

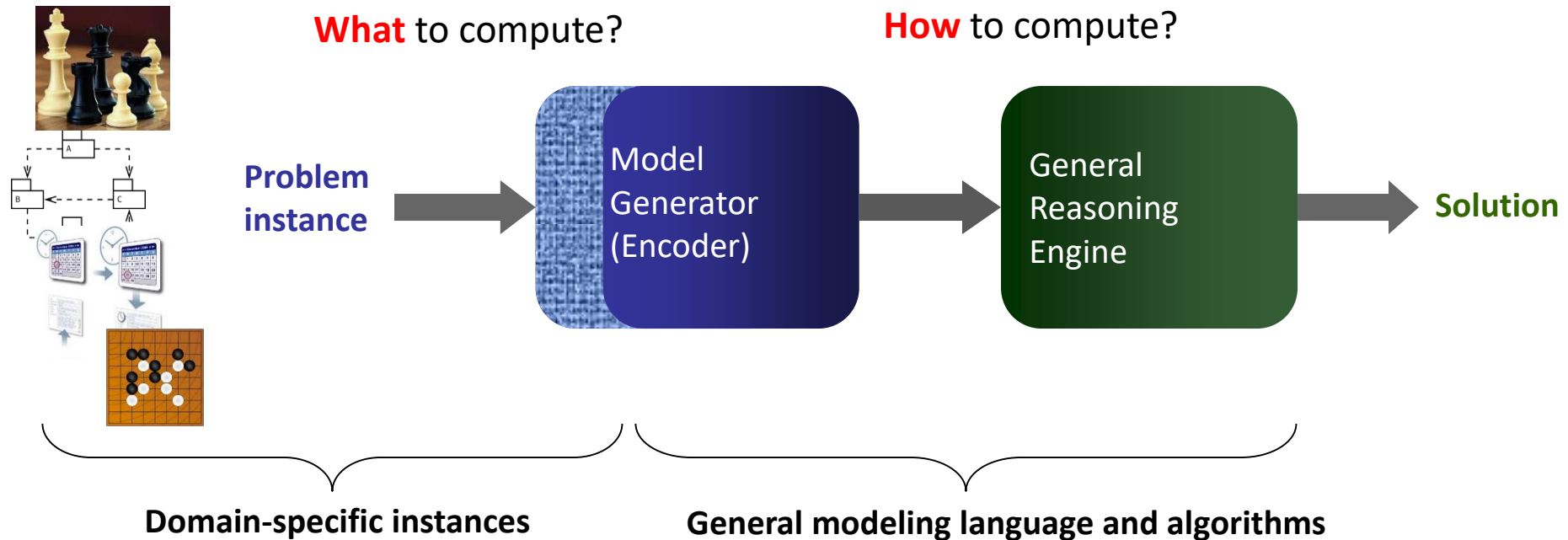


Robust probabilistic inference engines for autonomous agents

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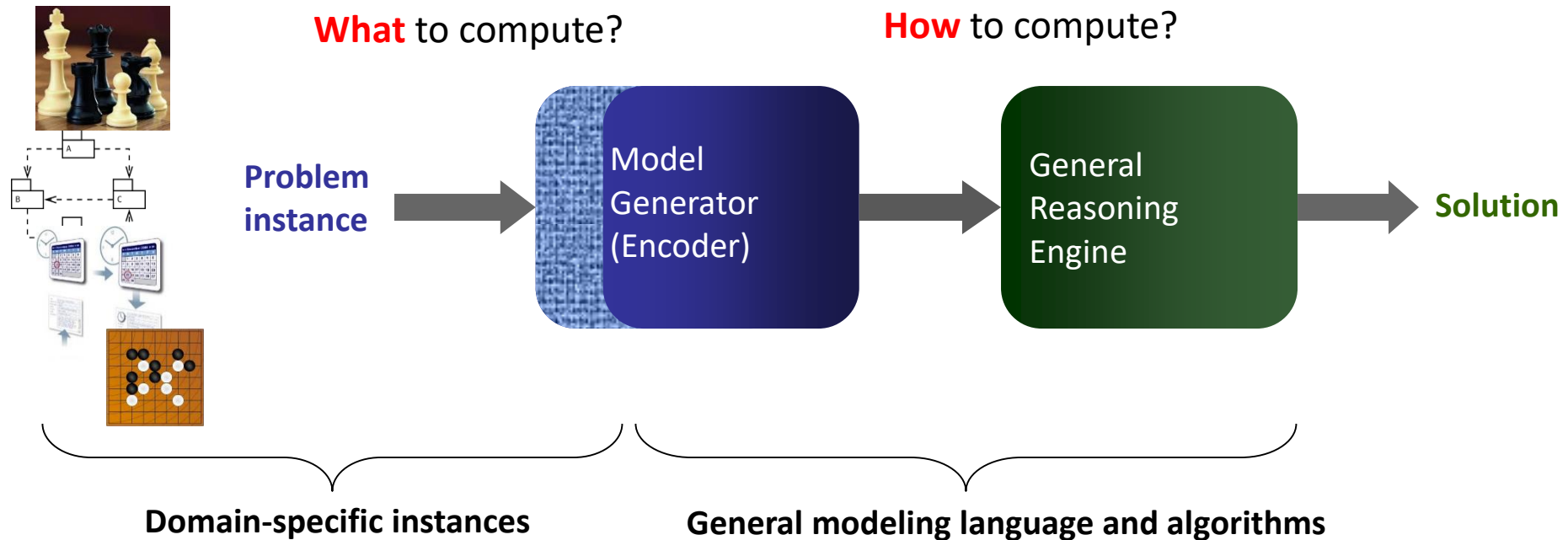
Problem Solving in AI



Problem solving in AI:

Separate modeling from algorithms

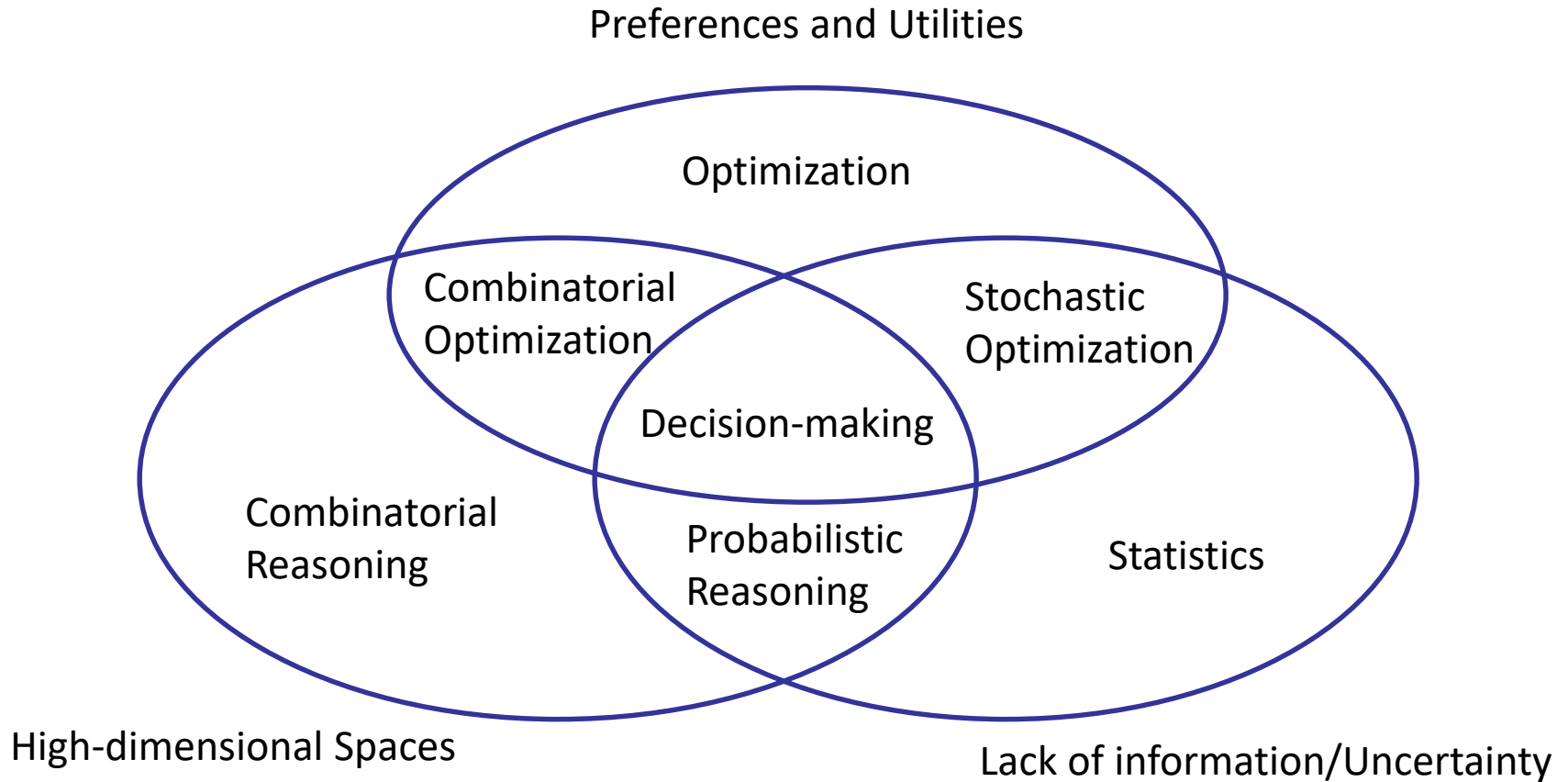
Problem Solving in AI



Safety and **reliability** require:

1. precise models
2. accurate reasoning techniques

Challenges in reasoning about complex systems



Challenges in reasoning about complex systems

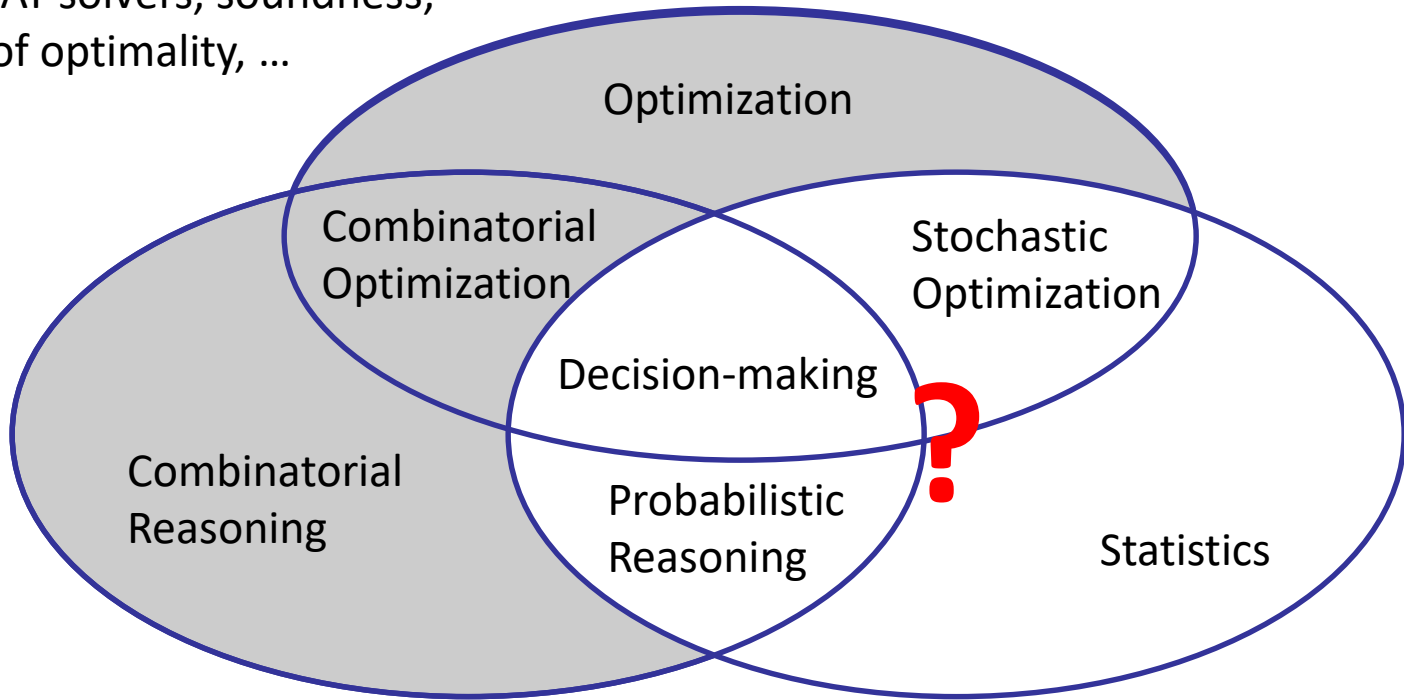


Theorem provers, logical reasoning, SAT solvers, soundness, certificates of optimality, ...

Preferences and Utilities



hardware verification



Combinatorial Reasoning

Optimization

Combinatorial Optimization

Stochastic Optimization

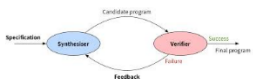
Decision-making

Probabilistic Reasoning

Statistics

High-dimensional Spaces

Lack of information/Uncertainty



Program synthesis

Proposal and recent results

Proposal: use *combinatorial reasoning/optimization* techniques (logic, verification, synthesis) for *probabilistic reasoning* tasks (machine learning)

- Algorithms that can provide **certificates/proofs of accuracy**
 - Handle **extreme (unsafe) events**
 - Can support deterministic + probabilistic dependencies
- Some recent results:
 - Satisfiability Modulo Theory solvers for statistical hypothesis testing (Zhao et al., AAI-2016)
 - Integer Linear Programming for sampling (Kim et al., AAI-2016)
 - Integer Linear Programming and SAT for decision making under uncertainty (Xue et al., NIPS-2016)
 - Variational methods with guarantees (Achim et al., AISTATS-2016)

Thanks!