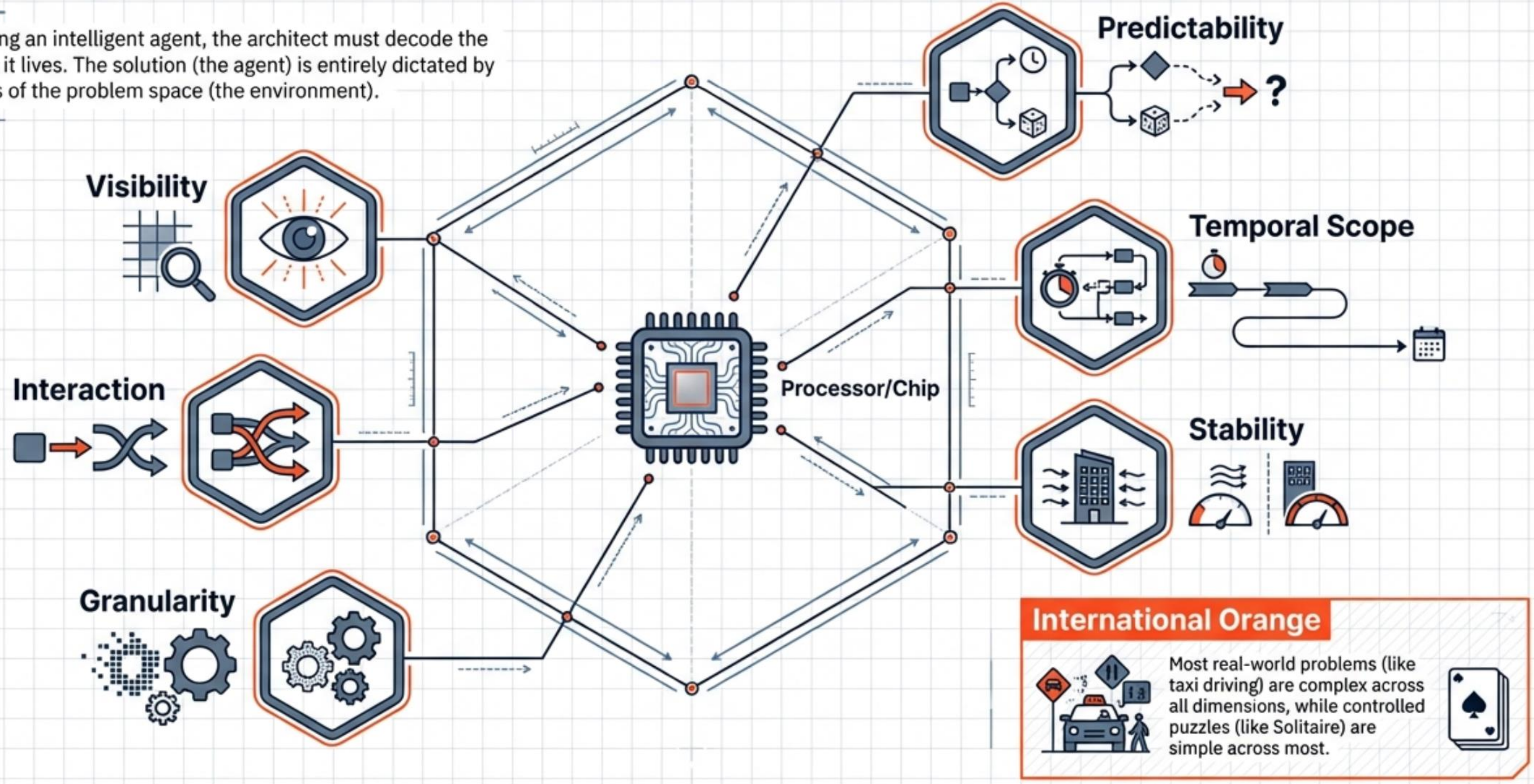
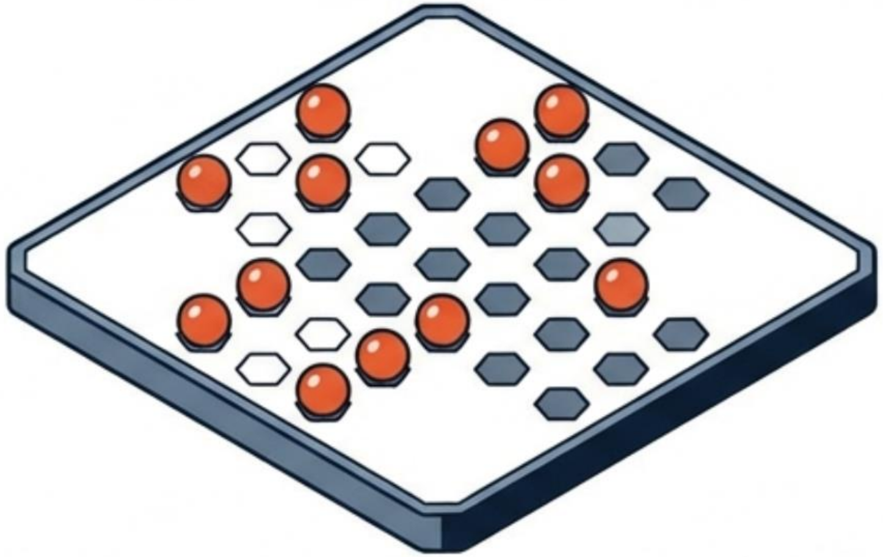
The difficulty of an AI problem is determined by the properties of its environment.

Before designing an intelligent agent, the architect must decode the world in which it lives. The solution (the agent) is entirely dictated by the constraints of the problem space (the environment).



Dimension 1: Visibility determines the need for internal memory.

Fully Observable



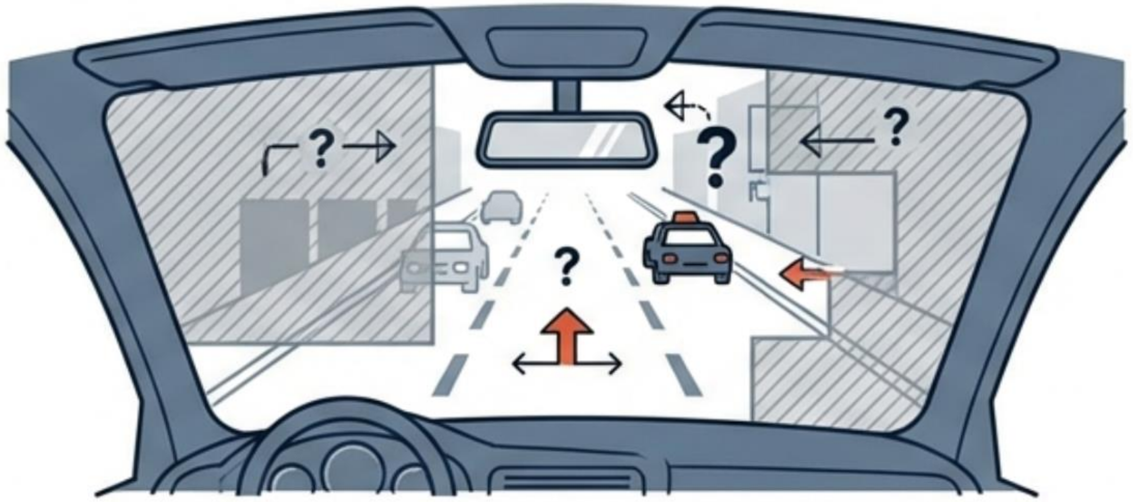
Definition: The agent perceives the complete state of the environment at every time step. No information is hidden.

Examples:
Peg Solitaire, Backgammon, Chess

Charcoal Navy

Architectural Benefit: No internal memory is required to infer hidden states.

Partially Observable



Definition: The agent operates with incomplete or noisy information.

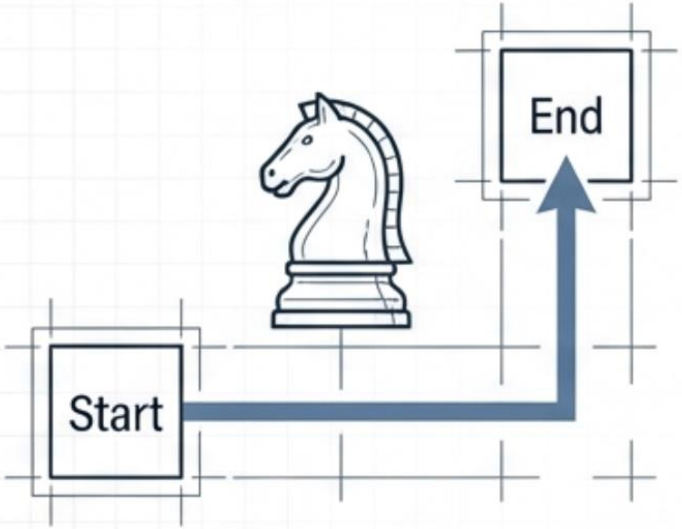
Examples:
Internet Shopping (hidden fees), Taxi Driving (blind spots)

Charcoal Navy

Architectural Cost: The agent must maintain an internal state (memory) to track the world.

Dimension 2: Randomness transforms deterministic logic into stochastic probability.

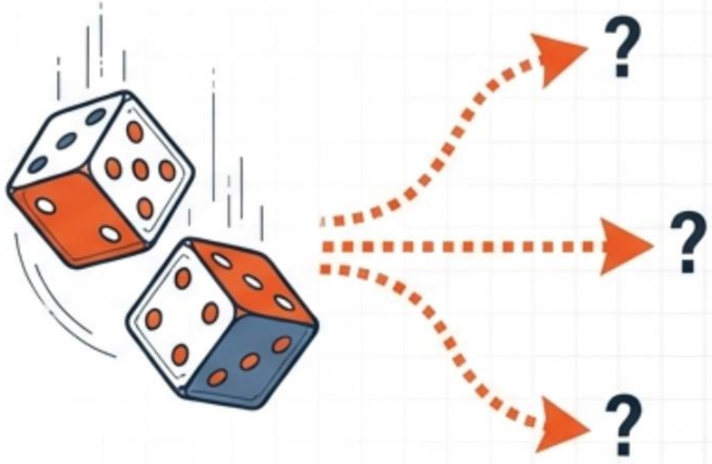
Deterministic



Definition: The next state of the world is completely determined by the current state and the agent's action.

Examples: Peg Solitaire, Chess (no clock)

Stochastic



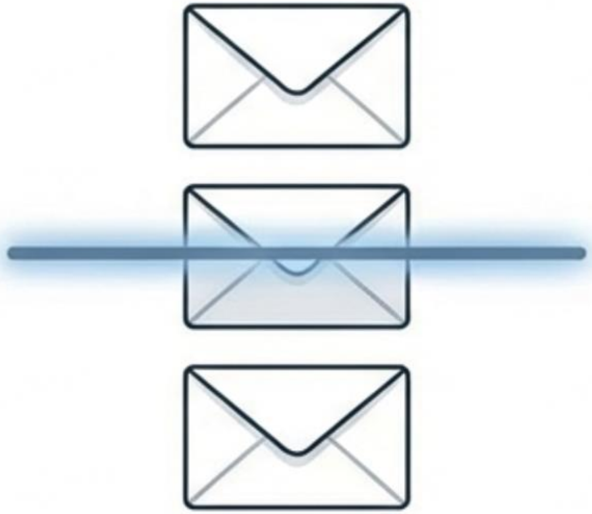
Definition: Outcomes involve randomness or uncertainty. Even with the same action, the result may vary.

Examples: Backgammon (dice), Taxi Driving (traffic/weather).

Key Insight: If randomness exists—whether through dice or weather—the environment is stochastic.

Dimension 3: Sequential environments require long-term planning over immediate reaction.

Episodic



Definition: Each action is independent. The current decision does not affect future decisions.

Examples: Spam Email Classification.

Requires only immediate analysis; no look-ahead required.

Sequential

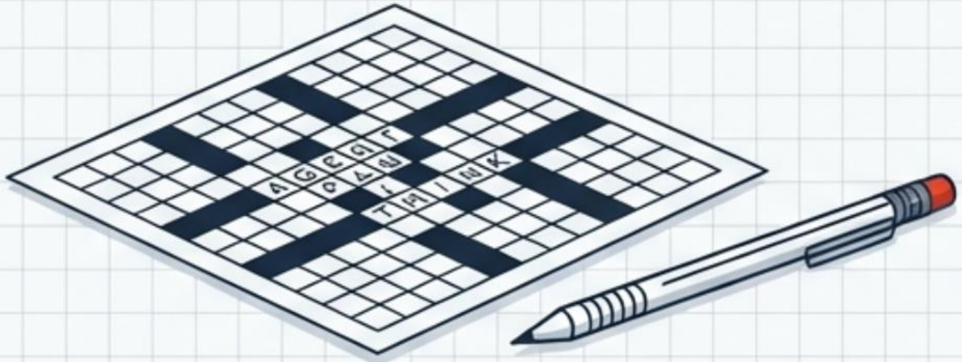
Definition: Current actions fundamentally alter future states and potential rewards.

Examples: Peg Solitaire, Taxi Driving, Chess.

Requires forward planning and consequence modeling.

Dimension 4: Dynamic worlds do not wait for the agent to deliberate.

Static



Definition: The environment does not change while the agent is thinking.

Examples: Crossword Puzzles, Peg Solitaire.

Implication: The agent can take as much time as needed to compute the optimal move.

Dynamic

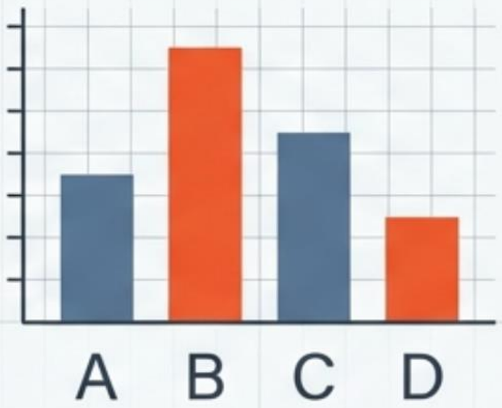
Definition: The environment changes during the decision-making process.

Examples: Taxi Driving, Internet Shopping (real-time prices).

Semi-dynamic: The environment doesn't change, but the score degrades over time (e.g., Chess with a clock).

Dimension 5: Handling infinite variables distinguishes continuous from discrete worlds.

Discrete

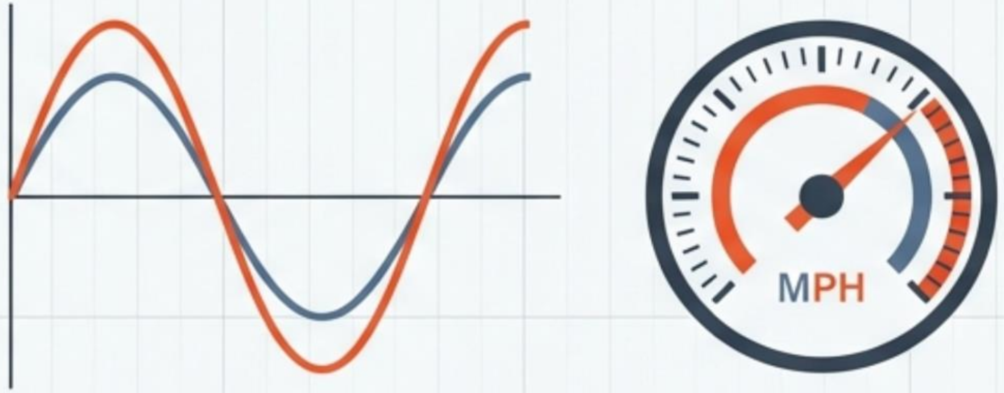


Definition: There are a finite number of distinct states, actions, and percepts.

Examples: Peg Solitaire, Backgammon, Chess.

Architecture: Solvable with search trees and logic tables.

Continuous



Definition: States, time, or actions are measured on a continuous value spectrum.

Examples: Taxi Driving (steering angles), Robot control.

Architecture: Requires physics-based modeling and fluid control functions.

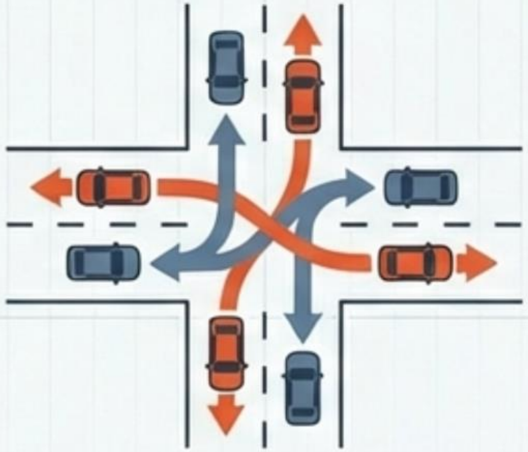
Dimension 6: Multi-agent environments introduce strategic competition and cooperation.

Single-Agent

Definition: Only one agent acts to achieve a goal. No other entities impact the outcome intentionally.

Examples: Peg Solitaire, Crossword Puzzles.

Multi-Agent



Definition: Multiple agents operate in the environment, and their actions affect one another.

- **Competitive** (e.g., Chess, Backgammon)
- **Cooperative** (e.g., Robot Swarms)

Proper classification dictates the selection of the agent's algorithm.

We do not analyze these dimensions for academic classification alone.
We analyze them to choose the right tools.

Problem	Solution
Partially Observable	State Estimation
Stochastic	Probabilistic Reasoning
Dynamic	Fast Reaction Times
Multi-Agent	Game Theory

The architect must respect the environment, or the agent will fail.