

MOTIVATION

Why do autonomous agents need adaptive algorithm selection?

- Algorithm performance is context-dependent
- No single algorithm dominates
- Conditions change at runtime

RESEARCH GAP

Rice's Algorithm Selection Framework (1976) treats selection as a **static, per-instance mapping**. Whether at design time or deployment, committing to a **fixed strategy** fails when conditions evolve during execution. Real-world agents require **adaptive, sequential decision-making** — not one-shot prediction.

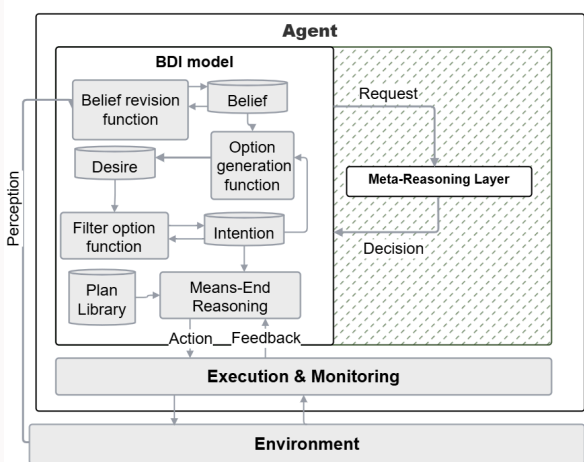
RESEARCH DESIGN

Phase I: Algorithm performance evaluation [1,2]

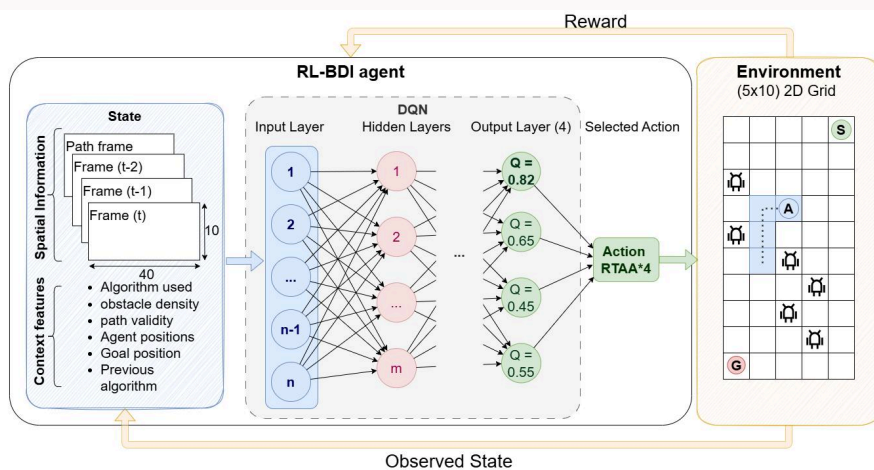
Phase II: Predict the best-performing algorithm [2]

Phase III: Meta reasoning within BDI architecture [3]

PROPOSED ARCHITECTURE



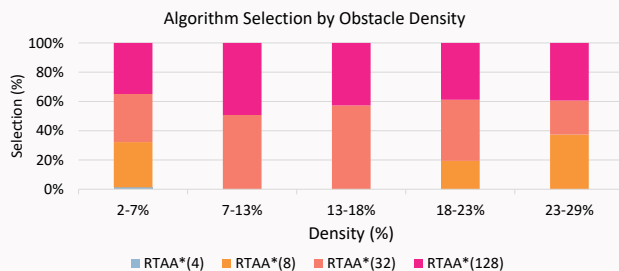
Meta-reasoner ARCHITECTURE



KEY RESULTS

Over **10,000 evaluation episodes in pathfinding domain**, the agent shifts from deep lookahead (128/32) in sparse environments to fast replanning (4/8) as density/dynamicity increases.

Method	Success	Avg. Reward	Latency (ms)
★ Trained Agent	99.43%	-14.50	2.34
RTAA*(128)	99.26%	-61.94	1.46
RTAA*(32)	99.00%	-28.74	1.07
RTAA*(8)	95.33%	-90.12	0.65
RTAA*(4)	88.83%	-166.40	0.48



CONCLUSION

Adaptive algorithm selection is not a one-time design decision — it is an **ongoing reasoning task**. BDI architectures reason symbolically and remain interpretable, but **cannot adapt** once execution begins; RL adapts continuously, but sacrifices **deliberative structure**. This work bridges both by embedding **learned meta-reasoning** into BDI without losing what makes it principled.

FUTURE WORK

- Extend meta-reasoning to intention selection and desire generation
- Transfer the architecture to resource allocation and scheduling domains

CONTRIBUTIONS

- Empirical analysis** of 6 heuristic search algorithms across diverse 2D grid environments, identifying performance variability drivers [1].
- Supervised algorithm selector** combining CNN-based map features and scalar descriptors to predict optimal planners for static instances [2].
- Extended BDI architecture with DQN-based meta-reasoner** - formalisation of algorithm selection as MDP within BDI means-end reasoning, evaluation in pathfinding domain [3].

REFERENCES

- [1] Kherrou, A., Robol, M., Roveri, M., Giorgini, P. (2023). Evaluating heuristic search algorithms in pathfinding. EPTCS (AREA Workshop, Krakow)
- [2] Kherrou, A., Robol, M., Roveri, M., Giorgini, P. (2024). Multi-algorithm pathfinding method for enhanced efficiency. Ann. Math. Artif. Intell.
- [3] Kherrou, A., Robol, M., Roveri, M., Giorgini, P. (2026). RL-Driven Meta-Reasoning for BDI Agents. ICAISC2026 (accepted).