

Reviewing Natural Actor Critic methods

Maximilian Gehrke

Tabea Wilke

Yannik Frisch

Group 19 Oleg Arenz



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- Optimization problem:

$$\begin{aligned} \max_{\delta\theta} J(\theta + \delta\theta) &\approx J(\theta) + \delta\theta^T \nabla_{\theta} J(\theta) \\ \text{s.t. } \epsilon = D_{KL}(\pi_{\theta} || \pi_{\theta+\delta\theta}) &\approx \frac{1}{2} \delta\theta^T F_{\theta} \delta\theta \end{aligned}$$

- Solution:

$$\tilde{\nabla}_{\theta} J(\theta) = F_{\theta}^{-1} \nabla_{\theta} J(\theta).$$

- Fisher Information Matrix:

$$F_{\theta} = \mathbb{E}_{\pi_{\theta}} \left[\nabla_{\theta} \log \pi_{\theta}(a|s) \nabla_{\theta} \log \pi_{\theta}(a|s)^T \right]$$

The Natural Actor Critic algorithm



- Compatible Function Approximation:

$$\nabla_w A_w(s, a) = \nabla_\theta \log \pi_\theta(a|s)$$

$$A_w(s, a) = \nabla_\theta \log \pi_\theta(a|s) w$$

- Actor update:

$$\begin{aligned}\nabla_\theta J(\theta) &= \mathbb{E}_{\pi_\theta} [\nabla_\theta \log \pi_\theta(a|s) A_w(s, a)] \\ &= \mathbb{E}_{\pi_\theta} [\nabla_\theta \log \pi_\theta(a|s) \nabla_\theta \log \pi_\theta(a|s)^T w] = F_\theta w \\ \tilde{\nabla}_\theta J(\theta) &= w\end{aligned}$$

- Critic update: Episodic \Leftrightarrow LSTD(λ)

Extensions



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- ▶ Recursive Least Squares
- ▶ Fitted NAC + Importance Sampling
- ▶ Incremental NAC
- ▶ Implicit Incremental NAC

Conclusion & Discussion



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