My Coding Story

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19th March 2015

My Journey to Code

Feb 2014

Mar 2015

First line
of code
(VBA)

My Journey to Code

My Journey to Code

Oct 2014

Mar 2015

Started
using
Python

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python
SOFTWARE FOUNDATION

PythonNamibia2015
OF NAMIBIA • WINDHOEK

Reinforcement Learning

Auraya

How to train a dog?

How to train a dog?

The Q-learning Algorithm

Set all Q and V values to 0

repeat

- Observe the current state s_t
- Select and perform an action a_t
- Observe the reward $r(s_t, a_t)$
- Perform the following updates:

$$Q_{t+1} \leftarrow (1-\alpha)Q_t(s_t, a_t) + \alpha[r(s_t, a_t) + \gamma V_t(s_{t+1})]$$

$$V_{t+1}(s) \leftarrow max_a Q_t(s, a)$$

until *convergence*

Rory The Robot

Rory The Robot

Rory The Robot

only 85% successful

Code Structure

```
class Board():
```

grid_height

grid_width

number_of_episodes

robot

squares

```
class Squares():
```

coords

identifier

reward

```
class Robot():
```

playing_board

actions

action_selection_parameter

learning_rate

discount_rate

moves

episode

coords

Vs

Qs

movement_dictionary

Action Selection - Exploration vs Exploitation

ϵ-Soft Policy

```
def select_action(self, sqr):
    """
    Selects which action to take using the epsilon-soft action selection policy
    """
    rnd_num = random.random()
    if rnd_num < 1 - self.action_selection_parameter:
        return str(max(self.Qs[sqr], key=lambda x: self.Qs[sqr][x]))
    return random.choice(self.actions)
```

Movement

```python
def find_destination(self, sqr, action):
    """
    Chooses the new coordinates after taking an action, according to the faultiness
    """
    rnd_num = random.random()
    sum_p, indx = 0, 0
    while rnd_num > sum_p:
        direction = self.actions[indx]
        sum_p += self.transitions[action][indx]
        indx += 1
    return self.movement_dict[direction](sqr)
```

Learning

```python
def Q_Learning(self, action, reward, sqr, new_sqr):
    """
    Updates Rory's Q and V values
    """
    self.Qs[sqr][action] = (
        1-self.learning_rate)*self.Qs[sqr][action] + self.learning_rate*(
        reward + self.discount_rate*self.Vs[new_sqr]
        )
    self.Vs[sqr] = max(self.Qs[sqr].values())
```

Simulation

```
def simulate(self):
    """
    Simulates many episodes of the game while the robots learns the best policies
    """
    plt.ion()
    self.show_board()
    wait = raw_input('Press enter to continue.')
    print 'Simulating .......'
    while self.robot.episode < self.number_of_episodes:
        action = self.robot.select_action(self.robot.coords)
        new_coords = self.robot.find_destination(self.robot.coords, action)
        self.robot.moves += 1

        reward = self.squares[new_coords[1]][new_coords[0]].reward + (
            self.squares[new_coords[1]][new_coords[0]].move_cost * self.robot.moves)
        self.robot.Q_Learning(action, reward, self.robot.coords, new_coords)

        self.robot.coords = new_coords

        if (self.squares[new_coords[1]][new_coords[0]].identifier == 'Death' or
            self.squares[new_coords[1]][new_coords[0]].identifier == 'Goal'):
            self.robot.moves = 0
            self.robot.coords = tuple(self.starting_coords)
            self.robot.episode += 1
    self.update_results()
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Demo

Learning Rate, α

Small $\alpha \implies$ historical rewards more important

Large $\alpha \implies$ the latest reward more important

Figure: $\alpha = 0.03$

Figure: $\alpha = 0.1$

Figure: $\alpha = 0.5$

Discount Rate, γ

Small $\gamma \implies$ look for immediate rewards

Large $\gamma \implies$ strive for long term rewards

Figure: $\gamma = 0.1$

Figure: $\gamma = 0.9$

Figure: $\gamma = 0.99$

Video

A robot learning to walk

Queueing Networks in Healthcare

Demo