MATLAB EXPO
FRANCE

8 octobre 2024 | Paris

# MASTERCLASS

## Coder sans Coder avec MATLAB

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Application Engineer

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Applications Engineer

MathWorks

## Objec

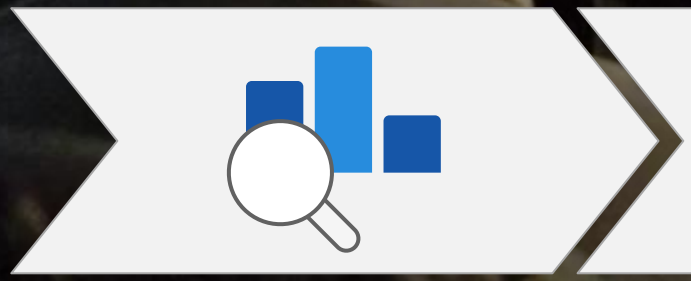
Crea *sensor* model to estimate the **True Air Speed** (*TAS*)

## Inpu

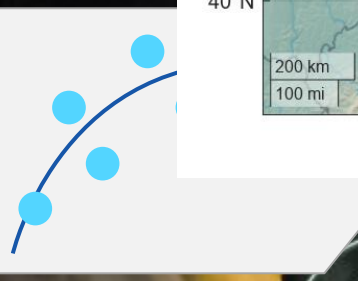
13 se m 1 flight

*Data so Dash Link: Sample Flight Data*

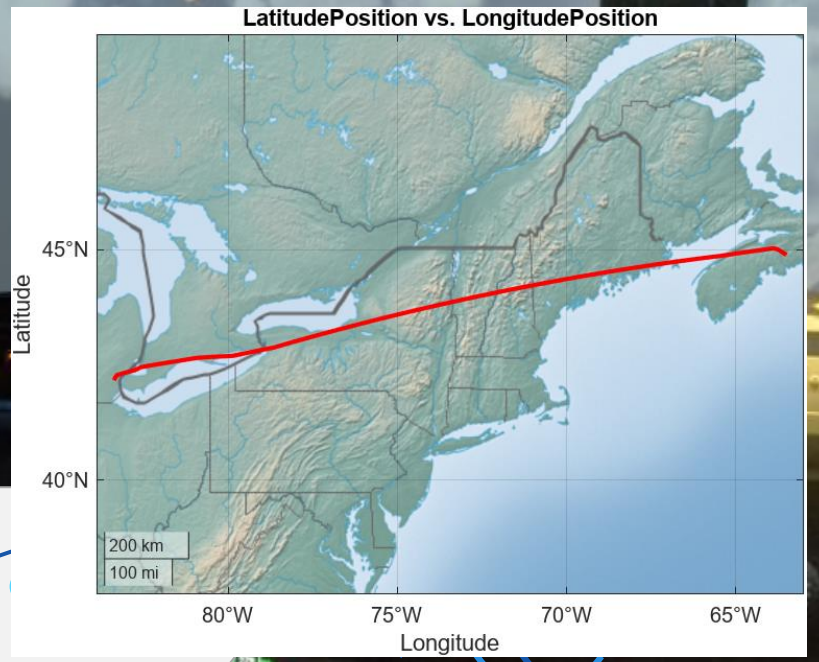
## Approach



Preprocess data

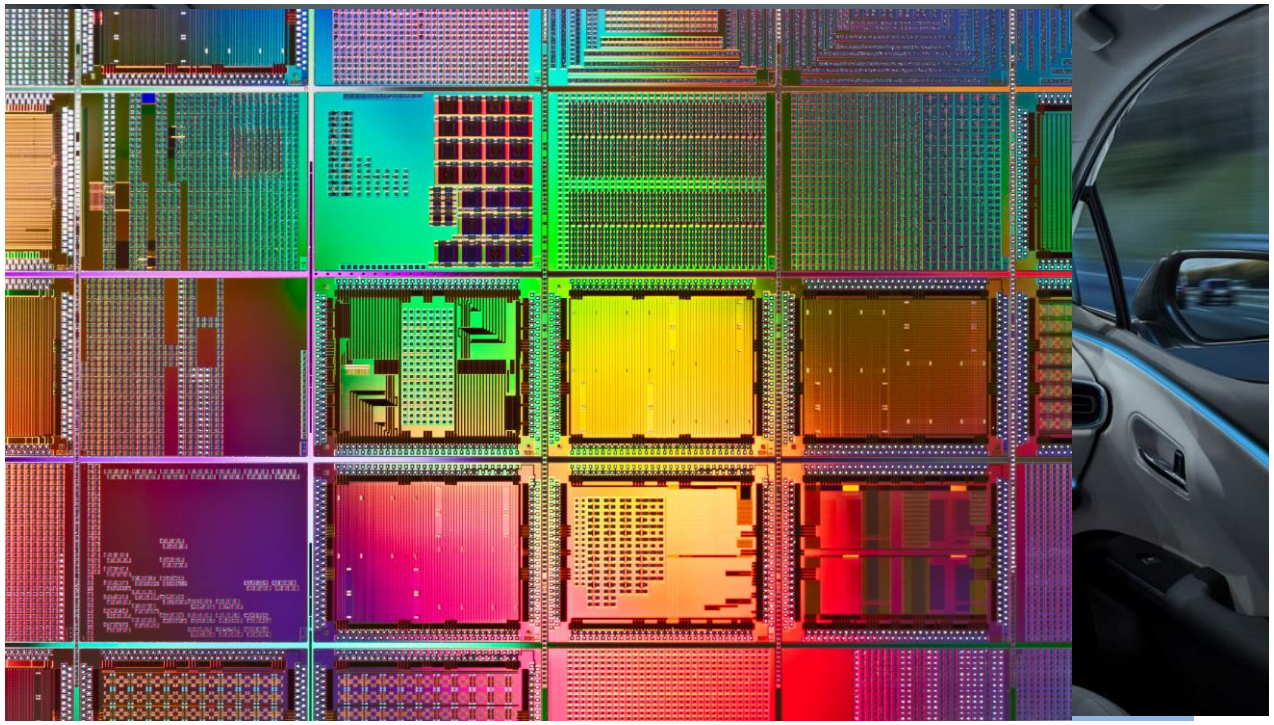


Build predictive model



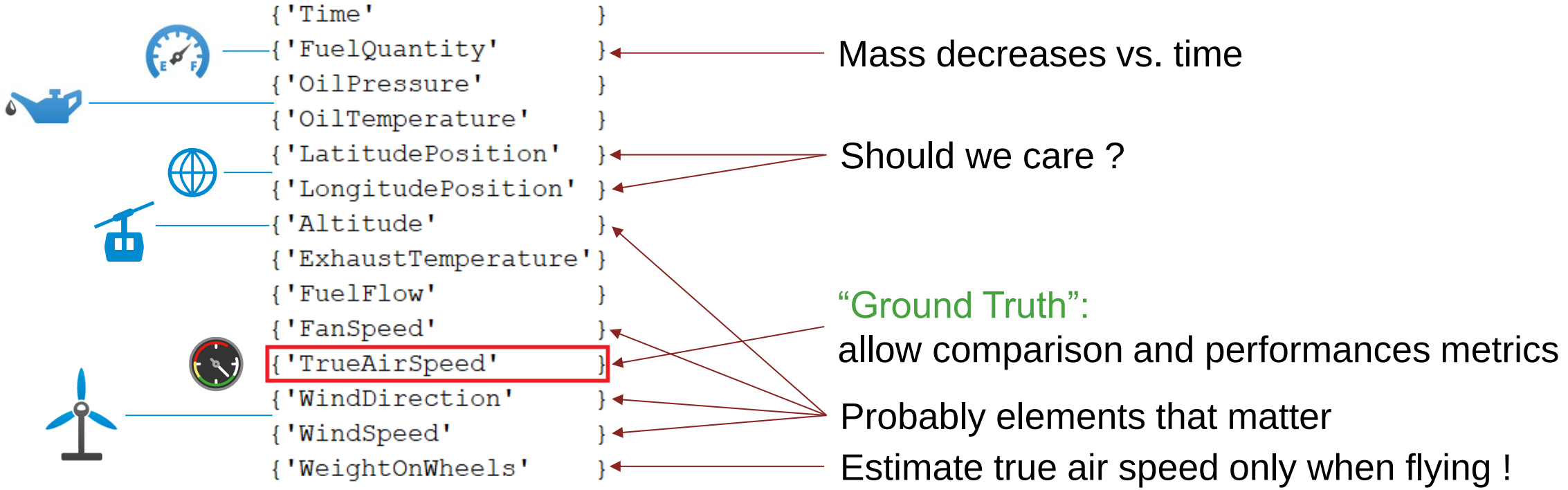
# Why this use-case ?

- Similar Workflow across industries
- “Virtual” sensor
- Dataset Availability
- Workflow in <1H ☺

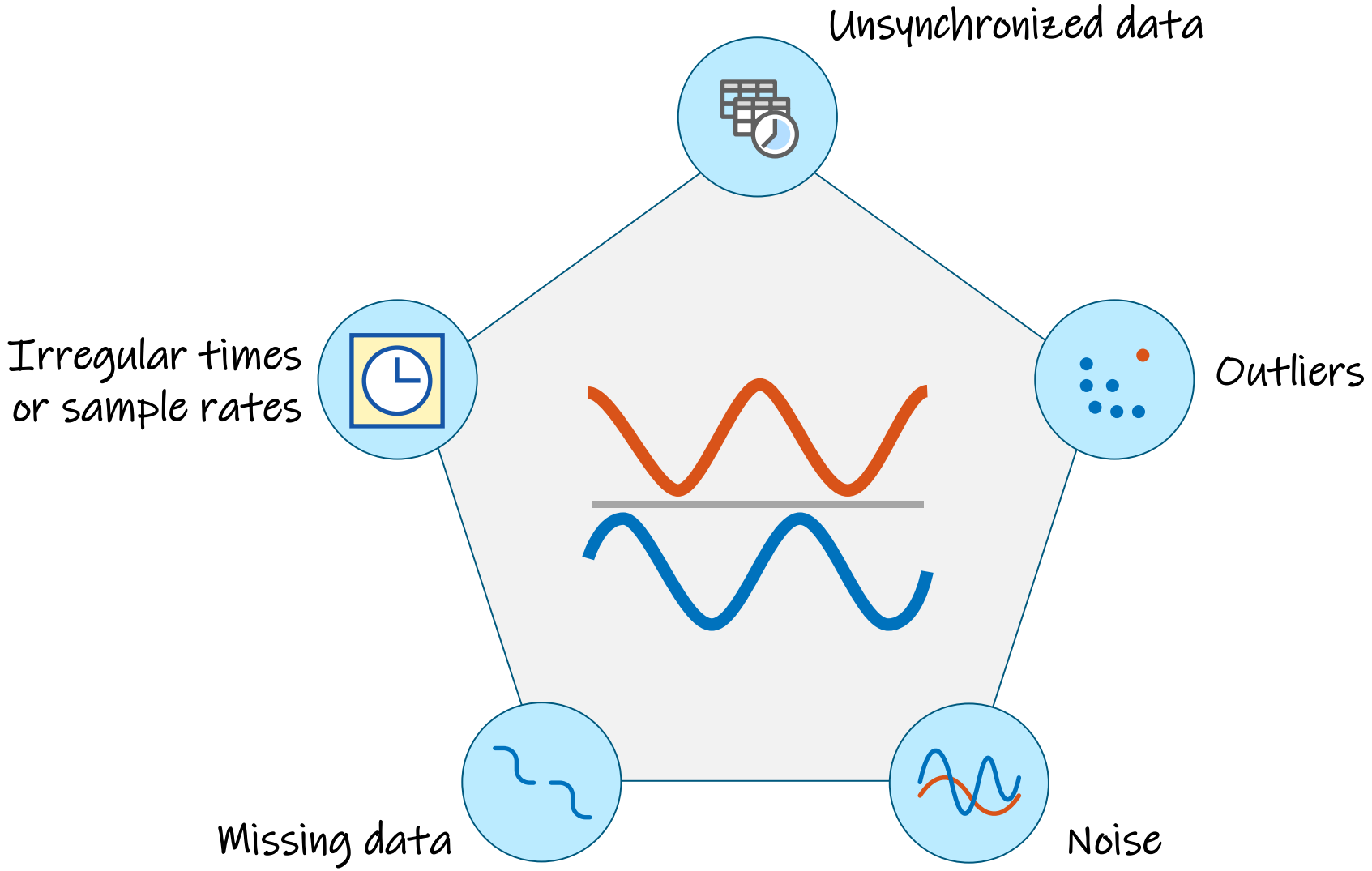


# Our goal: Infer a value from (other) sensors

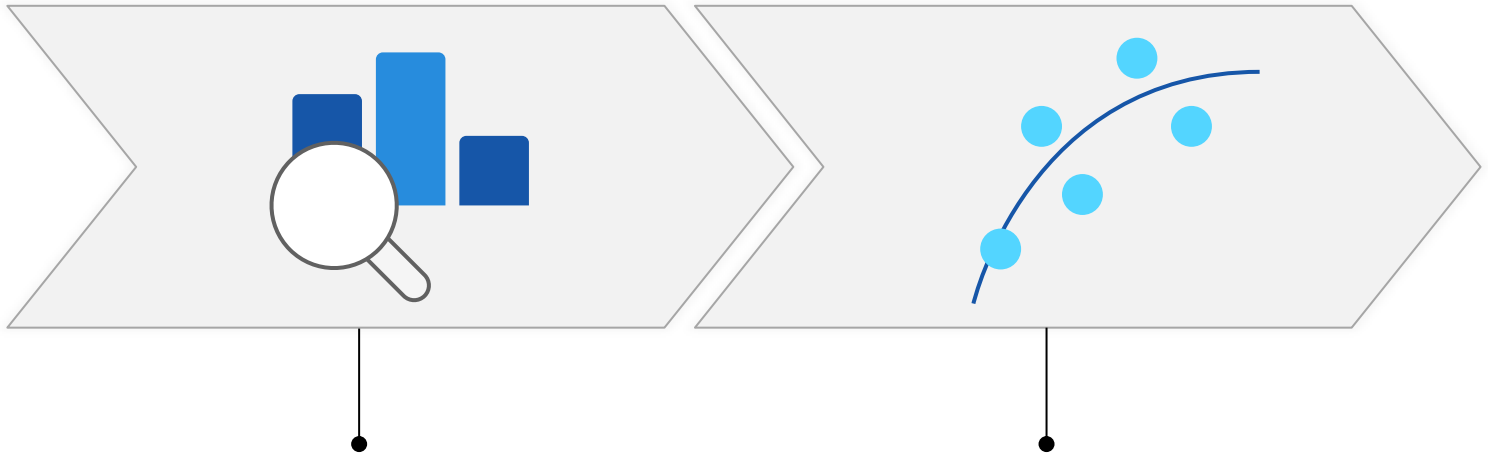
*without a dedicated sensor*



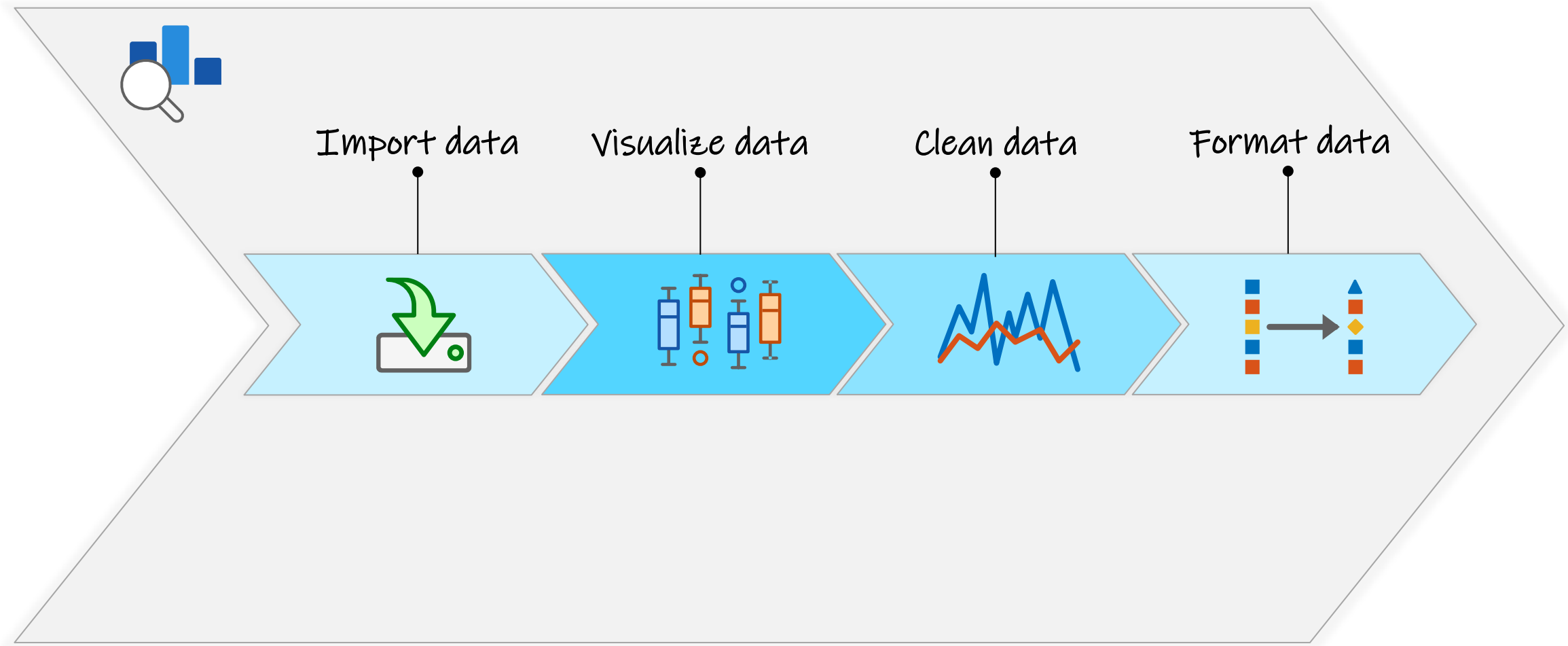
# **Challenges** you may have with your (time series) data



# Estimate True Air Speed – Approach



# Data preprocessing step



# What are “low-code/no-code” tools?

## Low-code and no-code tools

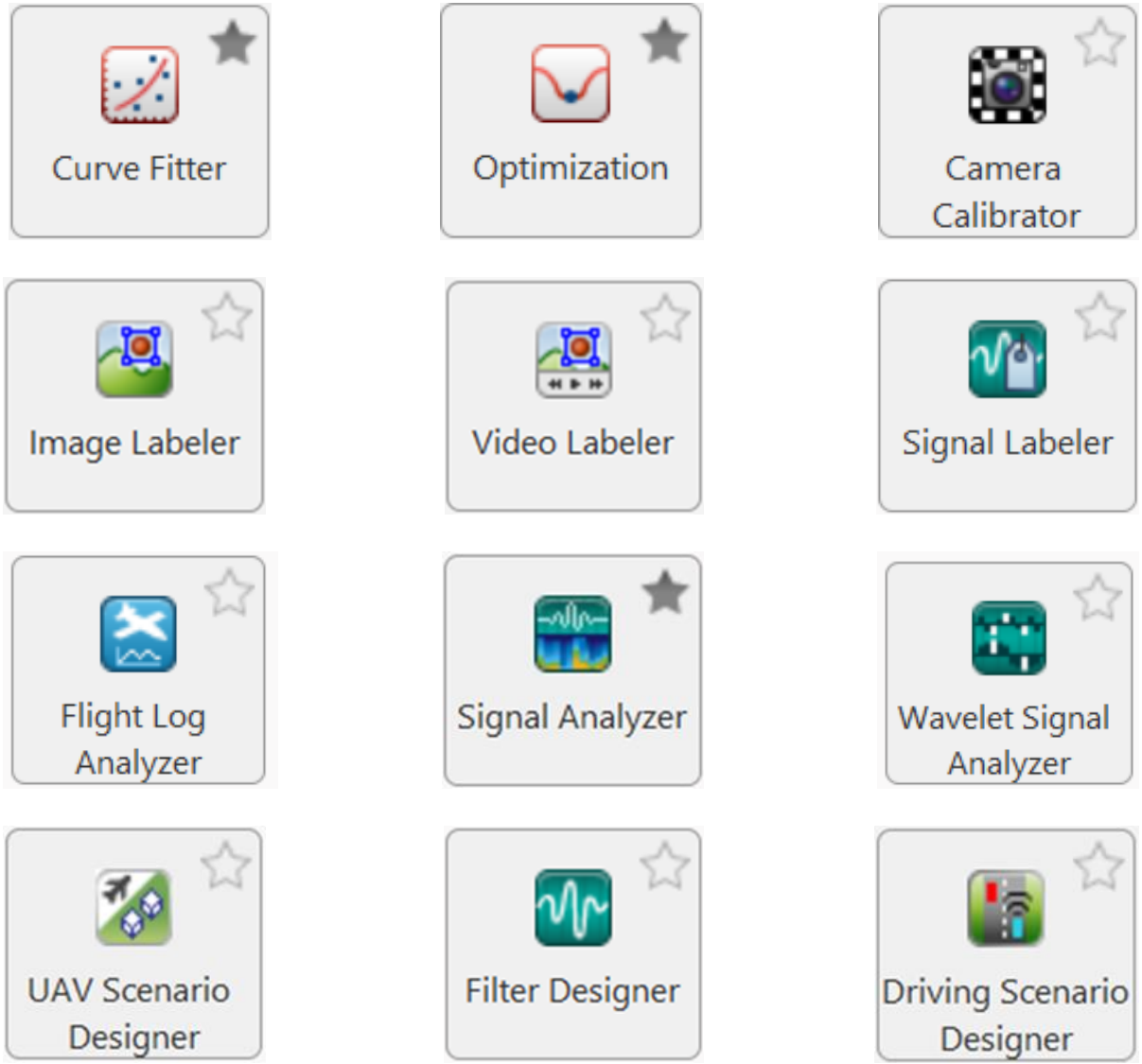
- Fast exploration
- Minimal or no manual coding
- Automatic MATLAB code generation

## Benefits

- Shallow learning curve
- Solve task first, code later
- Teach *how* to code

Not just for beginners

# Apps for your specific needs



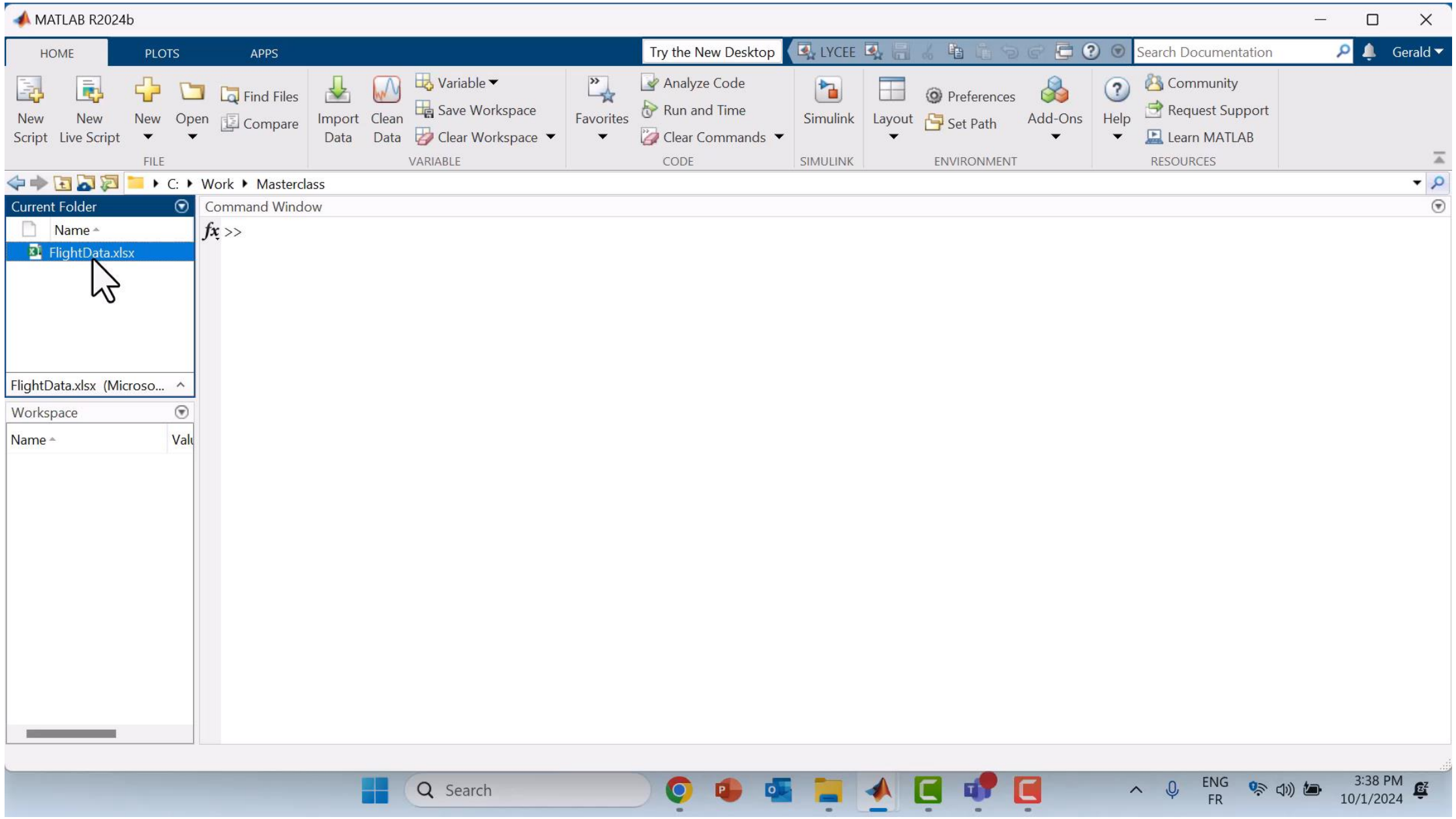

Core Tools

Labelers

Analyzers

Designers

# Import data


MATLAB R2024b
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Gerald
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Find Files
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Import Data
Clean Data
Variable
Save Workspace
Clear Workspace
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Analyze Code
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Community
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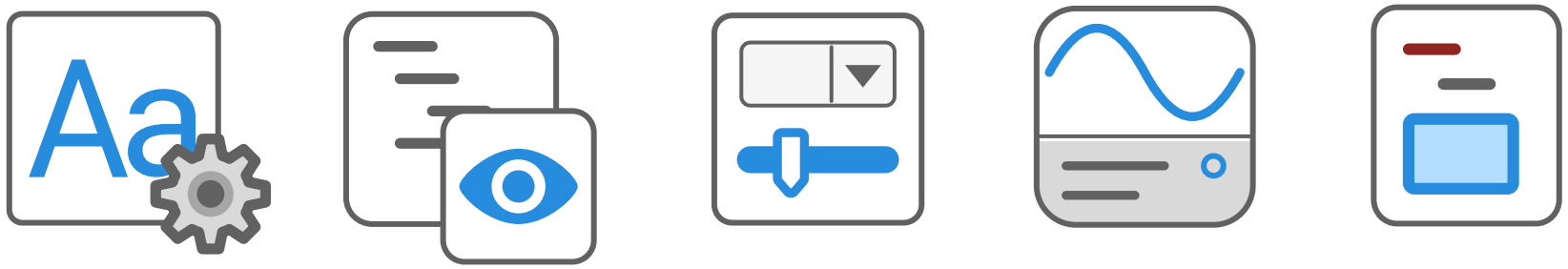
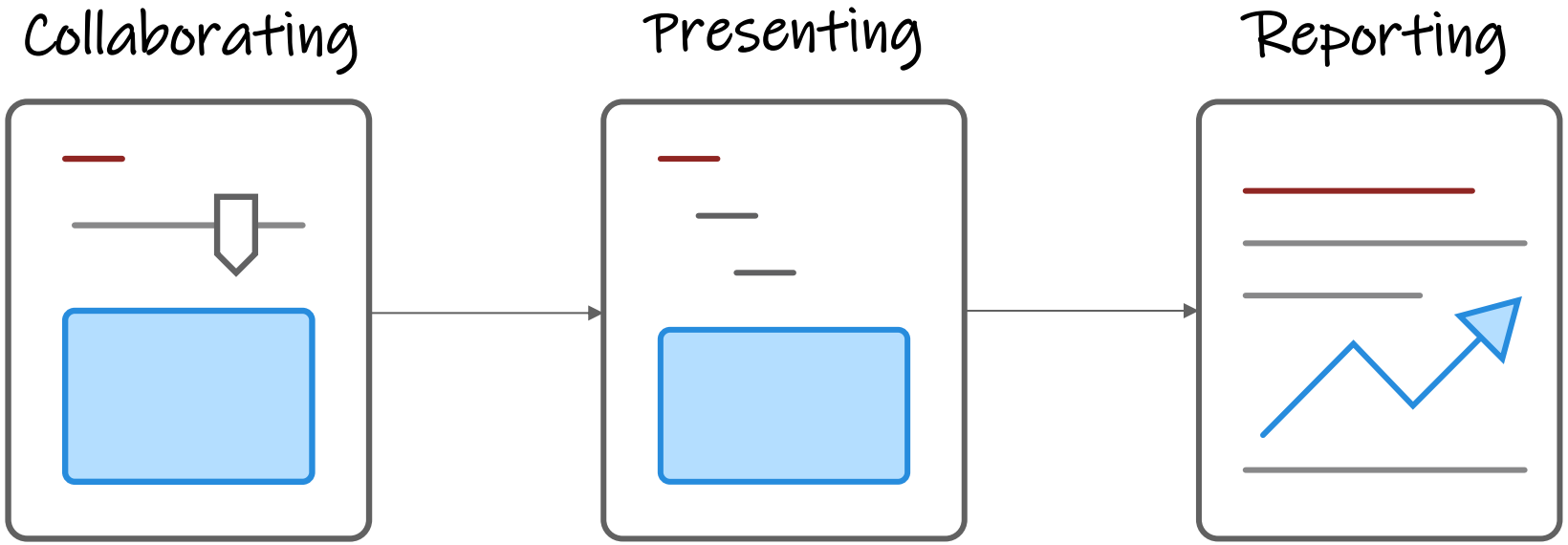
# MATLAB Live Editor

- Fast exploration:
  - Text
  - Code + output
  - Controls
  - Live tasks
  - Automated MATLAB code generation



# MATLAB Live Editor

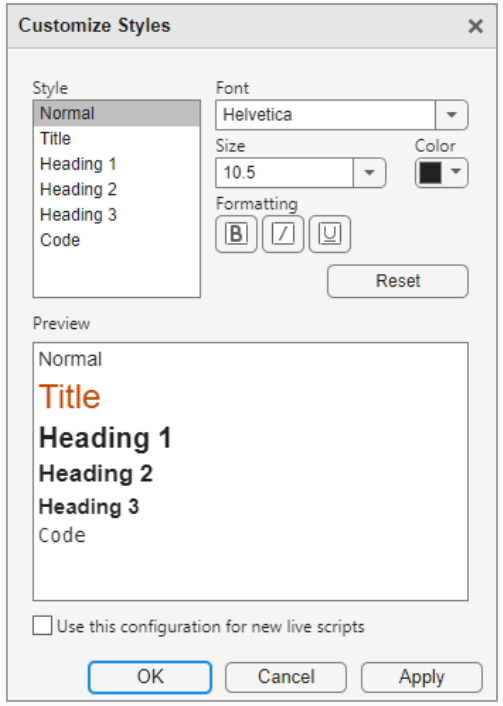
- Fast prototyping
- Environment for:



# MATLAB Live Editor

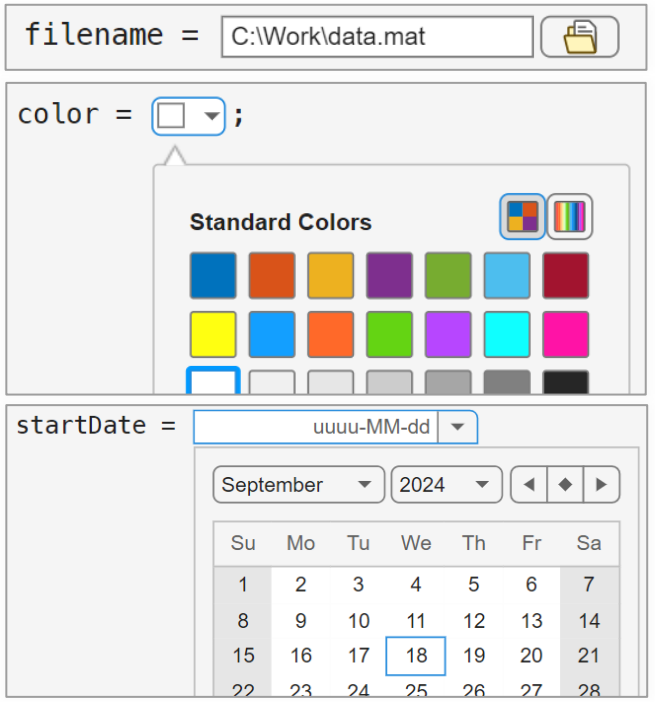
- Fast prototyping
- Environment for collaborating, presenting and reporting
- Continuous improvement with new features every new release

Font customization




Dark mode (New Desktop)


New controls



MATLAB R2024b

HOME PLOTS APPS LIVE EDITOR INSERT VIEW

Try the New Desktop | Clear | Search Documentation | Pierre

New Open Save | Compare Print Export | FILE
Go To | Find Bookmark | NAVIGATE
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Run Step Stop | RUN

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Current Folder

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Project

MATLABLiveEditor....

Project - fr-expo-2024_LowCode_NoCode_Masterclass

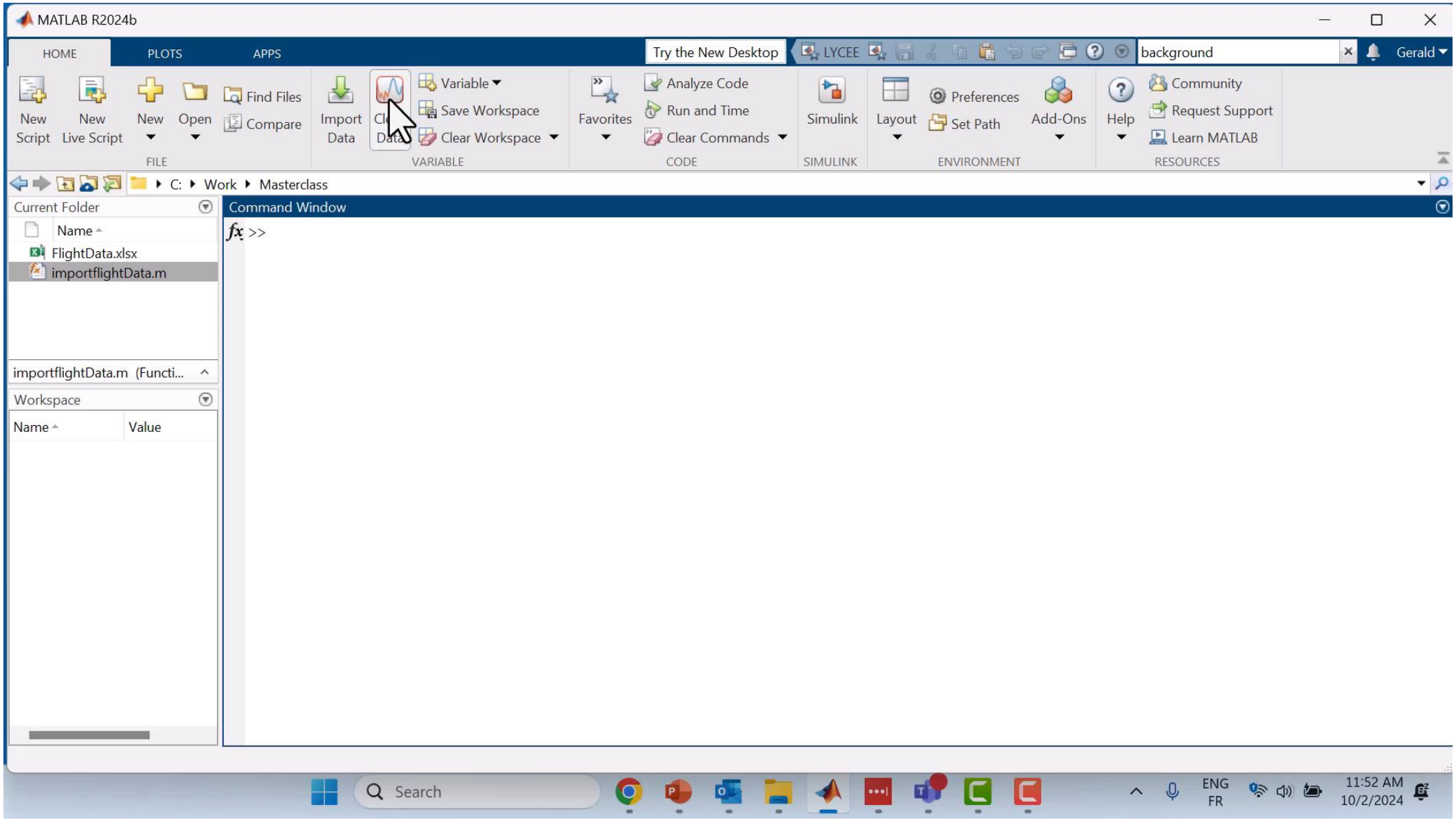
Live Editor - MATLABLiveEditor.mlx

MATLABLiveEditor.mlx

Command Window

Zoom: 175% | UTF-8 | LF | script

# Clean data


MATLAB R2024b
HOME
PLOTS
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Gerald
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Save Workspace
Clear Workspace
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Favorites
Analyze Code
Run and Time
Clear Commands
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MATLAB R2024b

HOME PLOTS APPS LIVE EDITOR INSERT VIEW

Try the New Desktop | Clear | Search Documentation | Pierre

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Project - fr-expo-2024_LowCode_NoCode_Masterclass

Live Editor - SmallApp.mlx

SmallApp.mlx

1. Choose the variable for the **bubble size**:

```
27  sizeVariable = FuelQuantity;
28  bubbleColor  = ;
```

2. Choose the **time step** :

```
29  timeStep = 2000 ;
```

3. Choose the **basemap**:

```
30  basemap = satellite;
```

4. Choose the **mapLayout**:

```
31  mapLayout = maximized;
```

---

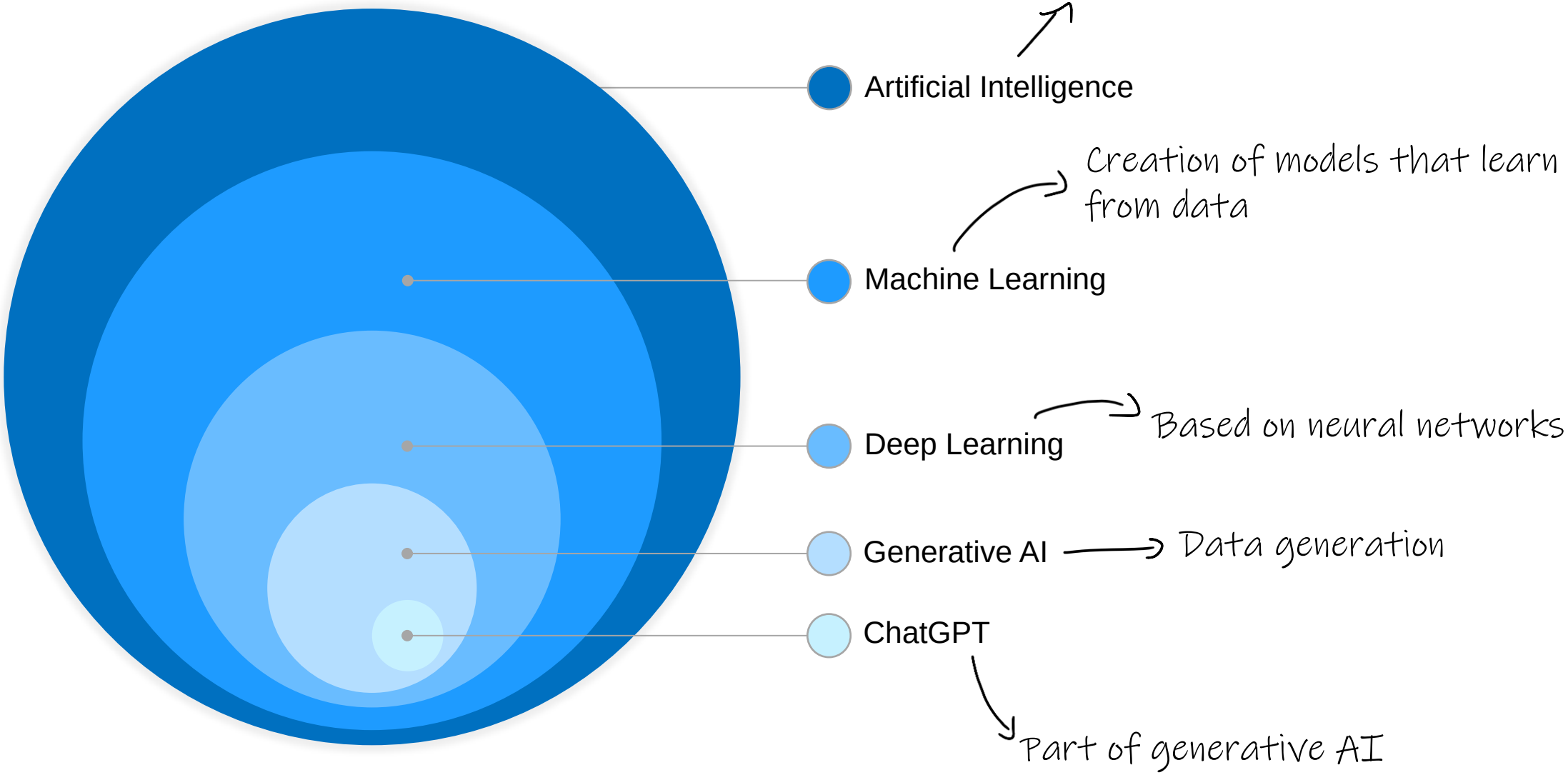
---

Command Window

3 usages of "sizeVariable" found

Zoom: 200% | UTF-8 | LF | script | Ln 27 | Col 11

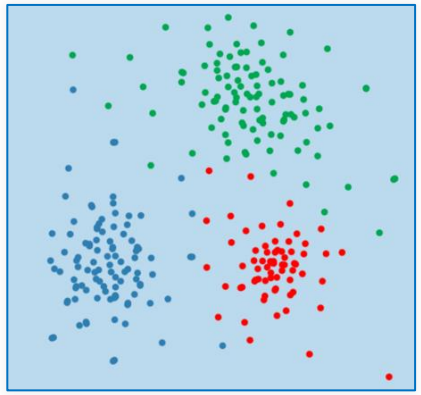
# What is AI?


Field of study
Artificial Intelligence
Creation of models that learn from data
Machine Learning
Deep Learning
Based on neural networks
Generative AI
Data generation
ChatGPT
Part of generative AI

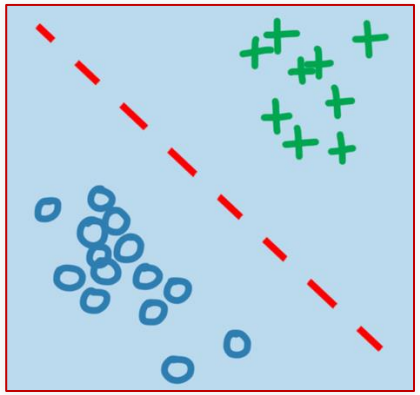
# Supervised vs unsupervised learning

Machine learning

Supervised learning



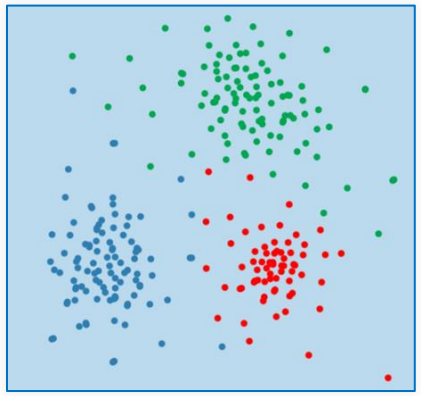
Unsupervised learning



# Supervised vs unsupervised learning

« I have no failure in my historical data »

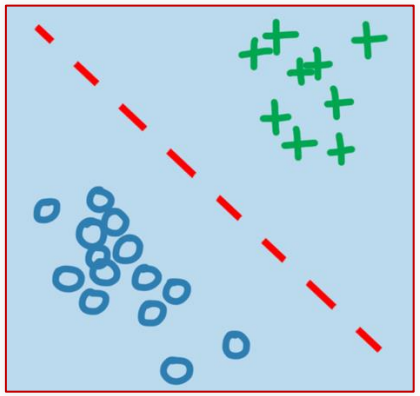
## Supervised learning



### Classification
ex: fault detection

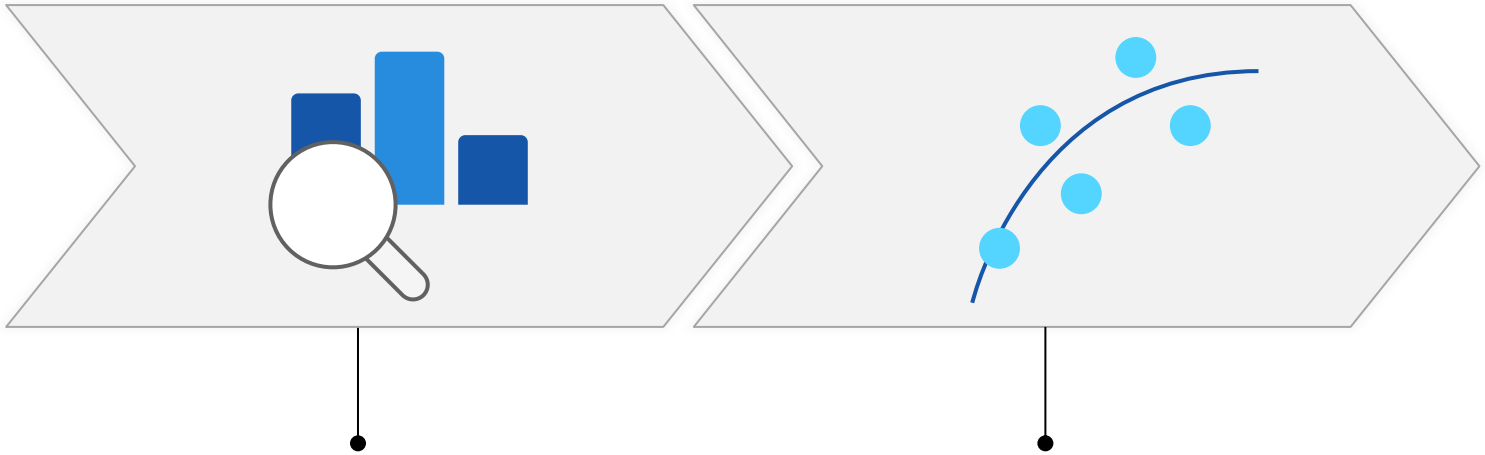
### Regression
ex: True Air Speed estimation

## Unsupervised learning

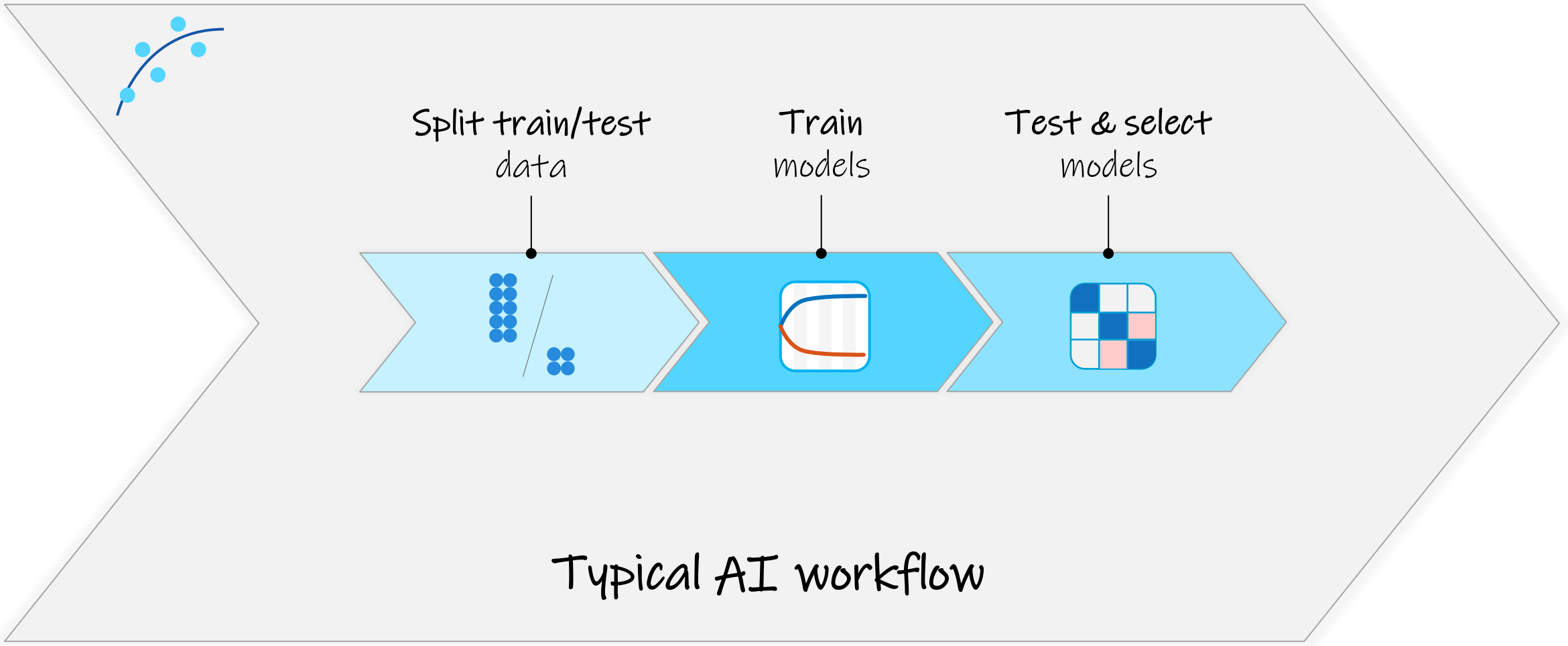


### Clustering, Anomaly detection

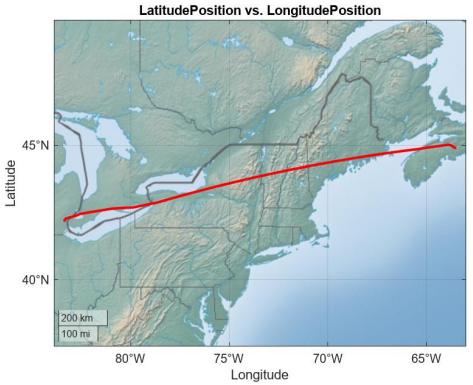
# Estimate True Air Speed – Approach



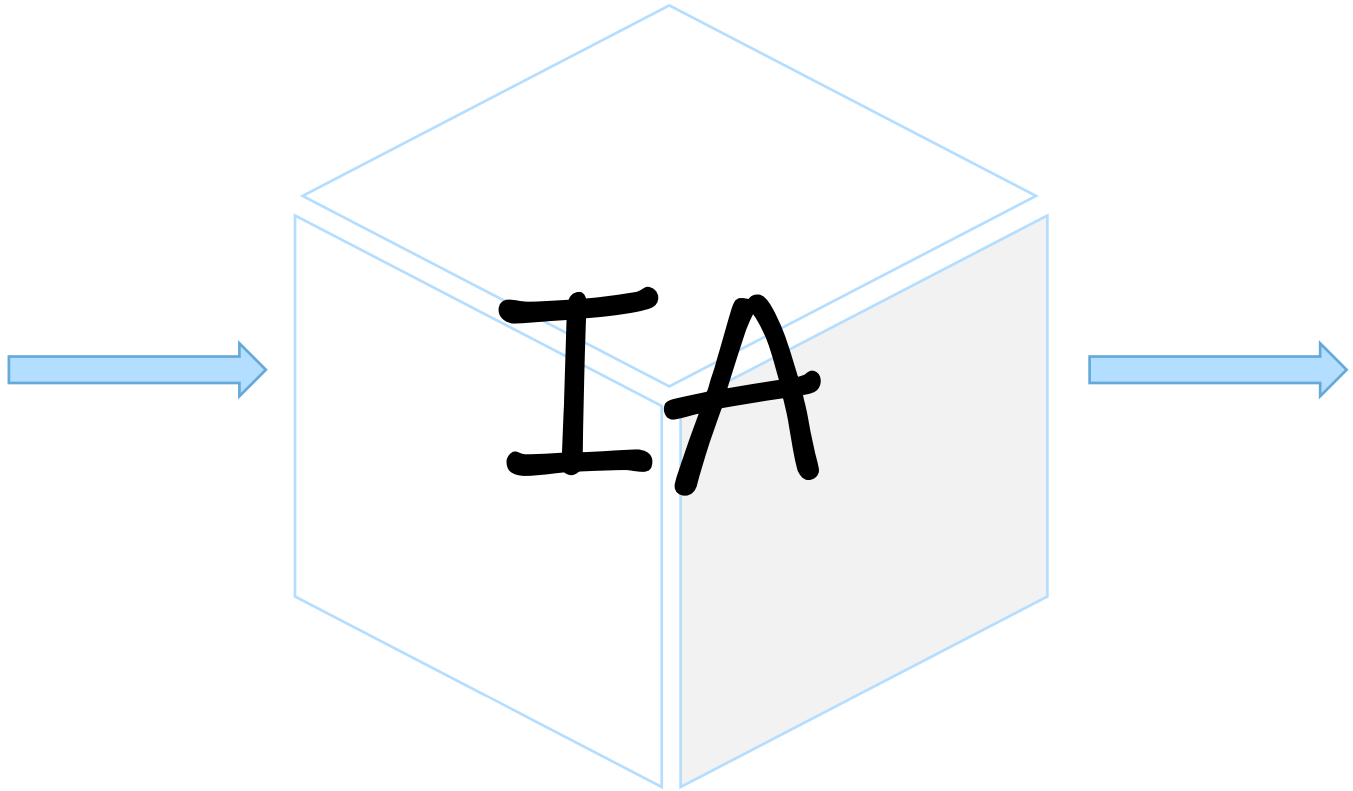
# Estimate True Air Speed – Approach



# True Air Speed estimation




```
{'Time'                }
{'FuelQuantity'        }
{'OilPressure'         }
{'OilTemperature'      }
{'LatitudePosition'    }
{'LongitudePosition'   }
{'Altitude'            }
{'ExhaustTemperature'  }
{'FuelFlow'            }
{'FanSpeed'            }
{'WindDirection'       }
{'WindSpeed'           }
{'WeightOnWheels'      }
```




**TrueAirSpeed**

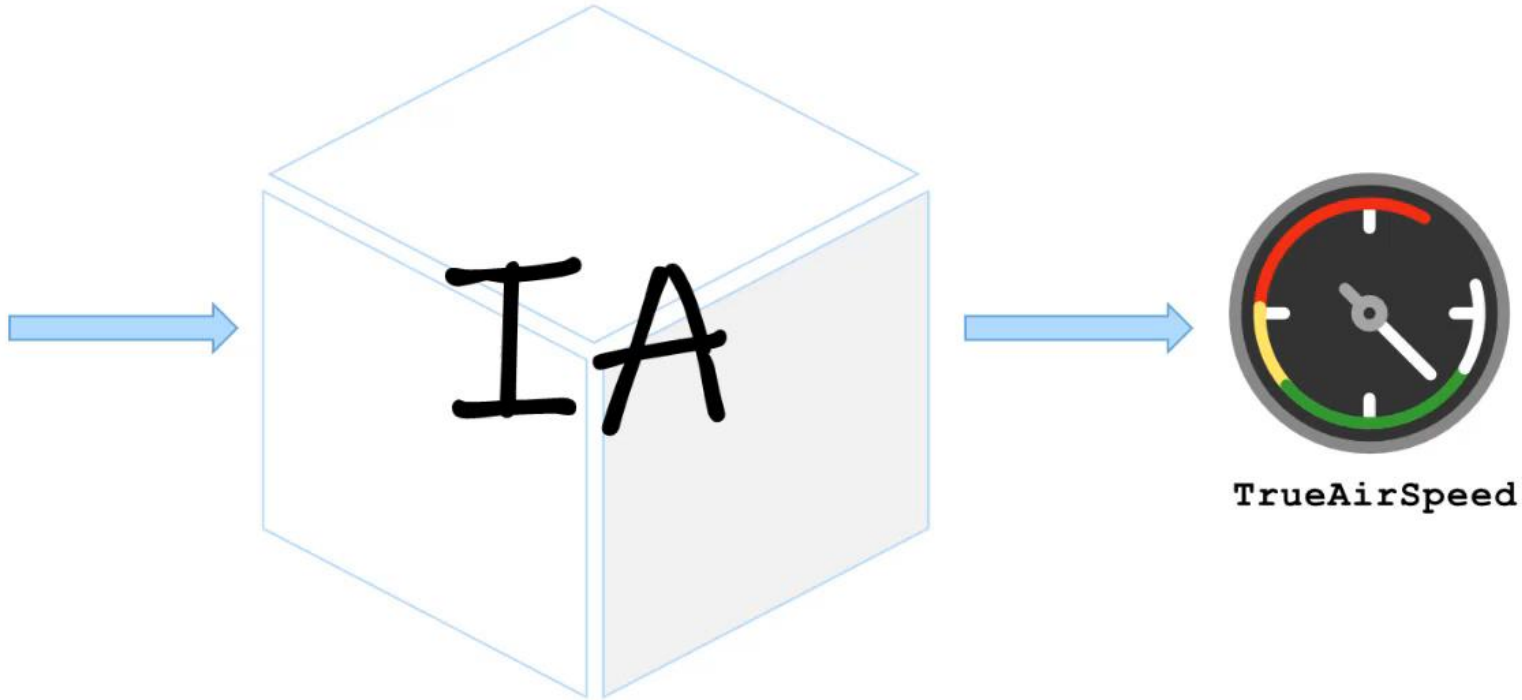
# Predicting True Air Speed from Other Sensors

Use historical data to train a regression model to predict the **True Air Speed** (TAS) of a flight from the other sensors.

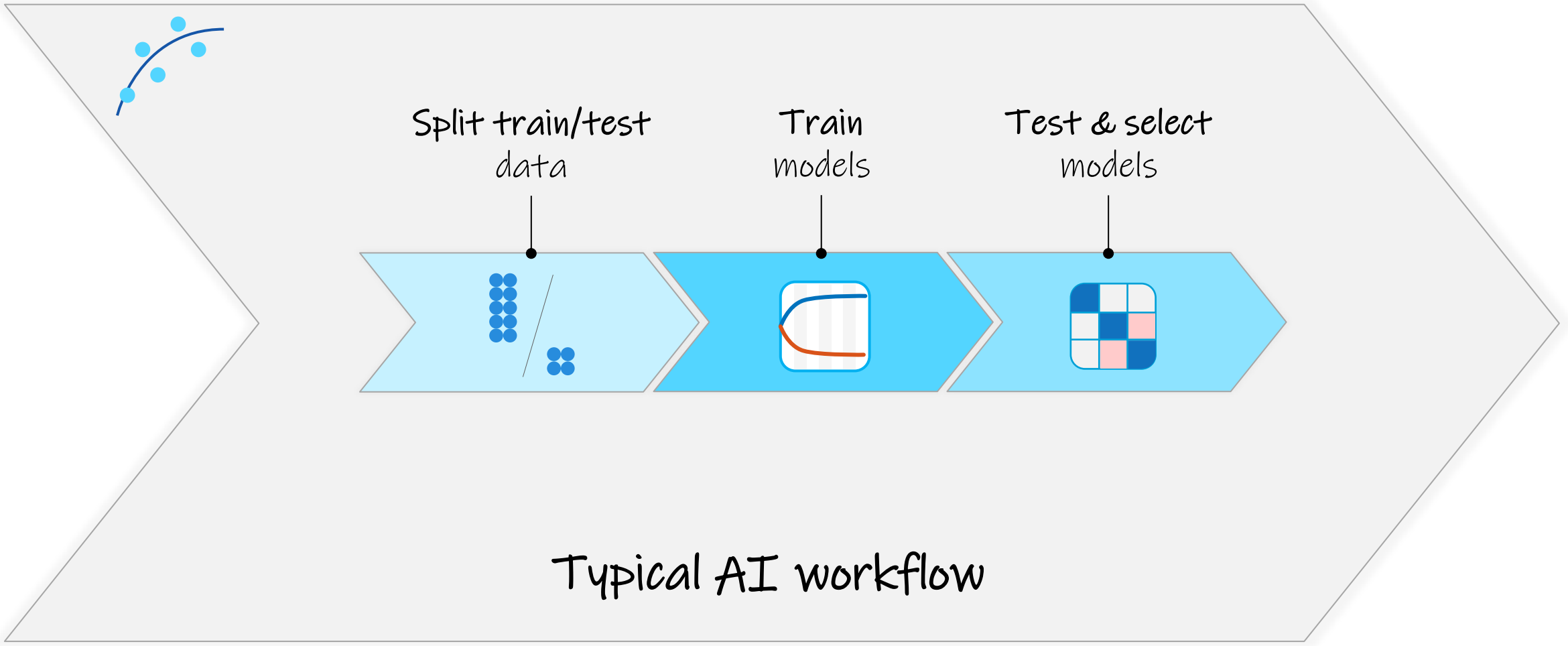
Such models can be useful where it may be desirable to use a model for a **non-observable or costly-to-observe state**.

These types of models can also be used as surrogate models in simulations and trade-studies, in cases where a physics-based model is **too complex** to create or takes **too long to simulate**.

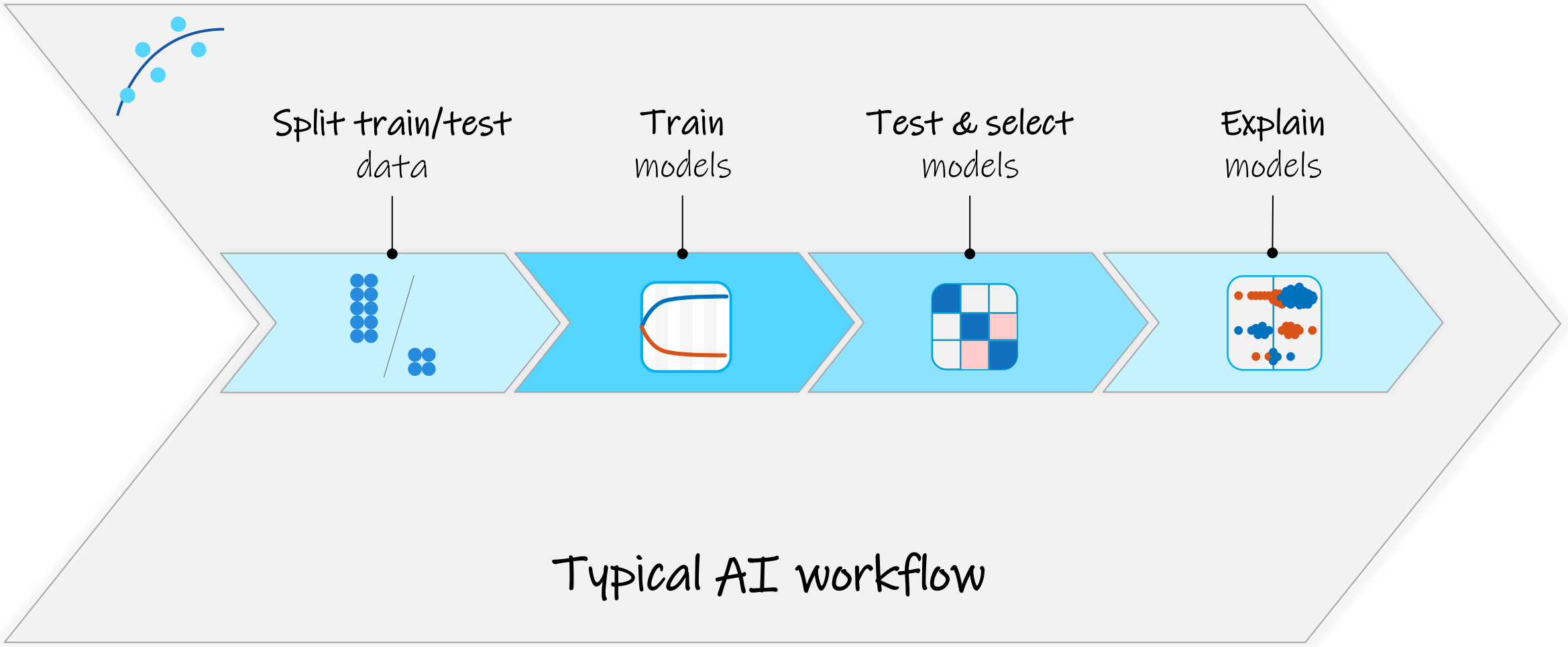
```
{'Time'            }
{'FuelQuantity'    }
{'OilPressure'     }
{'OilTemperature'  }
{'LatitudePosition'}
{'LongitudePosition'}
{'Altitude'        }
{'ExhaustTemperature'}
{'FuelFlow'        }
{'FanSpeed'        }
{'WindDirection'   }
{'WindSpeed'       }
{'WeightOnWheels'  }
```



# Estimate True Air Speed – Approach



# Estimate True Air Speed – Approach

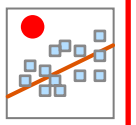


# AI is not just making great models… You must understand them!

How does the model behave under **different environments**?

I have to trust my model to **deploy** it

Why did the model make a **wrong/bad prediction** for this observation?



data → IA → decision

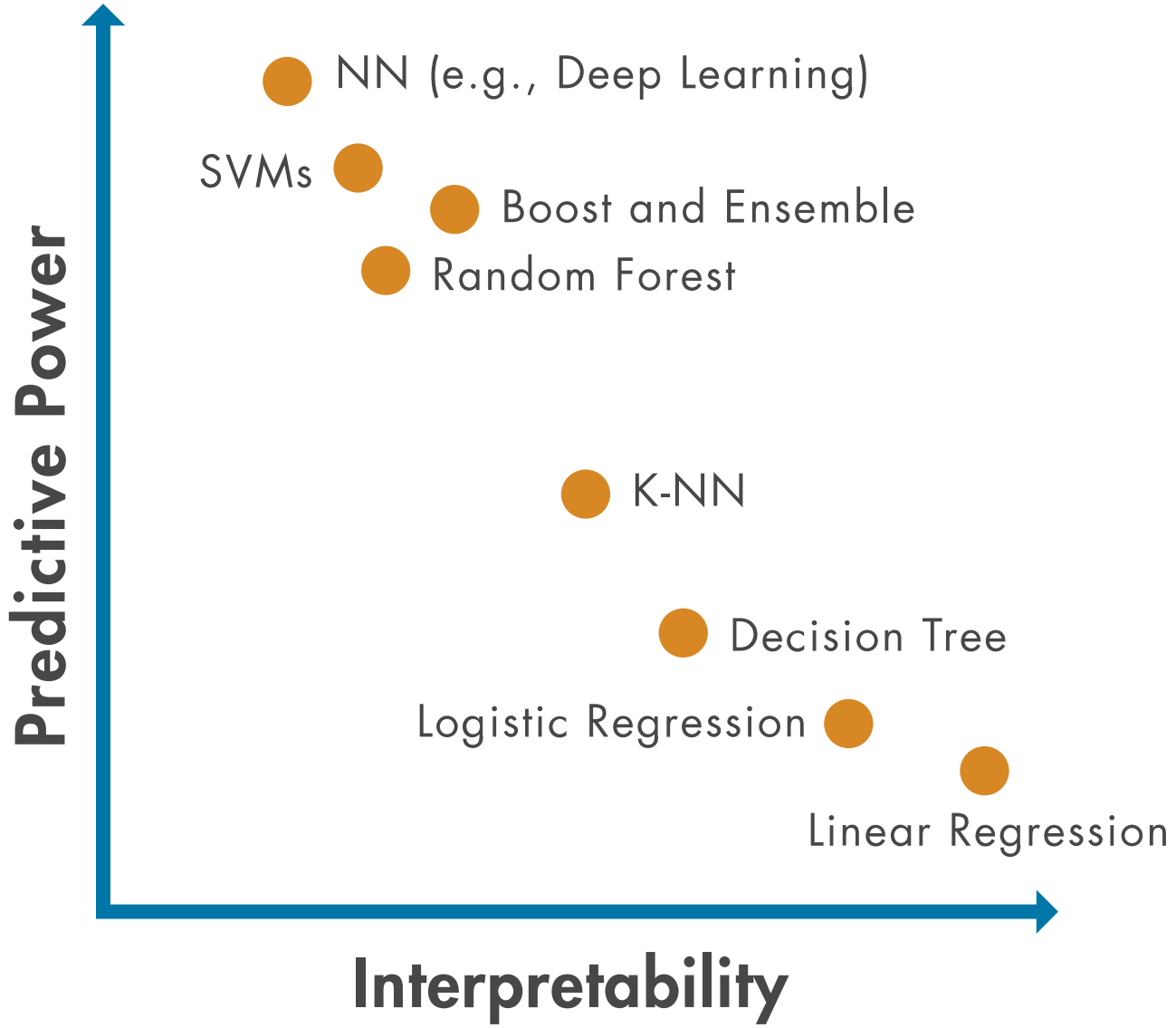
I need to certify my model

How to debug my code?

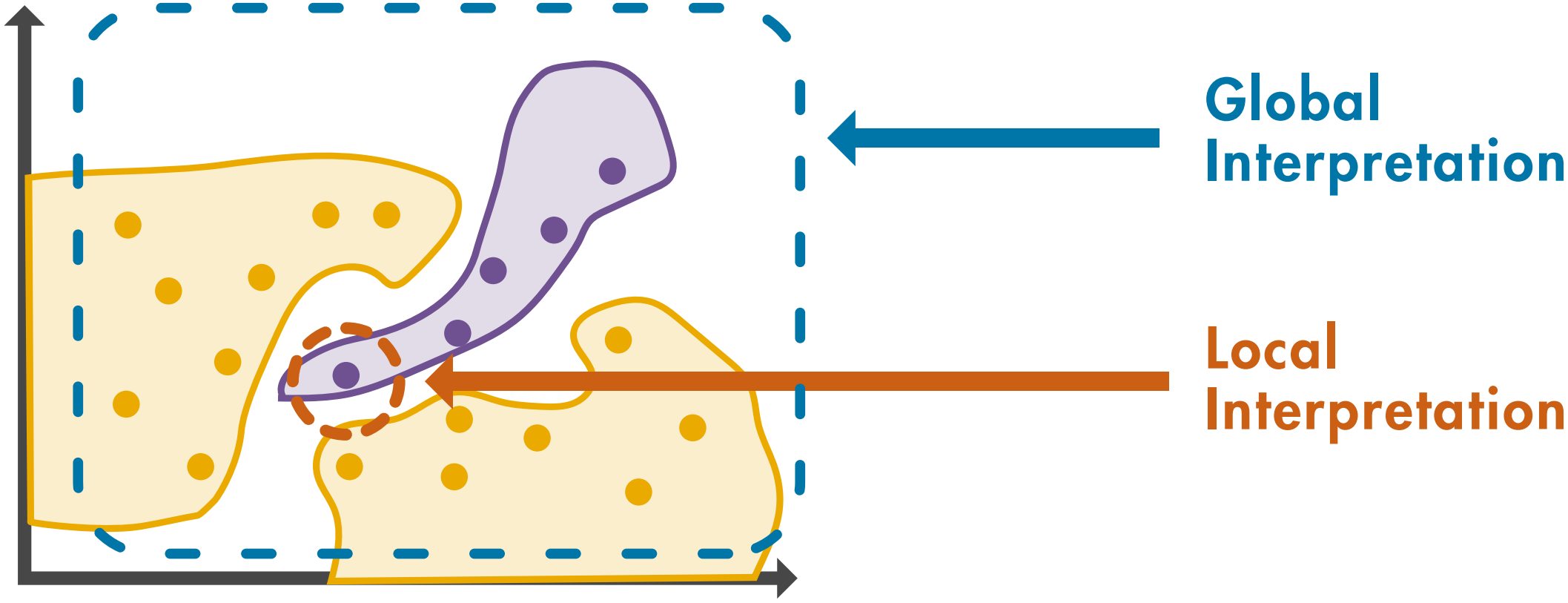
What are the **main drivers** in the model?

What are the **relationships** between data and decision?

# Interpretability vs Performance



# Global and local interpretations



Regression Learner - untitled*

LEARN TEST EXPLAIN

New Session | Open | Save | Feature Selection | PCA | Optimizer | All Quick-To-Train | All | All Simulink Supported | Linear | Use Parallel | Train All | Response | Predicted vs. Actual ... | Residuals (Validation) | Min MSE | Results Table | Layout | Export Plot | Generate Function | Export Model

FILE OPTIONS MODELS TRAIN PLOTS AND RESULTS EXPORT

Models

Sort by Model Number

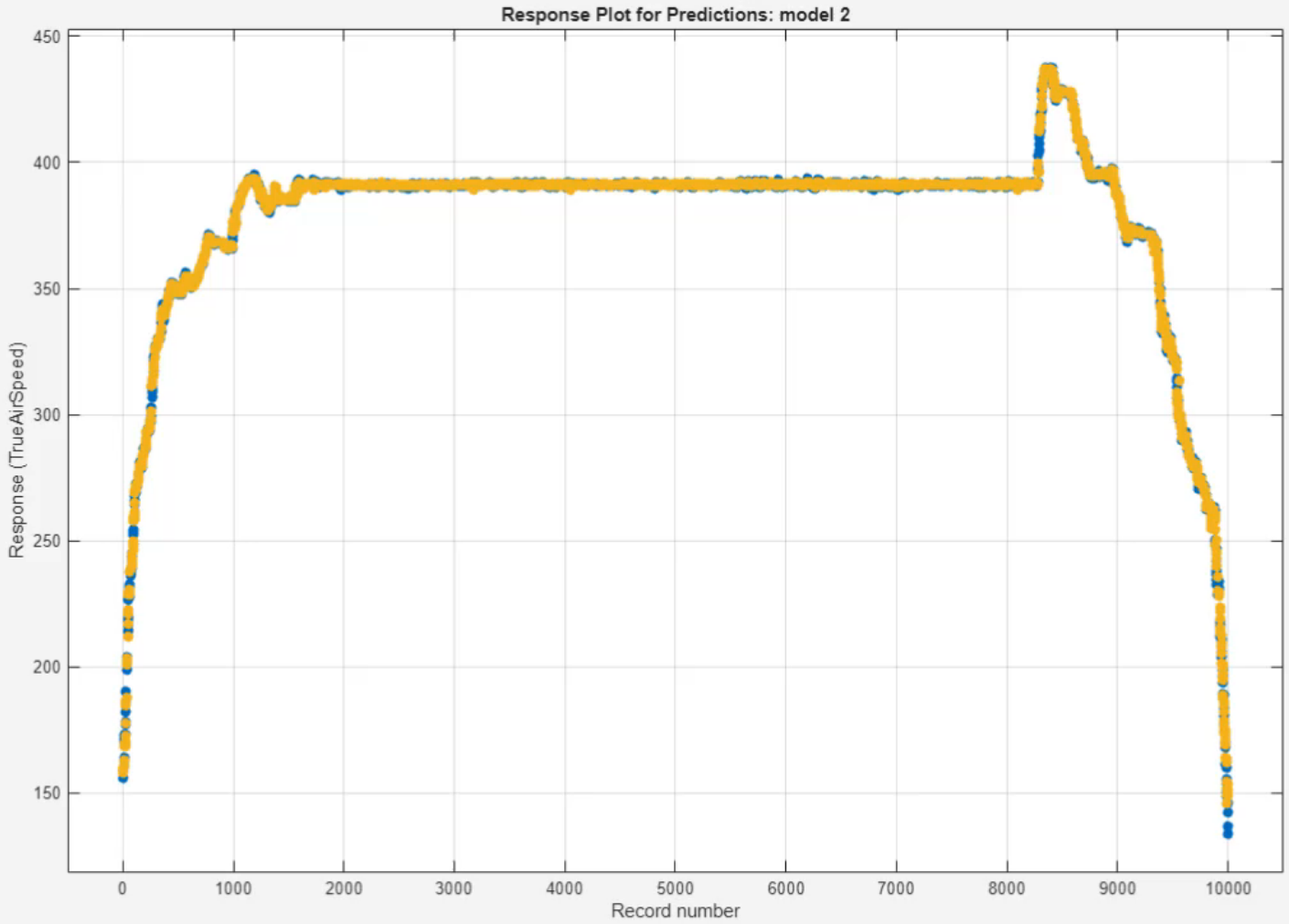
1 Tree RMSE (Validation): 0.98433
Last change: Fine Tree 9/9 features

2 Ensemble RMSE (Validation): 0.91934
Last change: Bagged Trees 9/9 features

3 SVM RMSE (Validation): 12.340
Last change: Linear SVM 9/9 features

Model 1 Model 2 Model 3

Summary Response Plot




Plot
True
Predicted
Errors

Style
Markers
Box plot

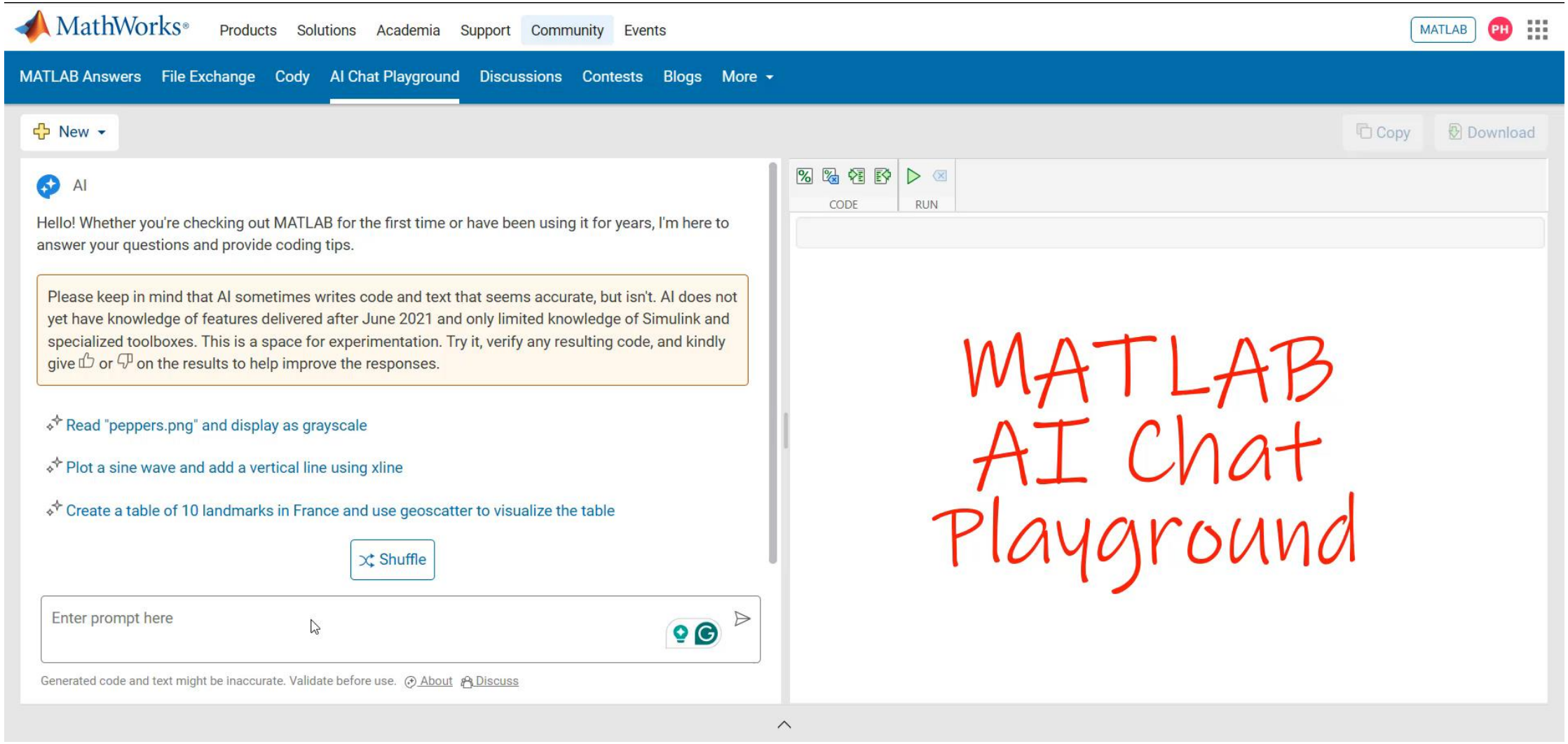
X-axis
X Record numbe

How to use the res

Data set: flightDataClean_subset Observations: 8000 Size: 1 MB Predictors: 9 Response: TrueAirSpeed Validation: 5-fold cross-validation Test Data set: flightDataClean_subset

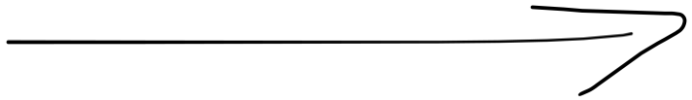
# What about Generative AI?

# MATLAB AI Chat Playground



# MATLAB Copilot

Today:
AI Chat Playground



Near future:
MATLAB Copilot

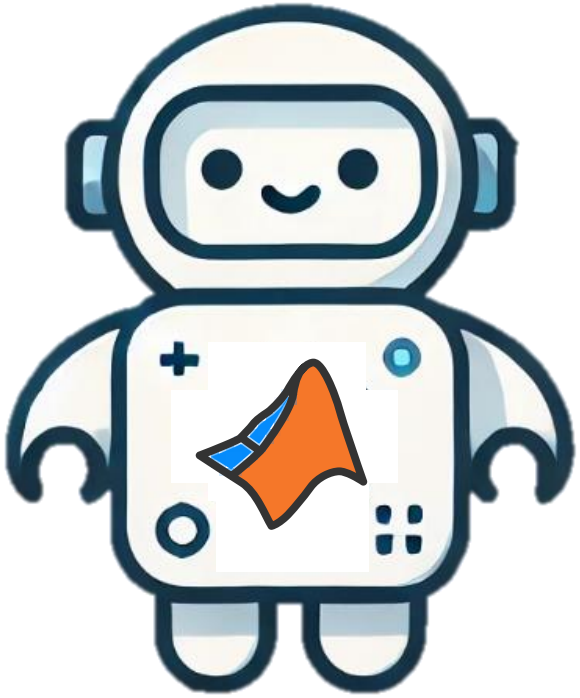


Image generated with chatGPT

# MathWorks Copilot Beta Sign-Up

# Next Steps

MathWorks
**Engineers**

MathWorks
**Training**

MathWorks
**Consulting**

Reach out for support to implement these practices in your projects

Pierre Harouimi
pharouim@mathworks.com

Gerald Albertini
galberti@mathworks.com

MATLAB EXPO
FRANCE

# Merci ☺

MathWorks