Efficient policy evaluation by matrix sketching

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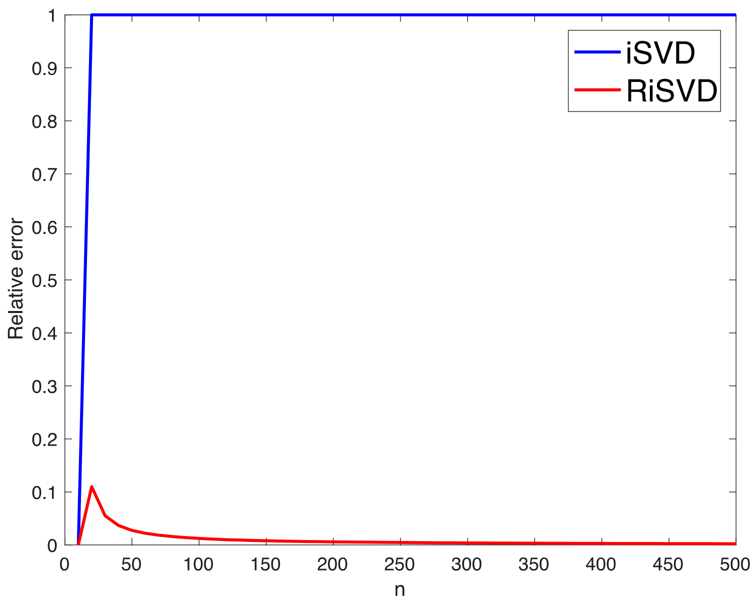
Problems & Ideas

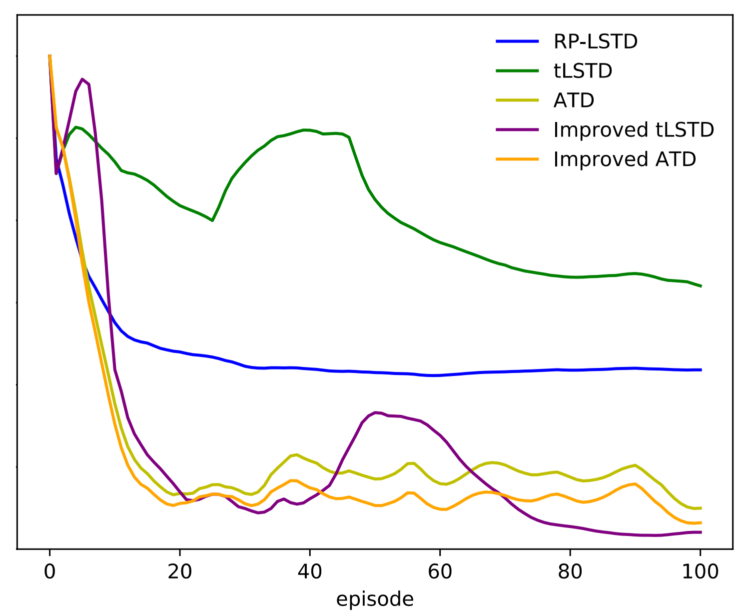
- Problem of linear value function approximations:
  - Classical methods are either sample inefficient (such as GTD) or computational inefficient (such as LSTD).
  - Existing approximate LSTD algorithms accelerate LSTD by matrix sketching. However, randomized algorithms (such as random projection) face the failure probability, while existing deterministic algorithms (such as truncated incremental SVD) do not guarantee the convergence.
  - Requiring a deterministic and provable matrix sketching algorithm to accelerate LSTD algorithm.

- Ideas: Periodically shrinks the singular values of the approximation matrix so that the fresh samples are more likely to be kept in the approximation matrix.

Main Contributions

- Contributions:
  - An explicit example of a simple low-rank matrix where traditional incremental SVD has very large approximation errors;
  - A variant of incremental SVD (called RiSVD) which has theoretical guarantees on the approximation errors;
  - Adopting RiSVD to improve t-LSTD and ATD(λ) algorithms and providing their theoretical guarantees.





Left: Comparison between iSVD and RiSVD; Right: Comparison between different policy evaluation methods on the Mountain Car domain.