An Actor Critic Algorithm for Mortgage Refinancing

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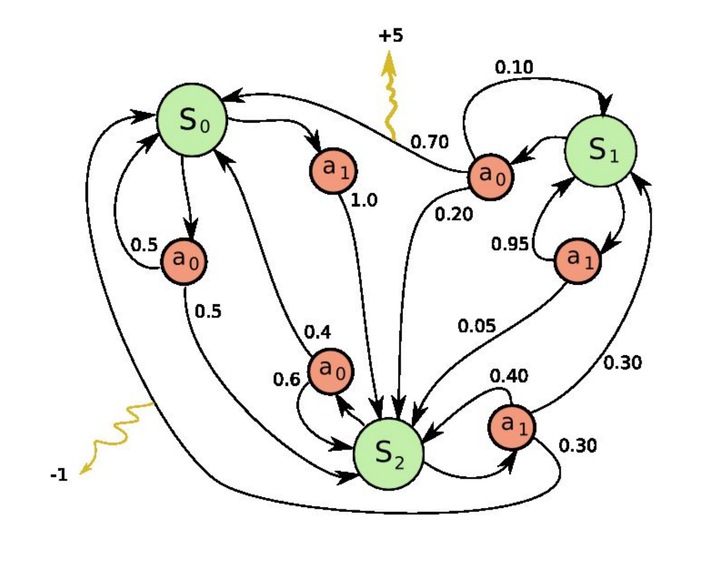
Reinforcement Learning

- Different from Supervised learning and Unsupervised learning
- State - Action - Reward scenario : A markov decision process

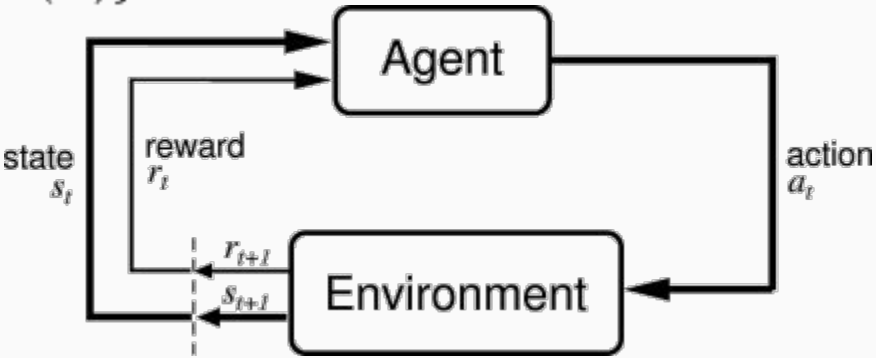
- Modern algorithms include Q-Learning, and Policy Gradients



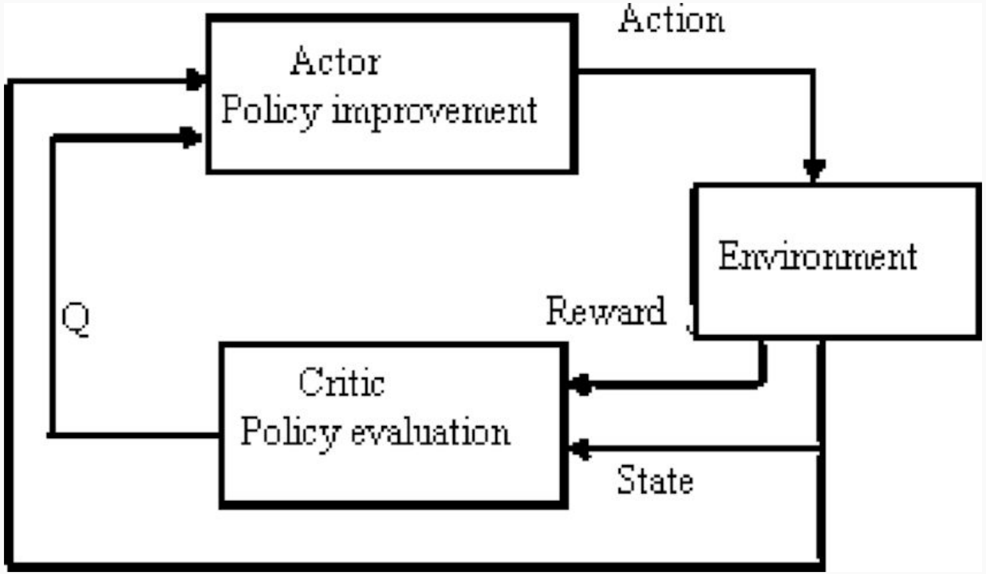
Reinforcement Learning

$$V^{\pi}(s) = R(s, \pi(s)) + \gamma \sum_{s'} P(s'|s, \pi(s)) V^{\pi}(s').$$

$$V^{*}(s) = \max_{a}\{R(s, a) + \gamma \sum_{s'} P(s'|s, a) V^{*}(s')\}.$$



Actor Critic Algorithms



Mortgage Refinancing Scenario

An agent has taken a loan with certain characteristics

Opportunities to refinance the loan arrive

Agent can choose whether to refinance

Objective: Minimise Cash Flow

Optimal Policies

In each state, it may or may not make sense to refinance - these decisions are made according to an (initially arbitrary) **policy**

The particular means of refinancing also need to be decided

The agent needs to learn how to make these decisions by learning an **optimal policy** over time

Difficulty of the Problem

The state space size is ~800,000

There is a lookahead involved with each value estimate, from an action set of size 11

Problem is intractable using typical Dynamic Programming, etc

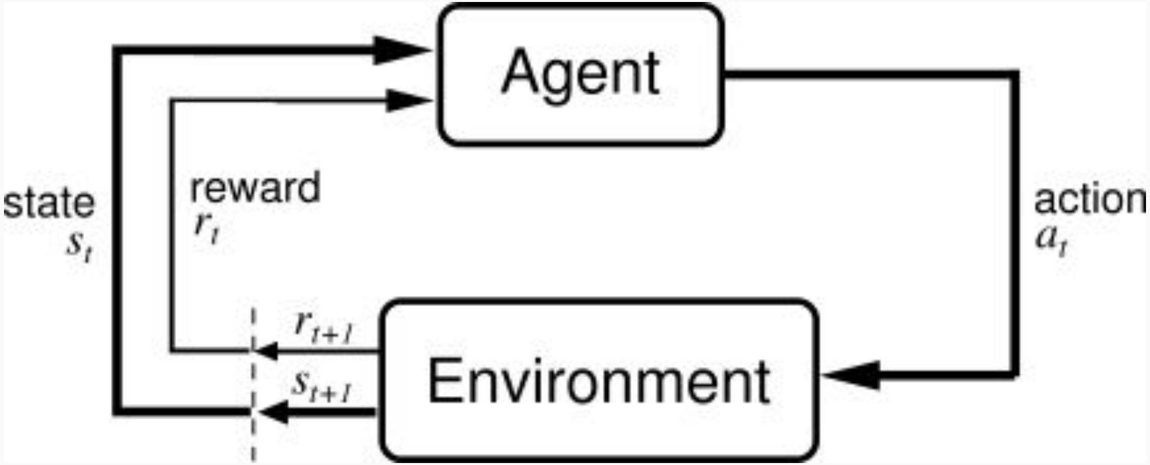
The Algorithm

Initialise arbitrary policies

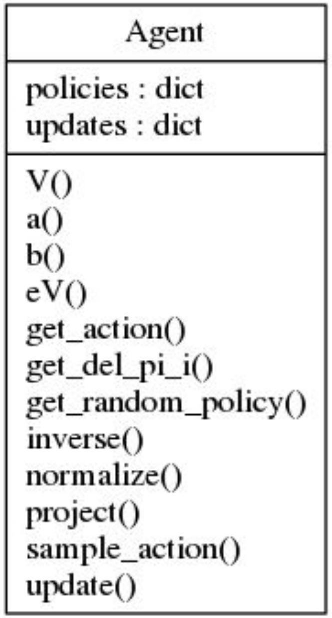
Modify them slightly (perturbations) based upon random updates using a hadamard matrix

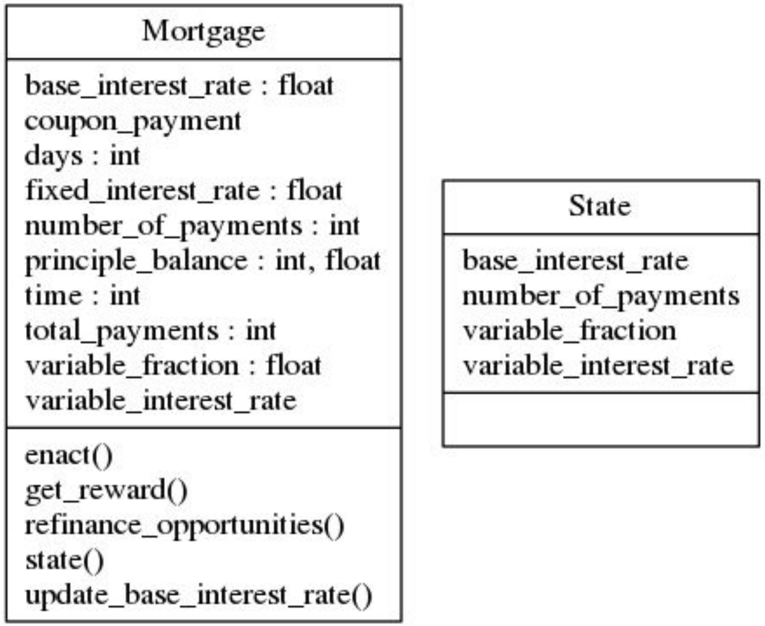
Use the wealth function to decide the direction of the updates, ultimately converging to optimal policies

Implementation Overview

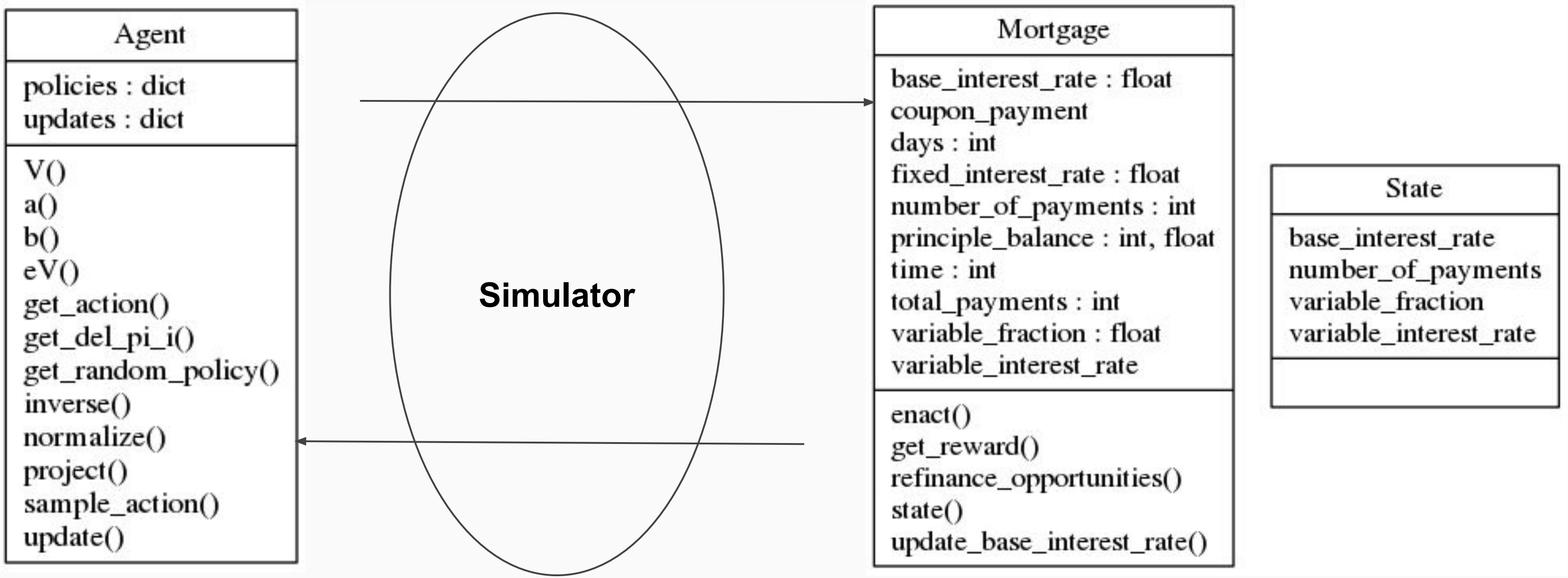


Implementation Overview





Implementation Overview



Demo

Code Demonstration

Expected runtime (1000 updates per state) until convergence > 20*11 days

Future Work

Comparison of different algorithms by using drop-in replacements for *agent.py*.

Comparison of same algorithm in different settings by using drop in replacements for environment like the OpenAI Gym.

Thank You