

# Efficient Sampling-based Approaches to Optimal Path Planning in Complex Cost Spaces

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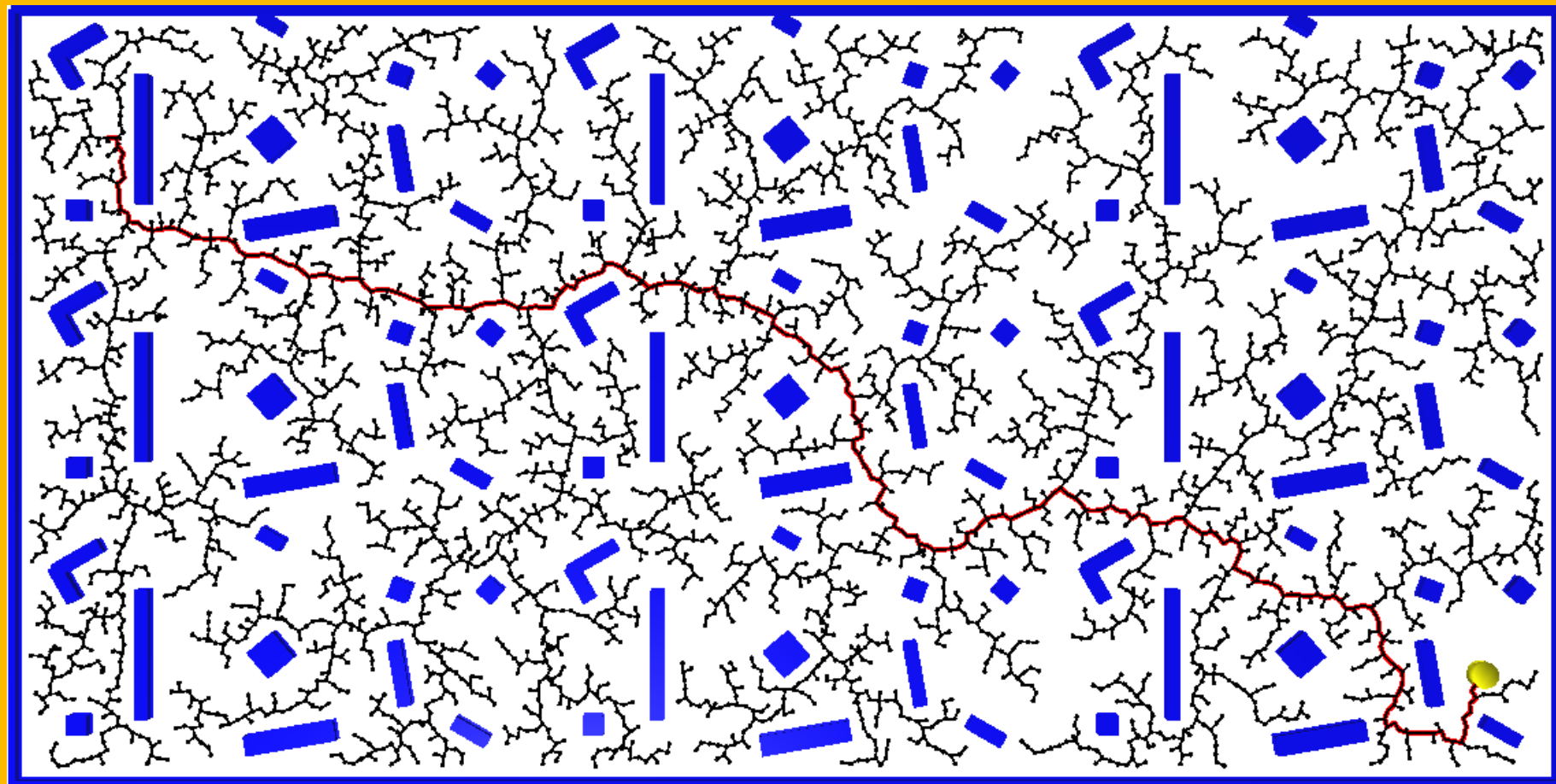
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## Sampling-based Path Planning

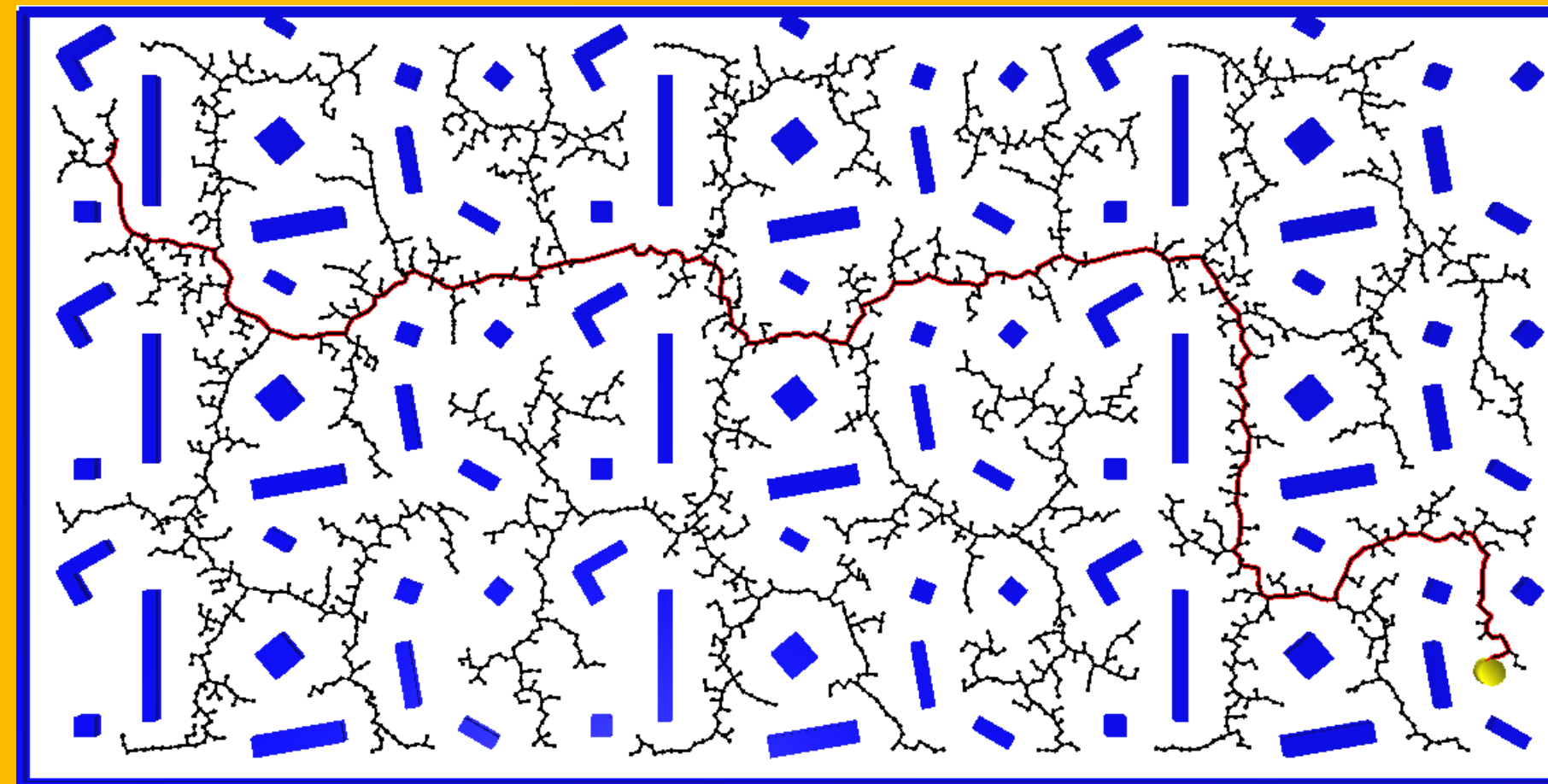
### Feasible Path Planning RRT [1]

- + produces collision-free paths rapidly
- not asymptotically optimal



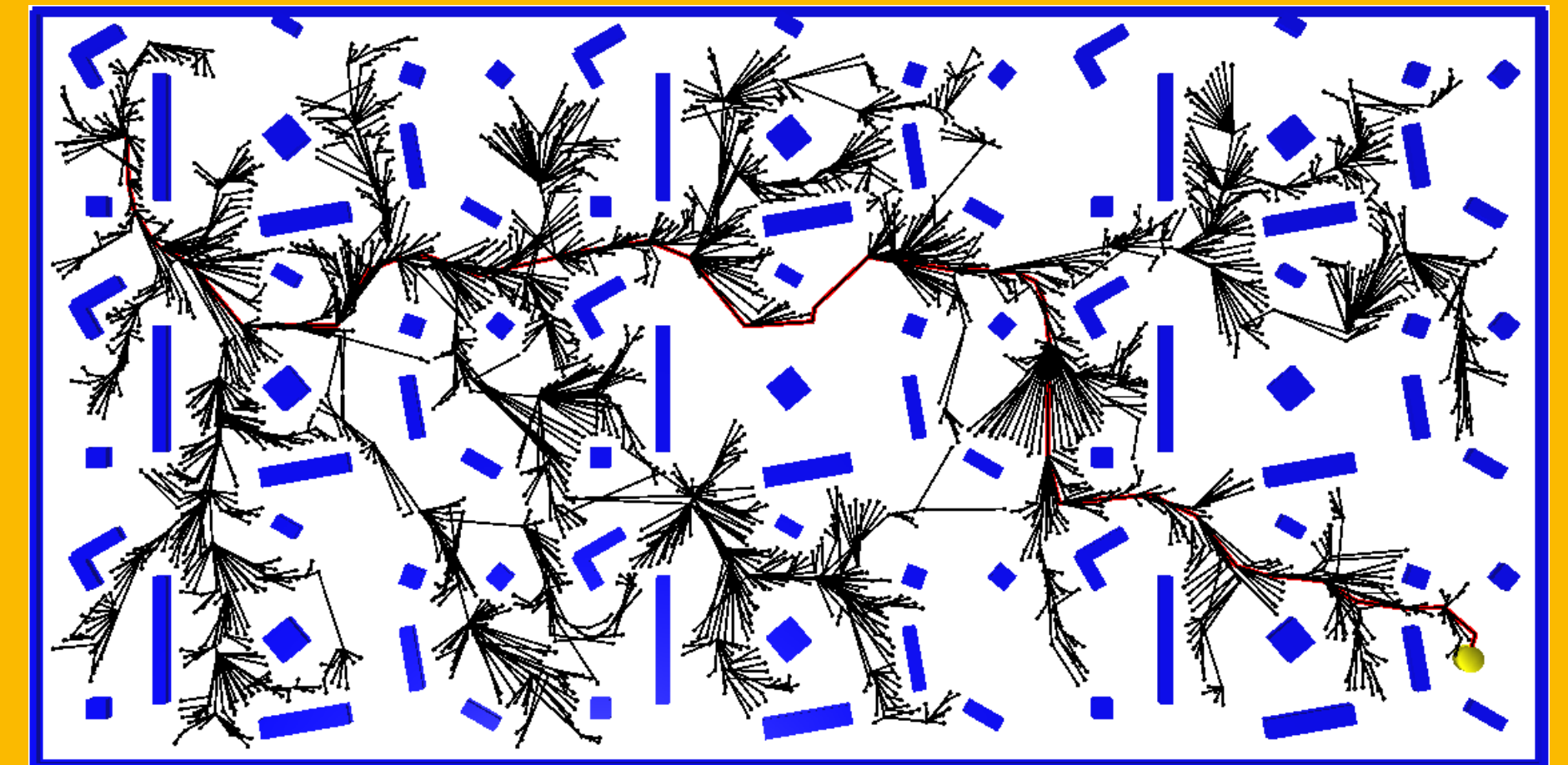
### Cost-Space Path Planning T-RRT [2]

- + produces high-quality paths (thanks to its transition test)
- not asymptotically optimal



### Optimal Path Planning RRT\* [3]

- + produces near-optimal paths
- converges slowly in high-dimensional spaces



Underlying concepts:

- + cost-based node creation
- regular edge creation
- only considers configuration cost

- regular node creation
- + cost-based edge management
- only considers path cost

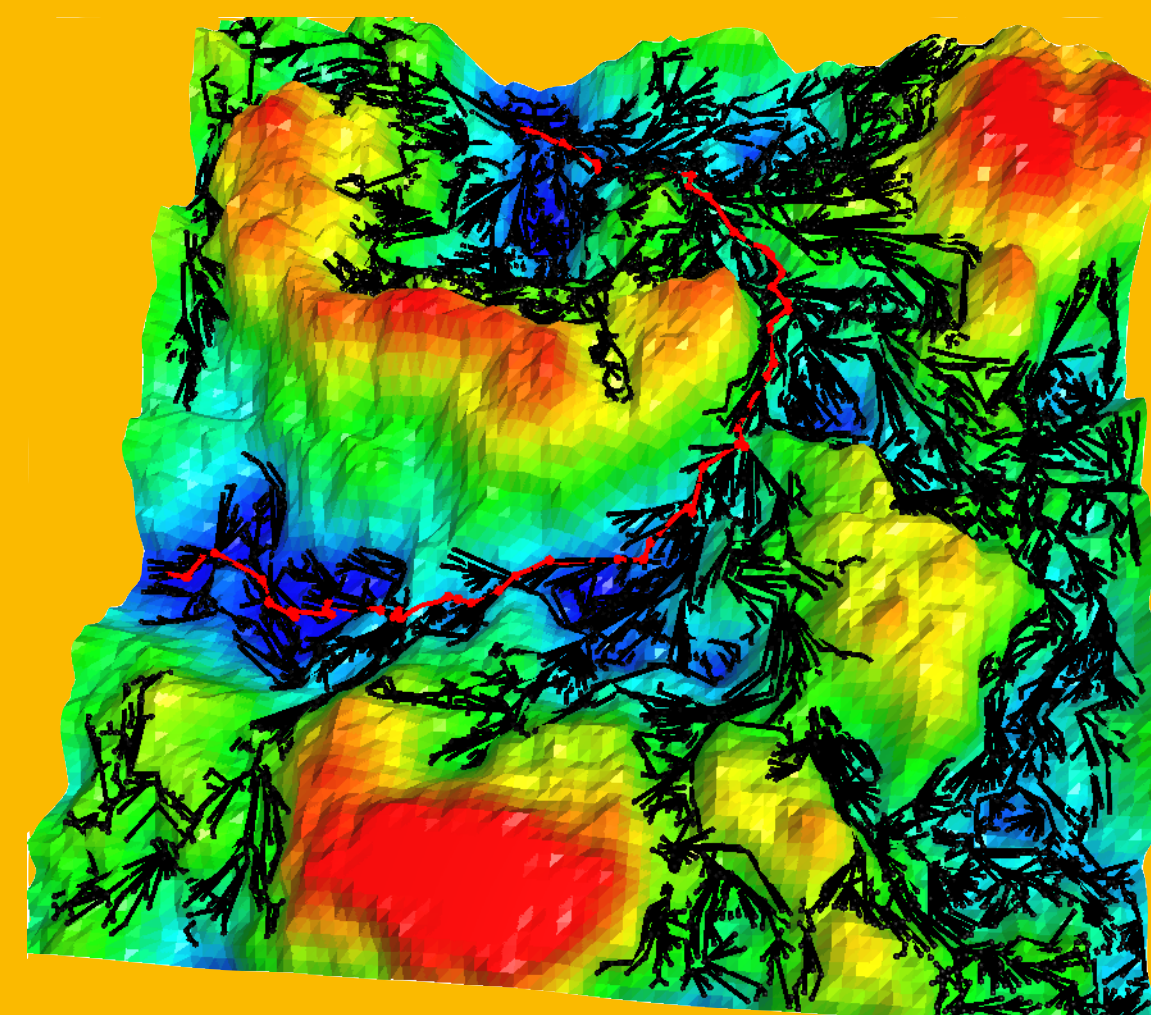
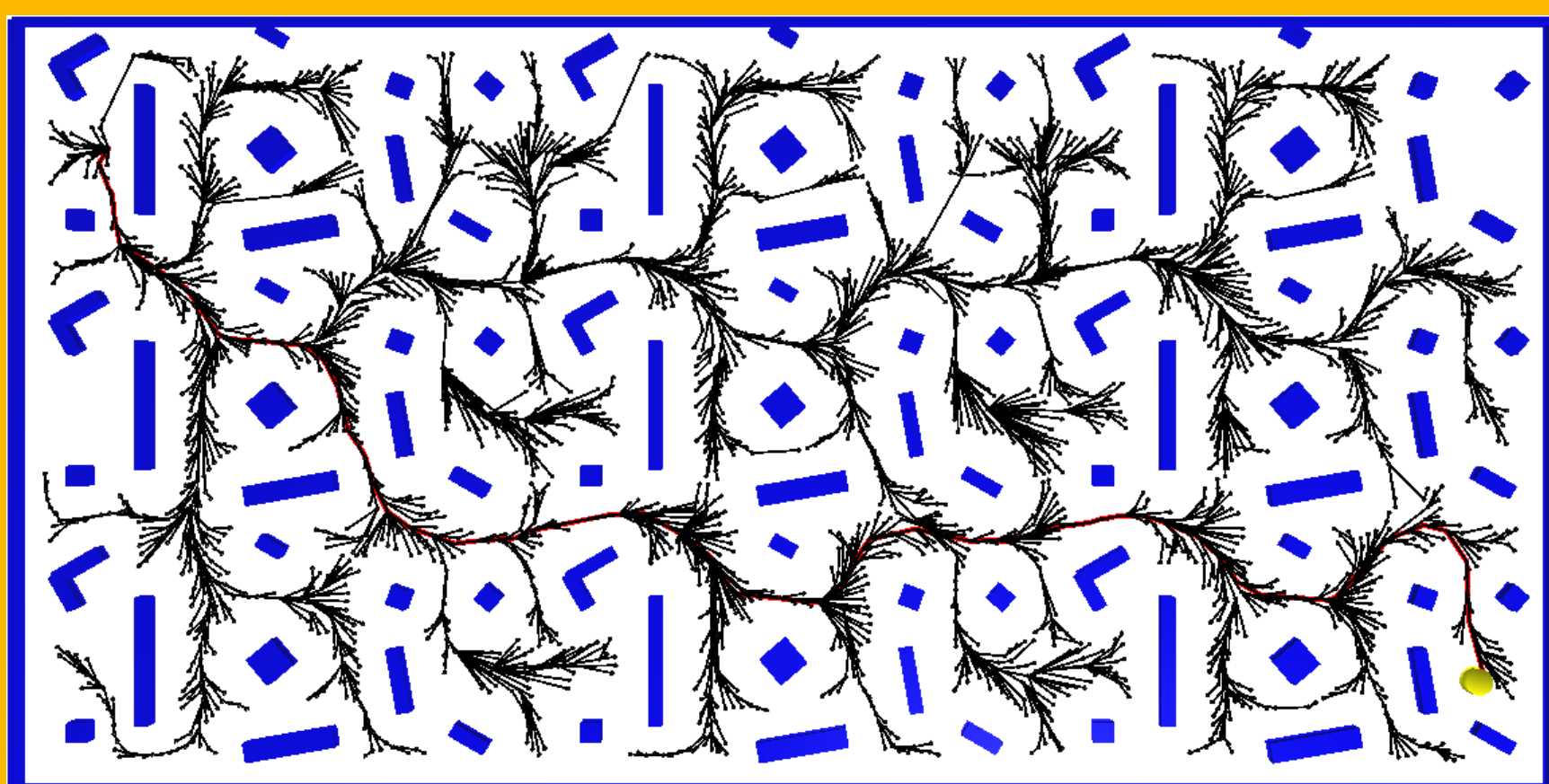
## Two New Algorithms for Optimal Path Planning

Combine the beneficial concepts underlying RRT\* and T-RRT in two different ways:

- + cost-based node creation (configuration cost)
- + cost-based edge management (path cost)

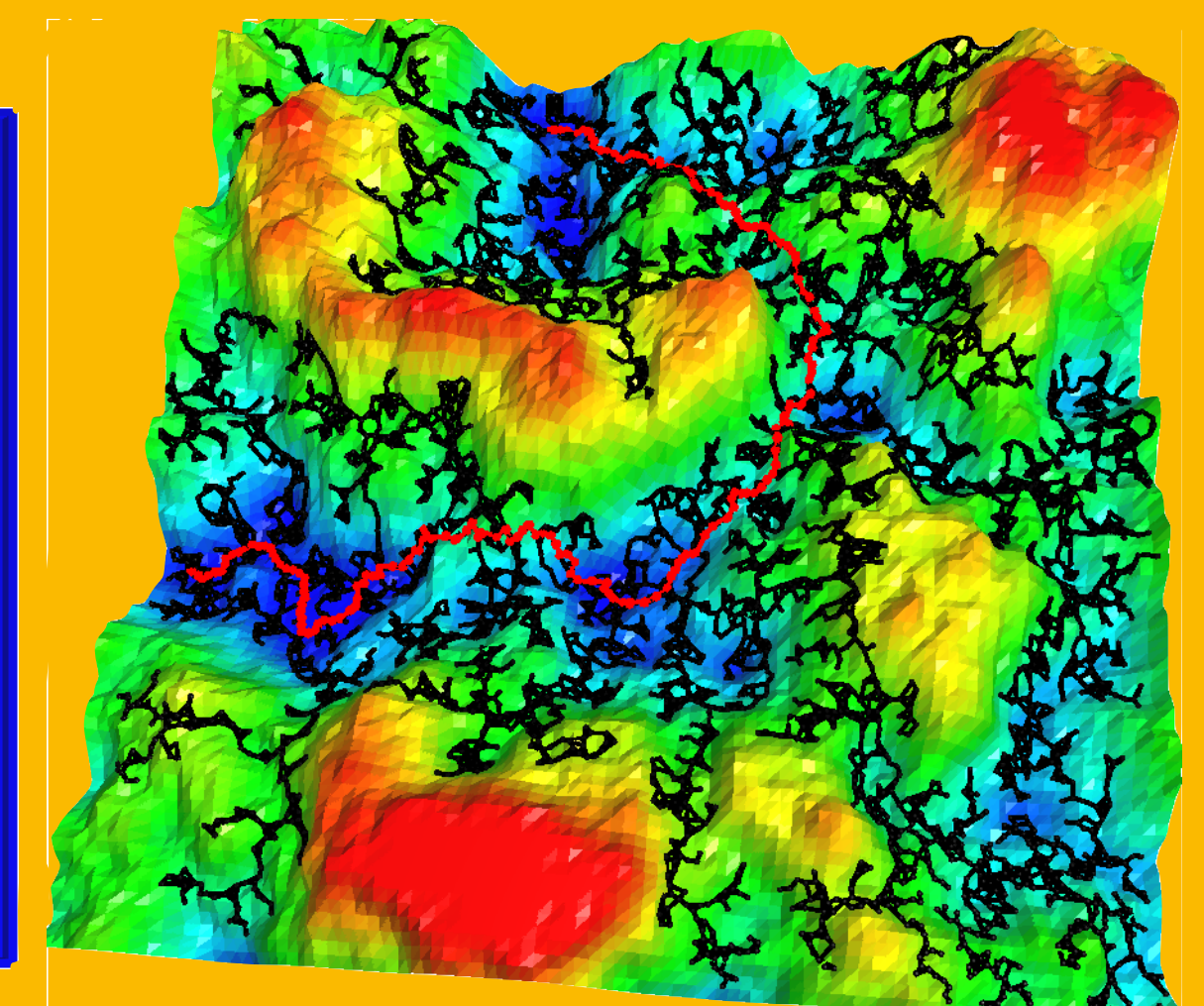
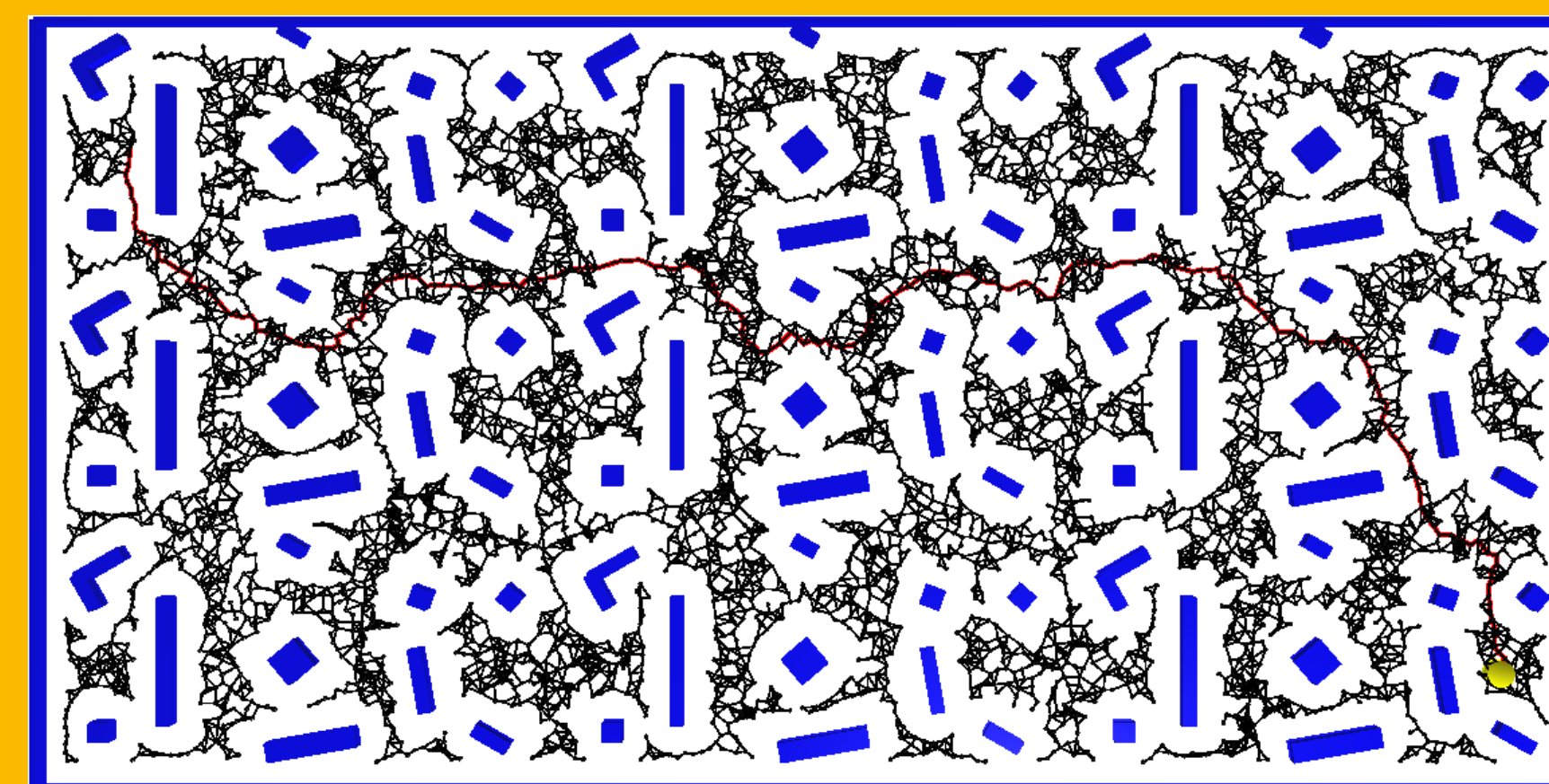
### Transition-based RRT\* (T-RRT\*)

idea: apply the transition test of T-RRT



### Anytime T-RRT (AT-RRT)

idea: add useful cycles to the graph



Theoretical guarantees: probabilistic completeness and asymptotic optimality

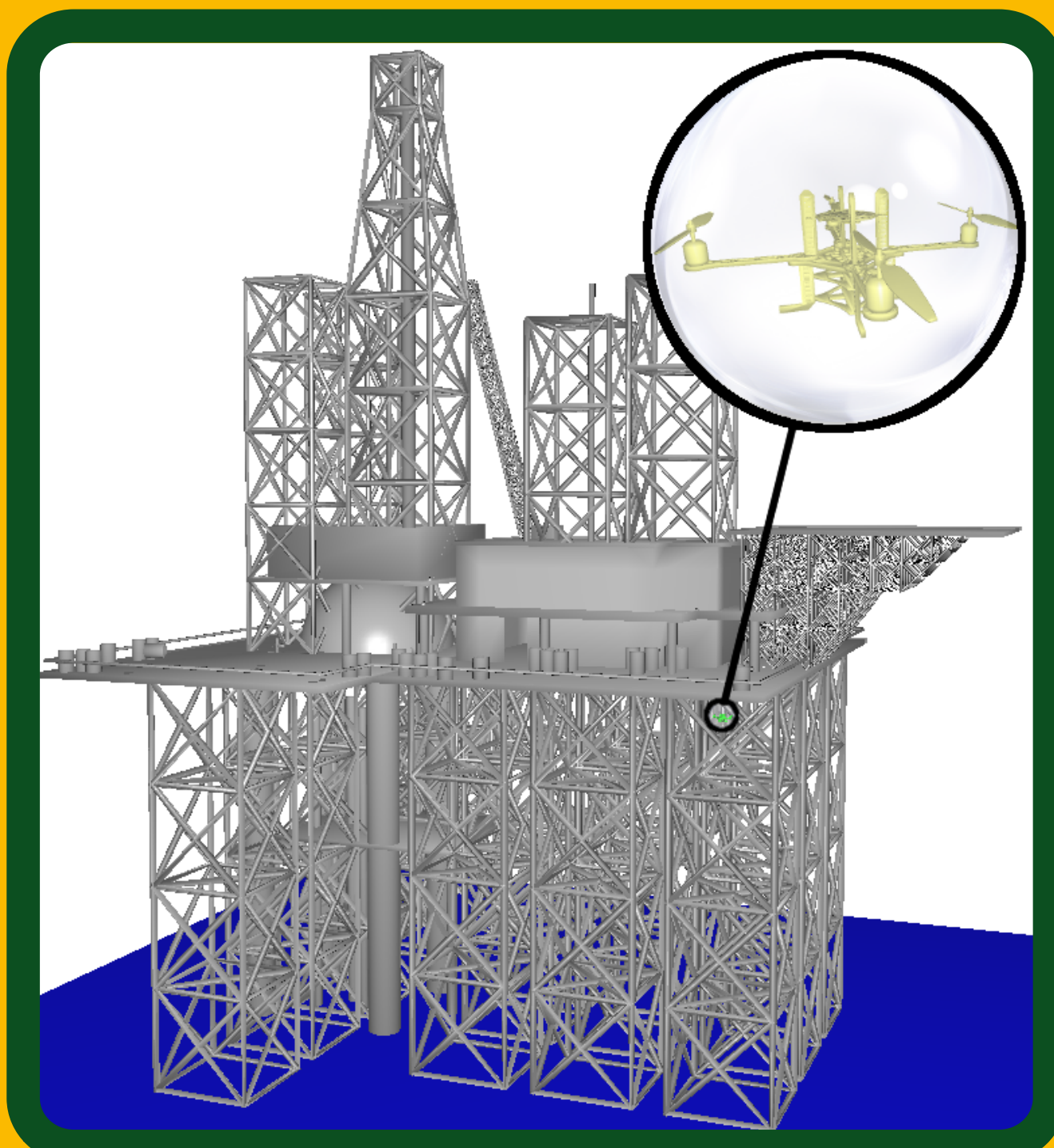
## Results

T-RRT\* and AT-RRT converge faster than RRT\* on difficult problems

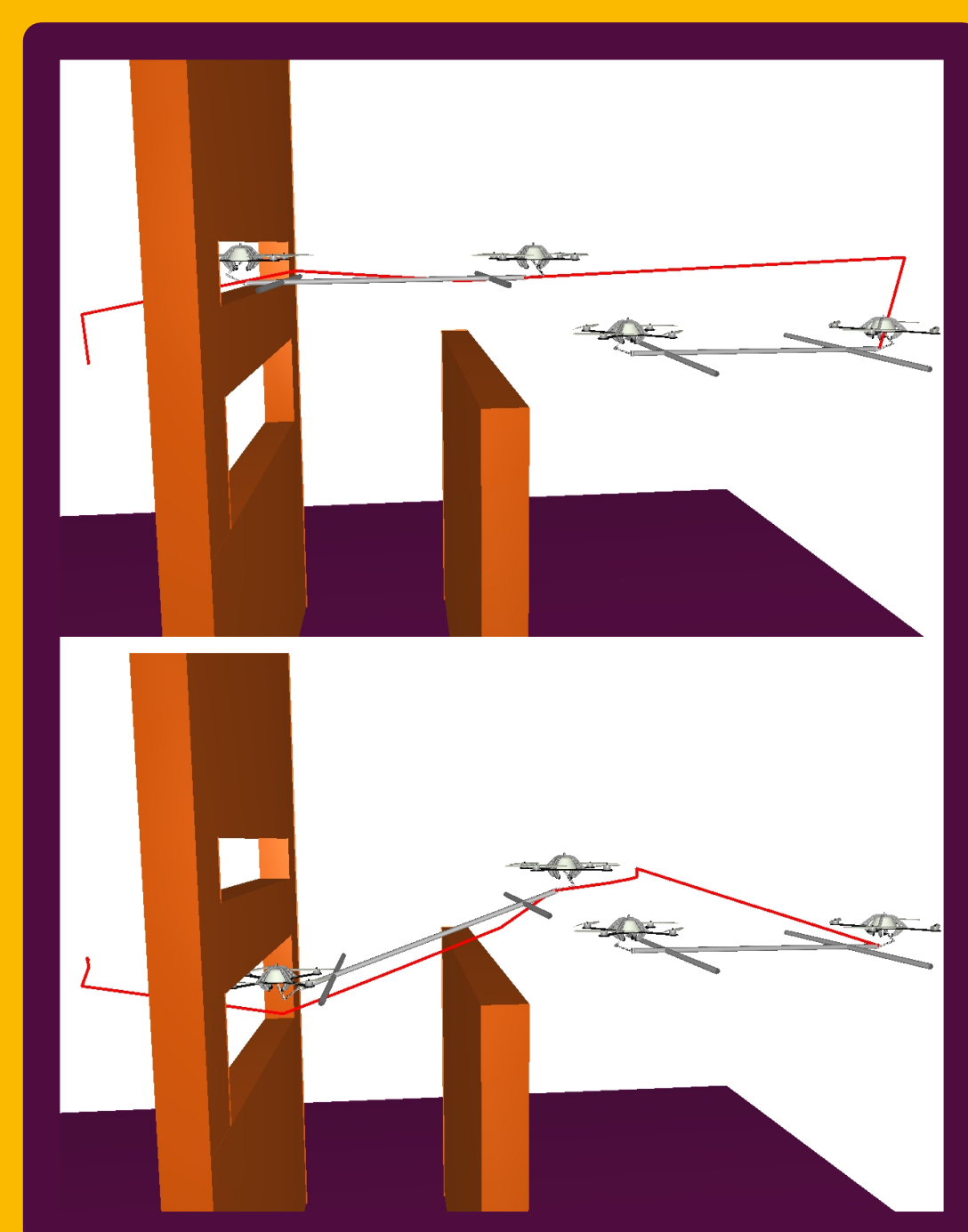
large-scale workspace

space with several homotopic classes

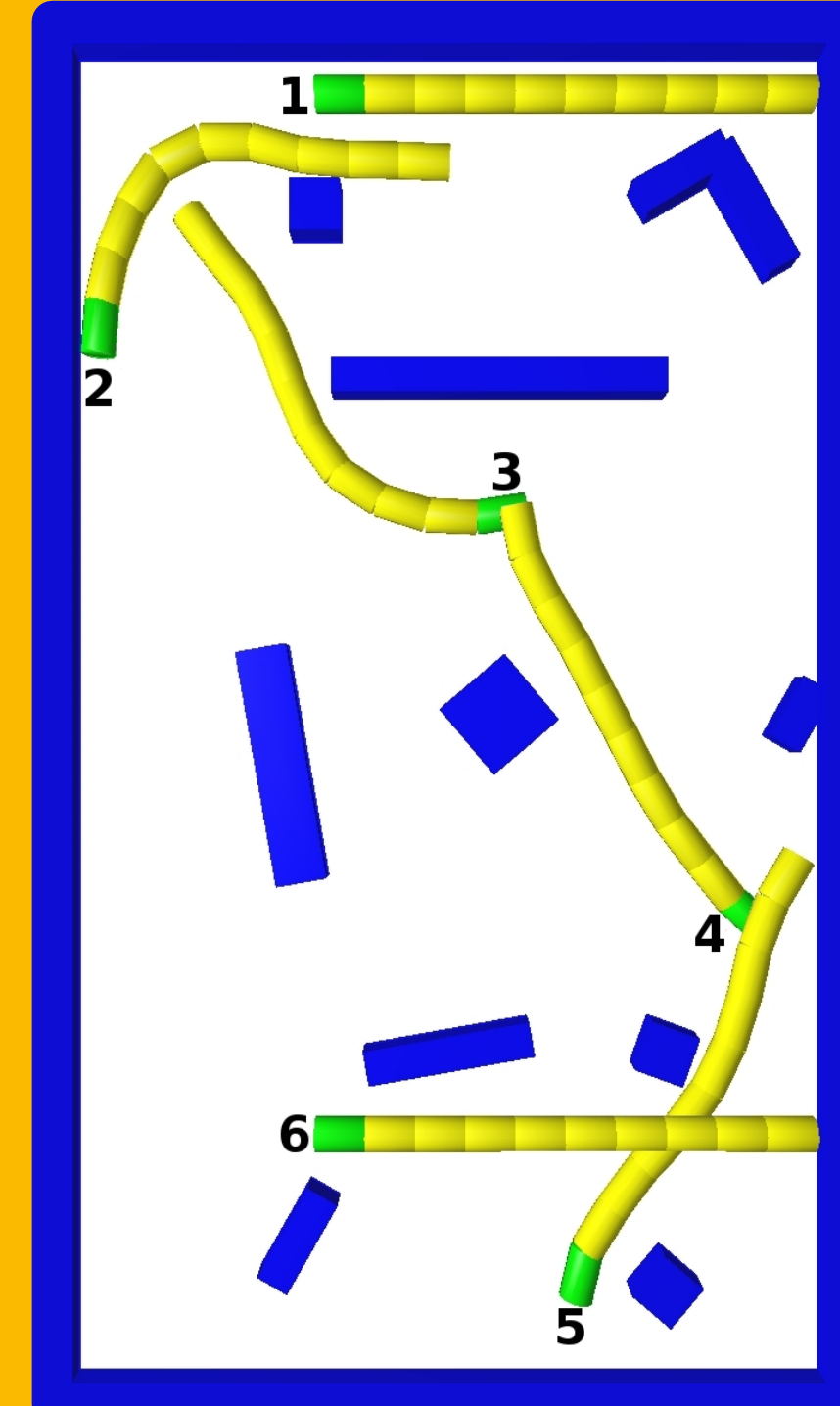
high-dimensional space



Inspection

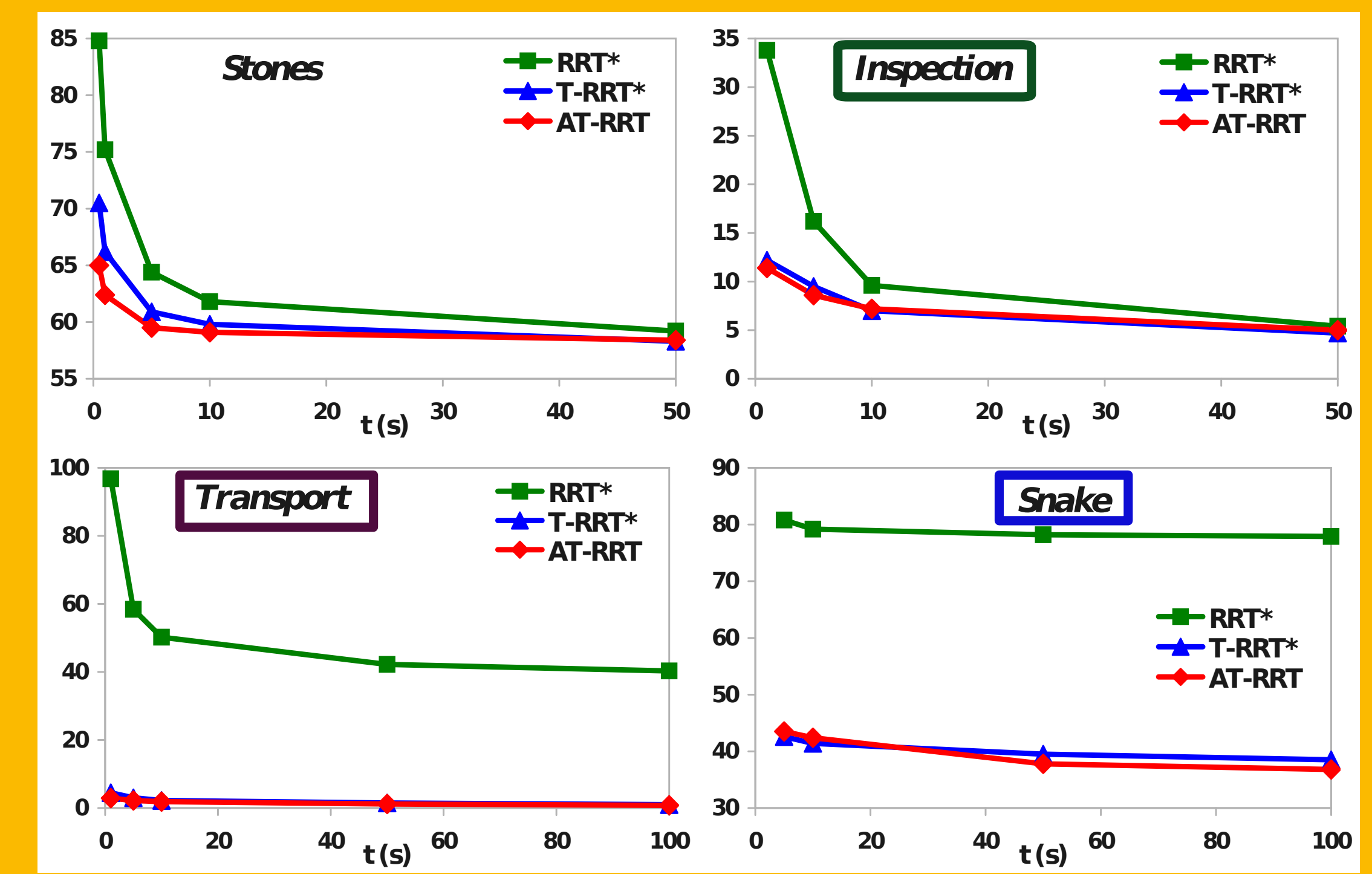


Transport



Snake

### Analysis of convergence



## References

- [1] S. LaValle and J. Kuffner. Rapidly-exploring random trees: progress and prospects. Algorithmic and Computational Robotics: New Directions. 2001
- [2] L. Jaillet, J. Cortés, and T. Siméon. Sampling-based path planning on configuration-space costmaps. IEEE Transactions on Robotics, 26 (4). 2010
- [3] S. Karaman and E. Frazzoli. Sampling-based algorithms for optimal motion planning. The International Journal of Robotics Research, 30 (7). 2011