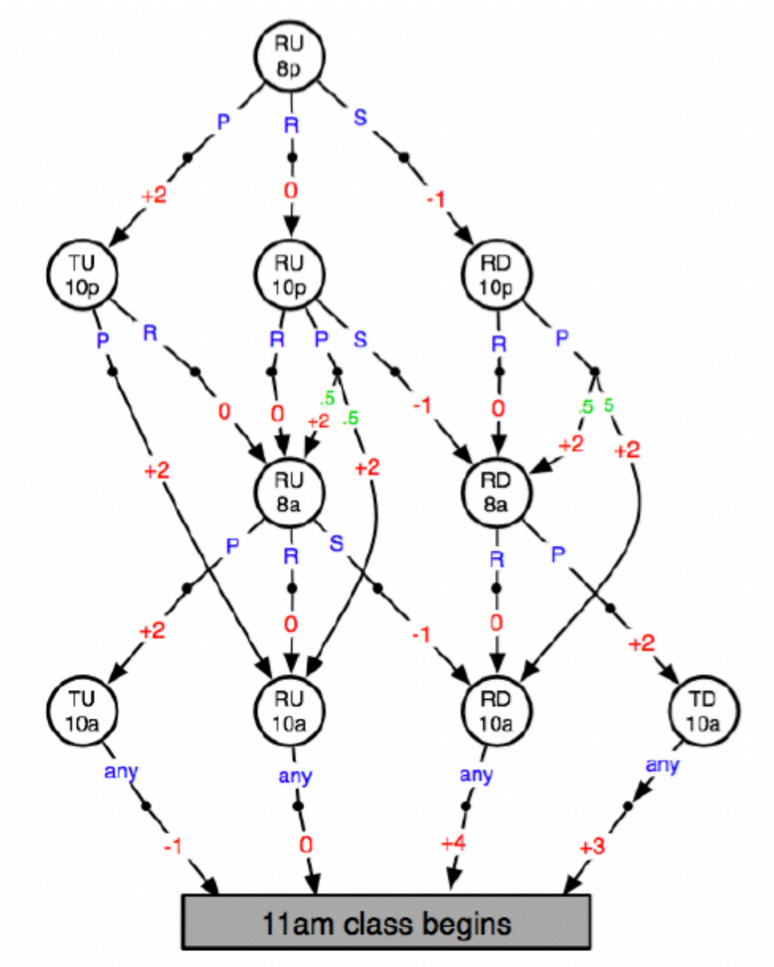
Programming assignment 3
Reinforcement learning – party problem

Yanbing Wang
11/7/2019

The figure below describes a Markov decision process based on life as a student and the decisions one must make to both have a good time and remain in good academic standing.



A.

1. Sequences of experiences from each episode, including the return observed.

```
episode 1
state RU8p, action R, reward 0
state RU10p, action P, reward 2
state RU8a, action R, reward 2
state RU10a, action R, reward 2
11am class begins

episode 2
state RU8p, action P, reward 2
state TU10p, action P, reward 4
state RU10a, action S, reward 4
11am class begins

episode 3
state RU8p, action R, reward 0
state RU10p, action P, reward 2
state RU8a, action R, reward 2
state RU10a, action S, reward 2
11am class begins

episode 4
state RU8p, action P, reward 2
state TU10p, action P, reward 4
state RU10a, action S, reward 4
11am class begins

episode 5
state RU8p, action P, reward 2
state TU10p, action P, reward 4
state RU10a, action R, reward 4
11am class begins

episode 6
state RU8p, action S, reward -1
state RD10p, action R, reward -1
state RD8a, action R, reward -1
state RD10a, action S, reward 3
11am class begins

episode 7
state RU8p, action R, reward 0
state RU10p, action P, reward 2
state RU8a, action S, reward 1
state RD10a, action R, reward 5
11am class begins

episode 8
state RU8p, action R, reward 0
state RU10p, action S, reward -1
state RD8a, action R, reward -1
state RD10a, action P, reward 3
11am class begins

episode 9
state RU8p, action R, reward 0
state RU10p, action P, reward 2
state RU10a, action R, reward 2
11am class begins

episode 10
state RU8p, action R, reward 0
state RU10p, action R, reward 0
state RU8a, action S, reward -1
state RD10a, action R, reward 3
11am class begins

episode 11
state RU8p, action R, reward 0
state RU10p, action P, reward 2
state RU8a, action P, reward 4
state TU10a, action S, reward 3
11am class begins

episode 12
state RU8p, action R, reward 0
state RU10p, action R, reward 0
state RU8a, action S, reward -1
state RD10a, action R, reward 3
11am class begins

episode 13
state RU8p, action S, reward -1
state RD10p, action P, reward 1
state RD8a, action R, reward 1
state RD10a, action S, reward 5
11am class begins

episode 14
state RU8p, action P, reward 2
state TU10p, action R, reward 2
state RU8a, action R, reward 2
state RU10a, action R, reward 2
```

```
11am class begins

episode 15
state RU8p, action S, reward -1
state RD10p, action R, reward -1
state RD8a, action P, reward 1
state TD10a, action R, reward 4
11am class begins

episode 16
state RU8p, action S, reward -1
state RD10p, action R, reward -1
state RD8a, action R, reward -1
state RD10a, action S, reward 3
11am class begins

episode 17
state RU8p, action P, reward 2
state TU10p, action R, reward 2
state RU8a, action R, reward 2
state RU10a, action R, reward 2
11am class begins

episode 18
state RU8p, action P, reward 2
state TU10p, action P, reward 4
state RU10a, action R, reward 4
11am class begins

episode 19
state RU8p, action S, reward -1
state RD10p, action R, reward -1
state RD8a, action R, reward -1
state RD10a, action P, reward 3
11am class begins

episode 20
state RU8p, action S, reward -1
state RD10p, action R, reward -1
state RD8a, action R, reward -1
state RD10a, action R, reward 3
11am class begins

episode 21
```

```
state RU8p, action R, reward 0
state RU10p, action S, reward -1
state RD8a, action R, reward -1
state RD10a, action R, reward 3
11am class begins

episode 22
state RU8p, action S, reward -1
state RD10p, action P, reward 1
state RD10a, action S, reward 5
11am class begins

episode 23
state RU8p, action R, reward 0
state RU10p, action S, reward -1
state RD8a, action R, reward -1
state RD10a, action R, reward 3
11am class begins

episode 24
state RU8p, action P, reward 2
state TU10p, action P, reward 4
state RU10a, action S, reward 4
11am class begins

episode 25
state RU8p, action S, reward -1
state RD10p, action P, reward 1
state RD8a, action R, reward 1
state RD10a, action P, reward 5
11am class begins

episode 26
state RU8p, action S, reward -1
state RD10p, action R, reward -1
state RD8a, action P, reward 1
state TD10a, action S, reward 4
11am class begins

episode 27
state RU8p, action S, reward -1
state RD10p, action R, reward -1
state RD8a, action R, reward -1
state RD10a, action S, reward 3
```

```
11am class begins

episode 28
state RU8p, action R, reward 0
state RU10p, action P, reward 2
state RU8a, action P, reward 4
state TU10a, action S, reward 3
11am class begins

episode 29
state RU8p, action P, reward 2
state TU10p, action R, reward 2
state RU8a, action S, reward 1
state RD10a, action S, reward 5
11am class begins

episode 30
state RU8p, action P, reward 2
state TU10p, action P, reward 4
state RU10a, action S, reward 4
11am class begins

episode 31
state RU8p, action S, reward -1
state RD10p, action P, reward 1
state RD8a, action P, reward 3
state TD10a, action P, reward 6
11am class begins

episode 32
state RU8p, action P, reward 2
state TU10p, action P, reward 4
state RU10a, action R, reward 4
11am class begins

episode 33
state RU8p, action S, reward -1
state RD10p, action P, reward 1
state RD8a, action P, reward 3
state TD10a, action R, reward 6
11am class begins

episode 34
state RU8p, action R, reward 0
state RU10p, action R, reward 0
state RU8a, action R, reward 0
state RU10a, action S, reward 0
11am class begins

episode 35
state RU8p, action P, reward 2
state TU10p, action P, reward 4
state RU10a, action S, reward 4
11am class begins

episode 36
state RU8p, action P, reward 2
state TU10p, action P, reward 4
state RU10a, action S, reward 4
11am class begins

episode 37
state RU8p, action P, reward 2
state TU10p, action R, reward 2
state RU8a, action S, reward 1
state RD10a, action P, reward 5
11am class begins

episode 38
state RU8p, action P, reward 2
state TU10p, action R, reward 2
state RU8a, action S, reward 1
state RD10a, action R, reward 5
11am class begins

episode 39
state RU8p, action S, reward -1
state RD10p, action P, reward 1
state RD10a, action R, reward 5
11am class begins

episode 40
state RU8p, action P, reward 2
state TU10p, action P, reward 4
state RU10a, action S, reward 4
11am class begins

episode 41
```

```
state RU8p, action P, reward 2
state TU10p, action P, reward 4
state RU10a, action S, reward 4
11am class begins

episode 42
state RU8p, action P, reward 2
state TU10p, action P, reward 4
state RU10a, action P, reward 4
11am class begins

episode 43
state RU8p, action R, reward 0
state RU10p, action S, reward -1
state RD8a, action R, reward -1
state RD10a, action S, reward 3
11am class begins

episode 44
state RU8p, action P, reward 2
state TU10p, action P, reward 4
state RU10a, action S, reward 4
11am class begins

episode 45
state RU8p, action R, reward 0
state RU10p, action P, reward 2
state RU10a, action R, reward 2
11am class begins

episode 46
state RU8p, action S, reward -1
state RD10p, action R, reward -1
state RD8a, action P, reward 1
state TD10a, action P, reward 4
11am class begins

episode 47
state RU8p, action R, reward 0
state RU10p, action S, reward -1
state RD8a, action R, reward -1
state RD10a, action S, reward 3
11am class begins
```

```
episode 48
state RU8p, action P, reward 2
state TU10p, action R, reward 2
state RU8a, action P, reward 4
state TU10a, action R, reward 3
11am class begins

episode 49
state RU8p, action S, reward -1
state RD10p, action R, reward -1
state RD8a, action R, reward -1
state RD10a, action P, reward 3
11am class begins

episode 50
state RU8p, action R, reward 0
state RU10p, action R, reward 0
state RU8a, action P, reward 2
state TU10a, action S, reward 1
11am class begins
```

2. The value of each state using the Bellman equation

```
Iteration 1, delta = 4.0
Iteration 2, delta = 3.5
Iteration 3, delta = 2.625
Iteration 4, delta = 1.5972222222222219
Iteration 5, delta = 0
The value of state RU8p is 3.514
The value of state TU10p is 1.667
The value of state RU10p is 2.500
The value of state RD10p is 5.375
The value of state RU8a is 1.333
The value of state RD8a is 4.500
The value of state TU10a is -1.000
The value of state RU10a is 0.000
The value of state RD10a is 4.000
The value of state TD10a is 3.000
The value of state 11am class begins is 0.000
```

3. The average return from 50 episodes

```
Average return for 50 episodes is 3.540.
This value is similar to the value of the start state “RU8P” obtained from
the Bellman equation, 3.514.
```

4. The source code and instructions are attached.

B. Policy iteration

1. The policy and value function for each iteration of the algorithm.

```
While iteration 0
State values: RU8p: 4.0 | TU10p: 2.0 | RU10p: 2.5 | RD10p: 6.5 | RU8a: 1.0
 | RD8a: 5.0 | TU10a: -1.0 | RU10a: 0.0 | RD10a: 4.0 | TD10a: 3.0 | 11am c
lass begins: 0.0 |
Policy: RU8p: S | TU10p: R | RU10p: S | RD10p: P | RU8a: S | RD8a: P | TU1
0a: P | RU10a: P | RD10a: P | TD10a: P |

While iteration 1
State values: RU8p: 5.5 | TU10p: 2.0 | RU10p: 4.0 | RD10p: 6.5 | RU8a: 3.0
 | RD8a: 5.0 | TU10a: -1.0 | RU10a: 0.0 | RD10a: 4.0 | TD10a: 3.0 | 11am c
lass begins: 0.0 |
Policy: RU8p: S | TU10p: R | RU10p: S | RD10p: P | RU8a: S | RD8a: P | TU1
0a: P | RU10a: P | RD10a: P | TD10a: P |

While iteration 2
State values: RU8p: 5.5 | TU10p: 3.0 | RU10p: 4.0 | RD10p: 6.5 | RU8a: 3.0
 | RD8a: 5.0 | TU10a: -1.0 | RU10a: 0.0 | RD10a: 4.0 | TD10a: 3.0 | 11am c
lass begins: 0.0 |
Policy: RU8p: S | TU10p: R | RU10p: S | RD10p: P | RU8a: S | RD8a: P | TU1
0a: P | RU10a: P | RD10a: P | TD10a: P |
```

2. Source code and instructions are attached.