Active Reinforcement Learning

Virginia Tech CS5804

Outline

- Active reinforcement learning
  - Active adaptive dynamic programming
  - Q-learning

Passive Learning

- Recordings of agent running fixed policy
- Observe states, rewards, actions
  - Direct utility estimation
  - Adaptive dynamic programming (ADP)
  - Temporal-difference (TD) learning

Problems with Passive Reinforcement Learning

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Exploration

- Naive approach: randomly choose random action
  - shrink probability of random action over time
- Better approach: always act **greedy**, but overestimate rewards for unexplored states

$$U^+(s) \leftarrow R(s) + \gamma \max_a f\left(\sum_{s'} P(s'|s,a)U^+(s'), N(s,a)\right)$$

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Active TD-Learning

- Exactly the same as non-active TD learning

$$U(s) \leftarrow U(s) + \alpha(R(s) + \gamma U(s') - U(s))$$

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- Still need estimates of transition probabilities

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Approximate Q-Learning

$$\hat{Q}(s,a) := g(s,a,\boldsymbol{\theta}) := \theta_1 f_1(s,a) + \theta_2 f_2(s,a) + \ldots + \theta_d f_d(s,a)$$

$$\theta_i \leftarrow \theta_i + \alpha \left(R(s) + \gamma \max_{a'} \hat{Q}(s',a') - \hat{Q}(s,a) \right) \frac{\partial g}{\partial \theta_i}$$

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- Active TD: exactly the same as standard TD
- Q-learning: learn action-reward function directly, via TD learning
- Approximation uses derivative of utility function, easy if linear