

# Comparison between NEAT and Deep-Q learning

## The Mountain Car problem

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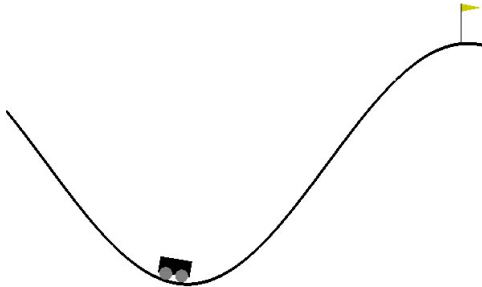
Projekt i datavetenskap, LTH, 2017

# Outline

- 1 MountainCar
- 2 Deep-Q learning
- 3 Neuroevolution of augmenting topologies (NEAT)
- 4 Results
- 5 Discussion

# Problem

## MountainCar



- Question: given a state  $s$ ; what is the action that leads to highest reward?

- ① Quick reward; long reward?

- Bellman equation:  $Q(s, a) = r(s, a) + \gamma \max_{a'} Q(s', a')$

- ①  $\gamma = 0$ ;  $\gamma = 1$ ?

- Q-learning:

$$Q(s, a) = Q(s, a) + \alpha(r(s, a) + \gamma \max_{a'} Q(s', a') - Q(s, a))$$

- ① Iteratively improve value system for  $(s, a)$ -pairs.

- Deep Q:

- ① Neural network architecture

- ② Episode:  $\langle s, a, r, s' \rangle$

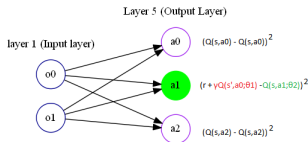
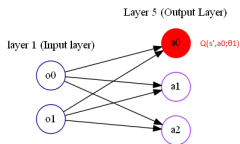
- ③ Loss =  $(r + \gamma \max_{a'} Q(s', a'; \theta^-) - Q(s, a; \theta))^2$

- ④ Interpret as: given  $\langle s, a, r, s' \rangle$ , calculate  $\gamma \max_{a'} Q(s', a'; \theta^-)$  in supporting network. Use this result to backpropagate in regular network on  $\langle s, a \rangle$ .

# Deep-Q

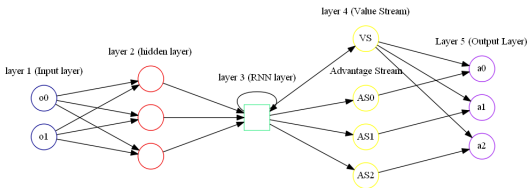
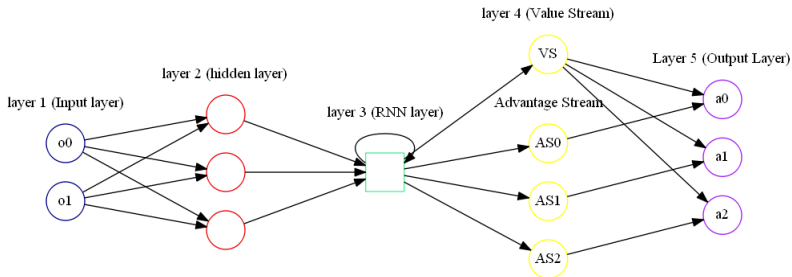
## Example, Deep Q Recurrent Network

- 2 Identical networks with different weights and learning rates. First network (supporting network) to calculate  $\max_{a'} Q(s', a'; \theta_1)$ . Second to backpropagate for  $\langle s, a \rangle$ .



# Deep-Q

## Network structure, Deep Q Recurrent Network



# NEAT

## What is NEAT?

- A genetic technique to evolve neural networks
- What makes NEAT unique compared to other genetic algorithms?

# NEAT

## What is NEAT?

### Different types of mutations

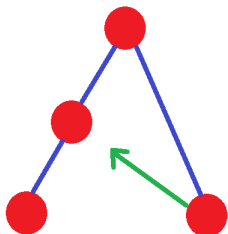
- Weight mutation
- Activation mutation
- Insert new link
- Insert new node
- Activation/deactivation of links



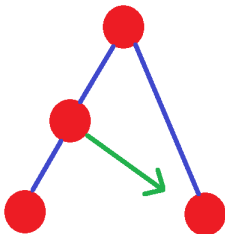
# NEAT

## What is NEAT?

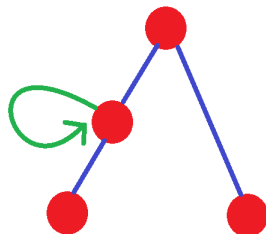
Different types of links



**Forward**



**Backward**



**Recurrent**

# NEAT

## What is NEAT?

What makes NEAT unique is:

- The population is divided into species
- Each specimen has their own fitness and each species has a fitness score

## Results

- <http://31.208.78.186:5891/>
- <https://supernovan.github.io/>

- Discussion of results
- Issues
- Further work

# For Further Reading I



Buckland, Mat.

*AI Techniques for Game Programming..*

Cincinnati: Premier Press, 2002.



Kenneth Stanley

AI for Game Programming: