

# The Core of MDP

Focus on what is important

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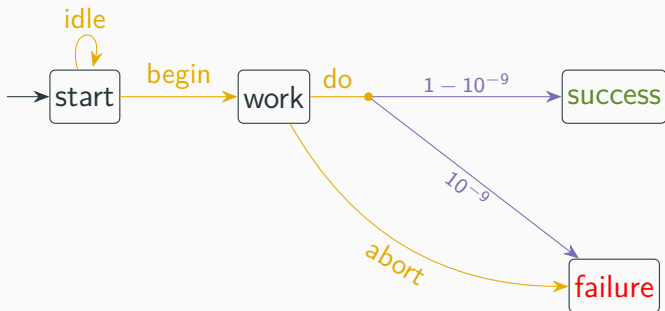
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# Preface – Context and Motivation

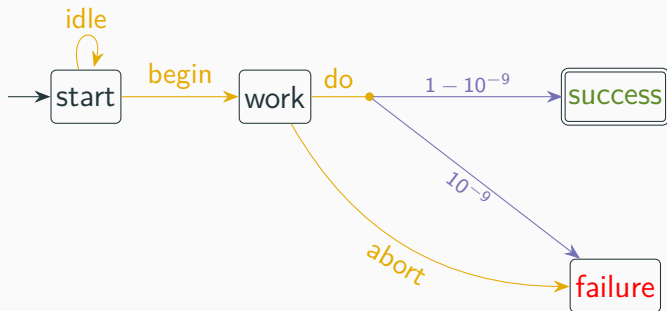
- Context: Probabilistic systems (MDP)
  - But: Approach generally applicable
  - Problem: (Practical) Systems usually
    1. **very large** (billions of states)
    2. with many **barely relevant** states
- ⇒ Identify **relevant** states + **restrict** computation to these

# Markov Decision Processes



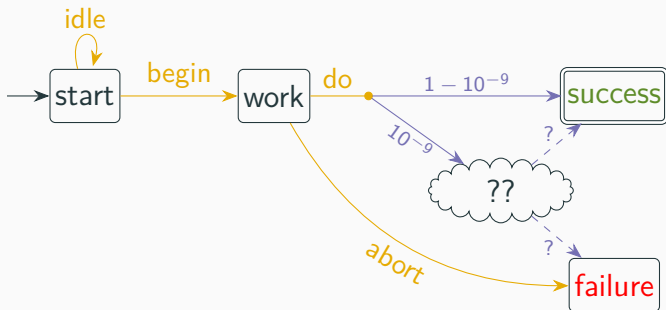
- States + **Actions** → **Probabilities**
- *Strategies* remove non-determinism
- *Objectives* formalize goals

# Example



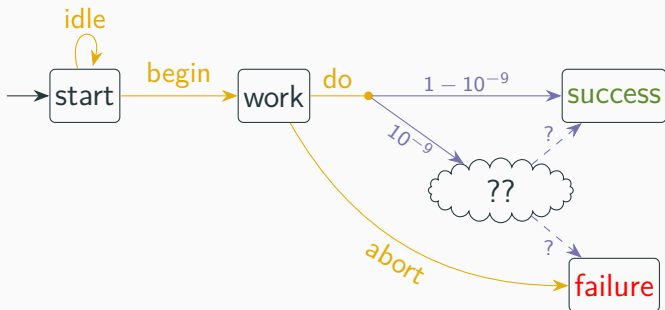
- Goal: Reach **success**
- Maximal probability:  $1 - 10^{-9}$
- Let's modify the example

# State of the Art



- Exact probability: We don't know!
  - But: We can make an educated guess ...
- ⇒ Don't need to investigate unknown region (already known)

# New Idea




- Actually: Don't need "??" region for *any* property
- $\Rightarrow$  Region **not important**

# The Core


- $S_\epsilon$  is  $\epsilon$ -core if system remains inside with prob.  $\geq 1 - \epsilon$
- Reachability restricted to “core states”  $\Rightarrow$  error at most  $\epsilon$
- 0-core = set of reachable states
- In paper:
  - Sampling / **Learning** approach to identify cores
  - Possibility of heuristic guidance
  - Connection to other objectives / systems
  - Step-bounded variant with further applications

# Conclusion

- Cores are an **intrinsic** property of the system ( $\Rightarrow$  reusable)
- Potentially **significantly smaller** and **easier to understand**
- Many applications, from analysis to design aid
- Key Idea: Only likely reached states are **interesting**

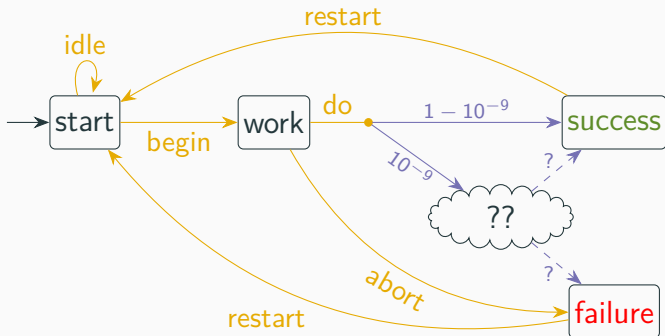
Interesting:  (+ accepted journal version)

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 Jan Kretínský and T. “Of Cores: A Partial-Exploration Framework for Markov Decision Processes”. In: *CONCUR*. 2019, 5:1–5:17. DOI: 10.4230/LIPIcs.CONCUR.2019.5



# Difficulties?



- Now "??" region is "interesting" (for infinite horizon)
- In paper:
  - On-the-fly MEC quotient
  - Finite-horizon cores