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Artificial Intelligence

Optimization Methods
Meta-Heuristics

Assignment No. 1
Airport Landing

Work Specification

- **Problem Definition:**
  - Scenario: Manage a continuous stream of airplanes landing at an airport with three landing strips.
  - Key Challenge: Design an algorithm for efficient and safe landing management.

- **Objectives:**
  - Safety First: Ensure minimum one hour of fuel is left upon landing for each airplane.
  - Optimal Scheduling: Minimize delays while respecting expected landing times.

- **Constraints:**
  - Constant fuel consumption rate.
  - Adherence to expected landing times.
  - Minimize crash risks and optimize landing efficiency.
  - Landing strip occupation post-landing: 3 minutes.
  - Airport's max capacity: 60 landings per hour.

- **Critical Failures:**
  - Any plane crash during landing is considered a failure of the algorithm.

- **Objective Function:**
  - Minimize crash risks while optimizing for fuel efficiency and punctuality.

- **Input Data Generation:**
  - Script provided to simulate arrivals with variable fuel levels, consumption rates, and expected landing times.

References

During the investigation phase of our initiative, the team encountered multiple algorithmic solutions suitable for our endeavor, including Python-coded greedy algorithms, genetic algorithms, and numerous online articles detailing various methodologies.

https://www.geeksforgeeks.org/introduction-hill-climbing-artificial-intelligence/

https://www.geeksforgeeks.org/what-is-tabu-search/

https://www.baeldung.com/cs/simulated-annealing

https://www.youtube.com/watch?v=rA3a8QDtYLs

Formulation of the Optimization Problem

Solution Representation: List of planes ordered by time of landing.

States: Aircraft queue with current fuel levels and expected landing times; status of landing strips (occupied/free).

Initial State: Queue of aircrafts approaching with known fuel levels and expected landing times; all landing strips are free.

Objective test: All aircraft have landed with at least one hour of fuel reserve, within the expected time frame, and without incidents.

Hard Constraints: Safety First, Optimal Scheduling, Fuel Consumption Rate, Expected Landing Times, Landing Strip Occupation Time, Airport Capacity.

Evaluation Functions: Maximize Fitness Function: Higher fitness values should correspond to fewer crashes and better adherence to landing times and fuel efficiency rules.

Work Implementation

Development Environment:
Languages & Tools: Python with VS Code and PyCharm for collaborative coding.

Data Structures:
Classes for airplane objects, lists for arrivals, pandas data frames for data management.

Algorithm Implementation:
Development of Hill Climbing, Tabu Search, Simulated Annealing underway.

Interactivity & Visualization:
Functions for user interaction, visualization of algorithm performance.