Trust Region Policy Optimization Demo

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July 11, 2018

Code

- The code for this project is available at: .

Implementation Details

Single Path Executable Pseudocode:

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- Initialize policy parameter $\theta$.
- Iterate until convergence:
    - Initialize/clear list $S$ of $\{\frac{G_\theta(s,a)}{\pi_\theta(s,a)}, s, a\}$.
    - Generate $N_\tau$ trajectories $\{\tau\}$.
    - For each trajectory $\tau \in \{\tau\}$:
        - For each $\{s, a\} \in \tau$:
            - Calculate discounted return $G_\theta(s, a)$ from this time to end of episode.
            - Calculate $\pi_\theta(s, a)$ at this $(s, a)$.
            - Store $\{\frac{G_\theta(s,a)}{\pi_\theta(s,a)}, s, a\}$ in $S$.
    - Use constraint optimizer to yield $\theta'$ by solving the problem:
        - Objective (to maximize): objective($S$, $\theta$).
        - Constraint: constraint($S$, $\theta$).
    - $\theta = \theta'$.
```

objective(S, θ') Pseudocode:

```
- Initialize $L = 0$.
- For $\{\frac{G_\theta(s,a)}{\pi_\theta(s,a)}, s, a\} \in S$:
    - Add $\pi_{\theta'}(s, a)\frac{G_\theta(s,a)}{\pi_\theta(s,a)}$ to $L$.
- Return $L$.
```

constraint(S, θ') Pseudocode:

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- Initialize $D = 0$.
- For $s \in S$:
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    - Add $D_{KL}(\pi_\theta(\cdot|s)||\pi_{\theta'}(\cdot|s))$ to D.
  - Return $\frac{D}{|S|}$.

Parameter Settings:

- $N_\tau = 5$ (adjusted to balance between empirical runtime and performance)
- $\gamma = 1$ (adjusted to maximize empirical performance)
- $\delta = 0.01$ (following Schulman et. al.)

Policy Function Encoding:

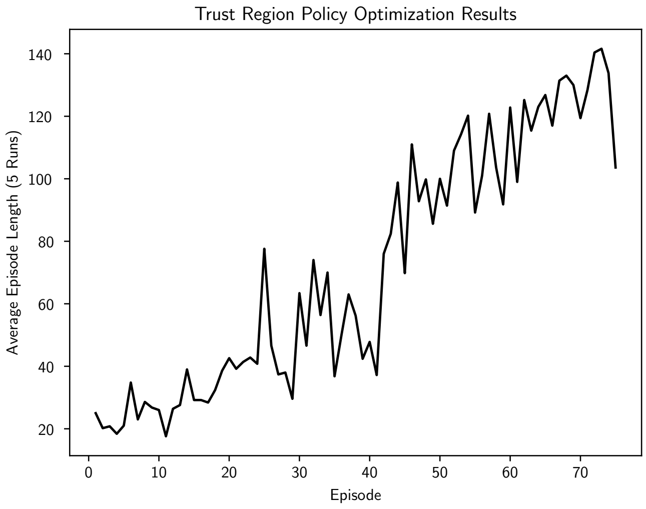
- Each state-action pair is converted to the feature vector $x(s, a)$. Letting S_{obs} and S_{act} be the size of the observation and action spaces, respectively, the size of the vector is $S_{obs} \times S_{act}$, where all features are 0 except for the S_{obs} features starting at index $S_{obs} \times a$, which are set to the environment's parameterization of s.
    - In this case, $S_{obs} = 4$ and $S_{act} = 2$.
- The policy function $\pi(a|s, \theta)$ performs the softmax on a parameterized linear mapping of feature vectors:

$$\pi(a|s, \theta) = \frac{e^{\theta^T x(s,a)}}{\sum_b e^{\theta^T x(s,b)}}$$

Constraint Optimization Method:

- I used scipy's optimize.minimize function, with the "trust-constr" method. All gradients and hessians were automatically calculated. A tolerance of 1×10^{-2} and a maximum iteration limit of 500 were used.

Results



- The results can be summarized as follows:
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