

Hybrid Planning in Self-adaptive Systems

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The Problem

For many self-adaptive systems, planning needs to find quality adaptation plans in a timely manner.

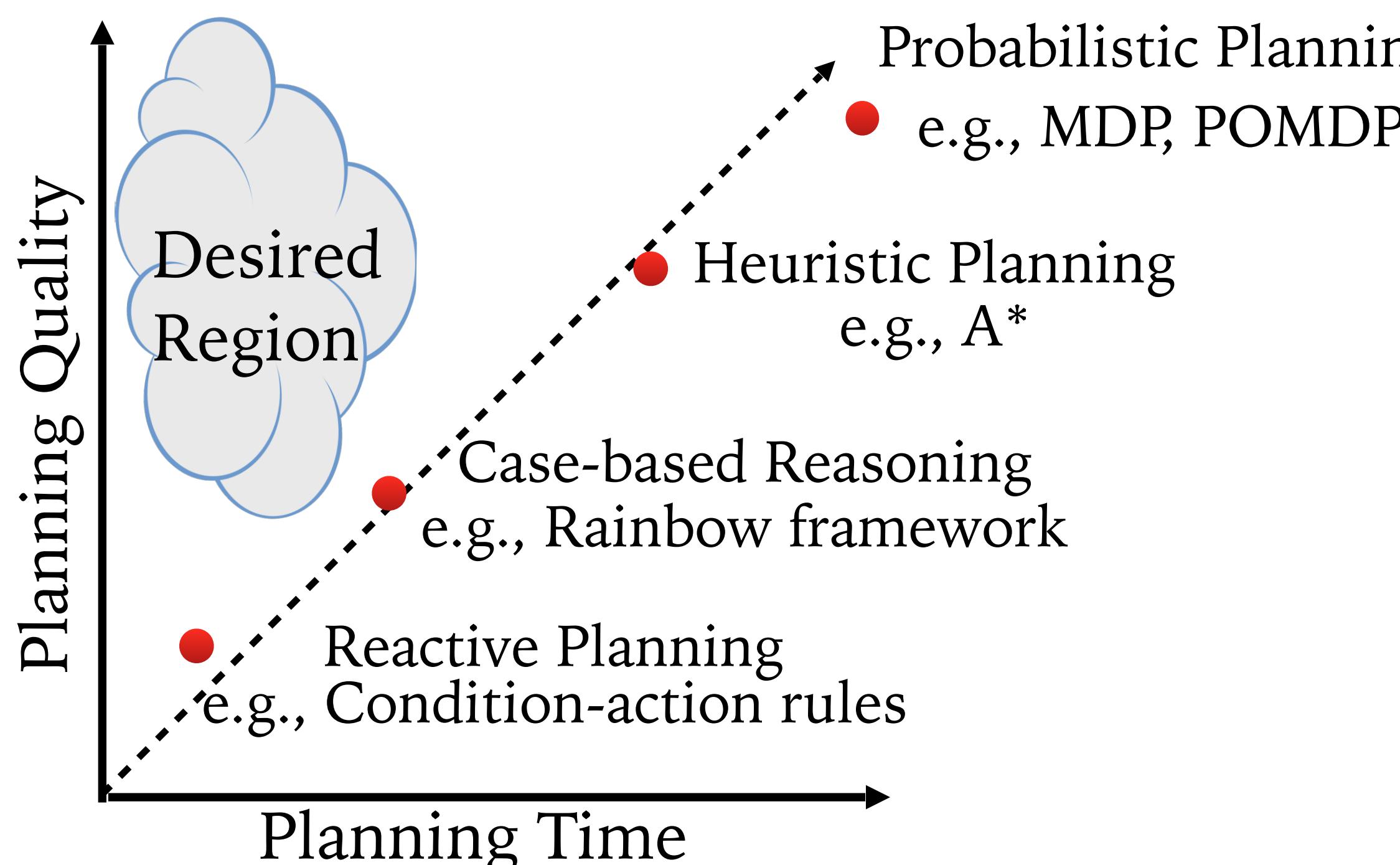


Although these systems are designed to balance multiple objectives (e.g., operating cost, throughput) to provide long term quality but they have some primary objectives.

- Amazon web services primarily cares about availability
- Netflix primarily cares about response time perceived by clients

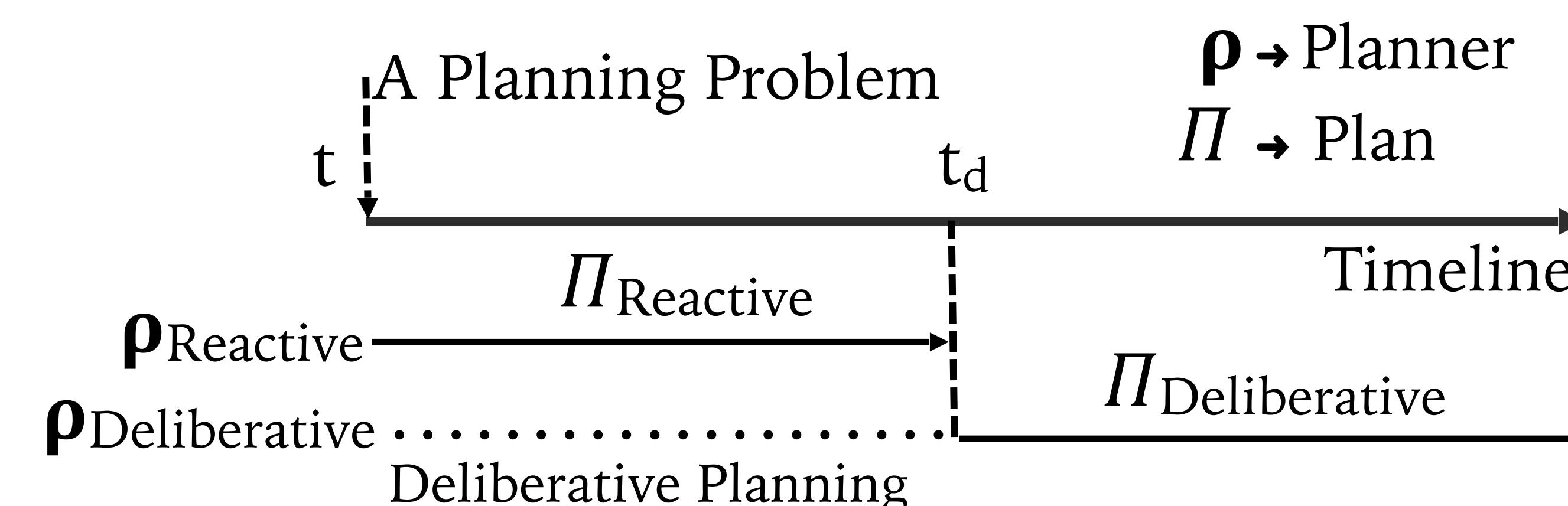
Meeting primary objectives is critical. If any of the primary objective is not met, these systems need to plan “quickly”. However, to maintain long-term quality, an adaptation plan should be as close to optimal as possible, by considering other objectives (e.g., operating cost) as well.

Unfortunately, quality and timeliness are conflicting requirements



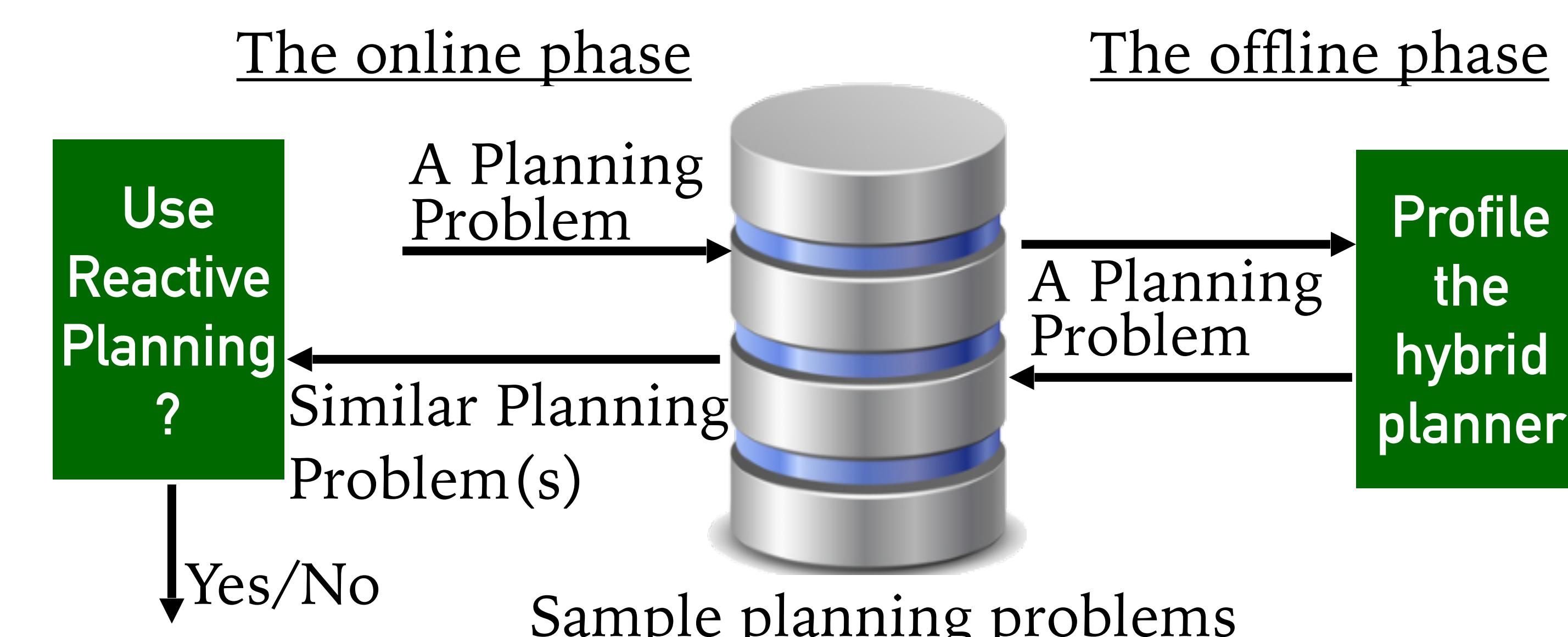
The Solution Approach

Combine off-the-shelf reactive and deliberative planning approaches; such a combination will help to find a balance between quality and timeliness of planning



Hybrid planning is an effective, a general, and a flexible approach. The key challenges to apply hybrid planning are

- Planning Selection (PLNSEL): Which planning approach(es) should be invoked to solve a planning problem?
Solution: Apply instance-based learning to solve PLNSEL



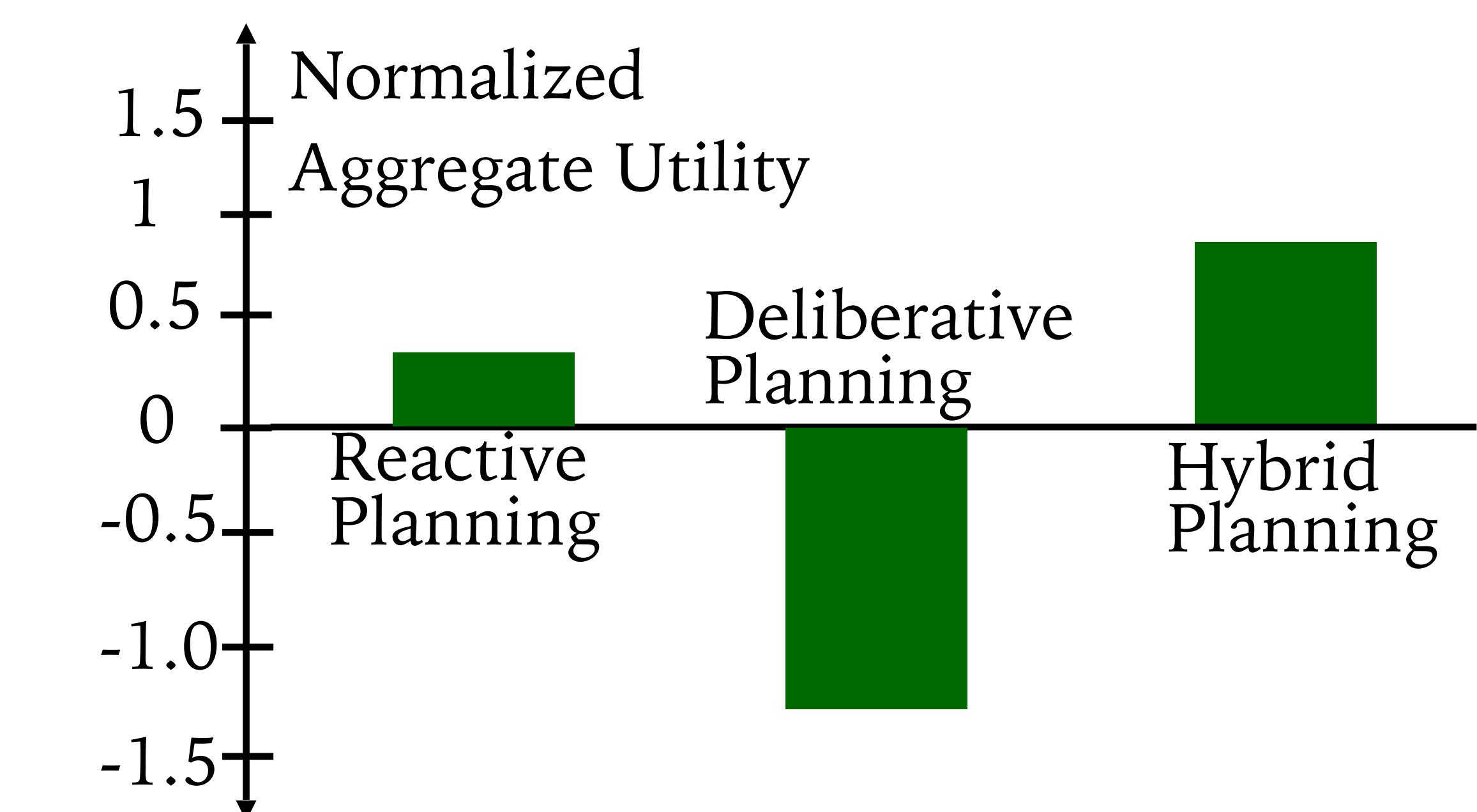
- Planning Coordination (PLNCRD): How to guarantee a seamless transition between plans determined by different planning approaches?
Solution: (1) Deliberative plan is a state-action pair for all the reachable states from the initial state, and (2) Operating domain is Markovian

Results to Date

Developed a formal framework that explains the general nature of the problem of hybrid planning [1]. This framework

- is used to explain our approach to apply hybrid planning
- sets a stage for going beyond the proposed solution to find even better solutions to the problem of hybrid planning

Demonstrated the effectiveness of hybrid planning in a cloud-based adaptive system using a particular instantiation of reactive and deliberative planning [2]



Evaluated instance-based learning as an initial proof-of-concept [3]

- Experiments performed in the context of cloud-based adaptive system indicated the potential of the instance-based learning to solve PLNSEL

References:

1. A. Pandey et. al. Towards a formal framework for hybrid planning in self-adaptation. **SEAMS-2017**
2. A. Pandey et. al. Hybrid planning for decision making in self-adaptive systems. **SASO-2016**
3. A. Pandey et. al. Instance-based learning for hybrid planning. **DSS-SASO-2017**