Contextual Modelling

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Data-driven trajectory prediction

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Introduction

Giving some *context*

- **Research Fellow in ATM** at *Cranfield University* since January 2016.
- Before that, I used to work at *CRIDA A.I.E.*

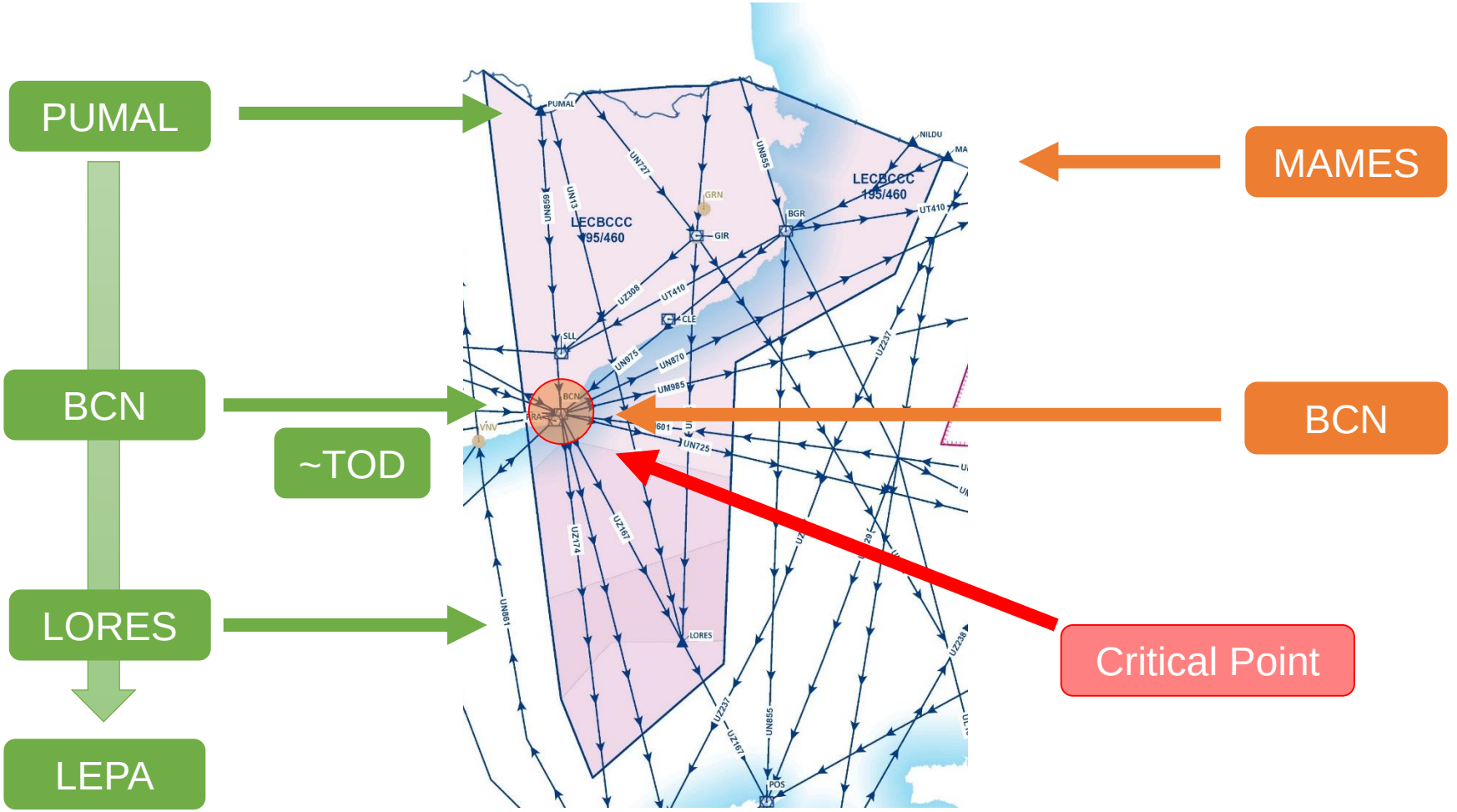
When I was there, I was assigned with an interesting problem:

If an ATCo issues a clearance to an aircraft: can we infer if it was because of a procedural intervention, or was it because a potential conflict with other aircraft?

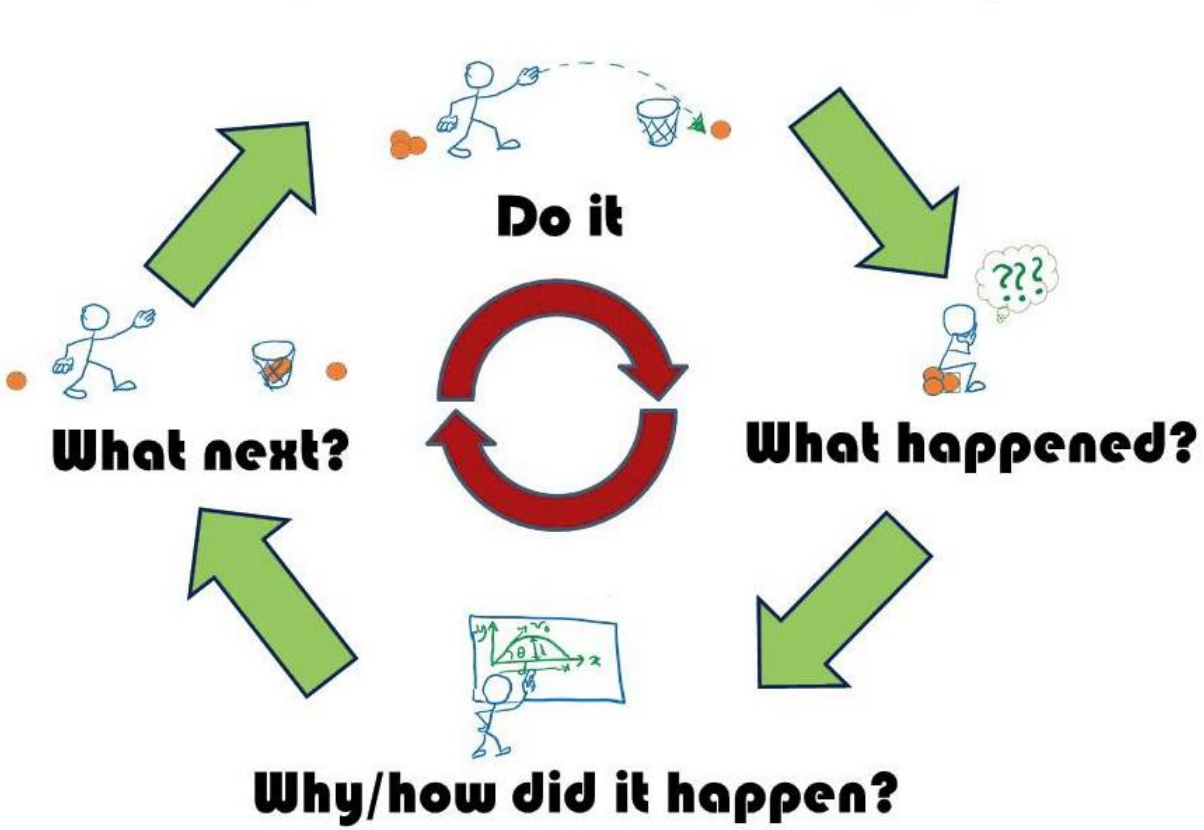
- I followed the "*logical"* approach: let's try to identify potential conflicts between aircraft.

The ATC intention problem

The operational context



The Kolb Learning Cycle



The research steps I

The initial approach

- If the horizontal and vertical separation minima are defined, then… I can predict the trajectories and determine if two aircraft were going to infringe it… Easy!

The result

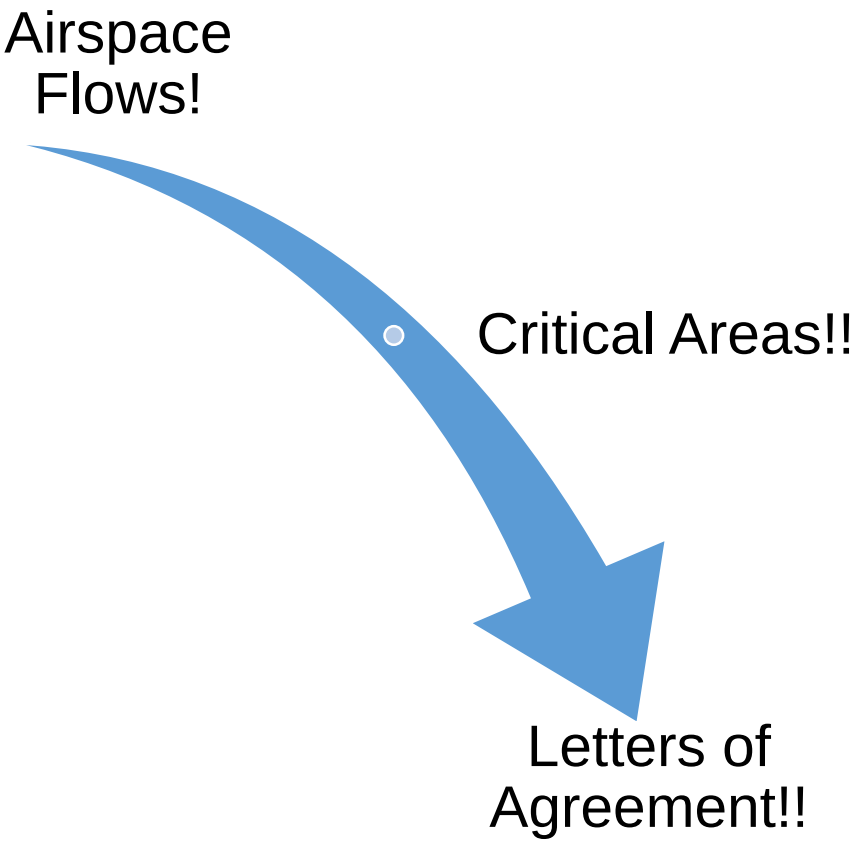
- Let's say it in *plain English*…I was very naïve.
- The Trajectory Predictor that I developed failed when analysing the vertical profiles. The main question was…
- When will the aircraft start descending?

"The primary limitations are …a lack of understanding of TP and CDR driver uncertainties (especially contextual, and aircraft state, operational and performance uncertainties)"

Schuster, W., Ochieng, W., 2014. Performance requirements of future Trajectory Prediction and Conflict Detection and Resolution tools within SESAR and NextGen: Framework for the derivation and discussion.

The research steps II

The reflective observation

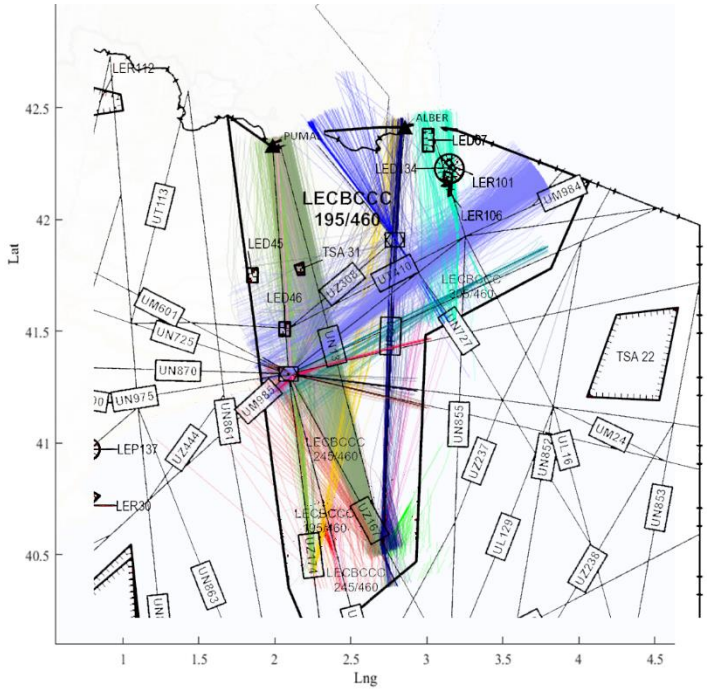


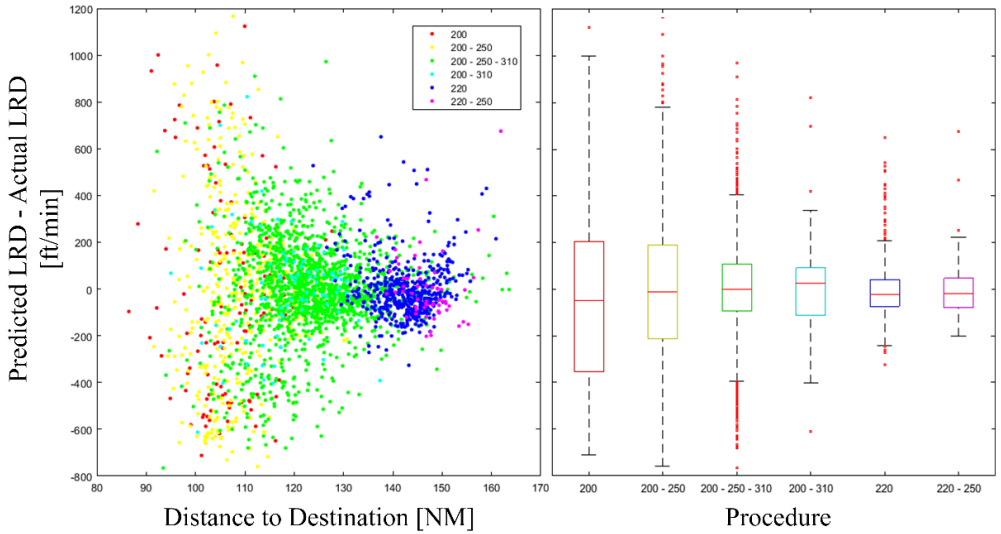
Well…it was already there

Histon, J.M., Hansman, R.J., 2008. Mitigating Complexity in Air Traffic Control: The Role of Structure-Based Abstractions.

The research steps III

The conceptualisation and deployment





Analysis of air traffic control operational impact on aircraft vertical profiles supported by machine learning. *Verdonk Gallego et al, 2018*.

https://doi.org/10.1016/j.trc.2018.03.017

The research steps IV

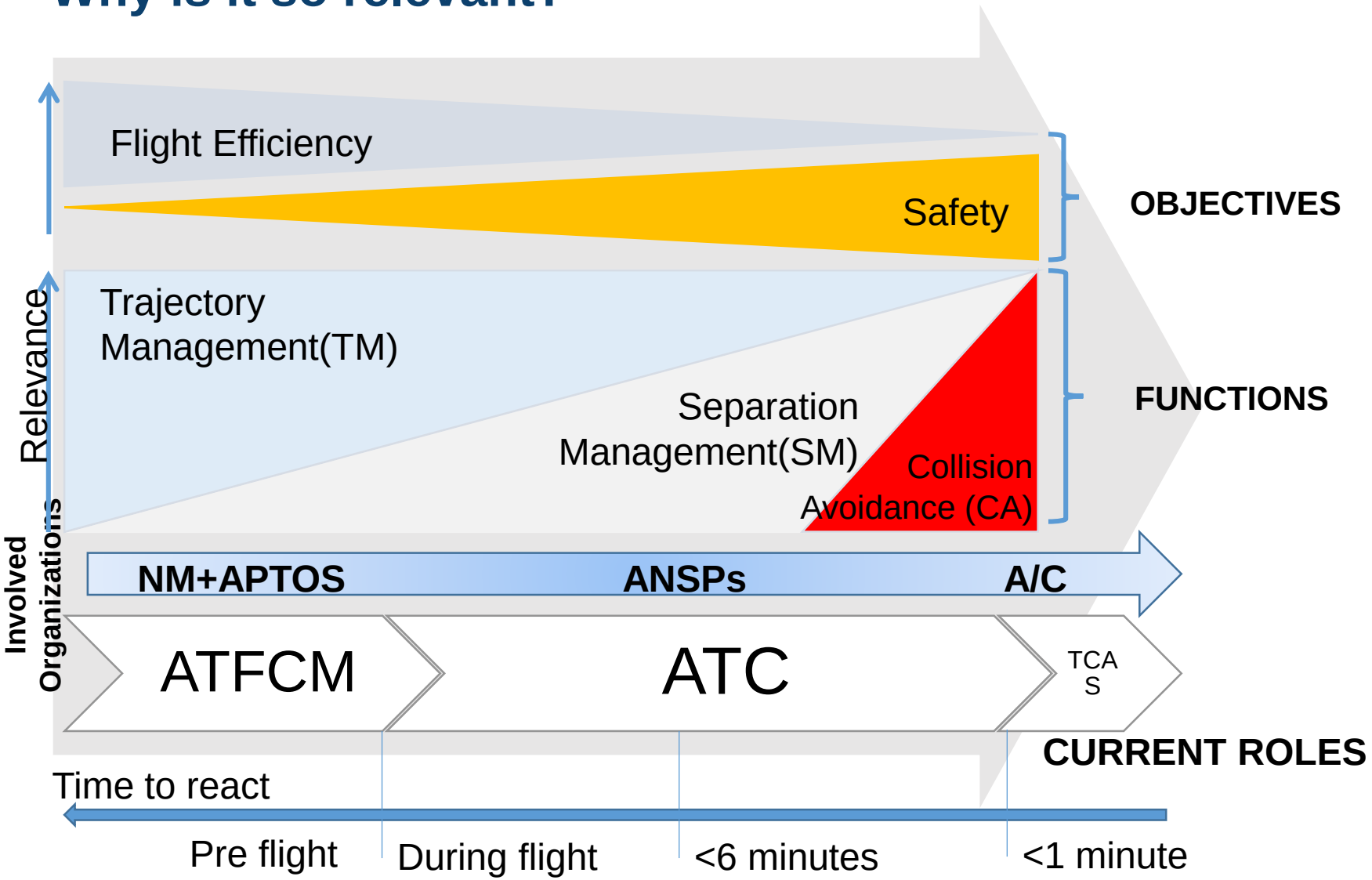
The “do it”

- Yes, the flows are basic for the trajectory prediction…But *where* and *when* does an aircraft start descending!

The “reflection”

- Mitigating Complexity in Air Traffic Control: The Role of Structure-Based Abstractions…Again. → ATCo focuses mainly on Critical Points.
- The ATCos are not *perfect machines.* Their predictions also have *errors.* They carry out *repetitive* actions.
- Let’s define the horizontal interdependency on the *crossing point* based on the *prediction errors.* For *all* possible patterns.

Why is it so relevant?



Contextual Modelling

Some Conclusions

- Mixed data- and model-driven approach.
- Surrounding traffic *is* a contextual factor.
- The proposed metric enabled us to *anticipate* ATCo clearances.
- ATCos work *every* day with this problem, let's learn from them!

Future Research

Some potential ideas

- Calibrating the interdependency triggering an ATC action depending of the sector state.
- Modelling the interdependency measure for other ATCo abstractions.
- Integrate and escalate the findings to *real* trajectory predictors.
- Escalate the *interdependency* measure to *big data*.
- Combine *hazards.* Integrate this approach with other *contextual factors* such as weather conditions.