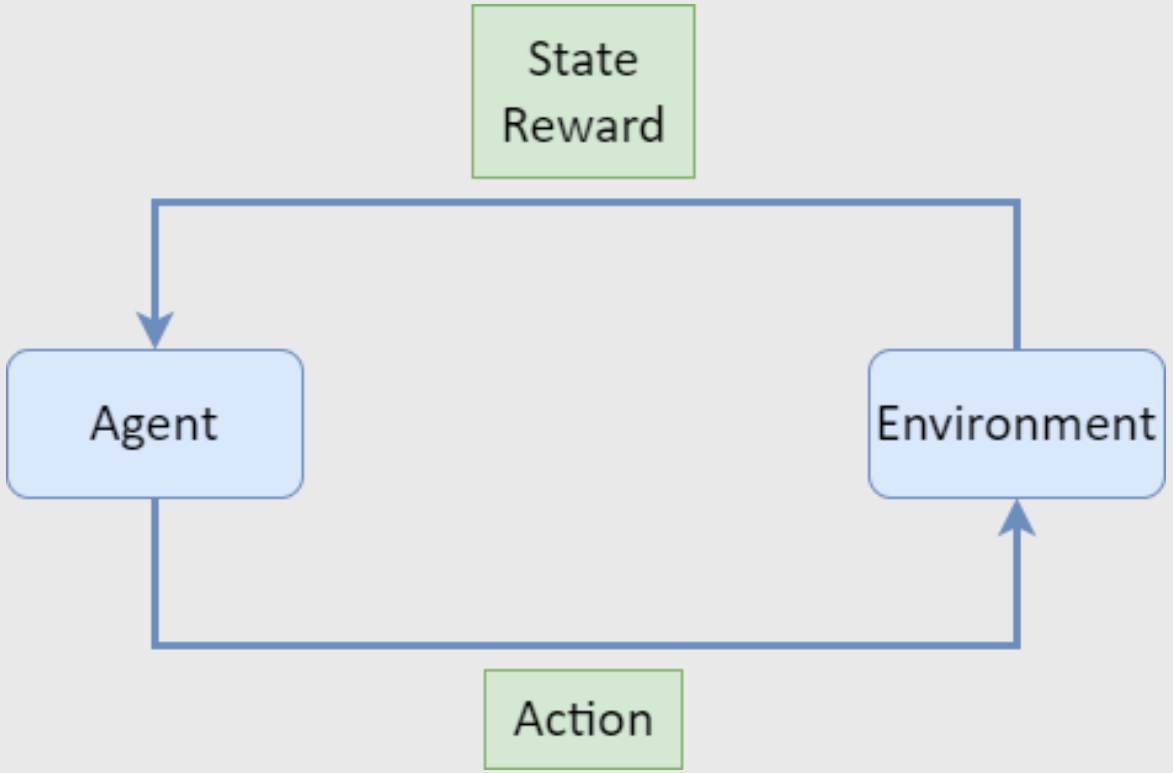
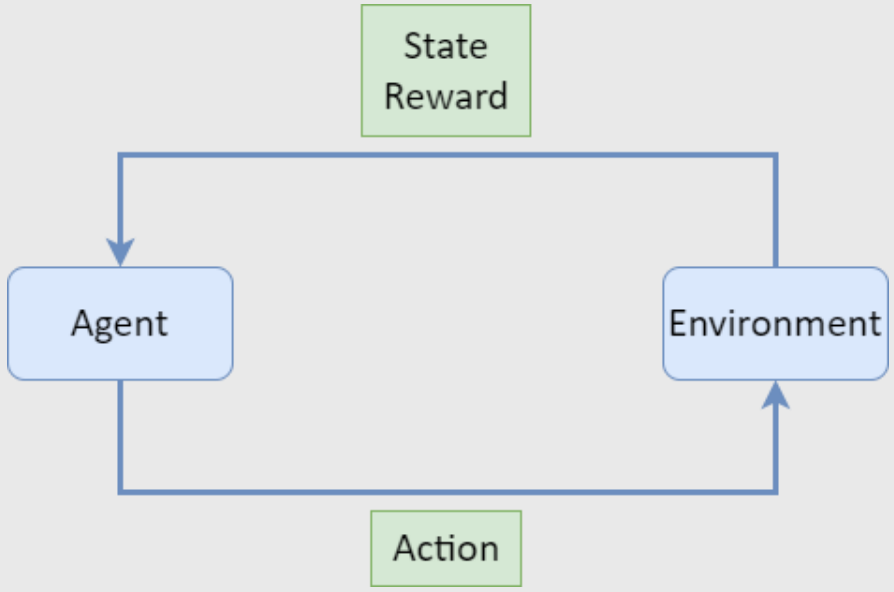
# What is Reinforcement Learning?

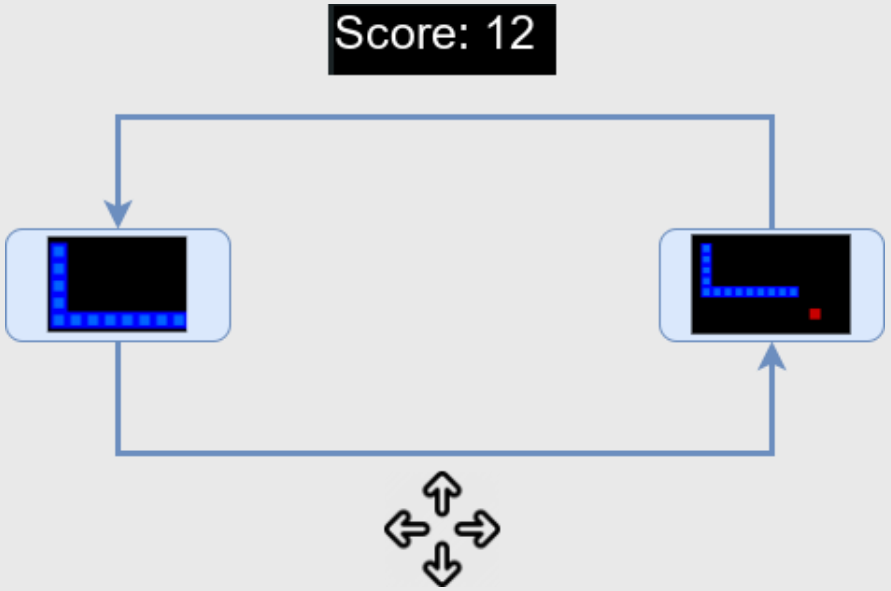
- Reinforcement learning studies how an agent can learn to behave via feedback and interaction with an environment to maximise rewards.
- There is no answer, but a reinforcement agent decides what to do to perform the task from past experiences.



# What are the uses of Reinforcement Learning?

- Robotics
- Autonomous Vehicles and Traffic Control
- Chatbots (NLP)
- Healthcare
- **Video Games**



# Bellman Equation (Q-Learning)

$$\underbrace{Q_{new}(s,a)}_{\text{Updated Q value}} = \underbrace{Q(s,a)}_{\text{Current Q value}} + \alpha[\underbrace{R(s,a)}_{\text{Immediate reward after taking action}} + \lambda \underbrace{\max[Q(s',a)]}_{\text{Maximum Q-Value among all possible actions in next state}} - \underbrace{Q(s,a)}_{\text{Current Q value}}]$$

**Variables**

$s$ = state

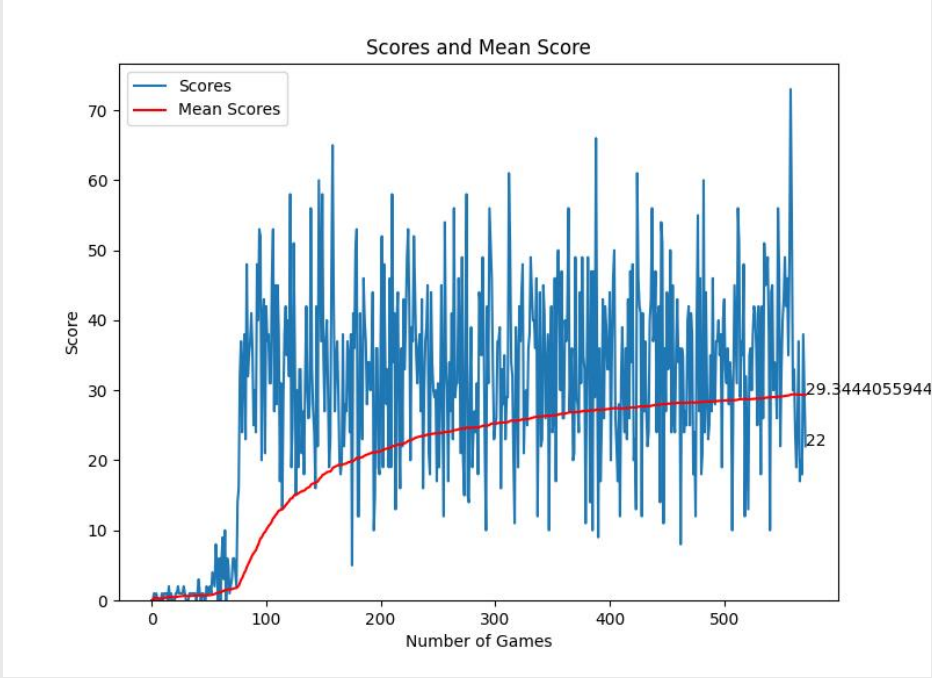
$a$ = action

**Parameters**

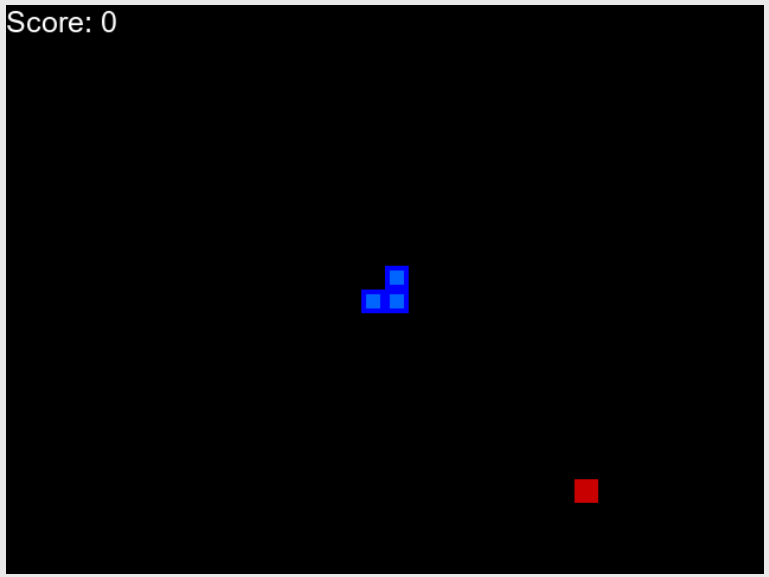
$\alpha$= Learning Rate – Controls step size of update

$\lambda$= Discount Rate – Balance immediate and future rewards

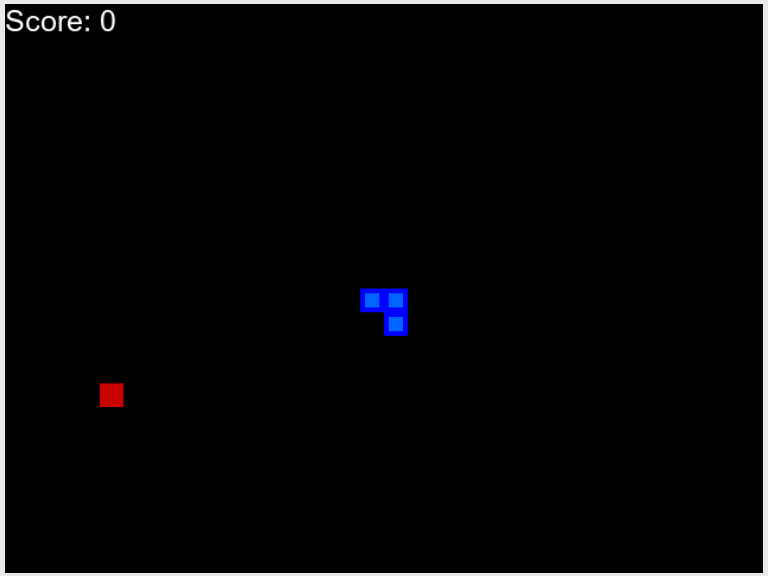
# Exploitation vs Exploration



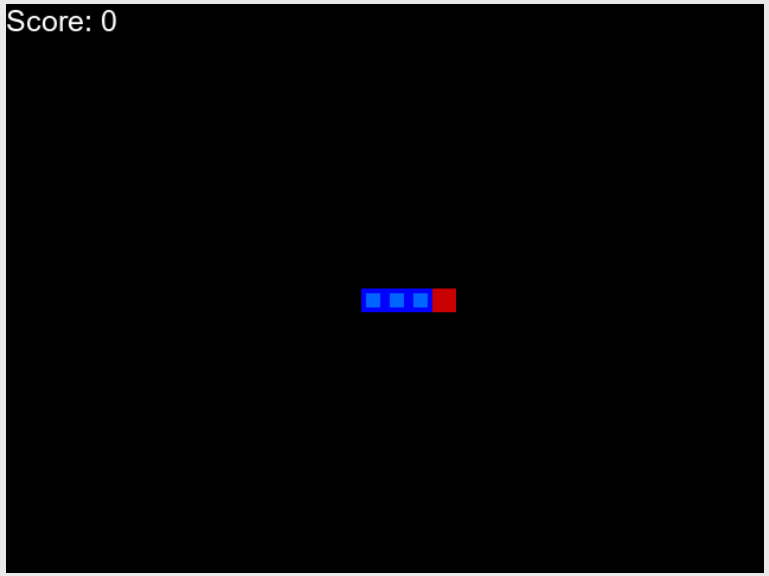

After 10 Games




After 50 Games




After 150 Games (125% speed)



# Thank You!