Project Proposal: AERO (Automated Escape Room Operations)

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Domain Description

The project aims to develop an intelligent **Game Master** for managing an automated Escape Room.
The agent must coordinate a set of logical puzzles and electronic mechanisms in order to allow the player to escape within predefined constraints.

The domain integrates both **logical** and **physical** constraints:

- **Logical Dependencies**:
  Puzzles must be solved in a specific sequential order (e.g., finding a key to open a drawer that contains a code).
- **Resource Management**:
  Actions consume **Battery** and **Time**. The system must balance:
  - *High-Tech actions* (fast but energy-consuming)
  - *Manual actions* (slow but with no energy consumption).
- **Exit Condition**:
  The final goal is constrained by the availability of sufficient remaining resources to activate the final door-opening mechanism.

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3. Problem Instances (PDDL)

Three scenarios with increasing complexity will be presented:

Scenario 1 (Easy – Logical Focus)

Set in a single room, this scenario focuses on the correct sequence of boolean actions and ADL preconditions.

- **Planner**: Fast-Downward
- **Heuristics**: Comparison between *Blind* (baseline) and *h_max*

Scenario 2 (Medium – Energy Focus)

Introduction of the **Battery** resource. Multiple paths lead to the exit, each with different energy costs.

The exit is possible only if the remaining battery level is sufficient to trigger the final electronic impulse.

- **Planner**: ENHSP
- **Heuristics**: Comparison between *sat-hadd* and *opt-hmax*

Scenario 3 (Hard – Global Optimization)

A multi-room layout with simultaneous constraints on **Time** (60 minutes) and **Battery**.
The scenario includes a recharging station and multiple sensors modeled using **ADL quantifiers (forall)**.

- **Planner**: ENHS
- **Heuristics**: Comparison between *sat-hadd* and *opt-hmax*
- **Analysis Focus**: Performance degradation when moving from one numerical constraint (Scenario 2) to two numerical constraints.

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4. Planners and Search Heuristics

- **Fast-Downward**:
  Used for validating pure logical planning (Scenario 1), exploiting the *Blind* and *h_max* heuristics and providing full support for ADL quantifiers.
- **ENHSP-20**:
  Used for numerical planning (Scenarios 2 and 3).
  Applying the same advanced heuristics (*hadd* and *hmax*) across both scenarios allows evaluation of the planner's efficiency in handling the search space explosion caused by the addition of time constraints.

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5. IndiGolog Controller and Reasoning Tasks

The system will use **IndiGolog** to manage interactivity and unexpected events typical of a real Escape Room:

Offline Controller

An offline search to compute the optimal sequence of actions under the assumption of a deterministic environment.

Reactive Controller

Using **prioritized interrupts**, the system monitors exogenous events (e.g., *player stuck* or *input error*) and triggers replanning based on the current resource state.

Reasoning Tasks

- **Legality**:
  Verifying whether an exit action is legal given the current resource levels.
- **Projection**:
  Predicting whether the chosen strategy will lead to failure due to battery or time exhaustion before achieving the goal.