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Decision Making Under Uncertainty

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Blizzard Landing at Courchevel

Introduction

The Courchevel airport in the French Alps was made famous by the James Bond film "Tomorrow Never Dies." Perched on a cliff, with a very short landing strip (1762ft) at a gradient of 18.5%—it is among the most dangerous altiports in the world. This research paper lays the groundwork for autonomous landing at Courchevel under blizzard conditions, applying reinforcement learning.

Problem

The pilot agent may control movement of the airplane—but while landing in high winds and low visibility, the actual movement of the airplane will be uncertain. Thus, from a planning point of view, closed-loop model predictive control is expected to fail.

Approach

The working hypothesis is that open-loop planning could account for uncertainty in the airplane's state, with an agent streaming reactions that result in a safe landing.

By applying approximate dynamic programming, the necessary computations may be performed in real-time.

Specifically, the use of Partially Observable Markov Decision Processes is under consideration. Thus, the agent's optimal action would depend on its belief state, and not on executing a precomputed policy that would depend on knowing the actual state.

With approaches that rely on knowing the State Transition Probability Distribution in advance out of the picture, it is also likely that the classic Q Learning approach will not work, even though it trains as it evaluates. Epsilon Greedy strategies will be evaluated, though their randomness-induced success is expected to be low. This project will contribute innovations in: Q Learning, greediness, rewards discounting, and hyper-parameter setting in general.

Success Metrics

The key metric will be how quickly the algorithm solves the problem: number of Episodes Before Solve. Another metric will be the average reward obtained over a consecutive number of episodes.

Prior Work

One possible way to undertake this project is by generalizing the Frozen Lake environment in OpenAI Gym. Turning it into a 3d high-dimension uncertain environment may fairly represent Courchevel. The agent would be rewarded for successfully landing on the runway. An alternative environment could be the Lunar Lander.

The Approximate POMDP Planning Toolkit is a key source of inspiration.