Machine learning applications to extend AGENT's conflict resolution capabilities

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Table of Contents

1. Introduction
2. Goals and objectives
3. Data driven complexity metric
4. Future work

Table of Contents

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2. Goals and objectives
3. Data driven complexity metric
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Automation in ATM

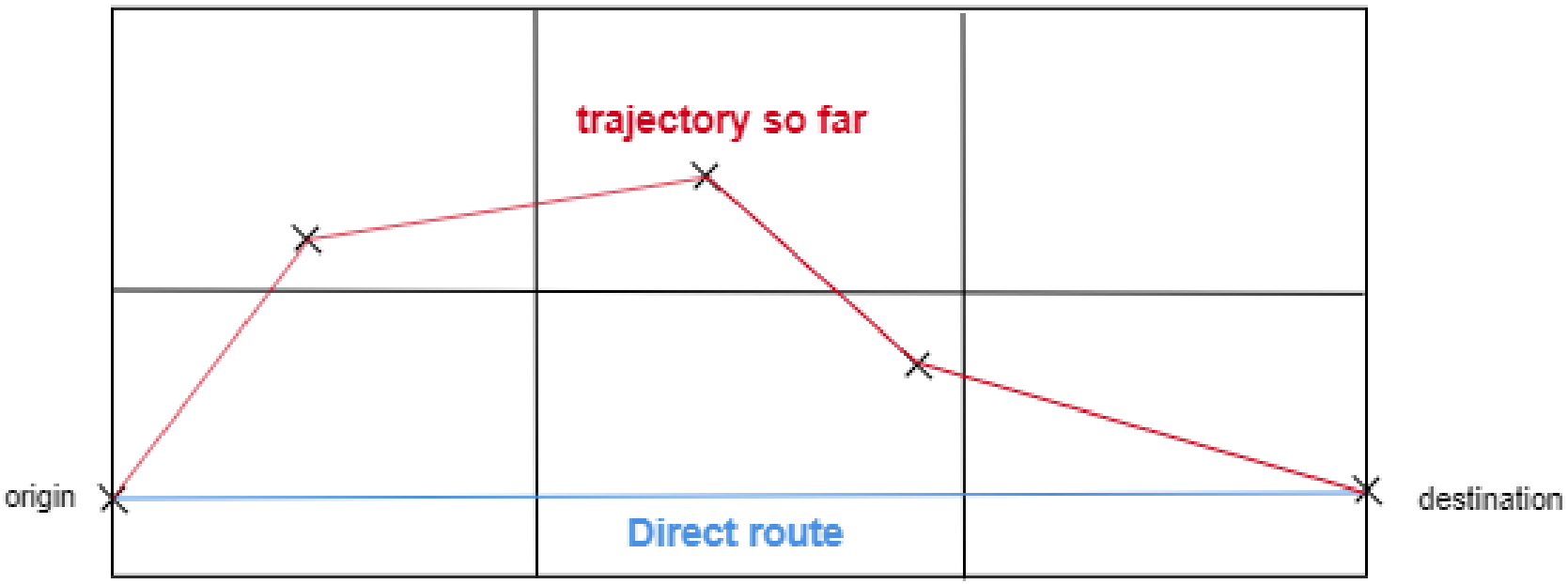

Table of Contents

1 Introduction

2 Goals and objectives

3 Data driven complexity metric

4 Future work

What we want to achieve

- **Overarching goal**:
  - Use machine learning to assist controllers in their conflict resolution duties,
- Intermediate problems to solve:
  - Define a sector complexity metric;
  - Classify sectors based on the metric;
  - Study the effects of learning capabilities of agents on the dynamics of a negotiation.

Table of Contents

1. Introduction
2. Goals and objectives
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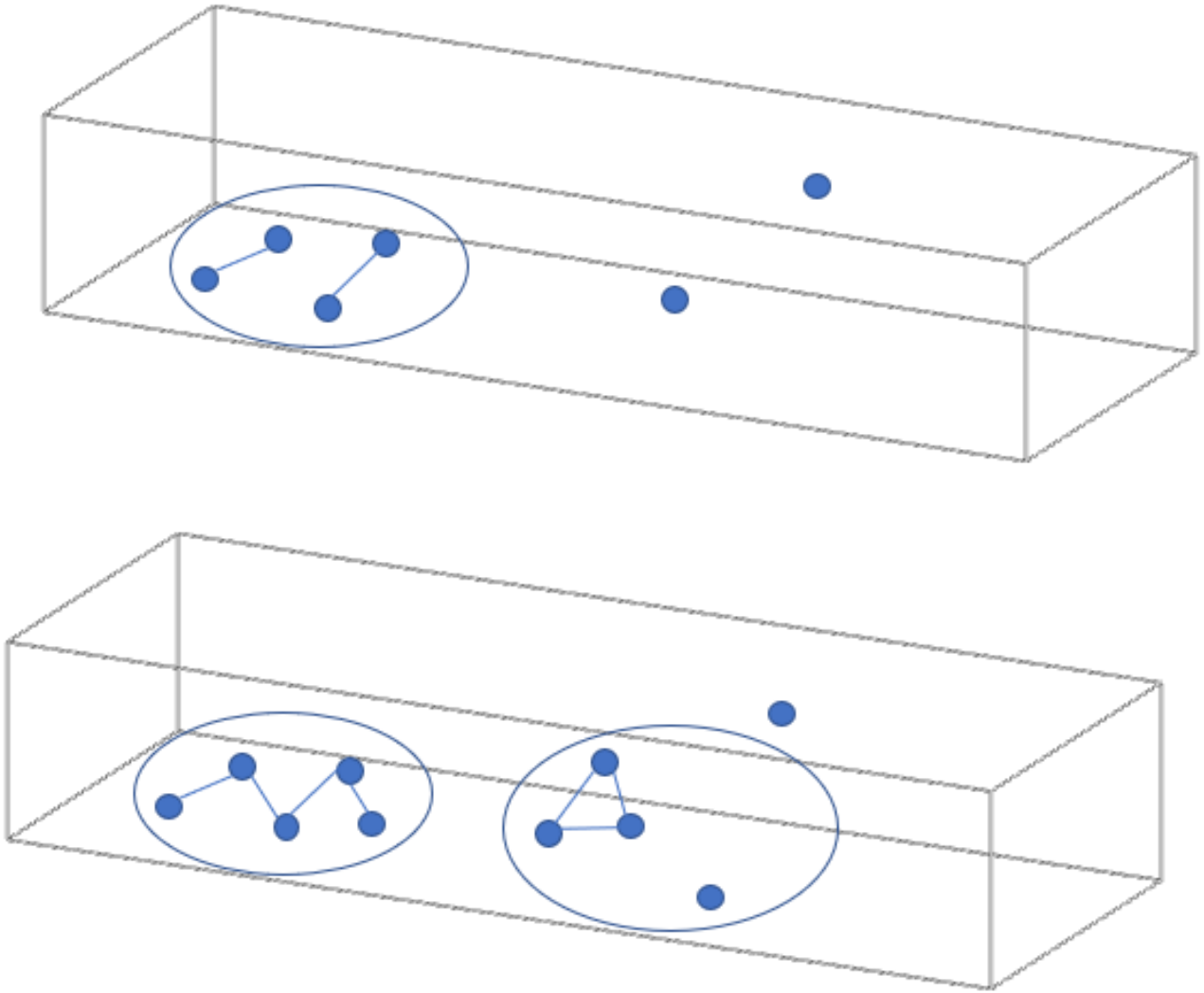
4. Future work

How we want to achieve our goals: Data driven complexity metric

- Why do we need another complexity metric?
  - (Most) Metrics so far: number of aircraft, number of conflicts etc.;
  - We believe such metrics don't capture the whole picture;
- Is it even possible to have a purely data driven complexity metric?
  - Hybrid approach combining data driven and knowledege based models.
- Defining a suitable complexity metric:
  - Find a suitable time window;
  - Use 4D trajectories;
  - Density based clustering to identify regions with high number of aircraft;
  - Study how strongly connected these aircraft are;
  - Calculate deadlock time (research already conducted in our department).

VIsualization of the metric



Benefits of such a metric

- Takes a broader view of the sector;
- Considers the risk that a solution of a conflict can cause another;
- Considers how trajectories can affect each other;
- Can be connected to controller workload:
  - This metric can give the controller a clearer picture where to guide conflict aircraft.
- Will guide our future RL models.

Constructing complexity classes

- We do not know beforehand the complexity classes;
- Common approach: unsupervised learning;
- We propose hierarchical clustering;
- Two main approaches:
  - Train one model per sector;
  - Generalize over different sectors;
  - Intricacies and characteristics of different sectors may be difficult to generalize.

Table of Contents

1. Introduction
2. Goals and objectives
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Future work

- Finish working on the complexity study:
  - Solidify the definition of the complexity metric;
  - Identify complexity classes;
  - Results will be summarised in an article;
- Build RL models for conflict resolution:
  - Work so far will serve as backbone;
  - Aircraft modeled as agents;
  - Study different agent behaviours.

Thank You!