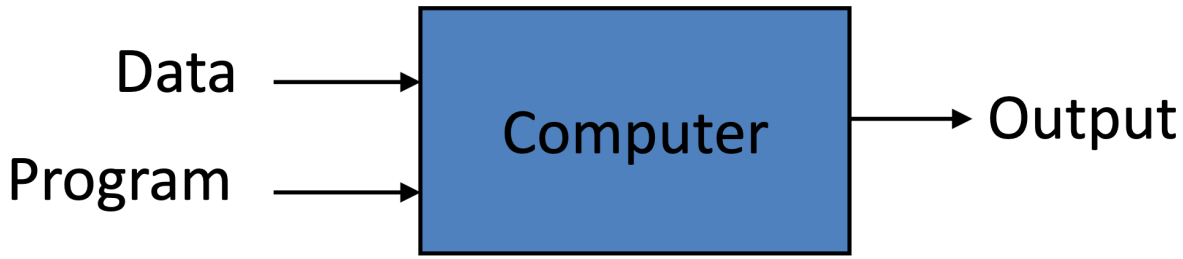
Machine Learning with scikit-learn

https://github.com/Milan-Chicago/Introduction-to-Python/tree/main/Day%208%20Intermediate%20Python/7%20-%20python_scikit_learn_2023

What is Machine Learning?

Traditional Programming



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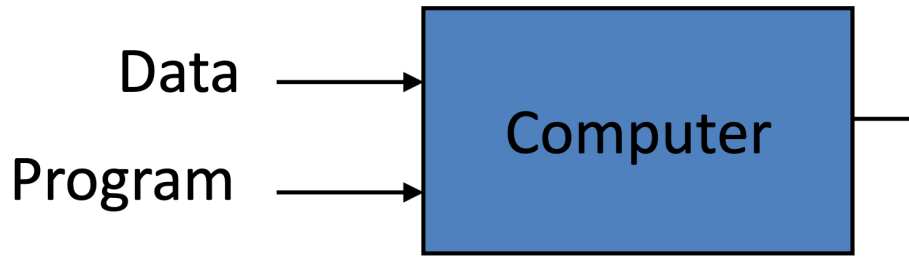
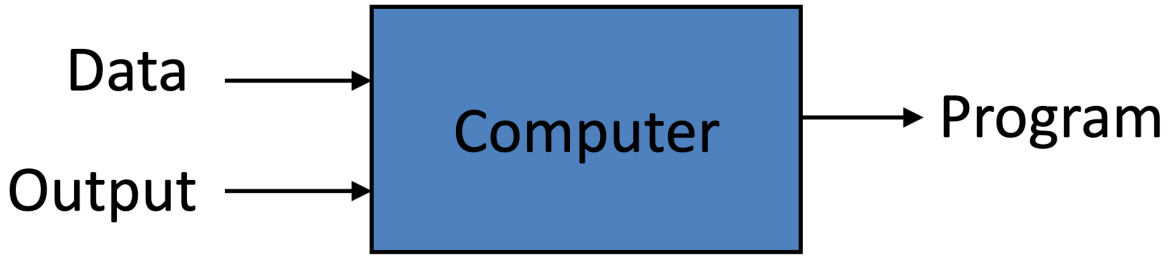


Machine Learning



When Do We Use Machine Learning?

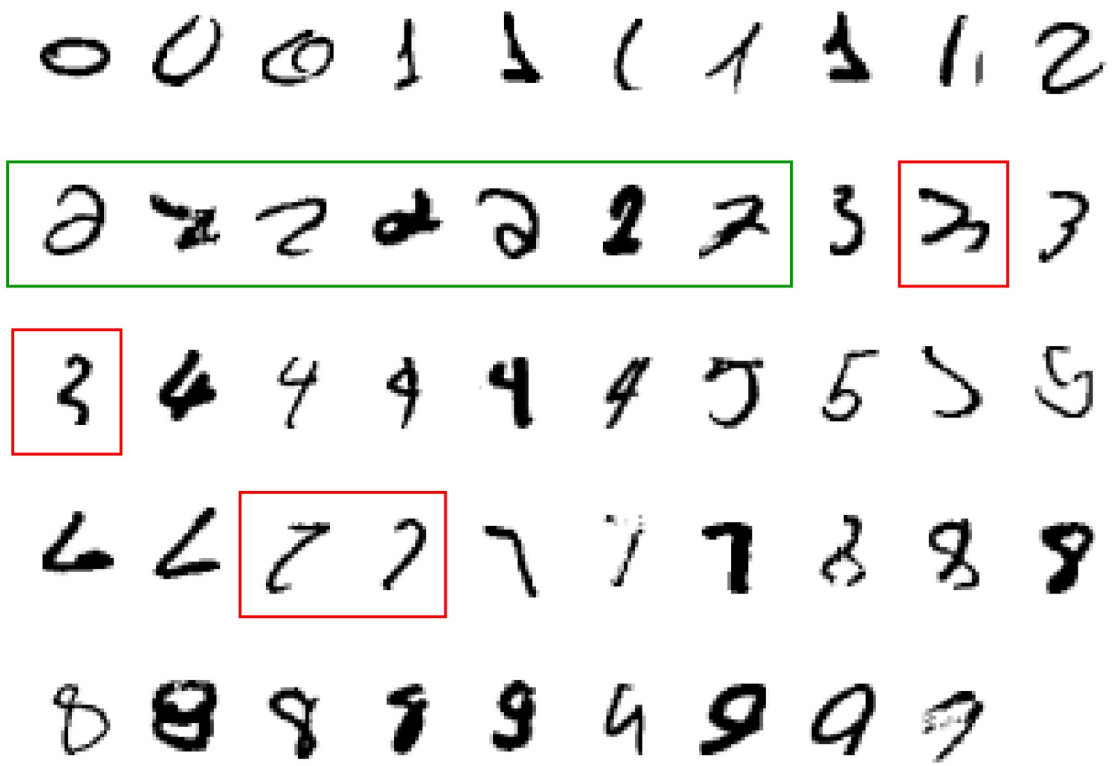
ML is used when:

- Human expertise does not exist (navigating on Mars)
- Humans can’t explain their expertise (speech recognition)
- Models must be customized (personalized medicine)
- Models are based on huge amounts of data (genomics)

Learning isn’t always useful:

There is no need to “learn” to calculate payroll

A classic example of a task requiring ML



What makes a “2” ?

Some more examples of ML tasks

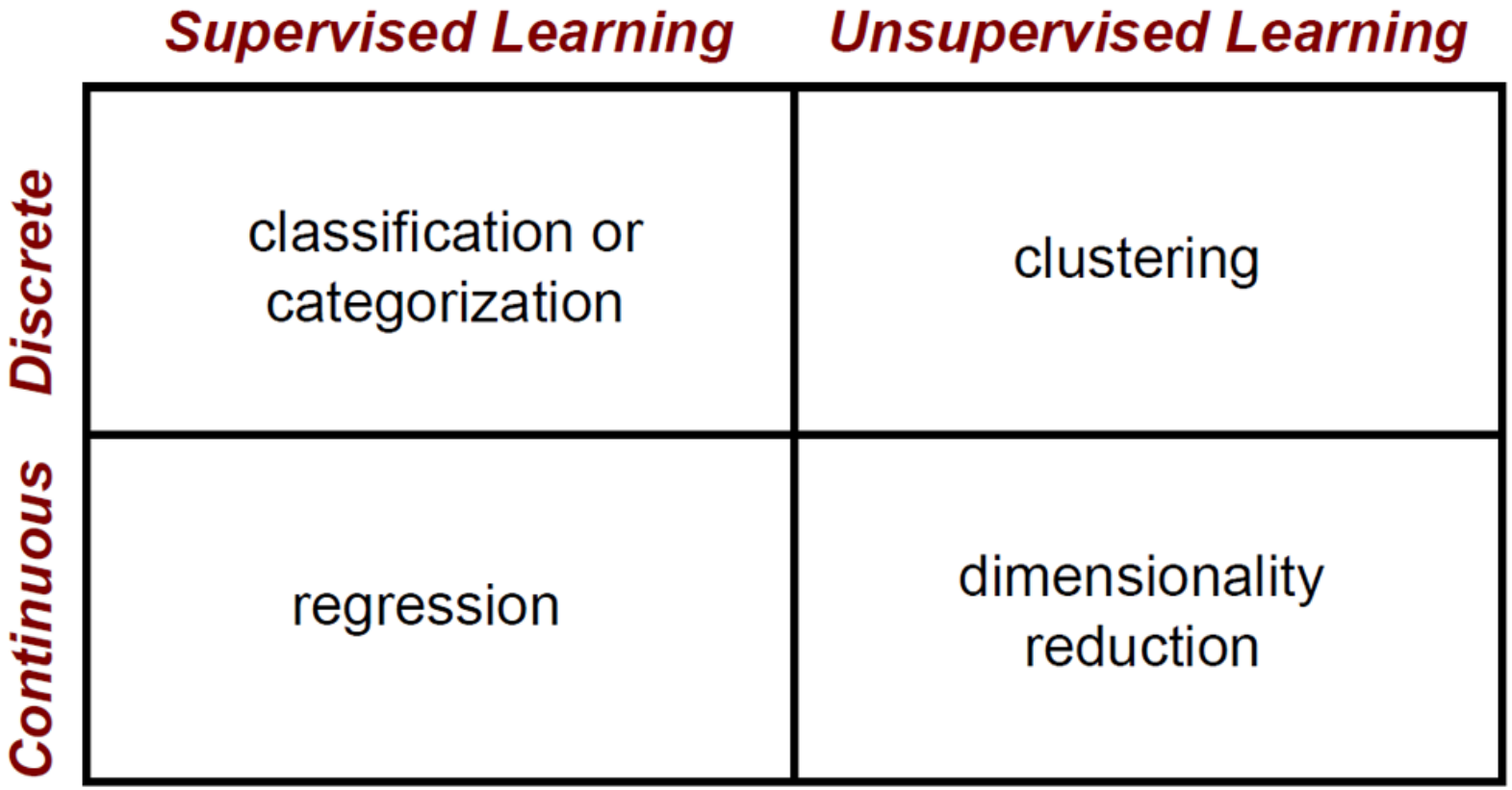
Recognizing patterns:
– Facial identities or facial expressions
– Handwritten or spoken words
– Medical images

Generating patterns:
– Generating images or motion sequences

Recognizing anomalies:
– Unusual credit card transactions
– Unusual patterns of sensor readings in a nuclear power plant

Prediction:
– Future stock prices or currency exchange rates

Types of ML Problems



Supervised Learning

When you already know the “answers”

And want to predict future “answers”

- Learn a discrete Classification
- Learn a continuous Regression

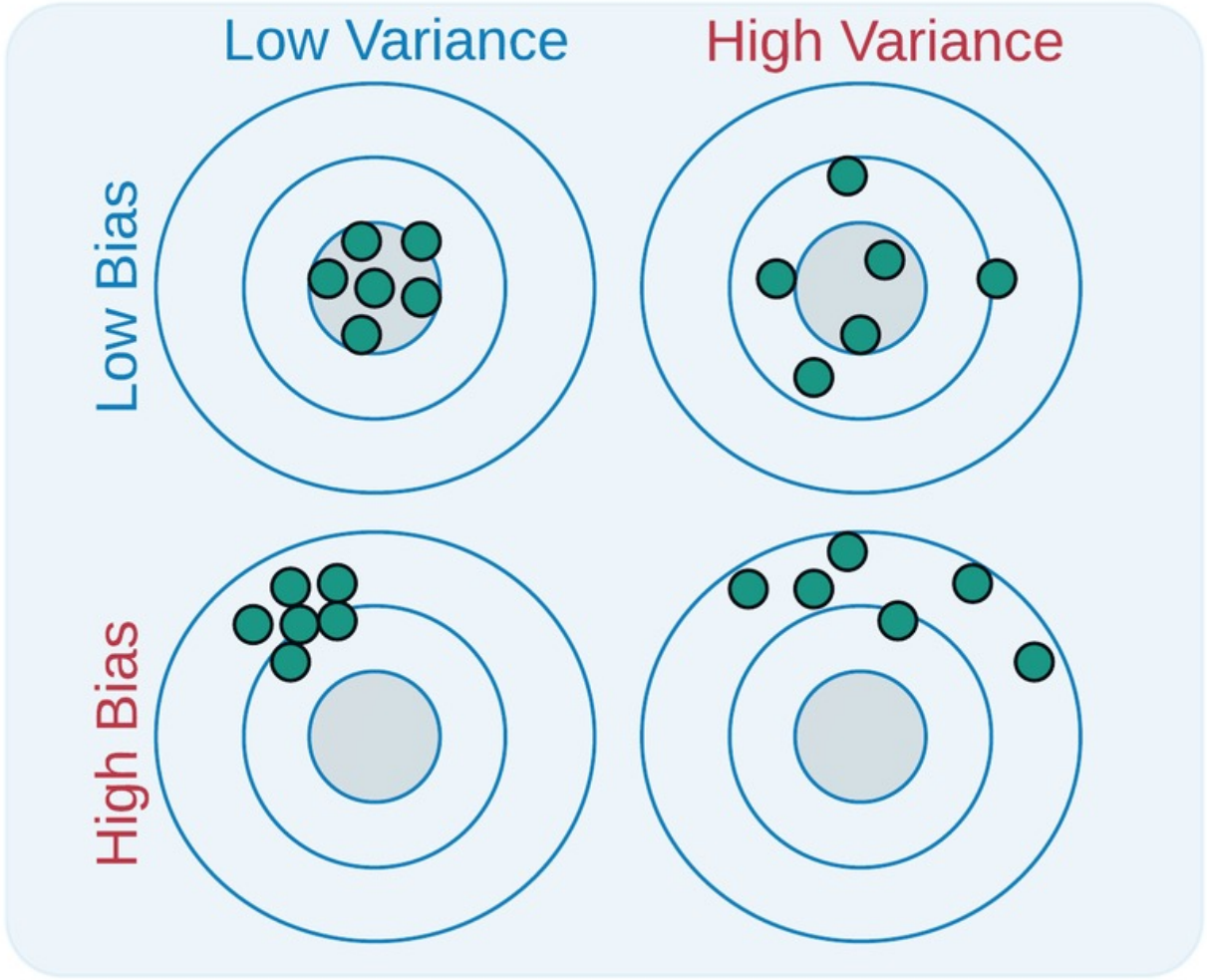
Unsupervised Learning

When you don't know any labels

But want to predict / learn useful labels

- Learn a discrete Clustering
- Learn a continuous Dimension Reduction

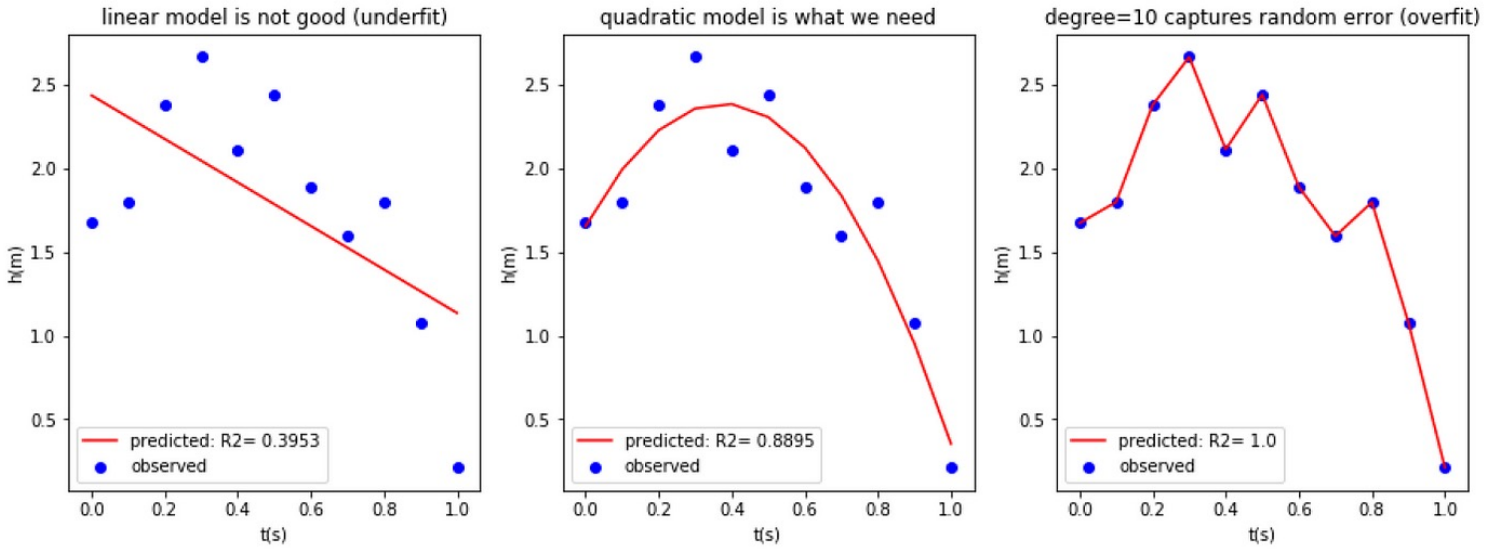
Model Optimization *Types of ML Errors*



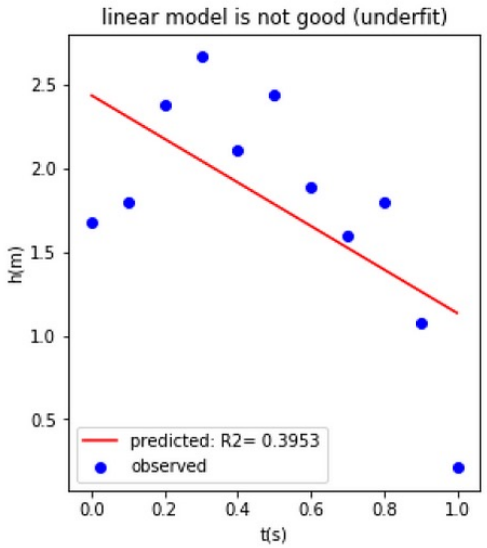
Bias:
Systematic prejudice in the model
Simple model = High bias

Variance:
Change in the model's prediction, when the dataset is changed a little bit
Complex model = High variance

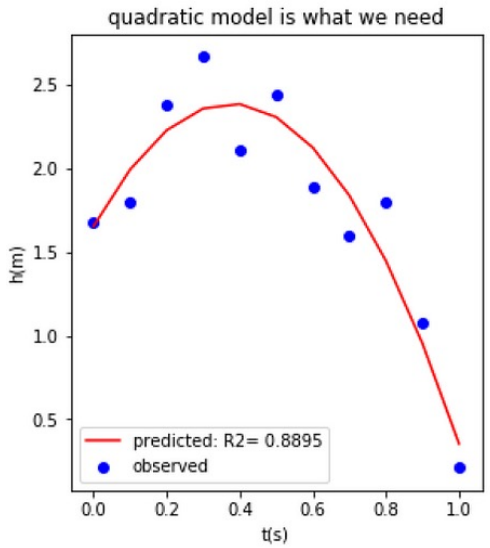
Model Optimization *Bias-variance trade-off*

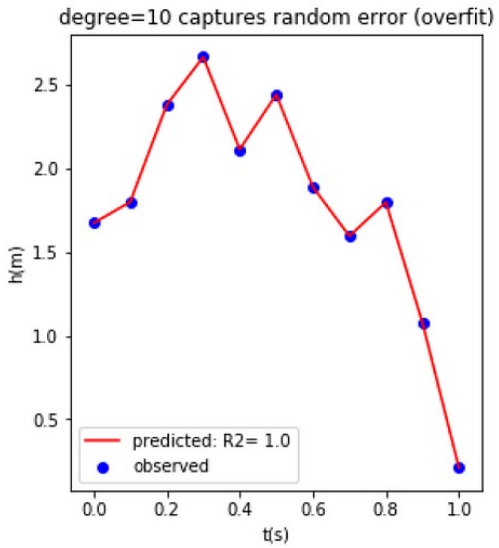


Model Optimization *Bias-variance trade-off*



High Bias
Low Variance

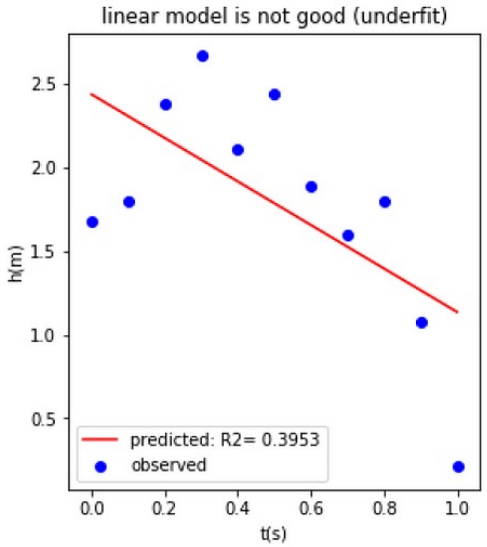


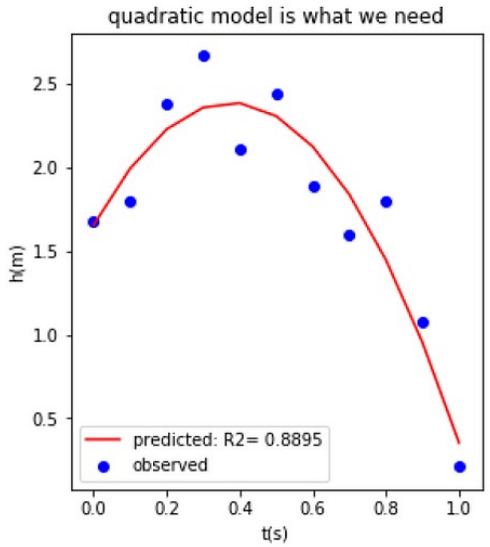


Low Bias
High Variance

Model Optimization *Bias-variance trade-off*

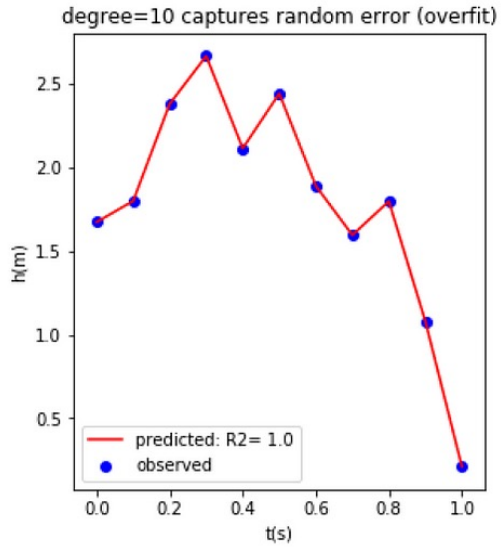
Under-fitting





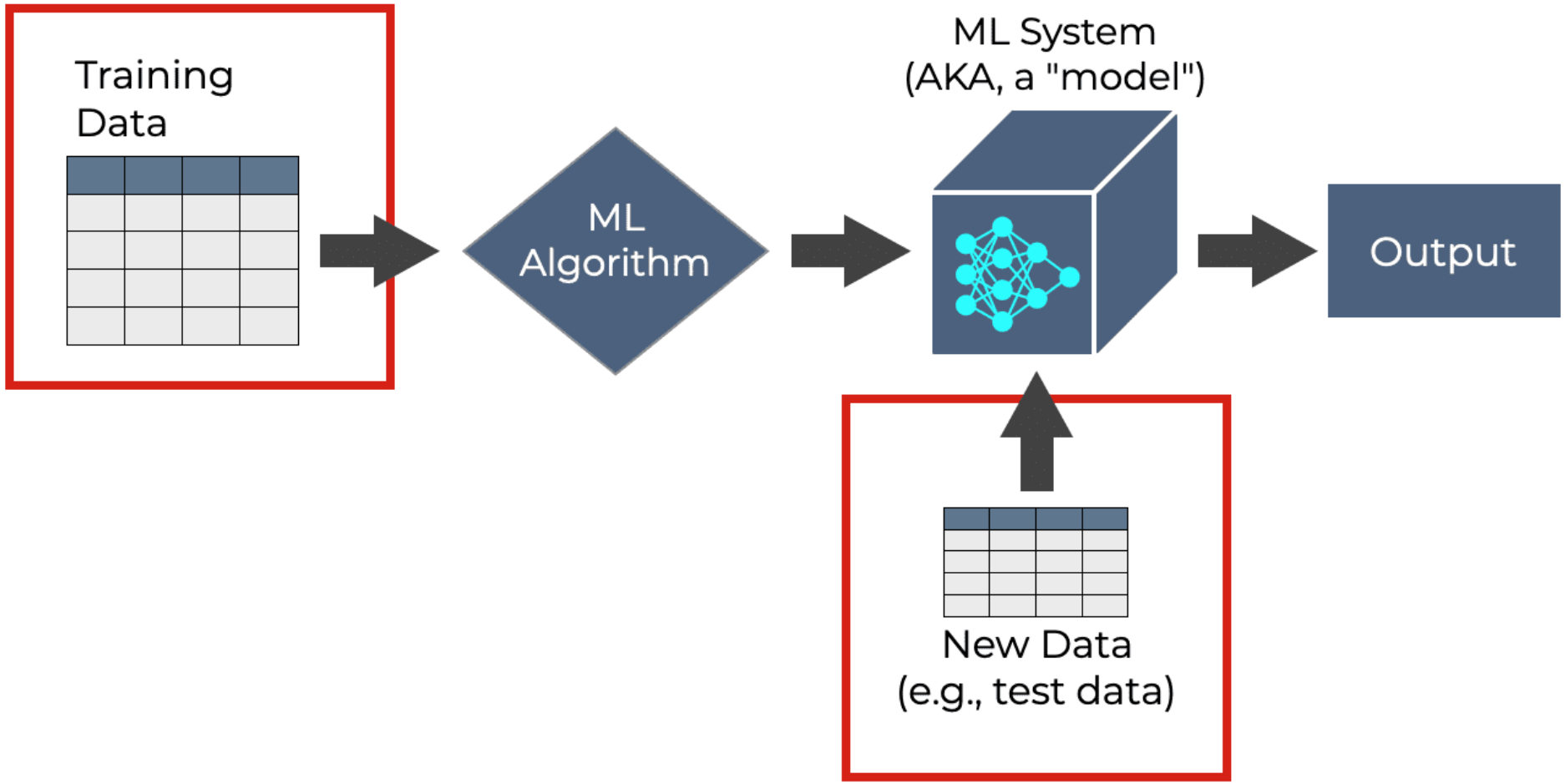
High Bias
Low Variance

Over-fitting

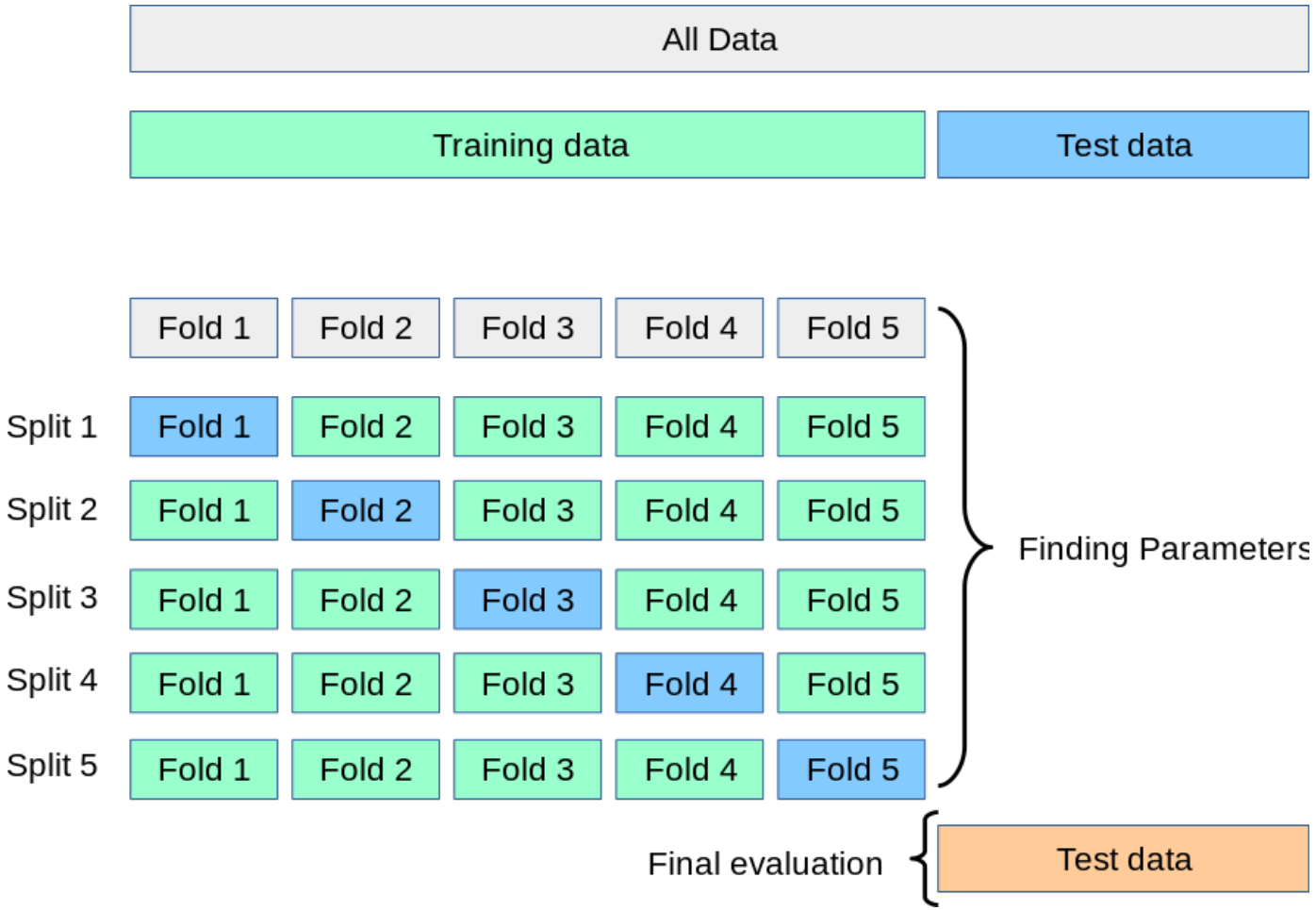


Low Bias
High Variance

Model Validation *Train – Test split*



Model Validation *k-fold cross-validation*



ML workflow

1. Should I use ML on this problem?

   Is there a pattern to detect?
   Can I solve it analytically?
   Do I have data?

2. Gather and organize data.

   Preprocessing, cleaning, visualizing.

3. Establishing a baseline.

4. Choosing a model, loss, regularization, ...

5. Optimization (could be simple, could be a PhD...).

6. Hyperparameter search.

7. Analyze performance & mistakes and iterate back to step 4 (or 2).