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# Reinforcement Learning for Routing in IoT Networks: A Comparative Analysis of Objectives, Methods, and Deployment Scenarios

## Communication Info


**Authors:**
Loubaba MALKI L'HLAIBI[1]
Kawtar RYAD[1]
Naoual ATTAOUI[2]
Otman AGHZOUT[1]

[1] *Department of AI and Digitization, ISI Lab, ENSA-Tétouan, UAE, Morocco*

[2] Faculty of Sciences, Abdelmalek Essaâdi University, Tetouan, Morocco



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(5) Deep Reinforcement Learning


## Abstract


Routing in Internet of Things (IoT) networks is challenging due to severe resource constraints, dynamic link conditions, heterogeneous traffic, and the need to optimize conflicting objectives such as energy efficiency, latency, reliability, and network lifetime [1]. Classical protocols like RPL and AODV rely on static metrics and struggle to adapt to non-stationary and partially observable environments [2].

Reinforcement Learning (RL) models routing as a sequential decision-making problem within a Markov Decision Process (MDP), allowing nodes to learn adaptive forwarding policies through interaction rather than predefined rules [3]. RL-based routing dynamically balances short-term performance and long-term energy sustainability.

This paper provides a comparative analysis along three dimensions: (i) optimization objectives (energy vs. delay vs. lifetime), (ii) methodological families (tabular Q-learning vs. Deep Reinforcement Learning), and (iii) deployment scenarios (resource-constrained Wireless Sensor Networks vs. smart environments such as industrial IoT and smart cities) [4].

Analyzed studies generally report significant improvements in network lifetime and packet delivery ratio over classical protocols in WSN settings, while Deep RL offers enhanced adaptability in complex environments at the cost of increased computational overhead, revealing a central performance–complexity trade-off [5].

Rather than presenting RL as a universal remedy, this work clarifies when learning-based routing is justified and outlines open challenges including convergence stability, exploration cost, scalability, and security resilience.




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