Generating optimal aircraft trajectories with respect to weather conditions
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To cite this version:
Brunilde Girardet, Laurent Lapasset, Virginie Aubreton. Generating optimal aircraft trajectories with respect to weather conditions. SID 2012, 2nd SESAR Innovation Days, Nov 2012, Braunschweig, Germany. hal-01511745

HAL Id: hal-01511745
https://hal-enac.archives-ouvertes.fr/hal-01511745
Submitted on 21 Apr 2017

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Generating optimal aircraft trajectories with respect to weather conditions

**Goal:** Compute optimal routes in Cruise Flight.

**Why?** Increase Air Traffic Capacity and reduce time travel and fuel consumption.

**Assumption:** Constant Air Speed and Constant Flight Level.

**Our methodology : Front Propagation method**

Relied on **Ordered Upwind Algorithm**: technique to track the propagation by solving a partial differential equation known as the **Hamilton-Jacobi equation**:

\[ \nabla u \Big| F \left( x, \frac{\nabla u}{\nabla u} \right) = 1, \text{ where } u \text{ is the optimal cost and } F \text{ is the speed of the front in the normal direction} \]

\[ u = 0 \text{ on the initial point} \]

**Principle:**
1. Start at the initial point with the cost \( u = 0 \);
2. Compute the propagation of the front from the initial point corresponding to the minimal cost \( u \);
3. Construct the optimal path by tracing backward.

**One aircraft**

**Without Obstacle**

Speed of the front: \( F = \text{Aircraft Ground Speed} \)

**With Obstacles**

\( F = \text{function(Aircraft Ground Speed, Obstacles)} \)

**Profit:** \(~30 \text{ seconds for 30 min of flight time; 1.9% of time saved for the trajectory.}\)

**Several aircraft**

**Idea:** Propagate the front in the configuration space of several aircraft.

**Example:** for two aircrafts, state space \( \mathbb{R}^4 - \Delta \) with \( \Delta = \{(x_1, y_1) = (x_2, y_2)\} \) and \((x_1, y_1, x_2, y_2) \in \mathbb{R}^4\) the coordinates of both aircraft.

**Problem:** Curse of dimensionality.

**Proposed solution:** Use **Approximate Dynamic Programming** methods to compute good approximations and not the exact optimal trajectories.

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