C Experimental Details

1 Import Modules

[1]:
```
import numpy as np
from fourrooms import Fourrooms
from IPython.display import clear_output
from aoaoc_tabular import *
import matplotlib.pyplot as plt
from visualize import Visualization
```

2 HyperParameters

[2]:
```
# Replace the command line argparse
class Arguments:
    def __init__(self):
        # Numbers
        self.nepisodes=3000
        self.nsteps=2000
        self.noptions=2

        # Learning Rates
        self.lr_term=0.25
        self.lr_intra=0.25
        self.lr_critic=0.5
        self.lr_criticA=0.5
        self.lr_attend=0.01

        # Environment Parameters
        self.discount=0.99
        self.punishEachStep = True
        self.modified = True

        # Attention Parameters
        self.h_learn = True
        self.normalize = True

        # Policy Parameters
        self.epsilon=1e-1
        self.temp=2.

        # Objective Parameters
        self.wo1 = 0.1   #q
        self.wo2 = 1.    #cosim
        self.wo3 = 0.    #entropy
        self.wo4 = 0.    #size

        # Randomness Parameters
        self.seed=2222
        self.seed_startstate=1111
```

```
        # Display Parameters
        self.showMap = False
        self.showAttention = False
        self.showOptPref = False
        self.showFrequency = 10

        # Other Parameters
        self.baseline=True
        self.dc = 2.


args = Arguments()
```

3 Run

3.1 Set up

[3]:
```
rng = np.random.RandomState(args.seed)
env = Fourrooms(args.seed_startstate, args.punishEachStep, args.modified)

features = Tabular(env.observation_space)
nfeatures, nactions = len(features), env.action_space

viz = Visualization(env, args, nactions)
```

3.2 Main loop

[ ]:
```
# Set up classes
policy_over_options = POO(rng, nfeatures, args)
CoSimObj.reset()
options = [Option(rng, nfeatures, nactions, args, policy_over_options, i) for i in
  range(args.noptions)]

# Loop through games
for episode in range(args.nepisodes):
    # Initial state
    return_per_episode = 0.0
    observation = env.reset()
    phi = features(observation)
    option = policy_over_options.sample(phi)
    action = options[option].sample(phi)
    traject = [[phi,option],[phi,option],action]
    viz.resetMap(phi)

    # Reset record
    cumreward = 0.
    duration = 1
    option_switches = 0
    avgduration = 0.

    # Loop through frames in 1 game
```

```
  for step in range(args.nsteps):
      # Collect feedback from environment
      observation, reward, done, _ = env.step(action)
      phi = features(observation)
      return_per_episode += pow(args.discount,step)*reward

      # Render
      if args.showMap and episode % 100 == 99:
          clear_output(wait=True)
          viz.showMap(phi, option)

      # Store option index
      last_option = option

      # Check termination
      termination = options[option].terminate(phi, value=True)
      if options[option].terminate(phi):
          option = policy_over_options.sample(phi)
          option_switches += 1
          avgduration += (1./option_switches)*(duration - avgduration)
          duration = 1

      # Record into trajectory
      traject[0] = traject[1]
      traject[1] = [phi, option]
      traject[2] = action

      # Sample next action
      action = options[option].sample(phi)

      # Policy Evaluation + Policy Improvement
      baseline = policy_over_options.value(traject[0][0], traject[0][1])
      advantage = policy_over_options.advantage(phi, last_option)
      options[last_option].update(traject, reward, done, phi, last_option,
termination, baseline, advantage)
      policy_over_options.update(traject, reward, done, termination)

      # End of frame
      cumreward += reward
      duration += 1
      if done:
          break

  # Attention graph
  if episode % args.showFrequency == 0:
      if args.showAttention:
          clear_output(wait=True)
          viz.showAttention(options)
          print(options[0].policy.attention.weights)
      if args.showOptPref:
          clear_output(wait=True)
  print('Episode {} steps {} cumreward {} avg. duration {} switches {}'.
format(episode, step, cumreward, avgduration, option_switches))
```

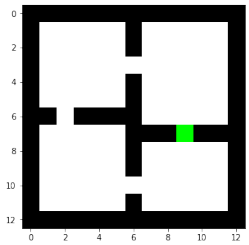
4 Visualization

4.1 Simulate an episode

[5]:
```
states = np.zeros((13,13), dtype="int")
occupancy = env.occupancy.astype('float64')
s=0
for i in range(13):
    for j in range(13):
        if occupancy[i,j] == 0:
            states[i,j] = s
            s+=1
print(states)
```

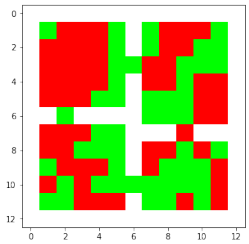
```
[[  0   0   0   0   0   0   0   0   0   0   0   0   0]
 [  0   0   1   2   3   4   0   5   6   7   8   9   0]
 [  0  10  11  12  13  14   0  15  16  17  18  19   0]
 [  0  20  21  22  23  24  25  26  27  28  29  30   0]
 [  0  31  32  33  34  35   0  36  37  38  39  40   0]
 [  0  41  42  43  44  45   0  46  47  48  49  50   0]
 [  0   0  51   0   0   0   0  52  53  54  55  56   0]
 [  0  57  58  59  60  61   0   0   0  62   0   0   0]
 [  0  63  64  65  66  67   0  68  69  70  71  72   0]
 [  0  73  74  75  76  77   0  78  79  80  81  82   0]
 [  0  83  84  85  86  87  88  89  90  91  92  93   0]
 [  0  94  95  96  97  98   0  99 100 101 102 103   0]
 [  0   0   0   0   0   0   0   0   0   0   0   0   0]]
```

[6]:
```
startState = 57
# Simulation
observation = env.reset(startState)
viz.resetMap(phi)

option = policy_over_options.sample(phi)
action = options[option].sample(phi)

for step in range(args.nsteps):
    observation, reward, done, _ = env.step(action)
    phi = features(observation)

    #render
    clear_output(wait=True)
    viz.showMap(phi, option)

    if options[option].terminate(phi):
        option = policy_over_options.sample(phi)

    action = options[option].sample(phi)

    if done:
        break
```

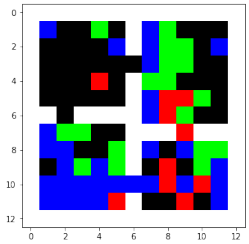


4.2 Display action and option preference in each state

[7]:
```
# Display option preference
viz.showPref(policy_over_options.weights)
```



[8]:
```
opt = 0
# Display action preference for opt
viz.showPref(options[opt].weights)
```



4.3 Display Attention

[9]:
```
viz.showAttention(options)
```