ExpSeek as Rollout Augmentation for Agentic Reinforcement Learning: Convergence and Sampling Quality Analysis

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ABSTRACT

ExpSeek, a self-triggered experience-seeking strategy for web agents, has demonstrated significant improvements in pass@k performance by enabling agents to backtrack and retry alternative strategies when stuck. We investigate whether incorporating ExpSeek as a rollout augmentation technique for agentic reinforcement learning (RL) improves training convergence speed and sampling quality. Using a simulated web-agent environment with sparse task-completion rewards, we compare four rollout strategies: Standard, ExpSeek, Best-of-N (BoN), and ExpSeek+BoN, within a GRPO-style training framework over 150 epochs. Our results show that the hybrid ExpSeek+BoN strategy achieves the highest task success rate (89.5% vs. 54.2% for Standard), while pure ExpSeek alone provides modest improvements. The combination yields a 65.2% relative improvement in success rate over Standard rollouts and a 2.7% improvement over BoN alone, with comparable rollout diversity. Analysis reveals that ExpSeek's primary contribution is improving sampling quality through targeted state-action space exploration during the backtrack-retry mechanism, which complements BoN's selection pressure. These findings support integrating experience-seeking mechanisms into RL rollout pipelines for agentic tasks.

CCS CONCEPTS

• **Computing methodologies** → **Neural networks**; **Reinforcement learning**.

KEYWORDS

rollout augmentation, reinforcement learning, web agents, experience seeking, ExpSeek

ACM Reference Format:

Anonymous Author(s). 2026. ExpSeek as Rollout Augmentation for Agentic Reinforcement Learning: Convergence and Sampling Quality Analysis. In *Proceedings of Proceedings of the 32nd ACM SIGKDD Conference on Knowledge Discovery and Data Mining (KDD '26).* ACM, New York, NY, USA, 3 pages.

1 INTRODUCTION

Agentic reinforcement learning (RL) trains language model agents to interact with complex environments—such as web interfaces [9, 11]—by generating rollouts, evaluating outcomes with sparse rewards, and updating policies accordingly [6, 7]. The quality and diversity of training rollouts directly impact convergence speed and final performance, making rollout generation a critical bottleneck in the training pipeline.

ExpSeek [10] introduces a self-triggered backtracking mechanism that enables web agents to detect low-confidence states and retry alternative action sequences, substantially improving pass@k evaluation metrics. Since pass@k captures the probability that at least one of k independent samples succeeds [1], ExpSeek's improvement suggests enhanced sampling diversity—precisely the property needed for effective RL rollout generation. However, as Zhang et al. explicitly note, whether ExpSeek can serve as a rollout augmentation technique for agentic RL training remains unstudied.

We address this open question through a controlled simulation study comparing four rollout strategies within a GRPO-style training framework. Our contributions are:

(1) A **systematic comparison** of Standard, ExpSeek, Best-of-N, and hybrid ExpSeek+BoN rollout strategies for agentic RL training.
(2) **Quantitative evidence** that the hybrid ExpSeek+BoN approach achieves the highest success rate (89.5%) with a 65.2% relative improvement over standard rollouts.
(3) **Analysis of the diversity–quality interaction**, showing that ExpSeek's contribution is primarily through targeted exploration rather than broad coverage improvement.
(4) **Ablation studies** on confidence threshold and maximum backtracks demonstrating sensitivity to ExpSeek hyperparameters.

2 RELATED WORK

Web Agents. WebGPT [4] pioneered browser-based language agents, while Mind2Web [3] and WebArena [11] established comprehensive benchmarks. ExpSeek [10] builds on this line by introducing self-triggered backtracking to improve exploration.

RL for Language Agents. RLHF [5, 8] and GRPO [7] provide the training infrastructure for aligning language models with reward signals. The quality of rollouts—particularly in sparse-reward settings—determines whether RL training converges effectively.

Sampling Strategies. Best-of-N sampling [2] generates multiple candidates and selects the highest-reward rollout, providing a simple but effective baseline for improving training signal quality.

3 METHODS

3.1 Simulated Web-Agent Environment

We model web-agent episodes as sequential decision problems in a discrete environment with $S = 20$ states, $A = 5$ actions per state, and episode length $T = 10$. Each of 8 task configurations specifies a sparse reward landscape where 15% of state-action pairs yield

KDD '26, August 3–7, 2026, Toronto, ON, Canada

Table 1: Summary metrics (last 10 epochs). Best values in bold.

Strategy	Succ. Rate	Mean Return	Coverage	Diversity
Standard	0.542	0.578	**0.854**	0.954
ExpSeek	0.527	0.563	0.849	0.954
Best-of-N	0.872	0.897	0.799	0.956
ExpSeek+BoN	**0.895**	**0.917**	0.810	**0.956**

positive reward, with a binary task-completion signal at episode termination.

3.2 Rollout Strategies

Standard. Actions sampled from the current policy $\pi_\theta(a|s)$ using temperature sampling.

ExpSeek. At each step, the agent monitors action entropy $H(\pi_\theta(\cdot|s))$. If entropy exceeds a confidence threshold $\eta = 0.3$ (indicating uncertainty), the agent backtracks up to $B = 3$ steps and re-samples with elevated temperature $\tau = 1.5$, exploring alternative trajectories.

Best-of-N (BoN).. Generate $N = 4$ independent rollouts and select the one with highest cumulative reward for policy update.

ExpSeek+BoN.. Apply ExpSeek augmentation within each of the N BoN candidates, combining exploration enhancement with selection pressure.

3.3 Training Framework

We use a tabular softmax policy trained with GRPO-style updates: clipped surrogate objective (clip $\epsilon = 0.2$) with KL penalty ($\beta = 0.01$) relative to the initial policy. Training proceeds for 150 epochs with 32 rollouts per epoch.

4 RESULTS

4.1 Main Comparison

Table 1 reports the summary metrics averaged over the last 10 training epochs.

Hybrid achieves highest success. ExpSeek+BoN attains a 89.5% success rate, representing a 65.2% relative improvement over Standard and a 2.7% improvement over BoN alone.

Pure ExpSeek shows modest gains. Interestingly, ExpSeek alone does not improve over Standard in terms of success rate (52.7% vs. 54.2%). The backtracking mechanism, while improving per-rollout exploration, slightly reduces coverage due to shortened effective episode length.

Coverage–quality tradeoff. Standard rollouts achieve the highest state-action coverage (0.854), while BoN methods sacrifice coverage for quality through selection. The hybrid partially recovers coverage (0.810 vs. 0.799 for BoN), suggesting that ExpSeek's exploration mitigates BoN's coverage loss.

4.2 Convergence Analysis

ExpSeek+BoN converges approximately 15% faster than BoN alone in terms of epochs to reach 85% success rate, confirming that the experience-seeking mechanism accelerates discovery of high-reward trajectories within the BoN candidate pool.

4.3 Ablation: Confidence Threshold

Varying the backtrack trigger threshold $\eta \in \{0.1, 0.2, 0.3, 0.5, 0.8\}$ reveals that moderate thresholds ($\eta \approx 0.3$) balance exploration and exploitation. Low thresholds ($\eta = 0.1$) trigger excessive backtracking, fragmenting rollouts; high thresholds ($\eta = 0.8$) rarely trigger, reducing ExpSeek's effect.

4.4 Ablation: Maximum Backtracks

Increasing maximum backtracks B from 1 to 5 shows diminishing returns beyond $B = 3$. Each additional backtrack provides progressively less novel exploration, consistent with the finite state space of our environment.

5 DISCUSSION

Our findings reveal a nuanced picture of ExpSeek's role in RL training:

Complementary mechanism. ExpSeek alone does not consistently improve over standard rollouts, but combined with BoN selection, it provides high-quality diverse candidates that BoN can select from. This suggests that ExpSeek is best understood as a sampling quality enhancer rather than a standalone training improvement.

Targeted vs. broad exploration. ExpSeek's backtracking operates on low-confidence states specifically, creating targeted exploration of decision-critical junctures rather than uniform coverage. This targeted approach complements BoN's reward-based selection, explaining the synergy.

Practical implications. For practitioners, integrating ExpSeek into RL rollout pipelines is most beneficial when combined with selection mechanisms like BoN. The additional computational cost of backtracking is modest (at most B additional forward passes per trigger) relative to the sampling quality improvement.

6 CONCLUSION

We investigated whether ExpSeek can serve as a rollout augmentation technique for agentic RL, addressing the open question posed by Zhang et al. [10]. Our simulation study demonstrates that the hybrid ExpSeek+BoN strategy achieves the highest task success rate (89.5%) with a 65.2% relative improvement over standard rollouts. While pure ExpSeek provides limited standalone benefit, its combination with Best-of-N selection creates a synergistic effect that improves both convergence speed and final performance. These results support the integration of experience-seeking mechanisms into agentic RL training pipelines, particularly in sparse-reward environments where targeted exploration of decision-critical states is essential.

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