

Characterisation of approaches in an FDM context

Using ML tools to
clusterise approach data

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The ATR logo is displayed in white, italicized, sans-serif capital letters. It is positioned in the bottom right corner of the slide, overlaid on a background image of an ATR aircraft's propeller and wing against a blue sky with clouds.



Content

1. Objective
2. Methodology
3. Usage
4. Prospects



Objective

ATR

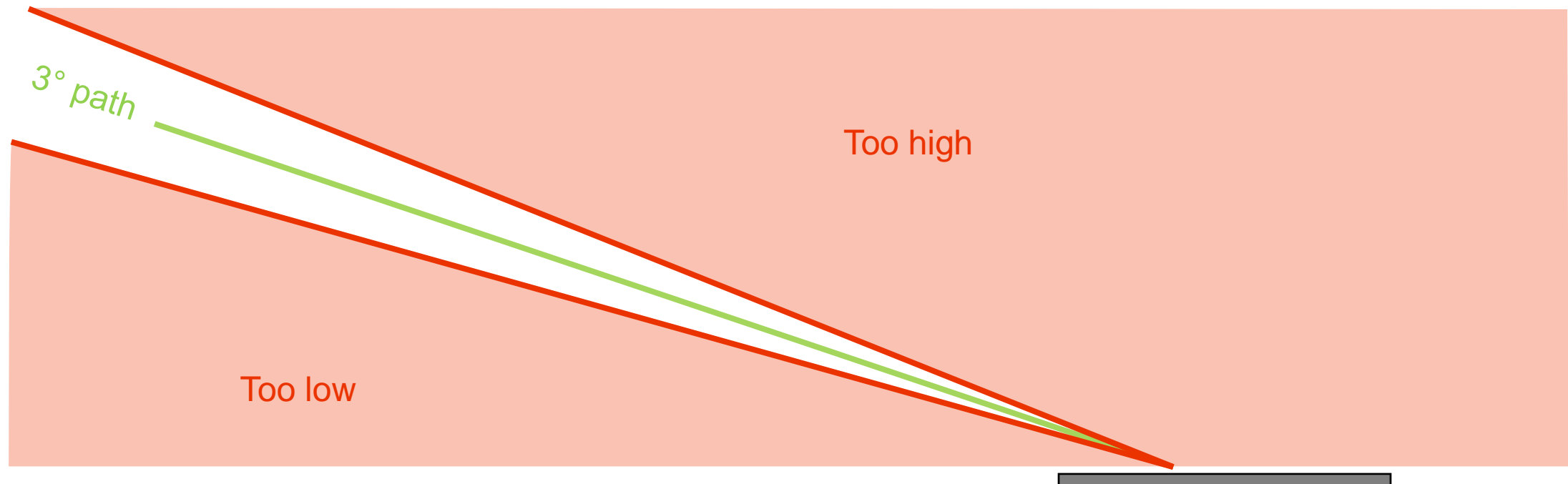
Objective

Not a vital issue, but...

- When analysing unstabilised approaches, difficult to categorise efficiently
 - Different analysts = different terms
 - Sometimes different interpretation of same facts
 - Combined events (eg “continuously high”) useful but limited granularity
- So ultimately some questions came up:
 - What are the typologies of approaches that are considered unstabilised?
 - What do we miss if we simply consider “continuously too high” or “too low”?
 - Are those categories that are just worth having?

Objective

Initial approach of combined events



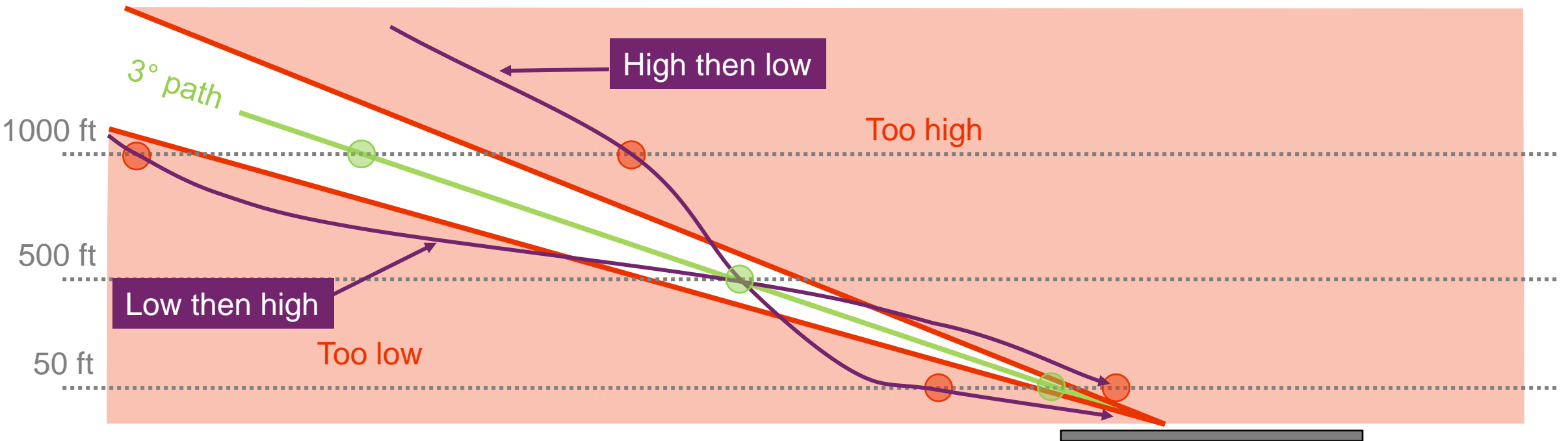
Objective

Initial approach of combined events



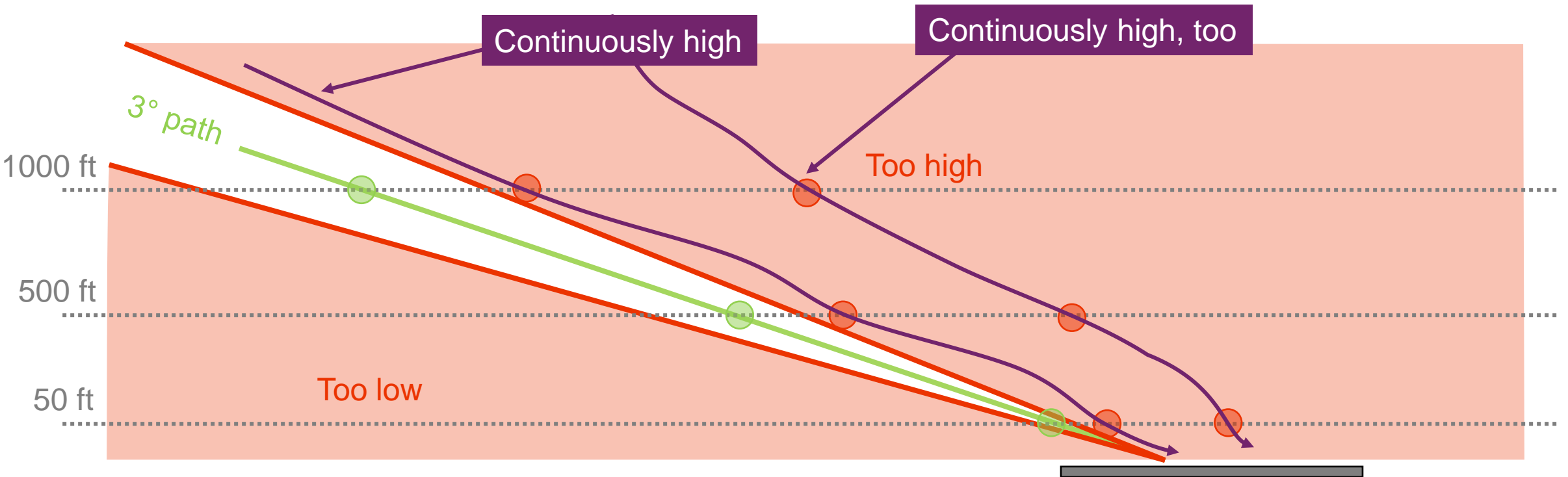
Objective

Initial approach of combined events



Objective

Limitations of such approach

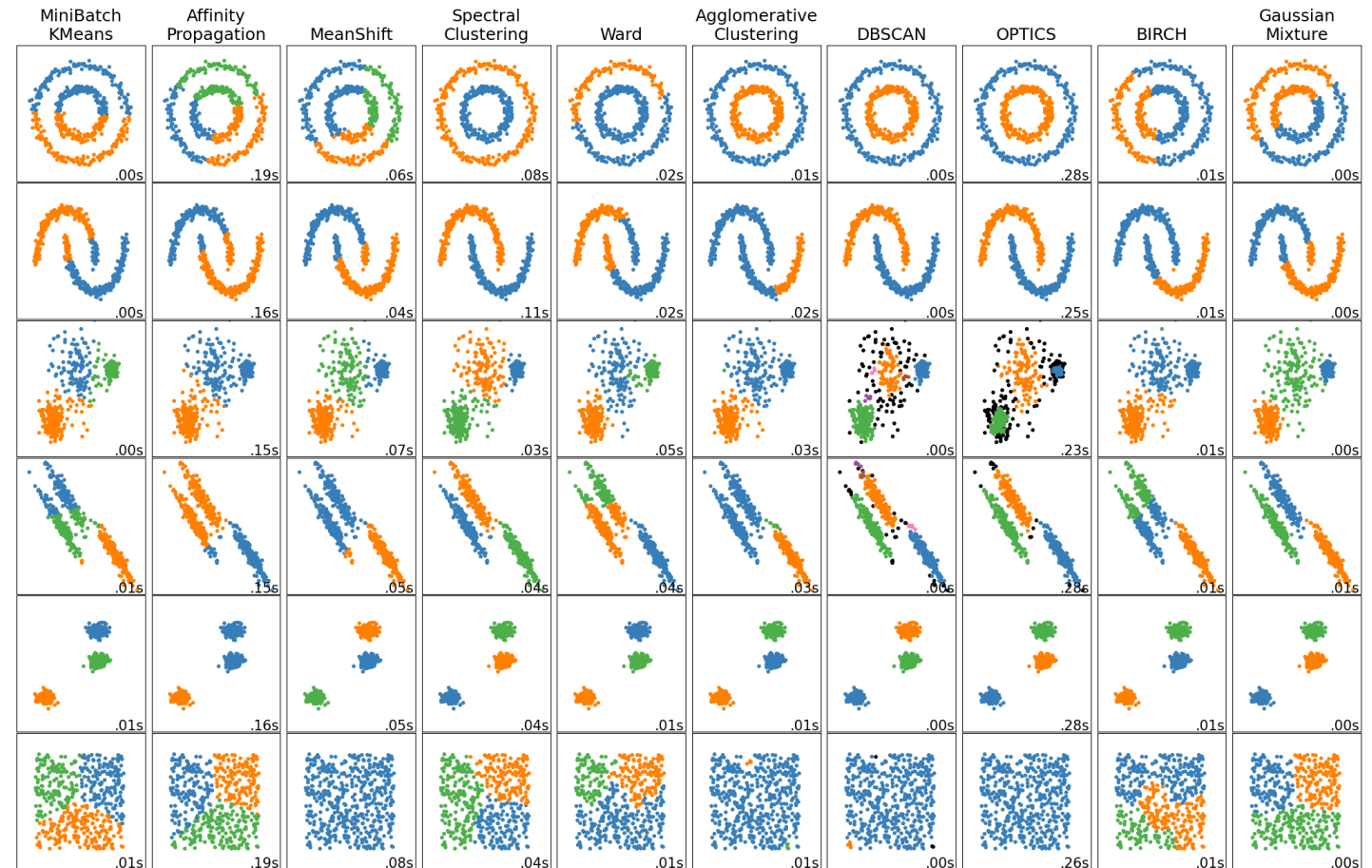


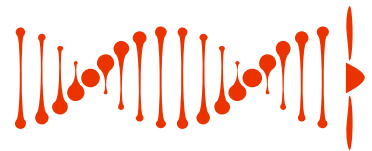
This combined event approach, while interesting, may sort very different pattern into the same bucket

Objective

The next step...

- To try and find a better way to group approaches we thought about using a ML technique called **clustering**
- Idea is that the algorithm is going to find groups (clusters) of data that go together among all data





Methodology

ATR

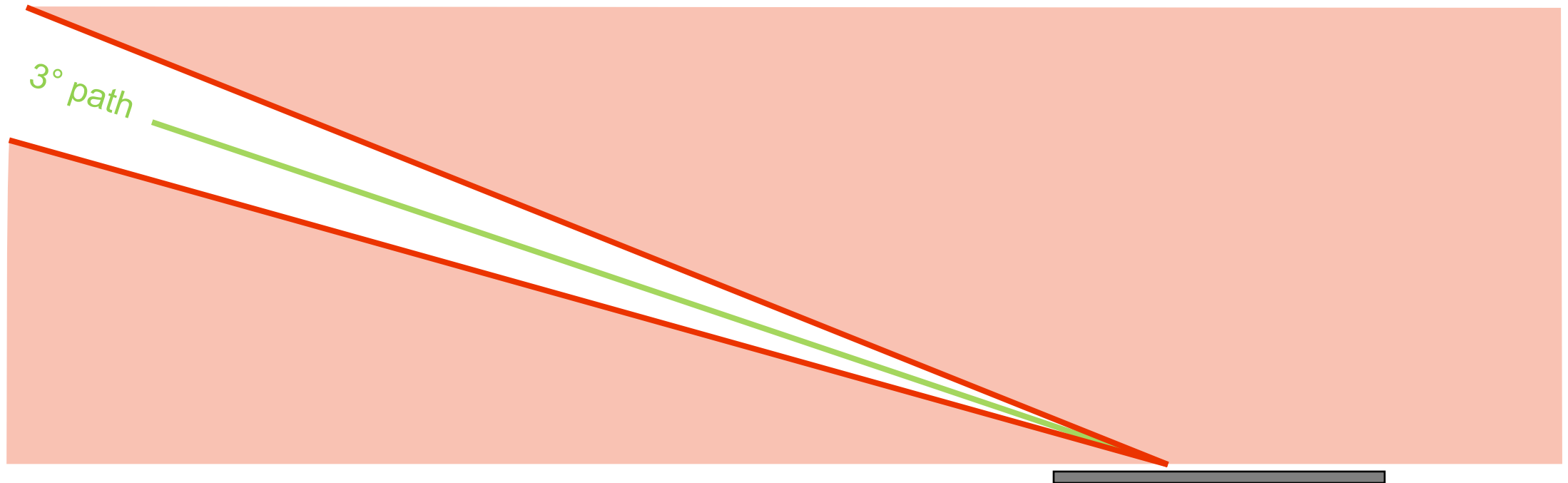
Methodology

Application to vertical approach path

1. Discretise / normalise
2. Compute a covariance matrix
3. Find clusters

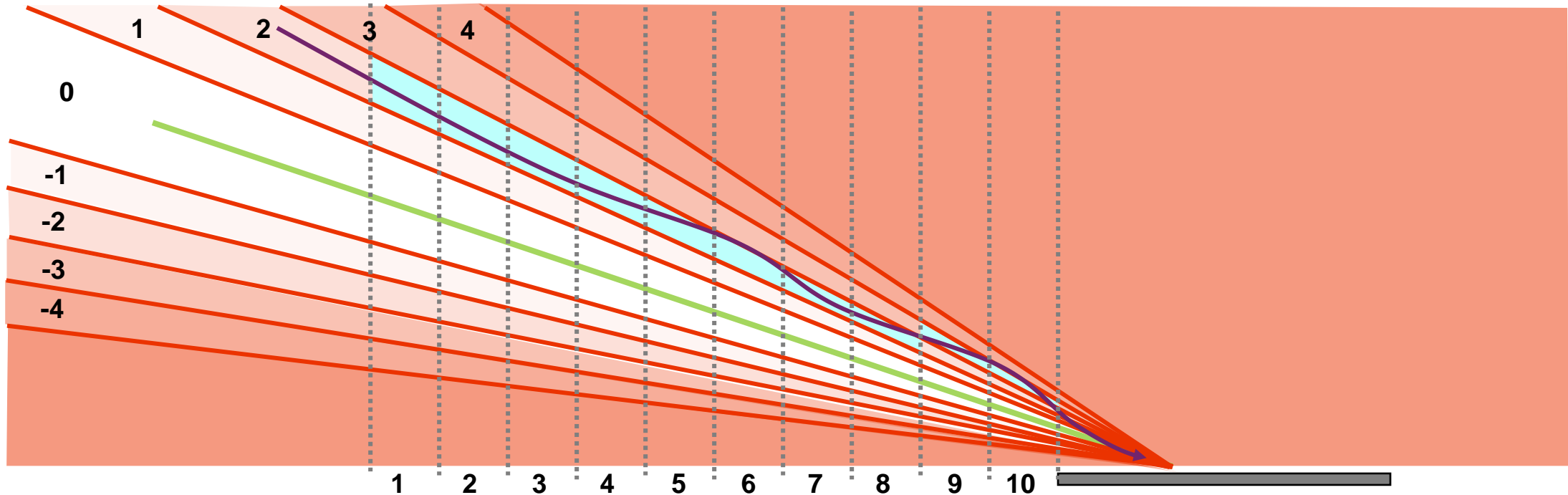
Methodology

1. Discretise / normalise



Methodology

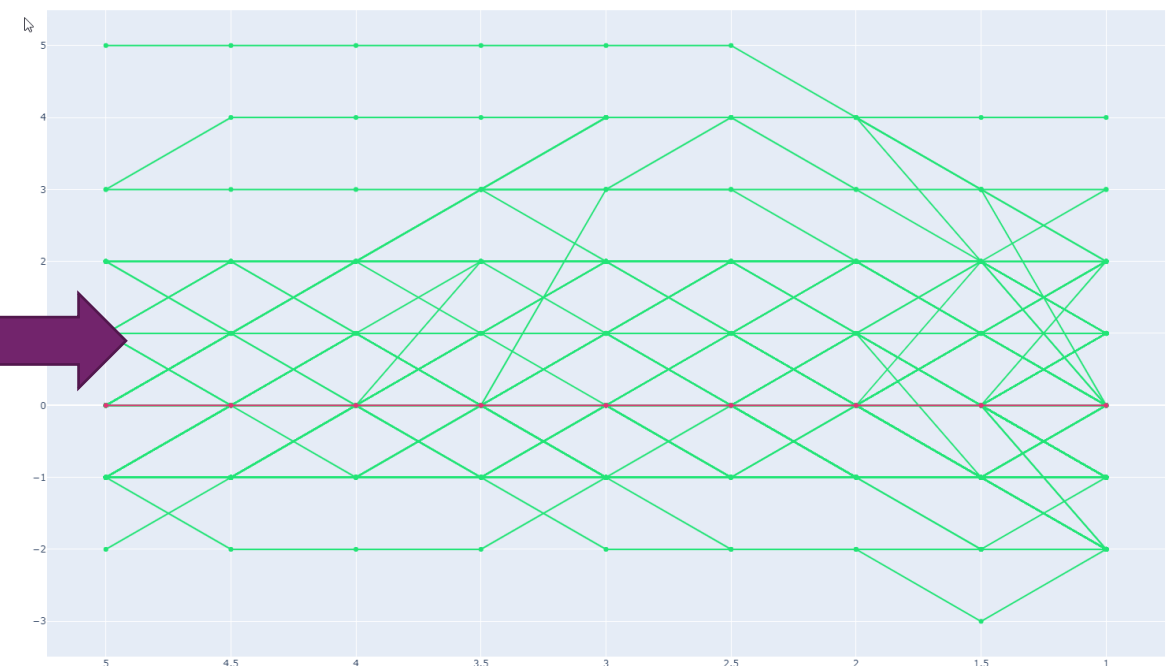
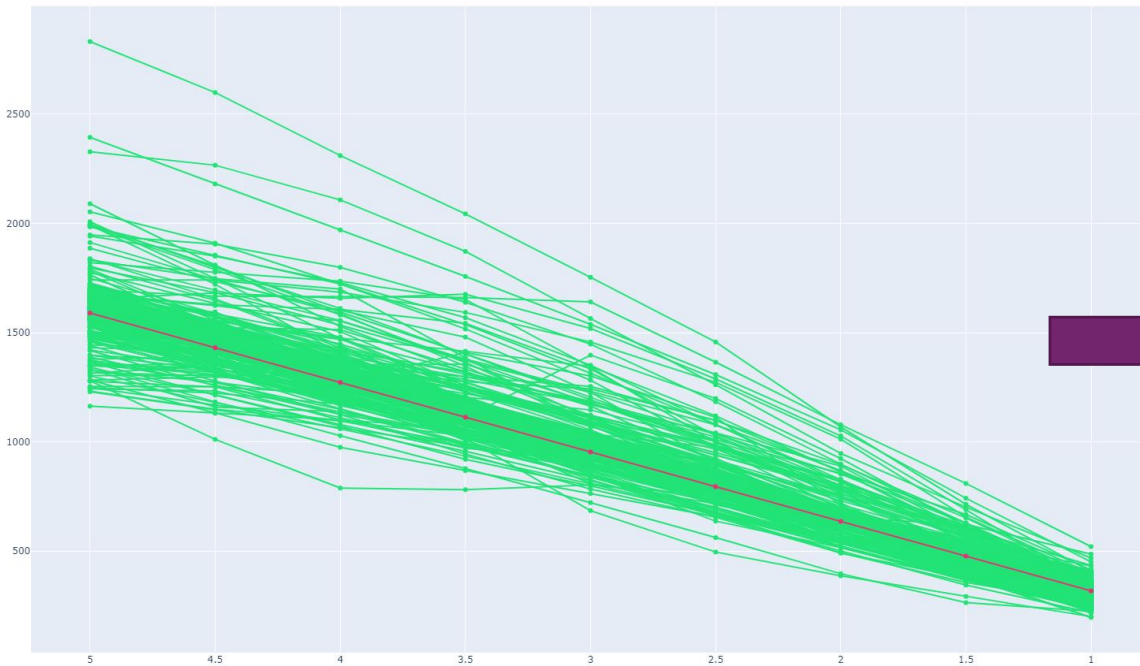
1. Discretise / normalise



For the approach, get a vector of integer values, here: [2,2,2,2,2,2,2,2,3,3]

Methodology

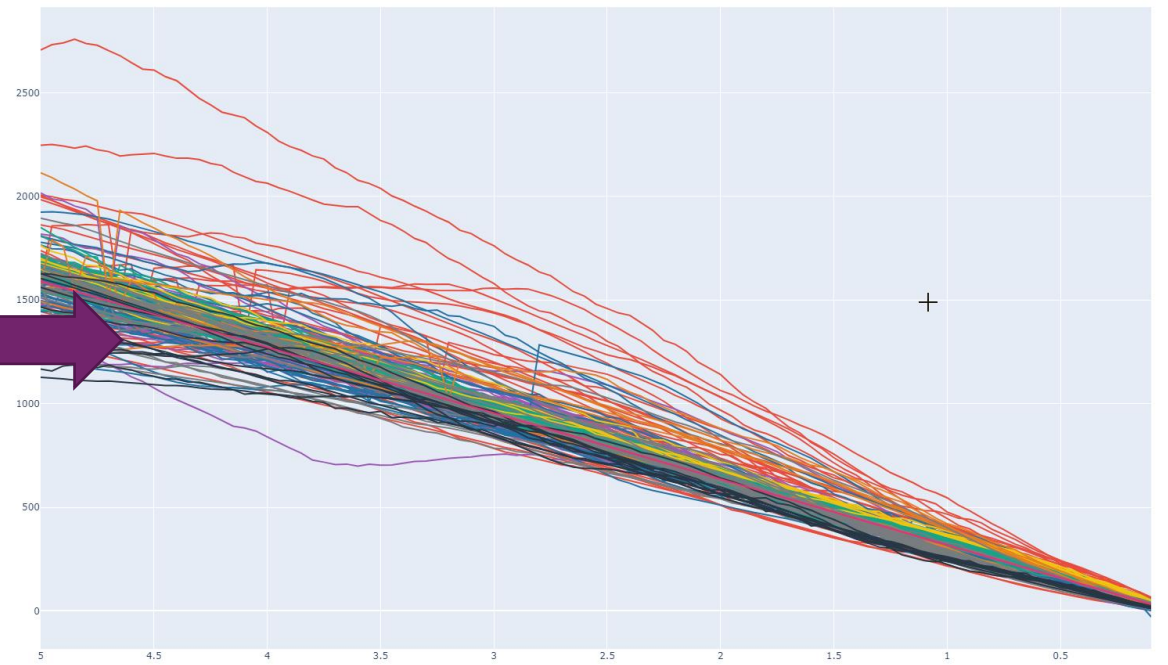
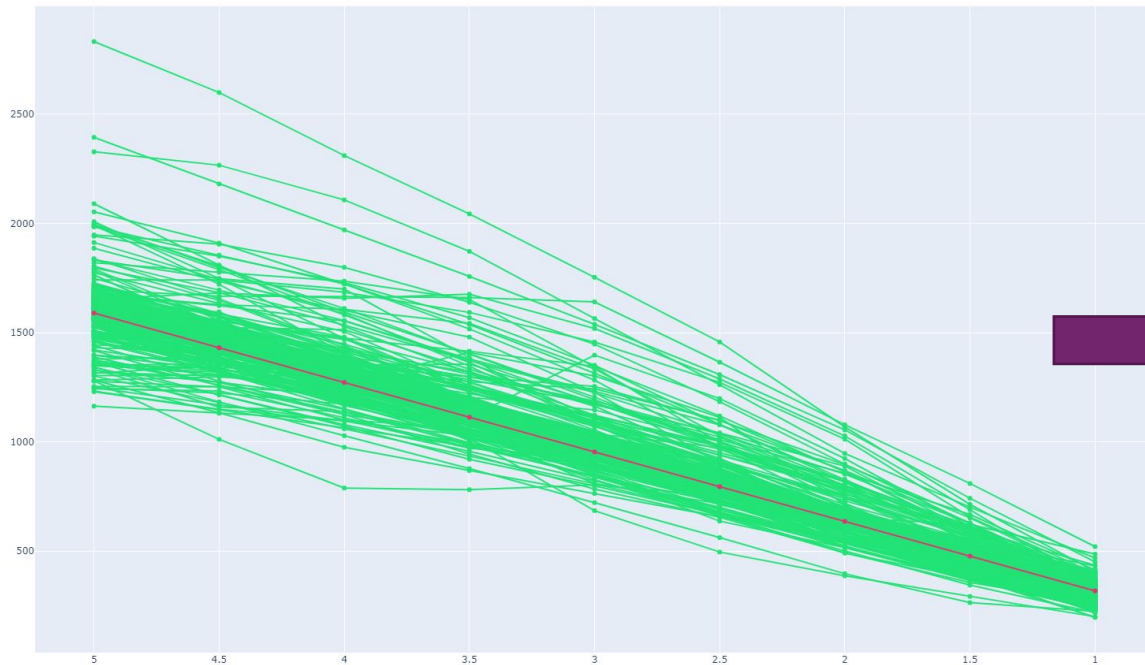
1. Discretise / normalise



Methodology

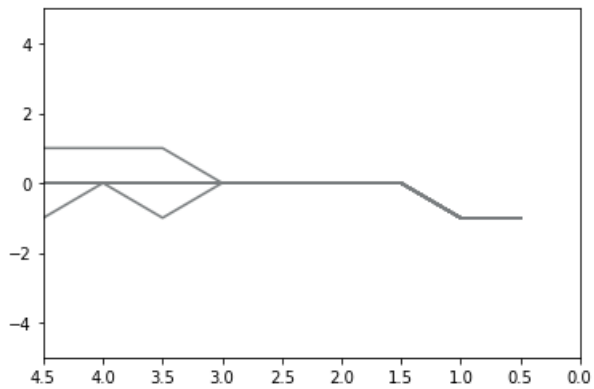
2. Compute a covariance matrix and 3. Find clusters

- Covariance matrix sort of represents the distance of a given path to each other
- That's what the clustering algorithms use to determine how two objects can be related

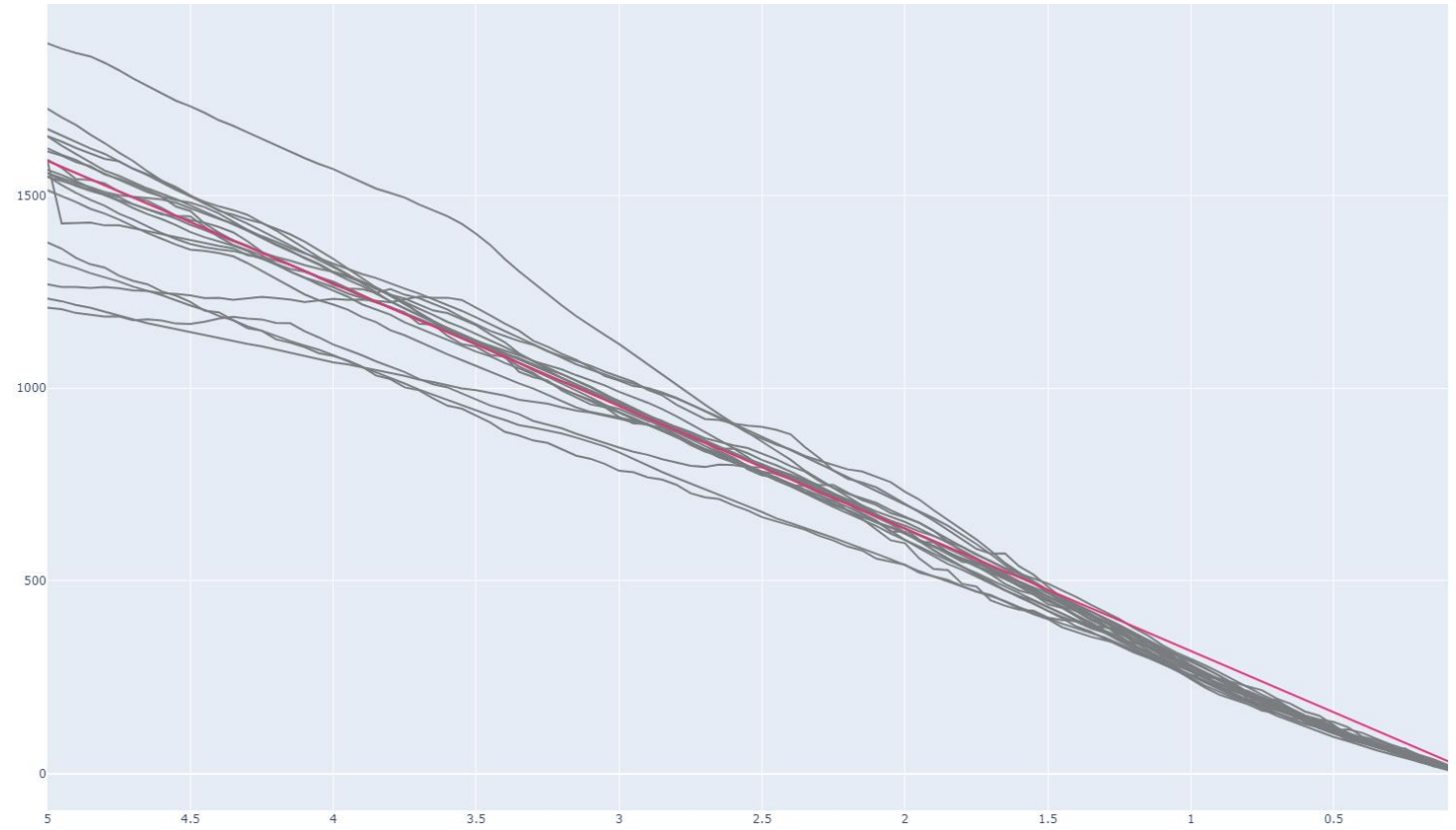
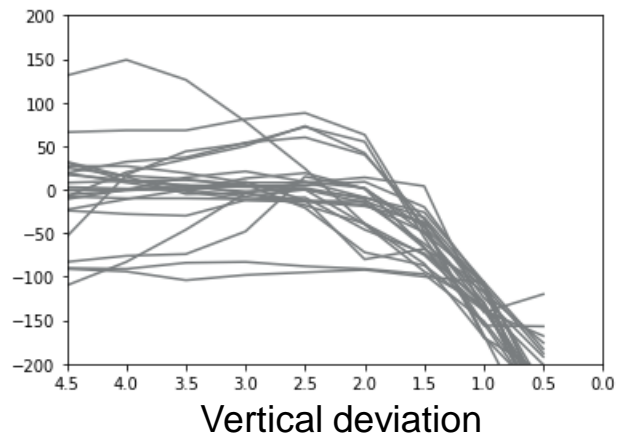


Methodology

Example of identified cluster



Vertical deviation, normalised + discretised



Flight path

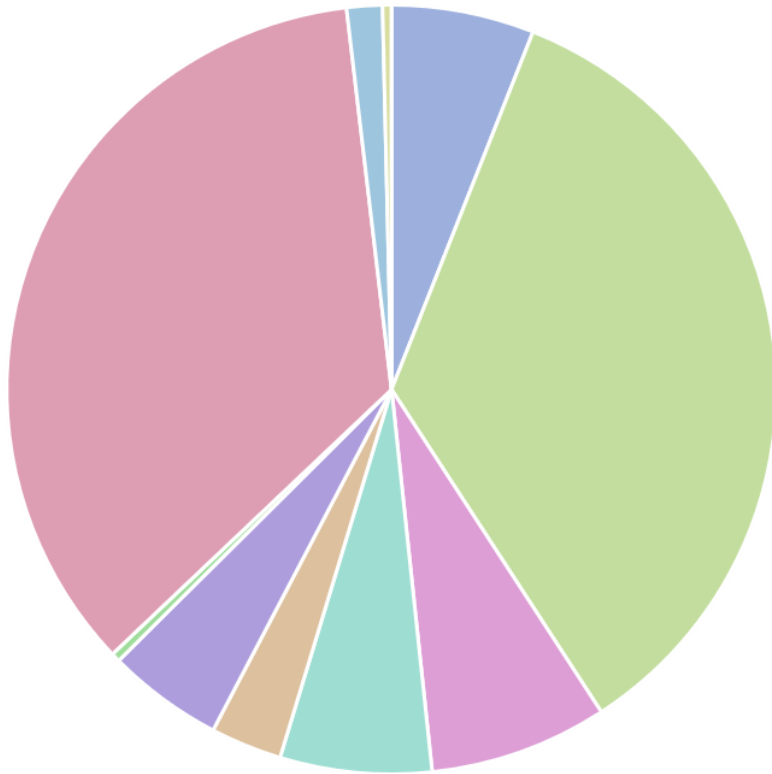


Usage

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Usage

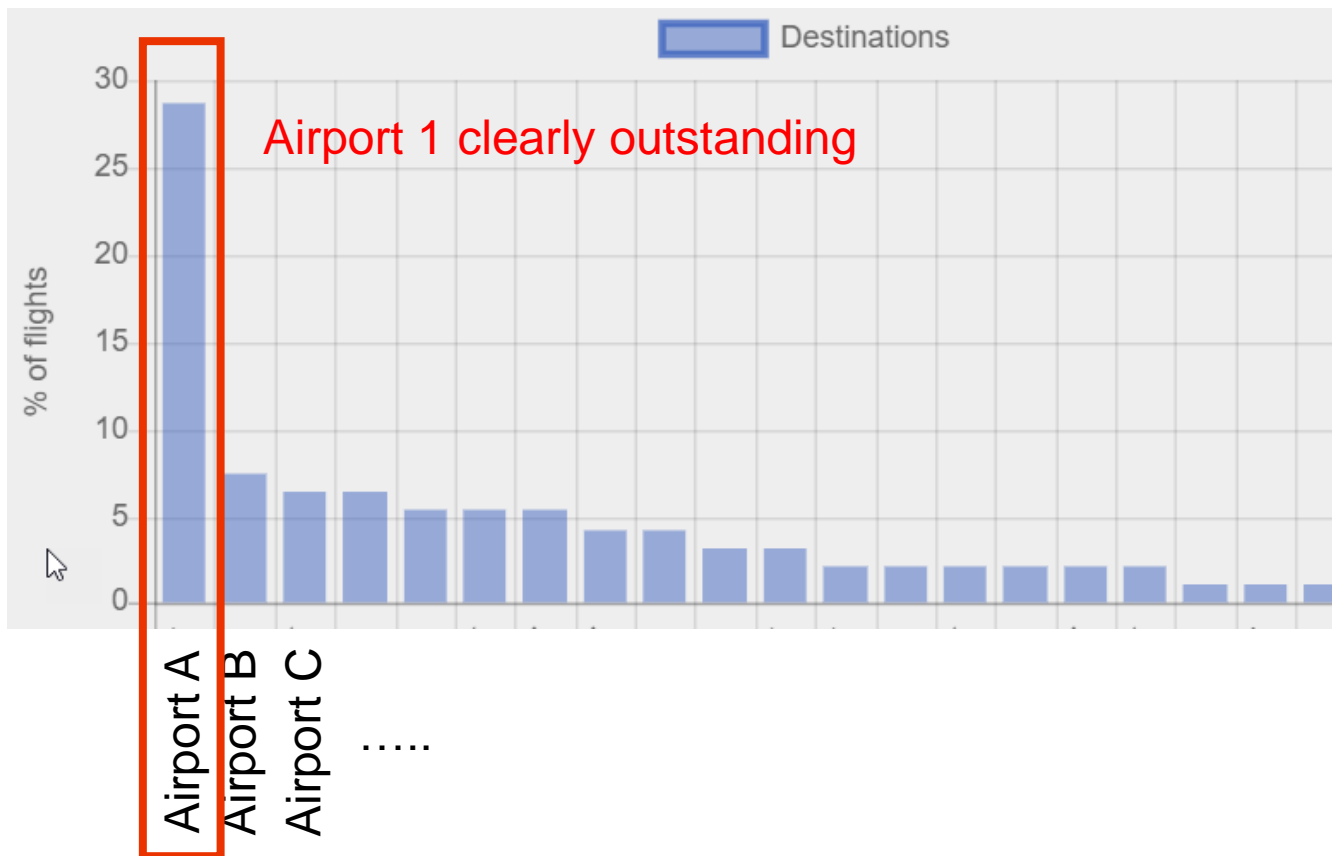
Cluster importance on a specific subgroup of flights



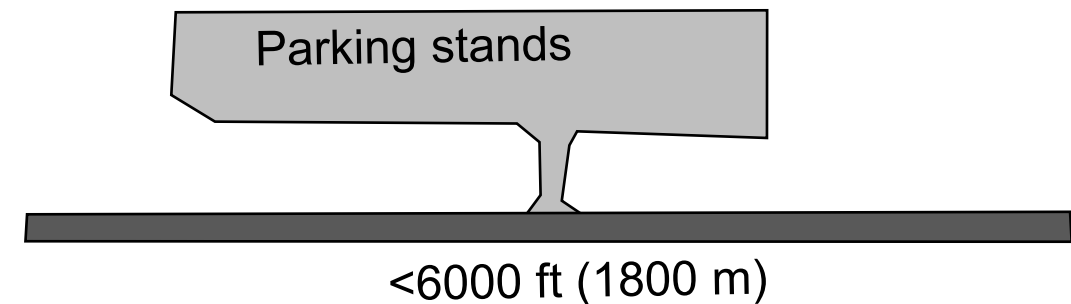
- 0: on path
- 1: increasingly below
- 2: increasingly above
- 3: increasingly above and recovering
- 4: on path then above then below in short final
- 5: continuously below
- 6: on path then increasingly below in last 1.5 nm
- 7: on path then increasingly above in last 1.5 nm
- 8: continuously above

Usage

Focus on category #6: *on path then increasingly below in last 1.5 nm*



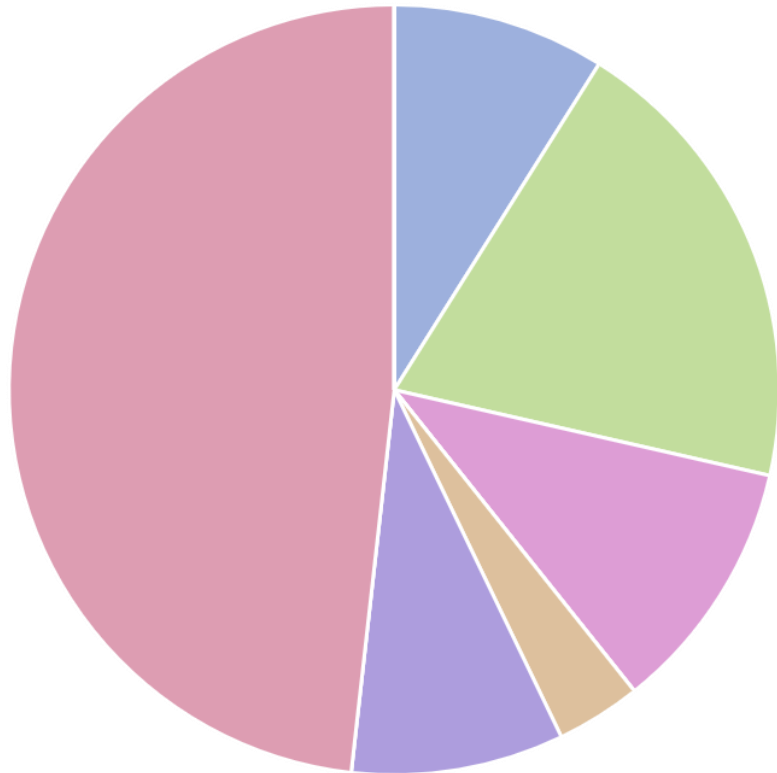
Configuration of airport A



- Taxiway mid-runway
- Probable will to reduce landing distance and avoid U-turn

Usage

Focus on Airport A



- 0: on path
- 1: increasingly below
- 2: increasingly above
- 3: increasingly above and recovering
- 4: on path then above then below in short final
- 5: continuously below
- 6: on path then increasingly below in last 1.5 nm
- 7: on path then increasingly above in last 1.5 nm
- 8: continuously above

- Significant predominance of pattern #6

Usage

Summary

- Added value is characterising the approaches to identify specific root cause
 - Breakdown by airfield / runway for each cluster
 - Breakdown by cluster for each airfield / runway
 - Breakdown by cluster for each flight crew (habits)
- For a specific cluster
 - Correlation with other events (e.g. short touchdown / strong braking)
 - Correlation with runway specificities (taxiway close to threshold)
 - Correlation with environment (weather, ATC)
- Allowing to provide better guidance to flight crews



Perspectives

ATR

Perspectives

- Methodology that can be widely used for other cases
 - Lateral path / speed management in approach
 - Other events correlations
- Clustering methods are highly customizable
 - Can be tricky to get added value
 - Discretisation and correlation are key and can be tuned to look at different aspects (short final, intermediate approach, flare) with the same data



Thank you

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