

Developing predictive models for COVID-19 diagnosis in paediatric patients

A case study about the potentials of Machine Learning in Public Health

By Anna Mas-Casadesús

15th July 2020

1



WHAT IS THE PROBLEM?



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Children appear to have a **similar prevalence** of COVID-19 antibodies to adults
But most of them tend to present **mild or no symptoms**
Making **COVID-19 diagnosis in children particularly difficult**

<https://www.sjdhospitalbarcelona.org/en/kidscorona>



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Dataset on paediatric patients with and without
COVID-19 but similar symptoms



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Contact with Dr. Antoni Soriano-Arandes



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Machine Learning classification models to
predict COVID-19 diagnose in children



2

→ WHAT DO I NEED TO DO TO USE THE DATA?



2

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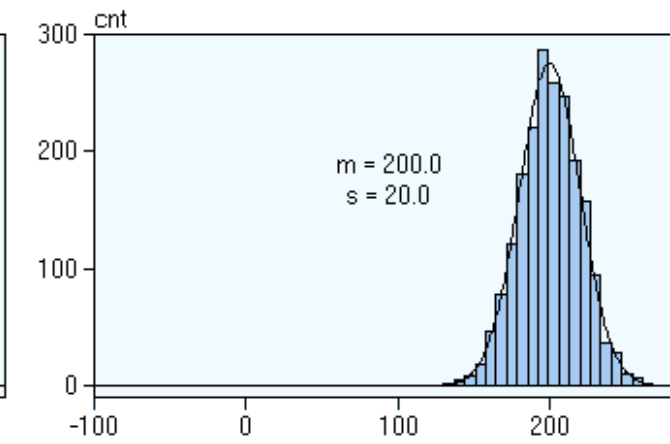
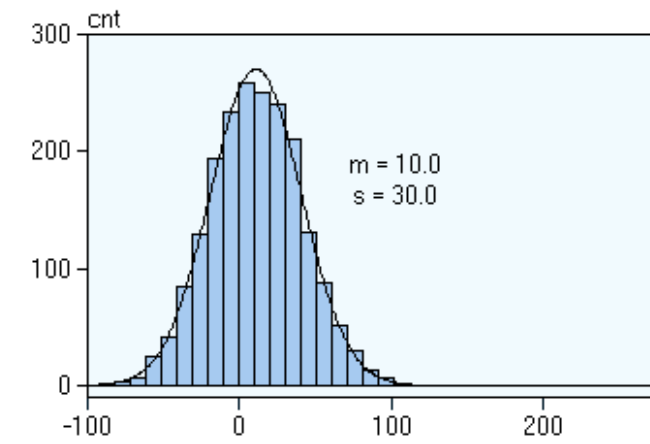
BASIC DATA CLEANING &
MANIPULATIONS

2

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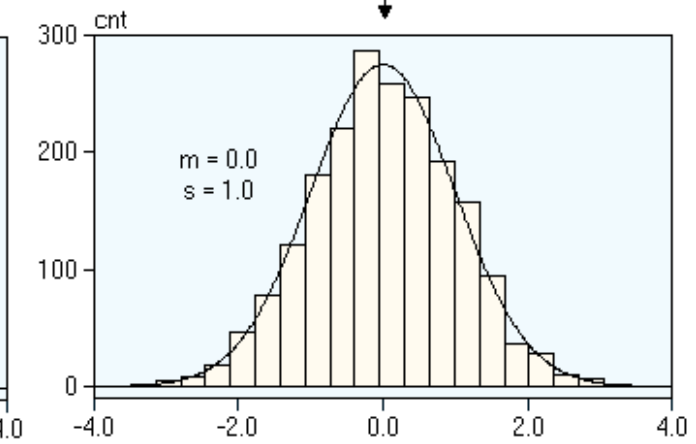
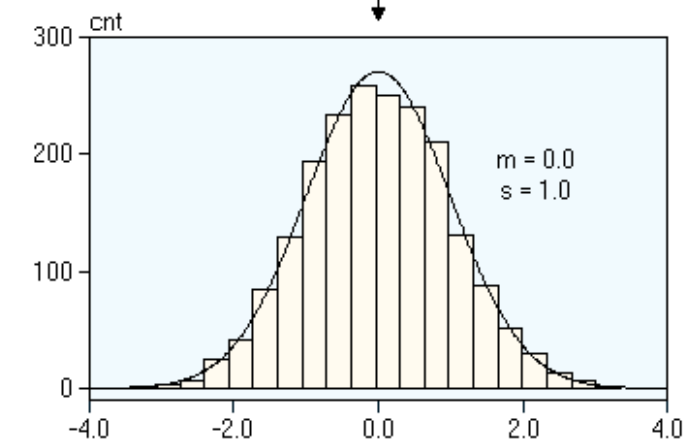
BASIC DATA CLEANING &
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STANDARDISATION



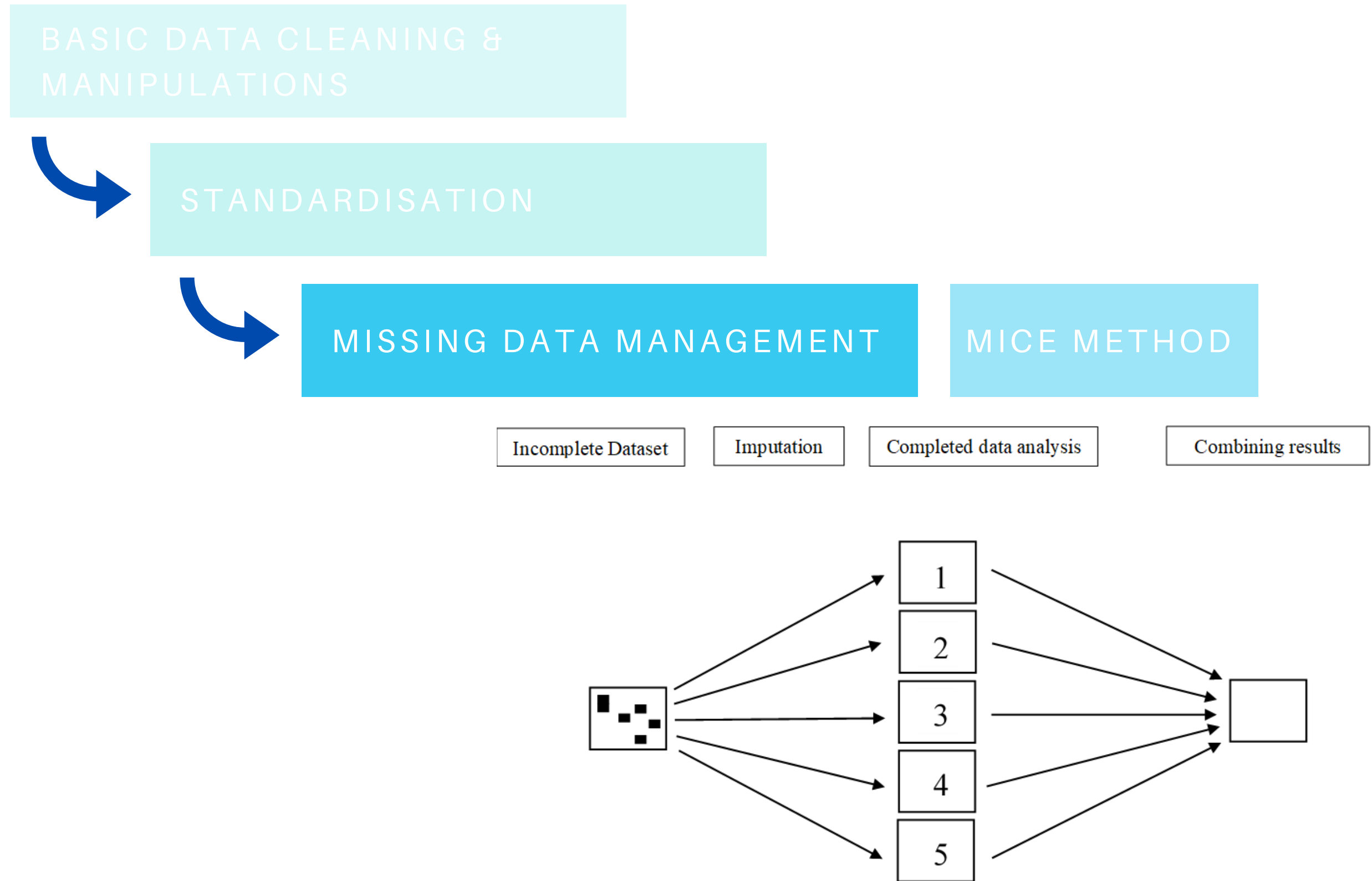
Standardisation

Standardisation

comparable distributions
($m = 0.0, s = 1.0$)

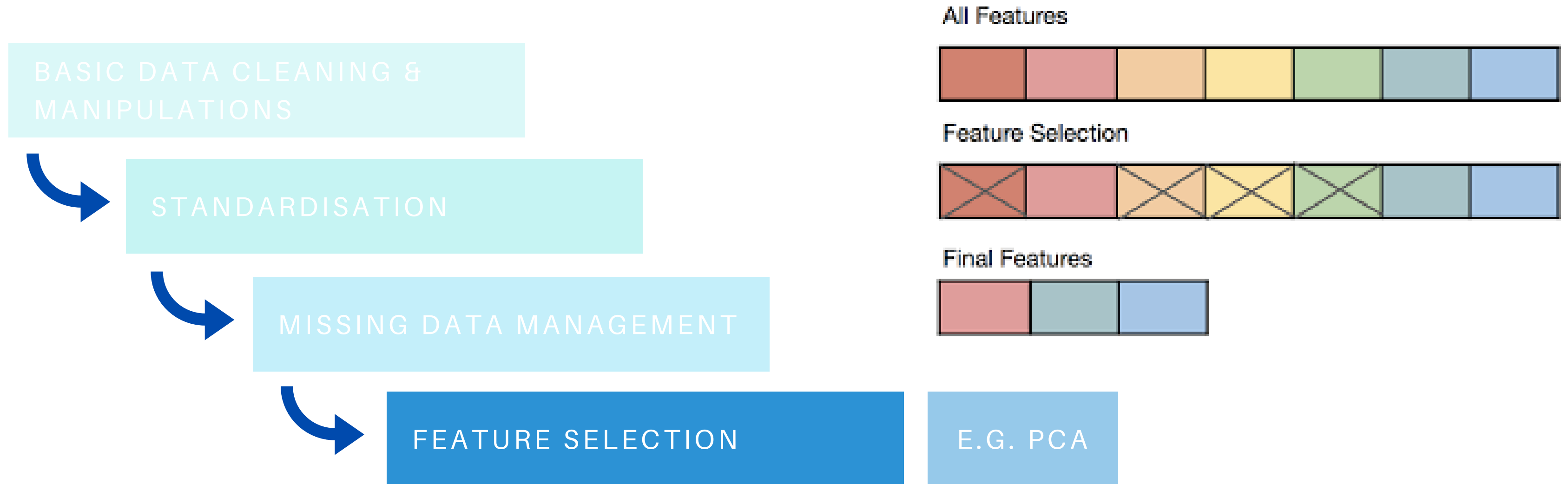
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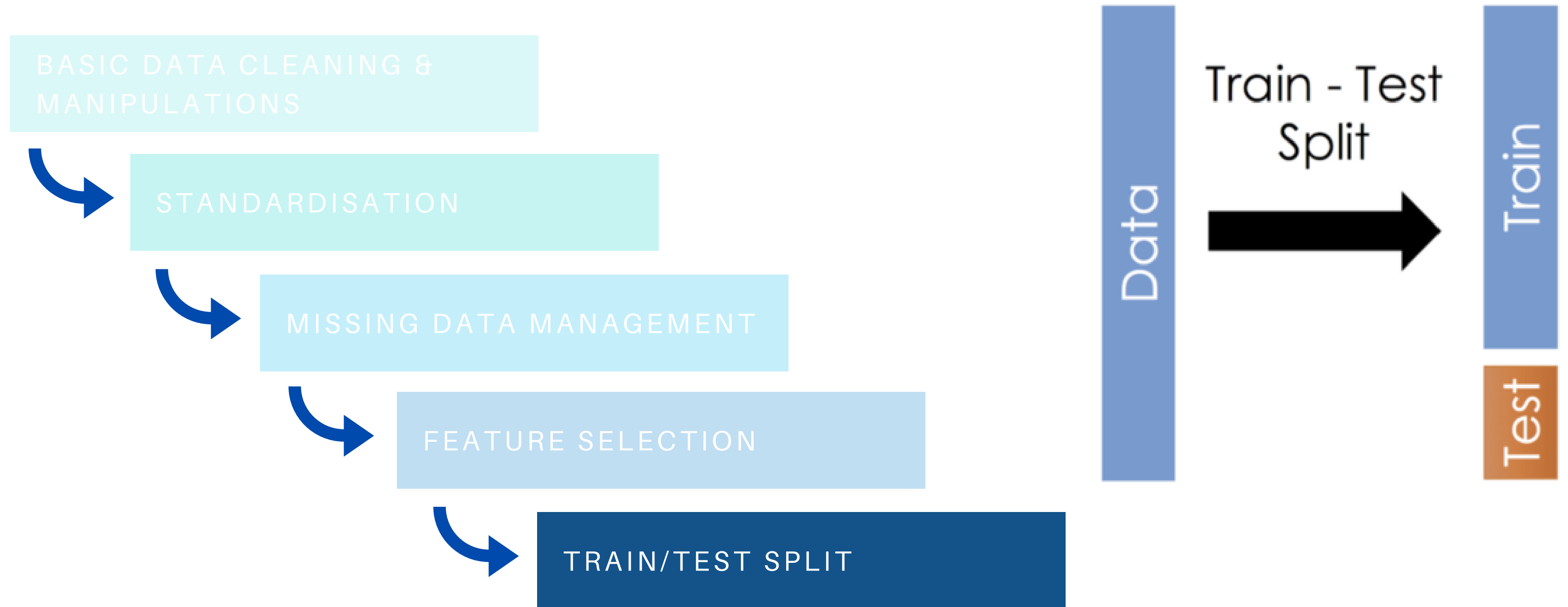
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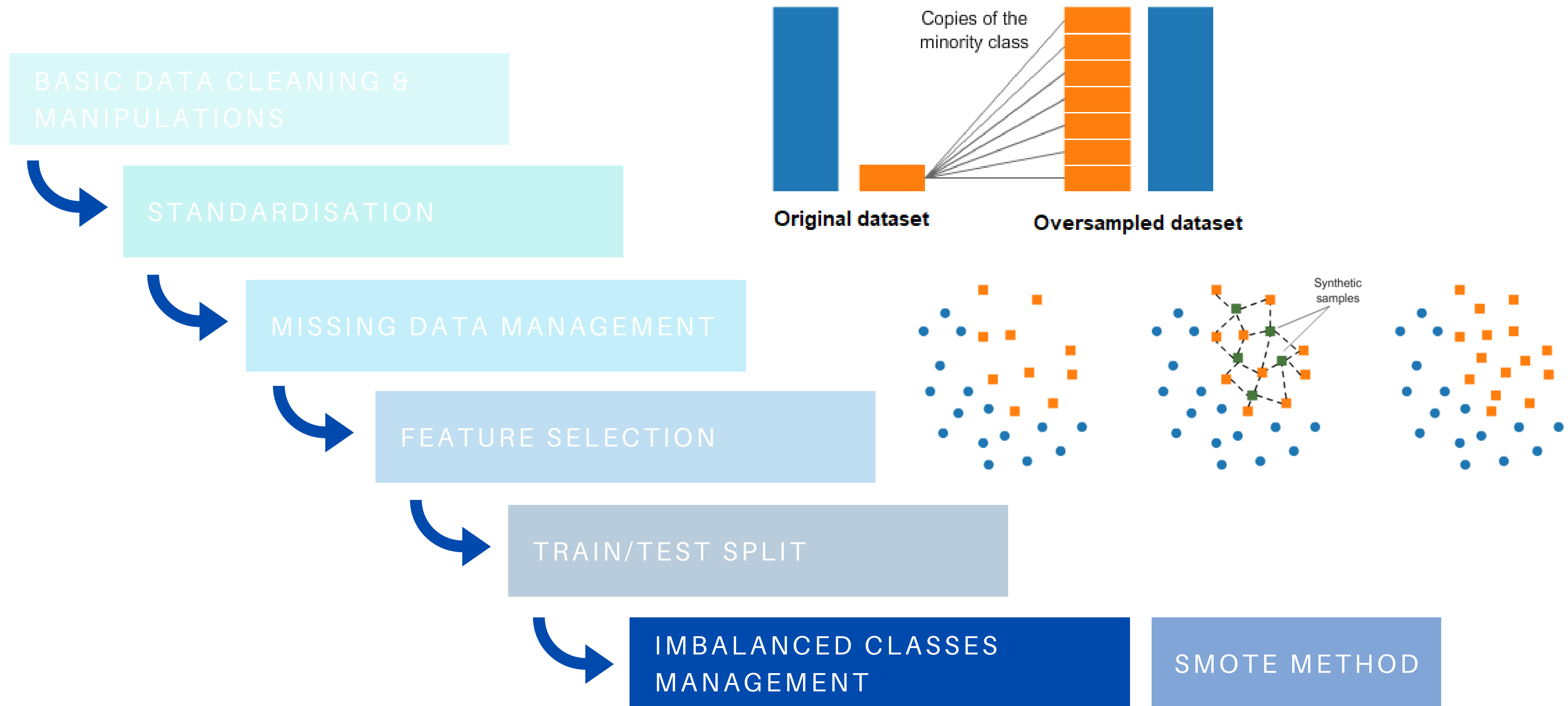
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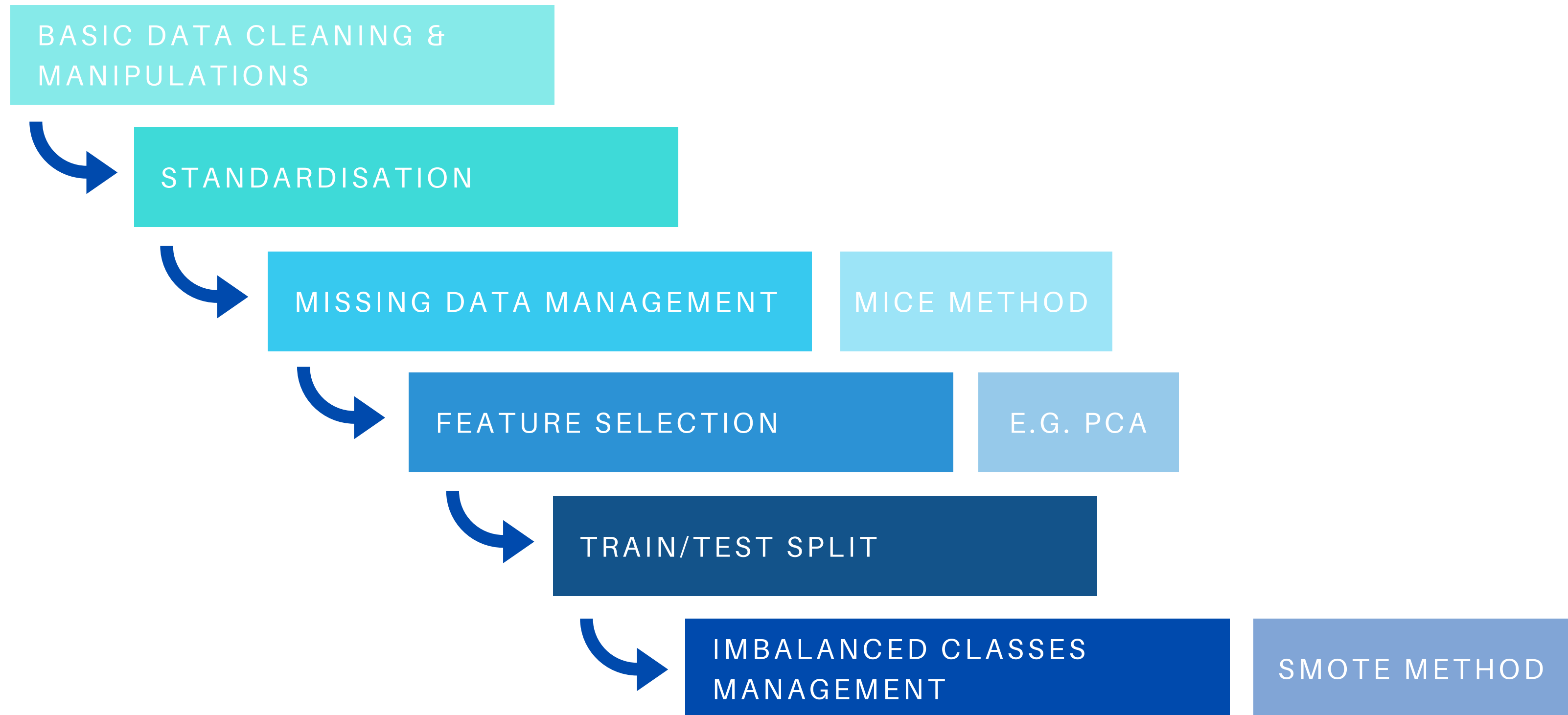
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WHAT DO I NEED TO DO TO USE THE DATA?



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WHAT DO I NEED TO DO TO USE THE DATA?



3



HOW DOES THE DATA LOOK LIKE?



3



HOW DOES THE DATA LOOK LIKE?

86 cases

19 CovidPos

67 CovidNeg

18 features

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HOW DOES THE DATA LOOK LIKE?

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Demographics

Symptoms

Previous conditions

Treatments

Tests

Evolution

Age

Gender

Respiratory symptoms

Gastrointestinal symp.

Pneumonia

Fever

Immunosuppression

Immunodeficiency

Other previous cond.

Oxygen therapy

Antibiotics

Corticoids

Chest x-ray

Neutrocytes

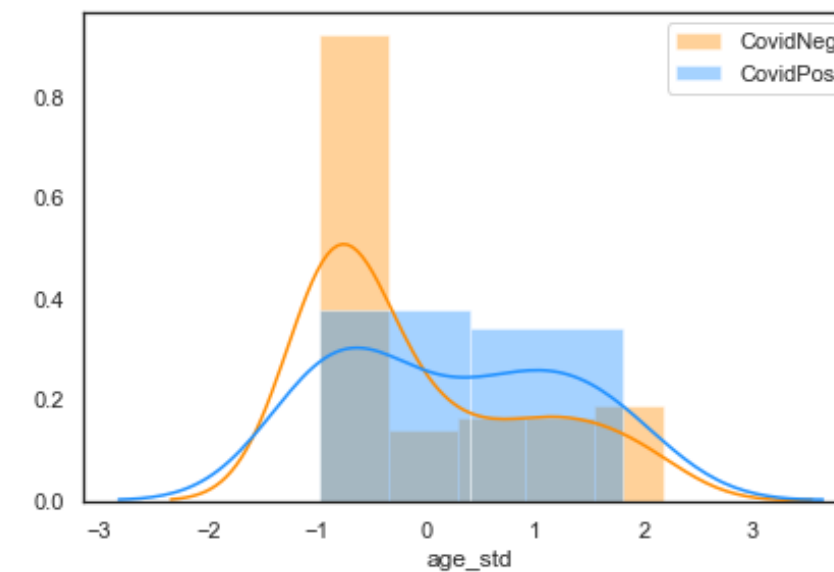
Lymphocytes

C-reactive protein

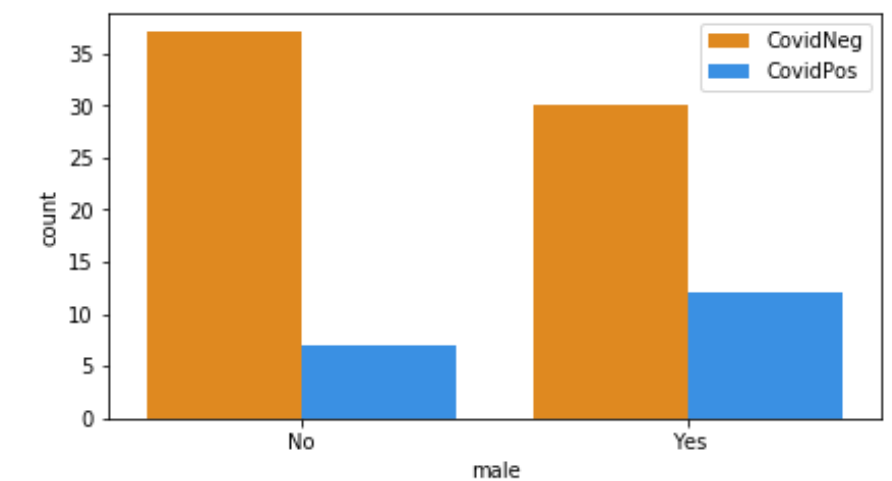
Diagnosis delay

Adm. Intensive Care Unit

AGE



GENDER



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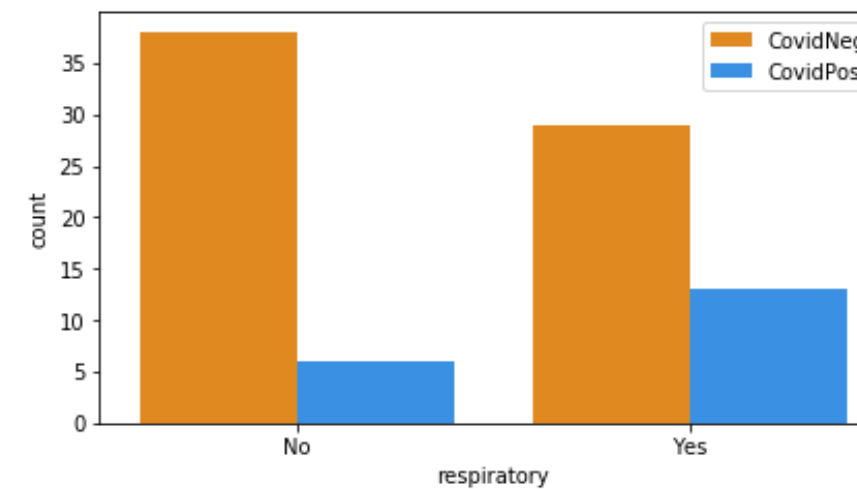
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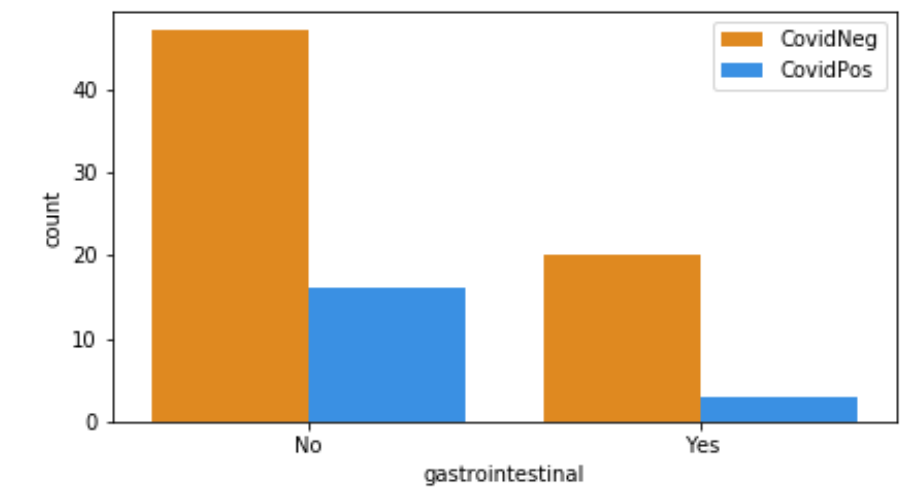
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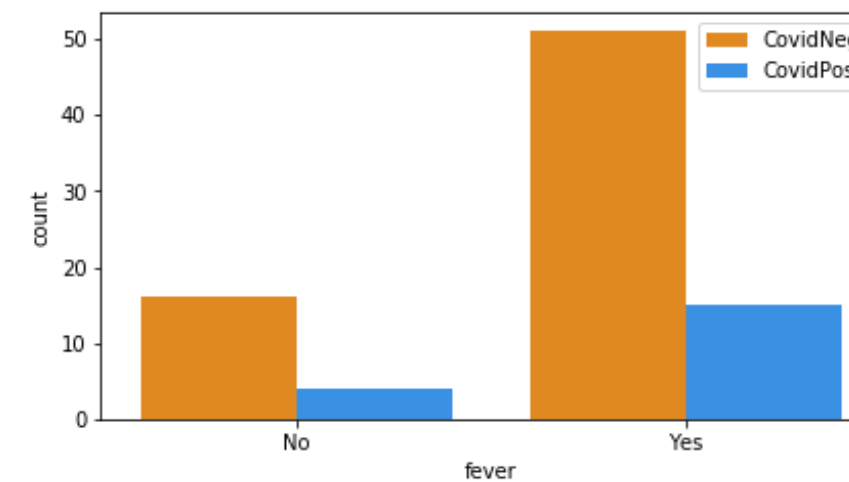
RESPIRATORY



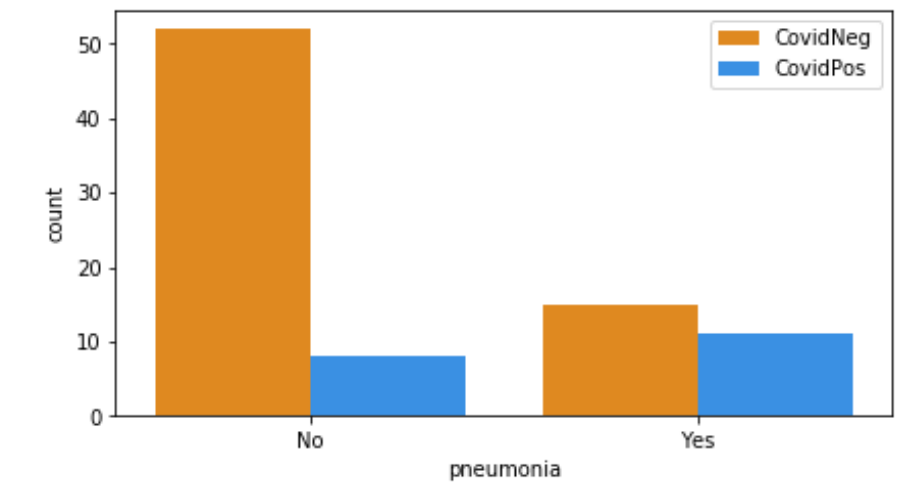
GASTROINTESTINAL



FEVER



PNEUMONIA



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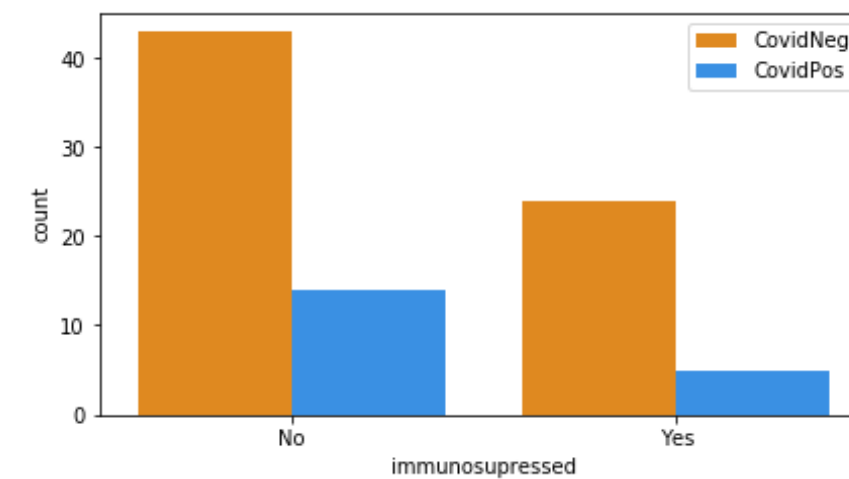
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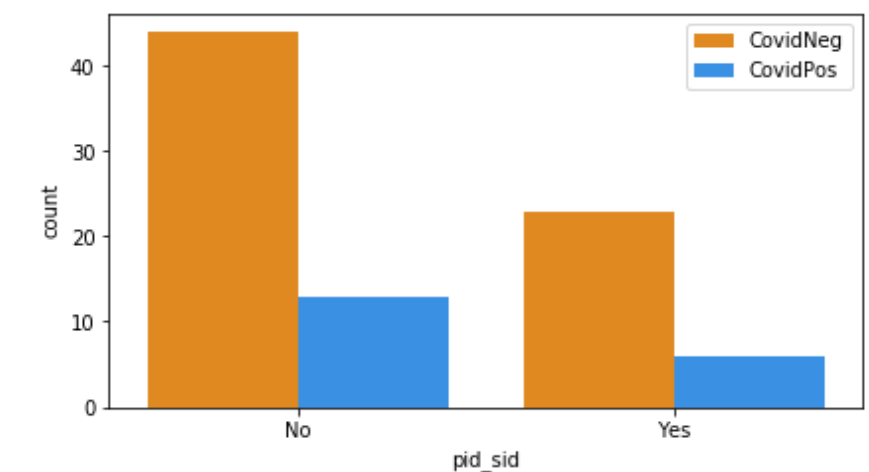
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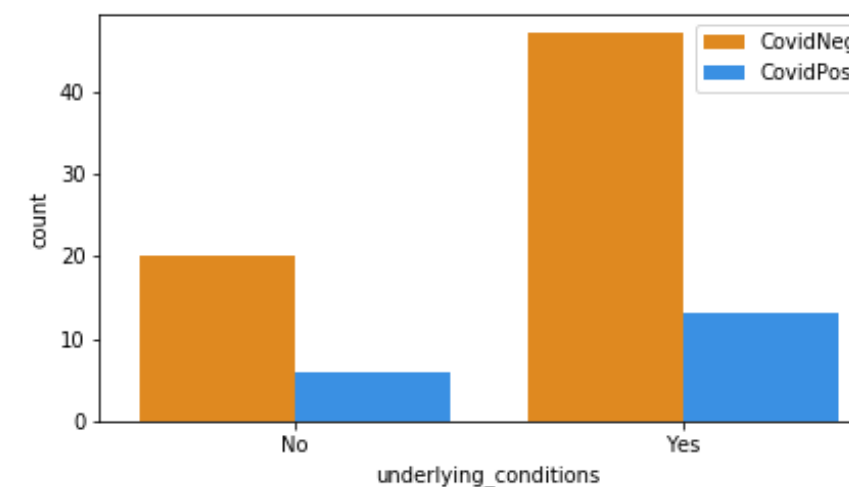
IMMUNOSUPPRESSION



IMMUNODEFICIENCY



OTHER PREVIOUS CONDITIONS



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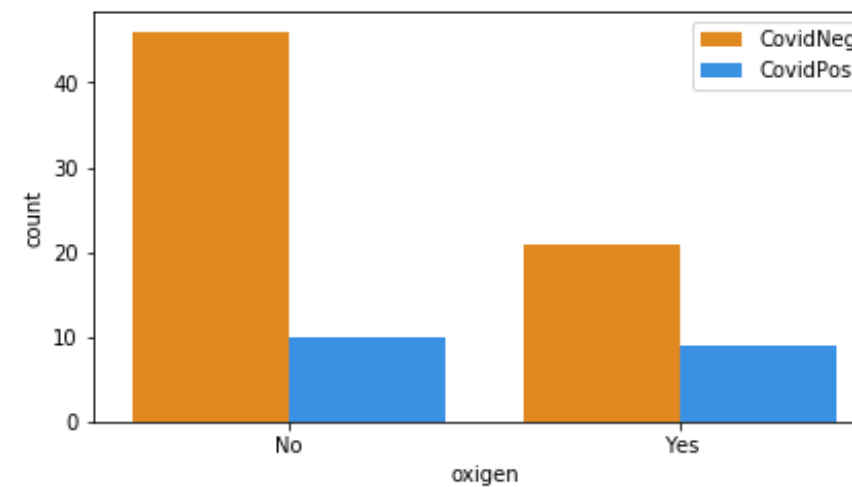
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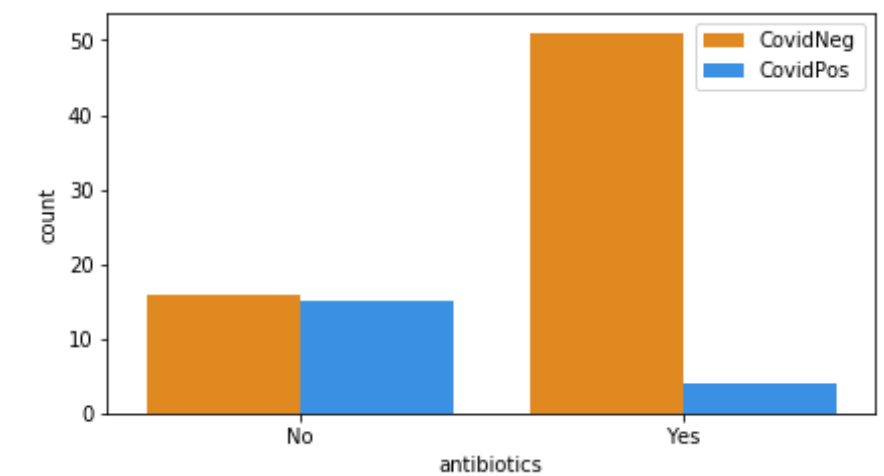
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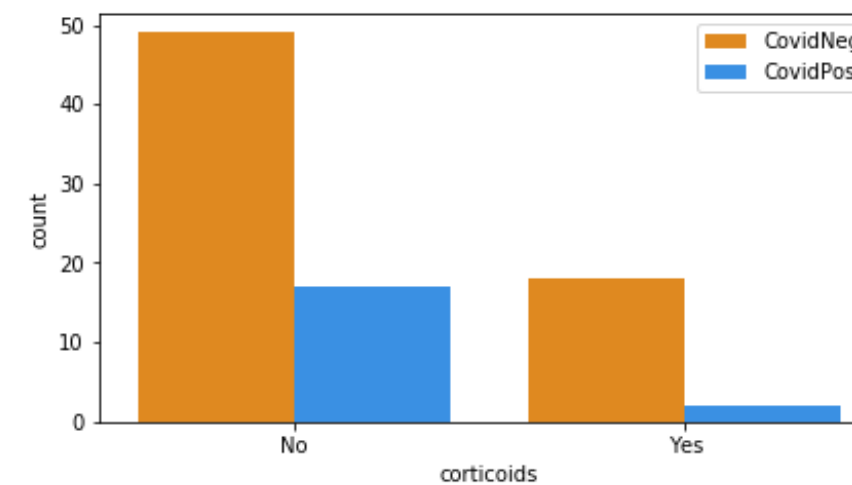
OXYGEN THERAPY



ANTIBIOTICS



CORTICOIDS



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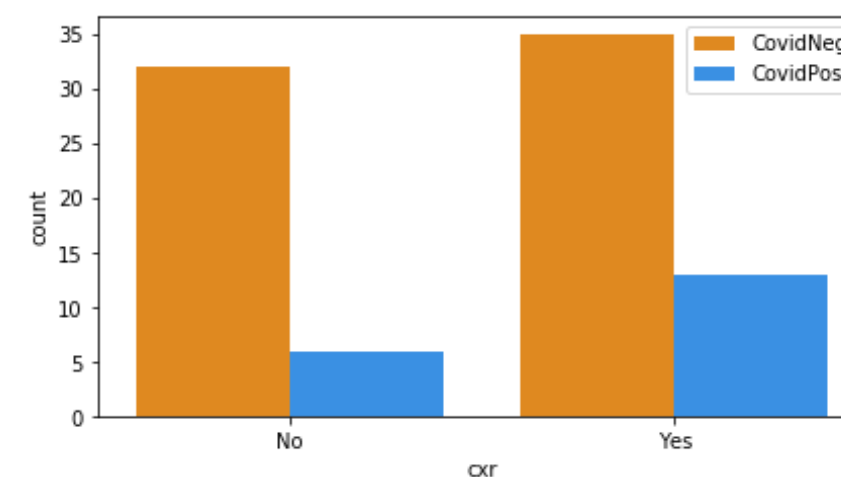
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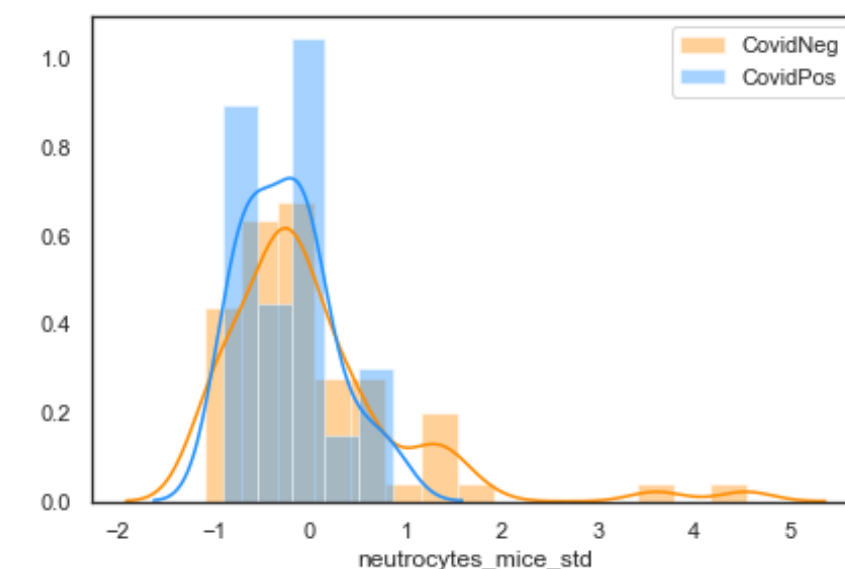
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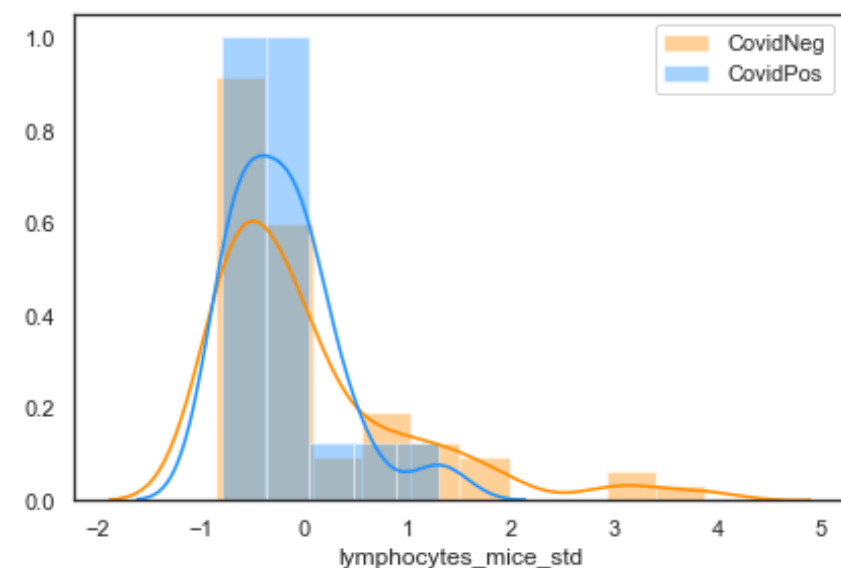
CHEST X-RAY



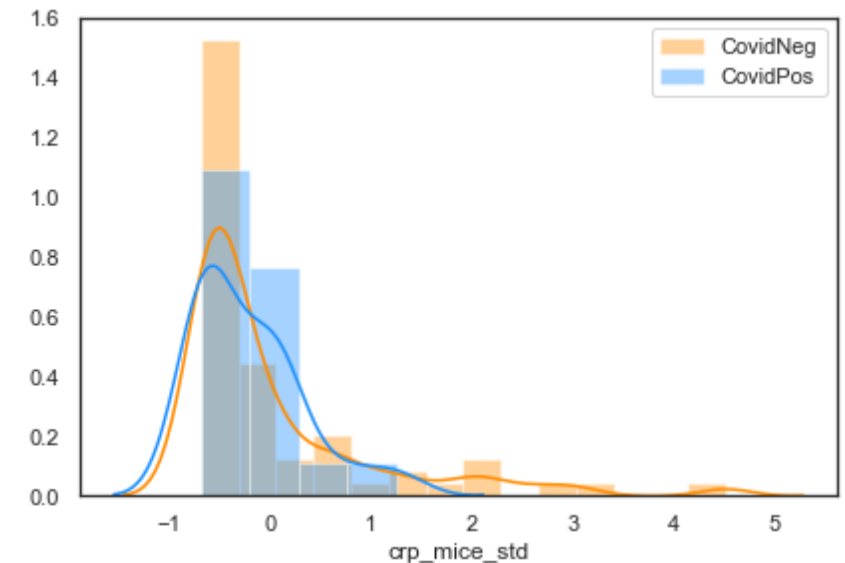
NEUTROCYTES



LYMPHOCYTES



C-REACTIVE PROTEIN



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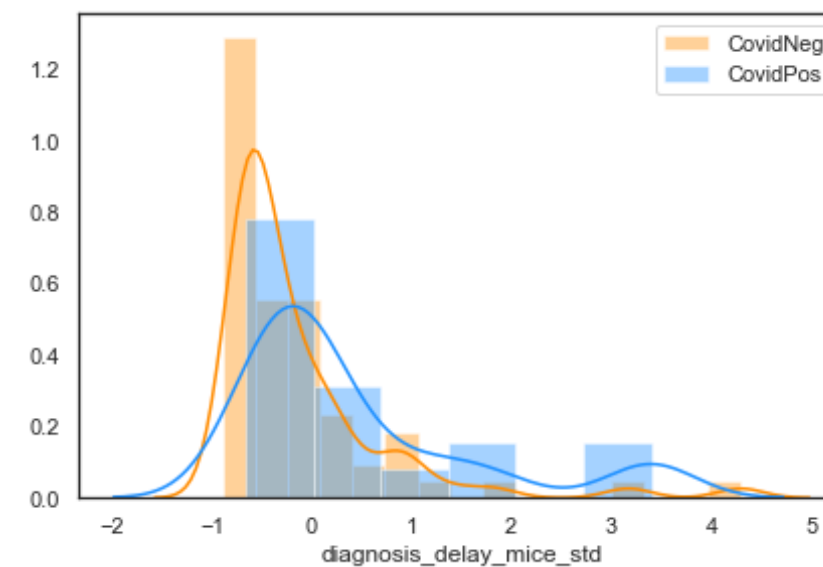
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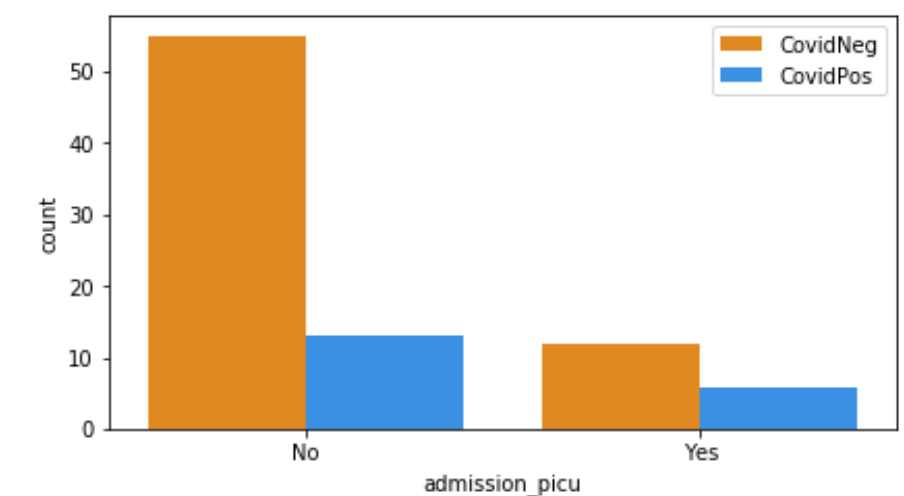
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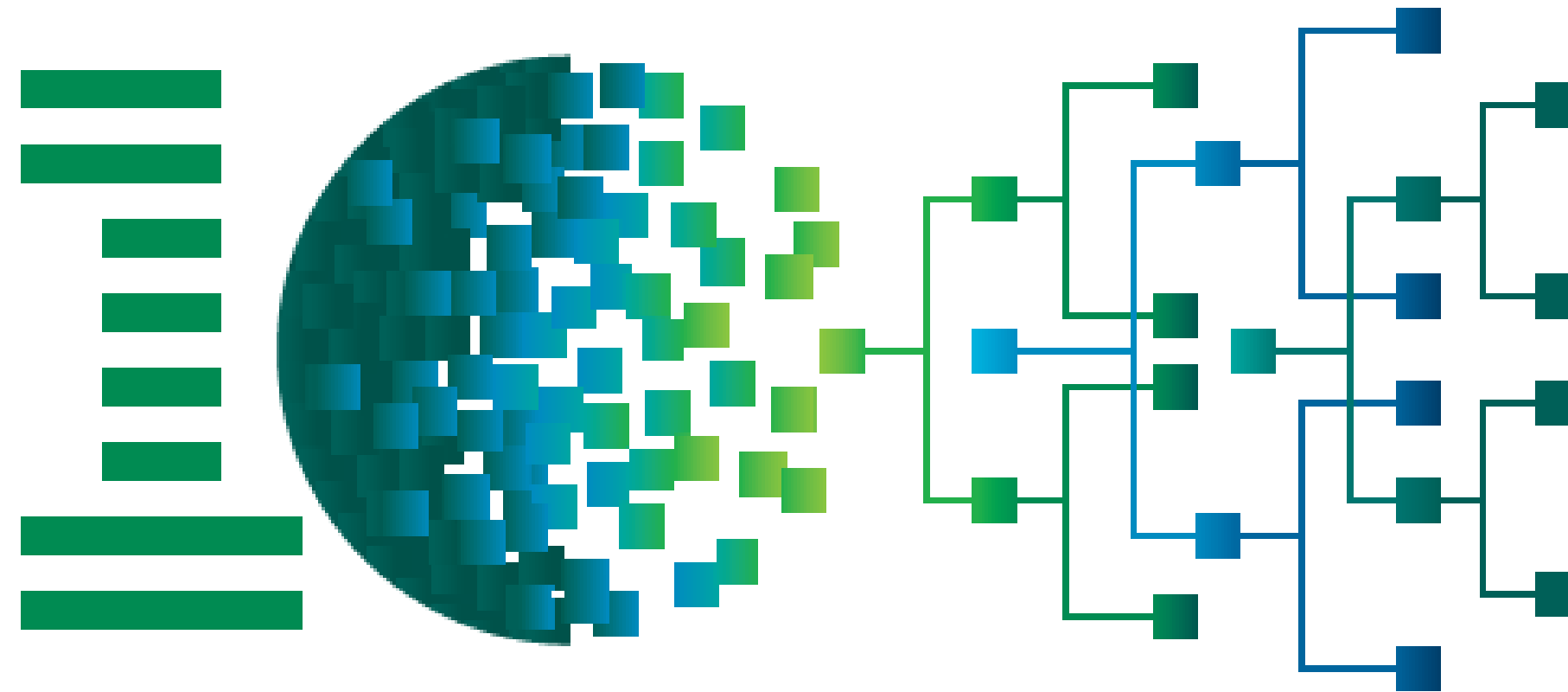
DIAGNOSIS DELAY



ADMISSION TO INTENSIVE CARE UNIT



4 → WHAT CAN I DO WITH THE DATA?



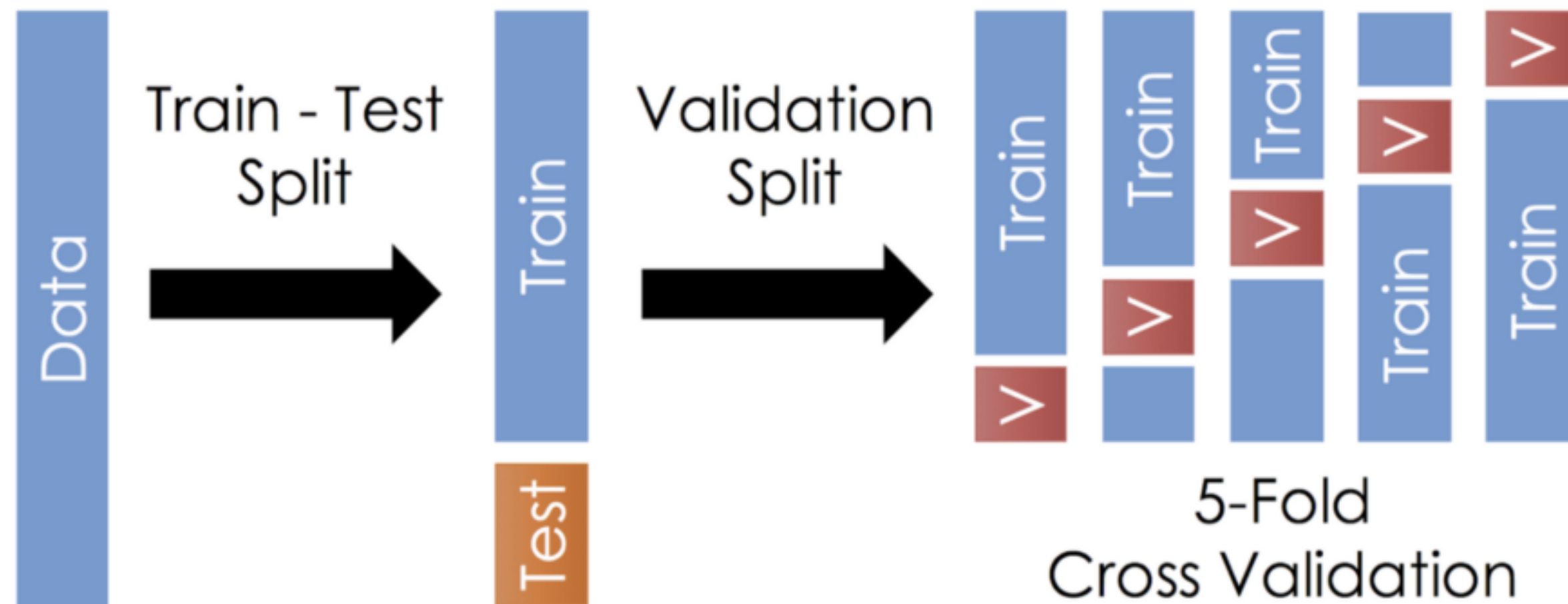
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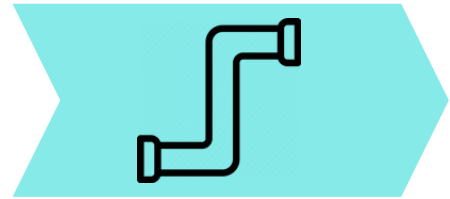
1) TRAIN DIFFERENT MACHINE LEARNING MODELS

Pipeline with different classification models (Stratified KFold cross-validation, RandomizedSearch strategy)



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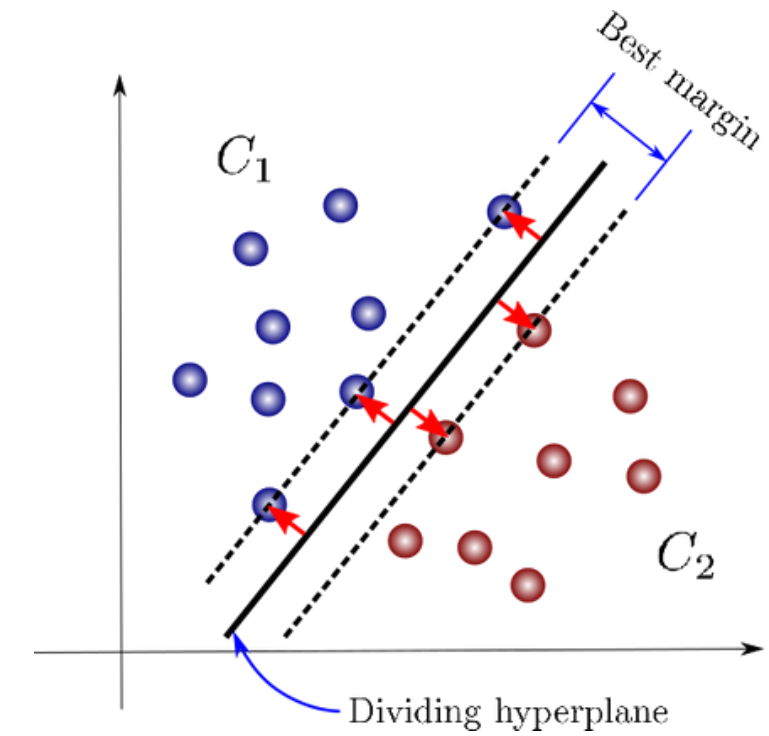
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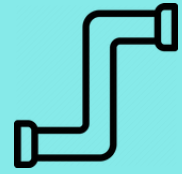
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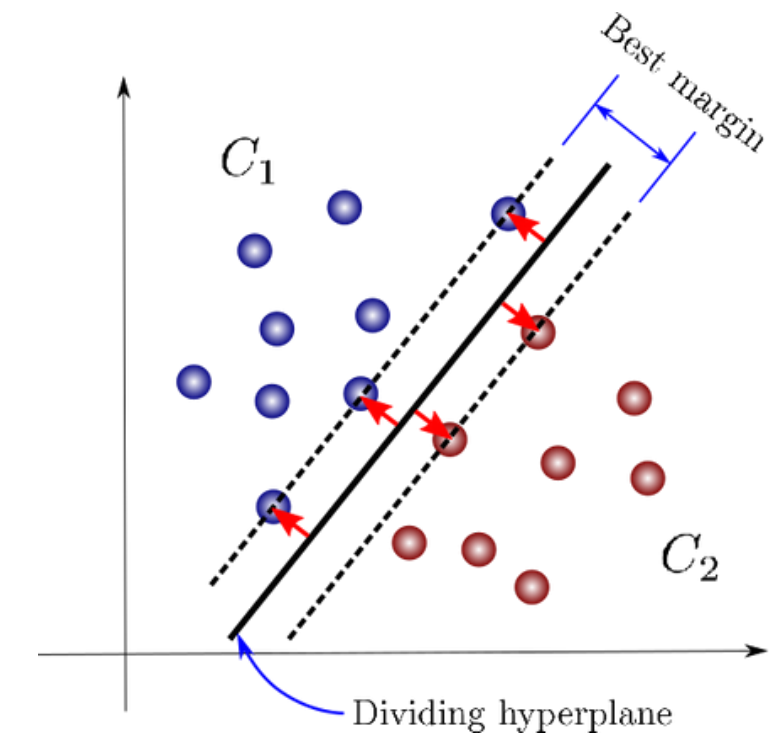
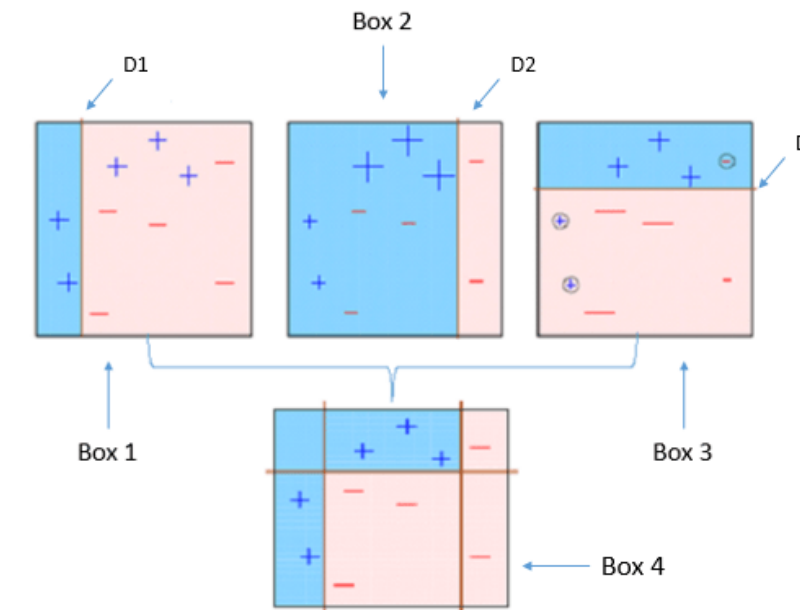
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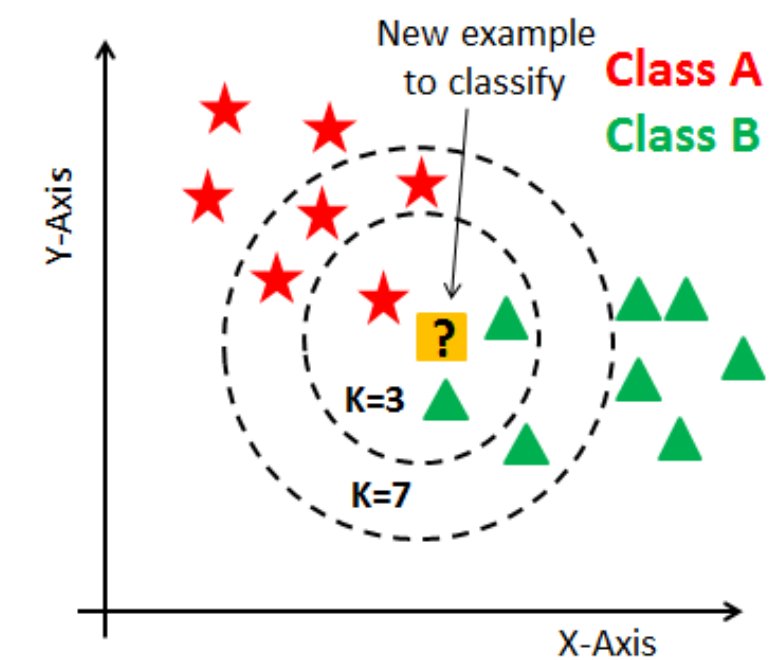
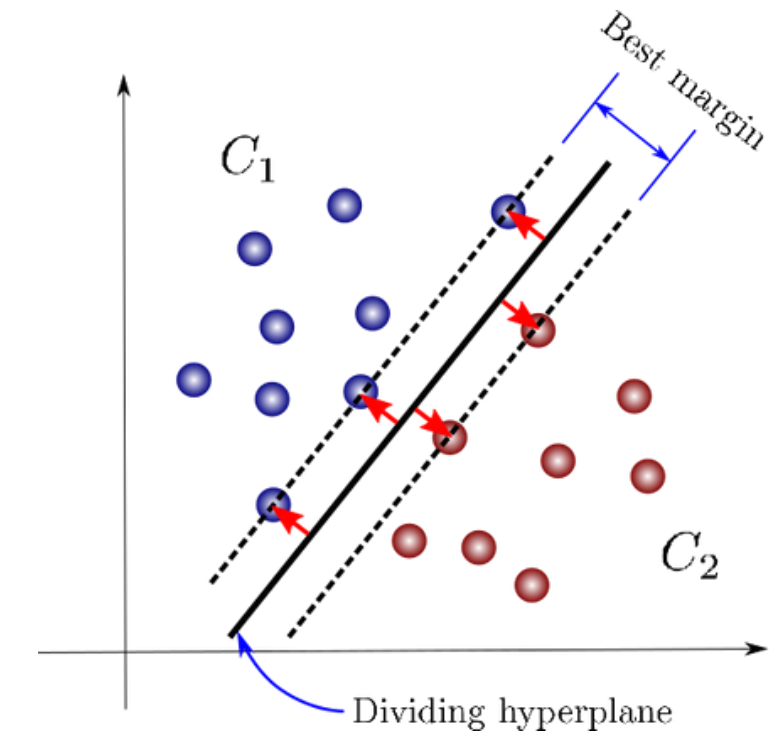
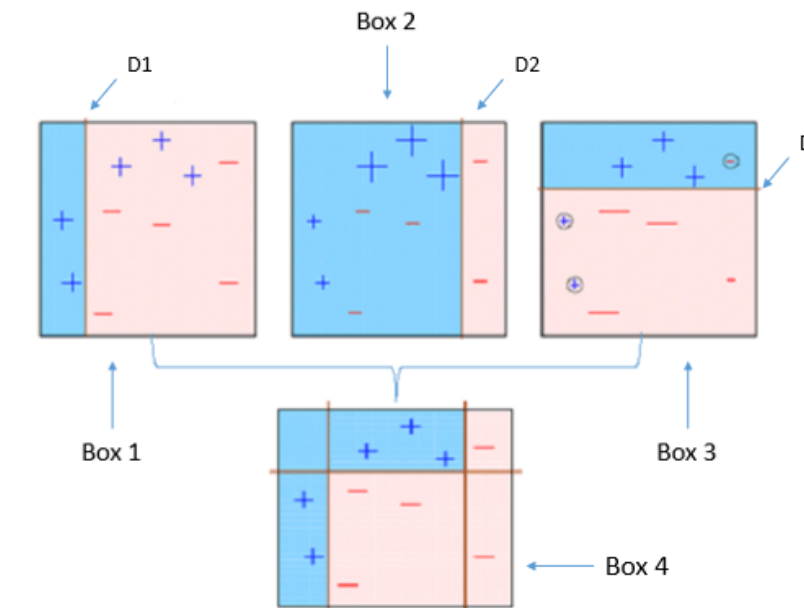
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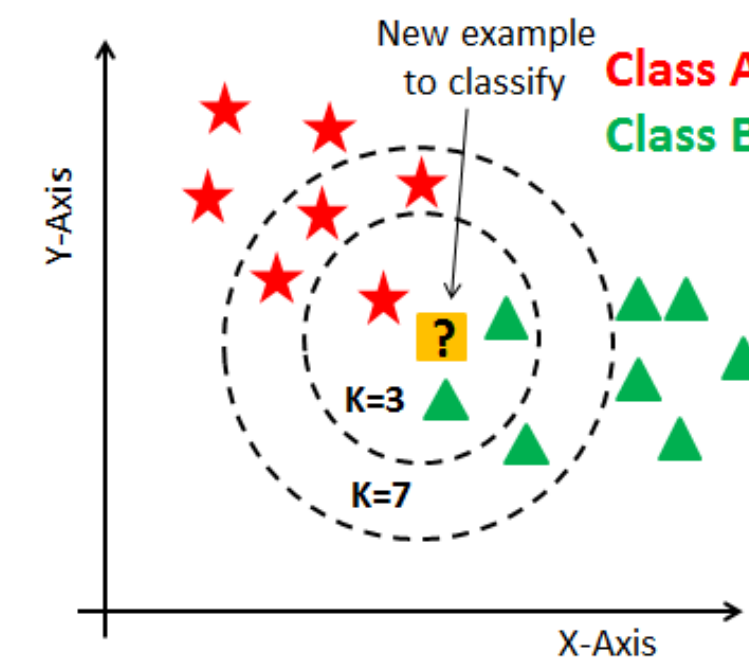
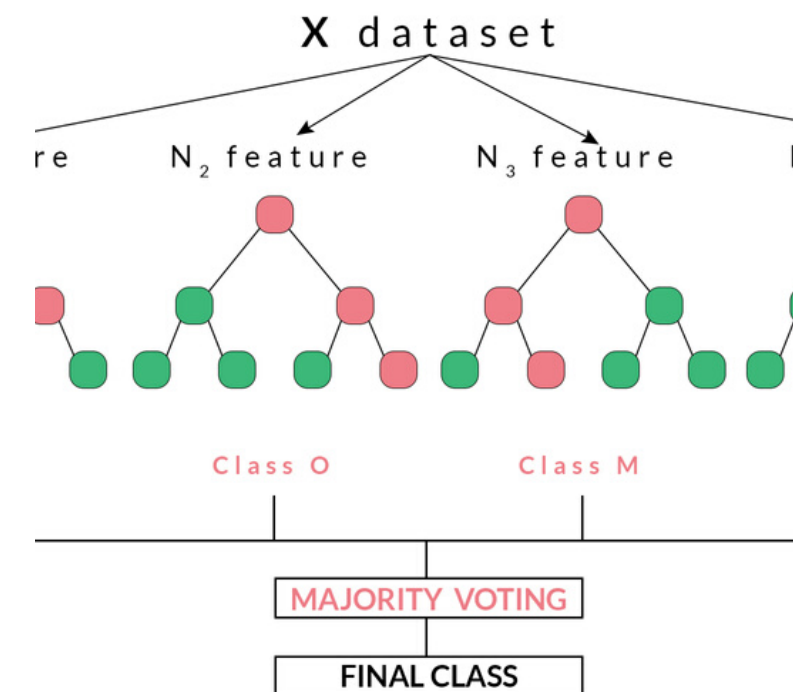
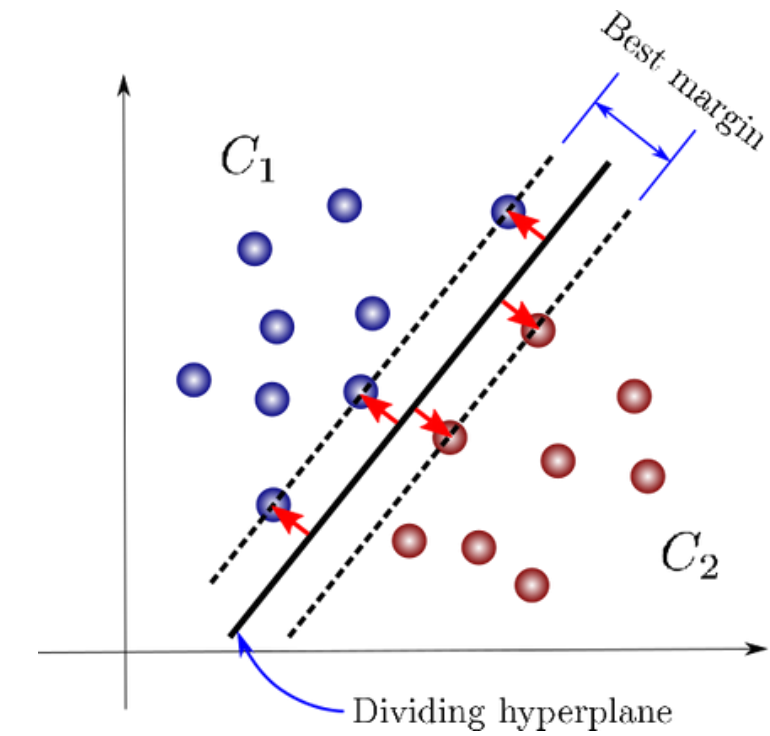
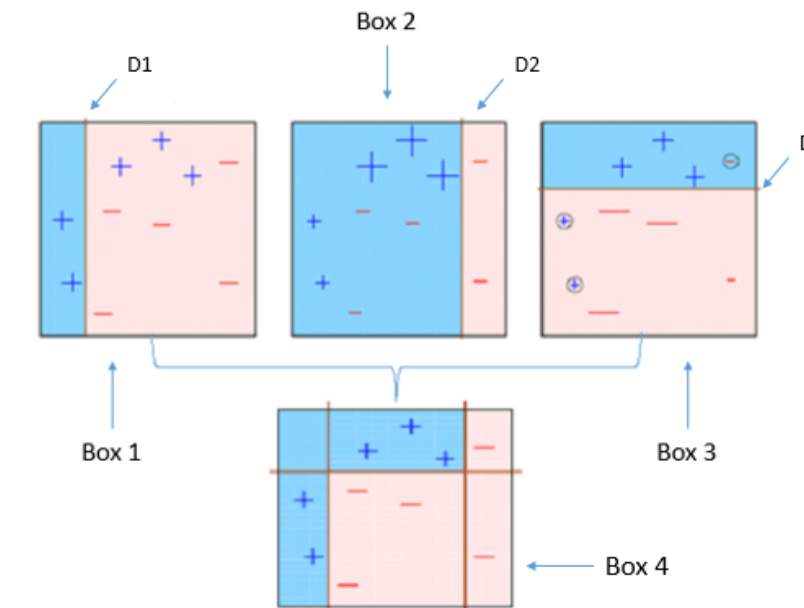
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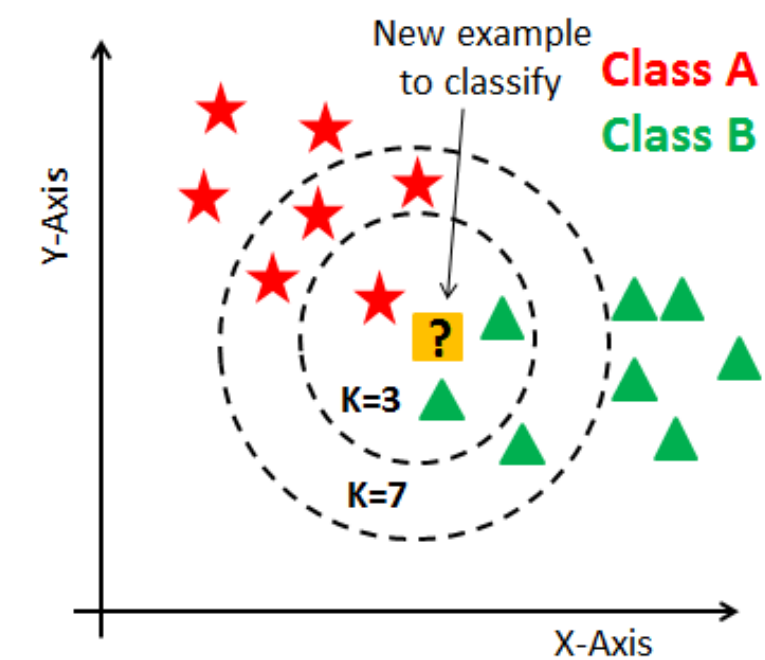
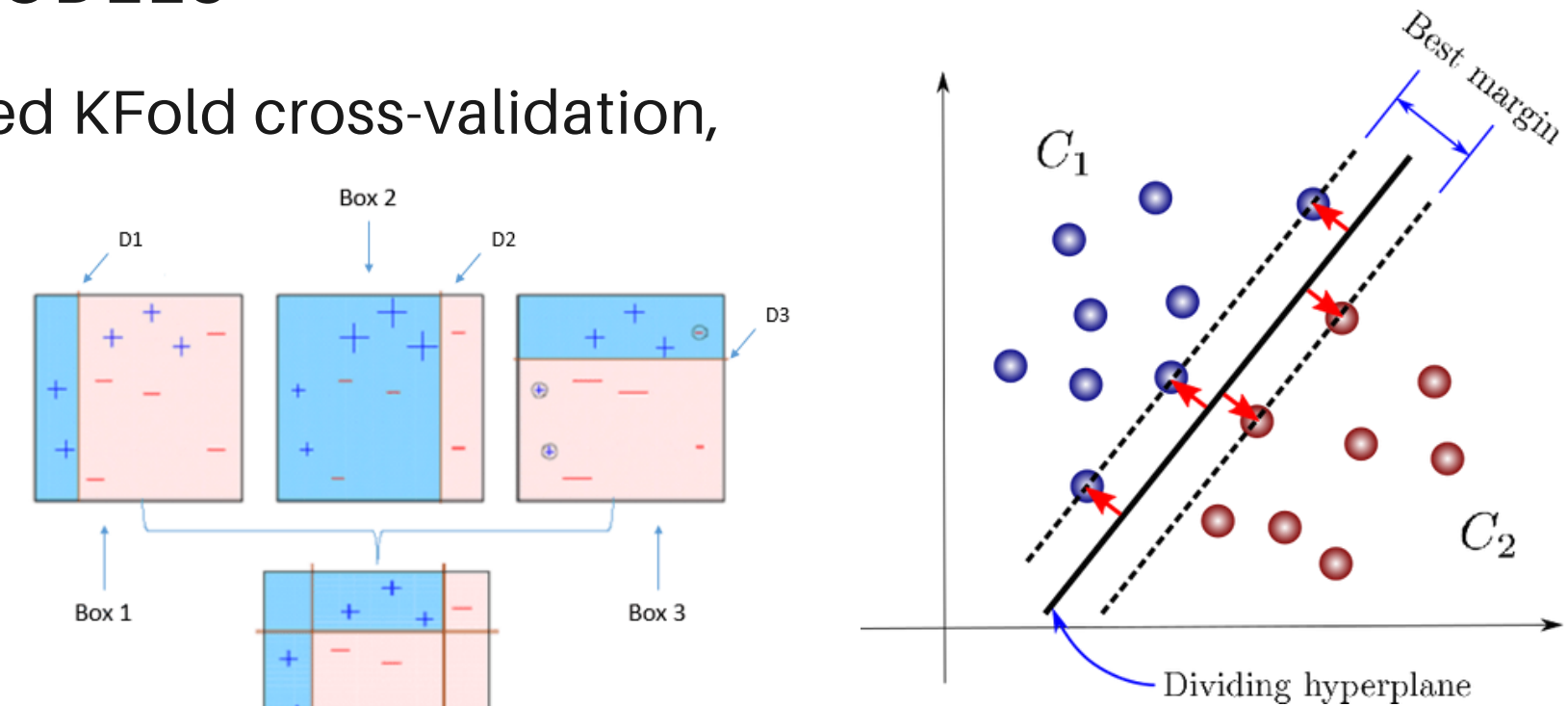
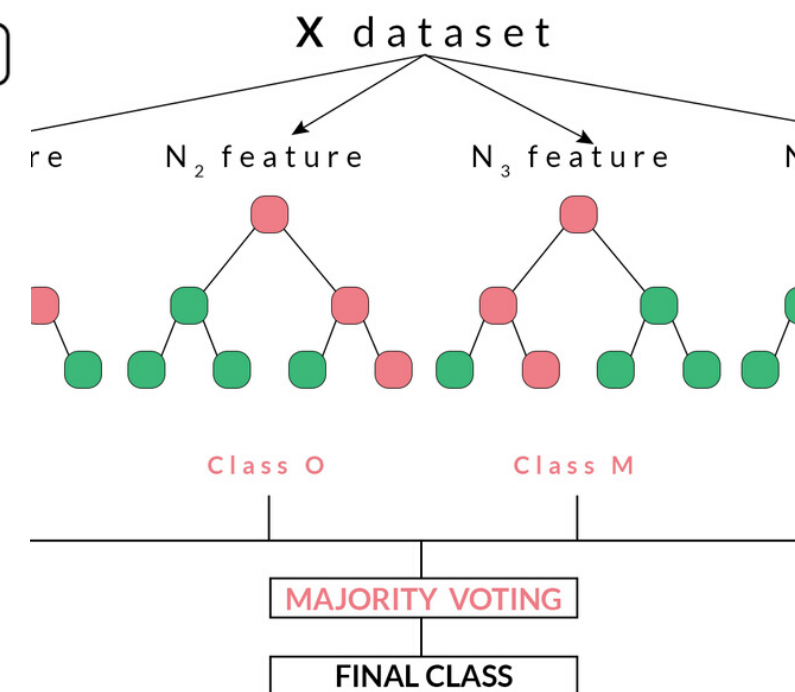
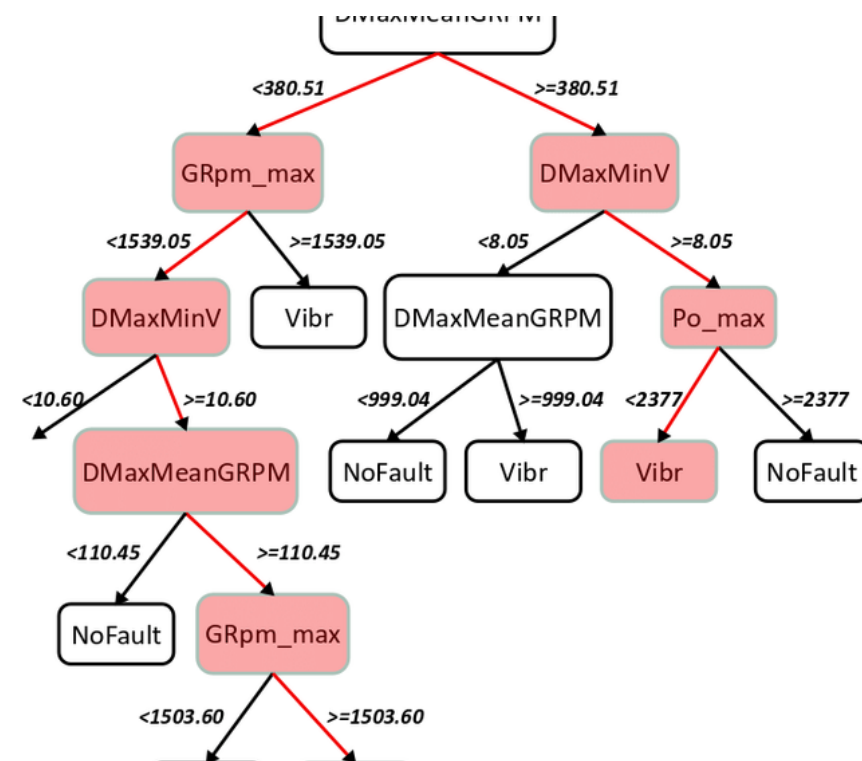


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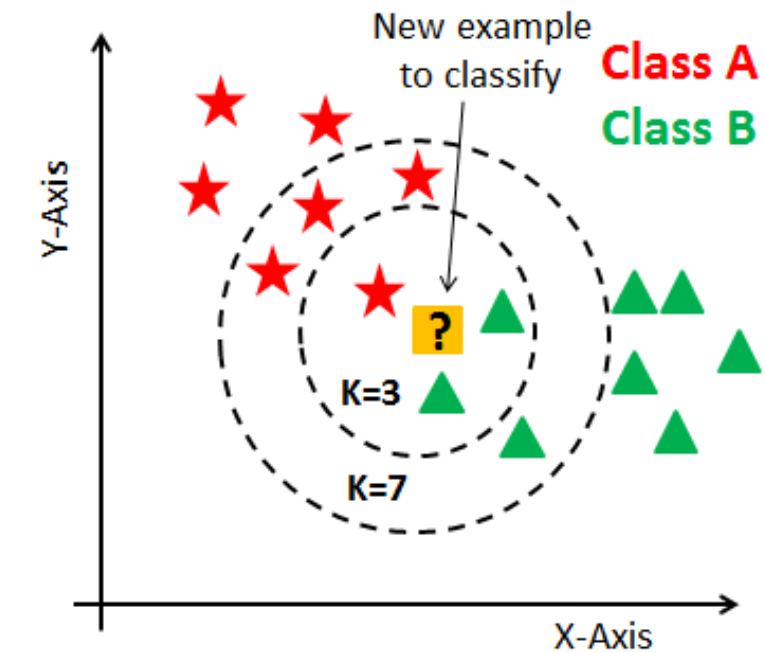
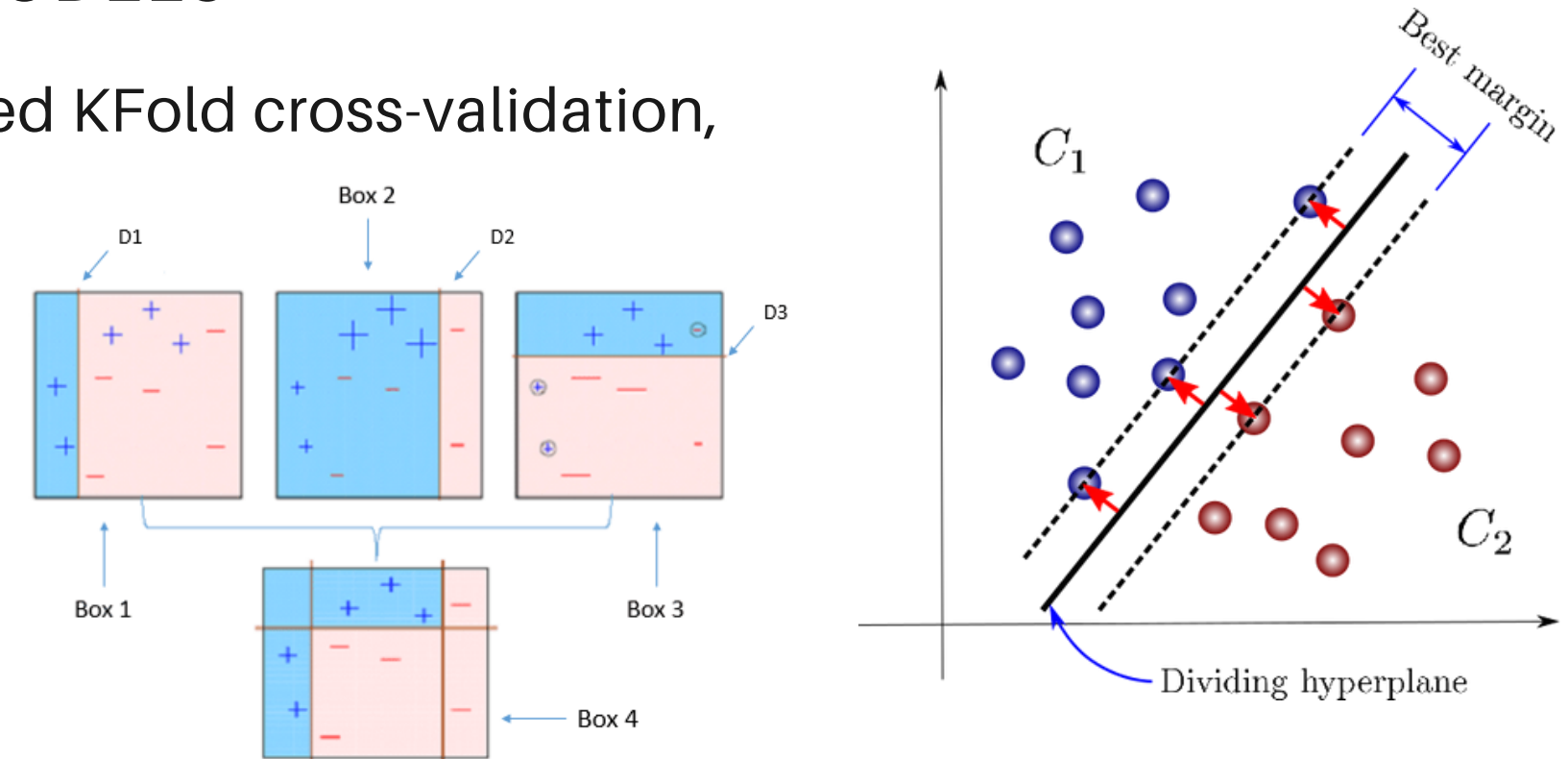
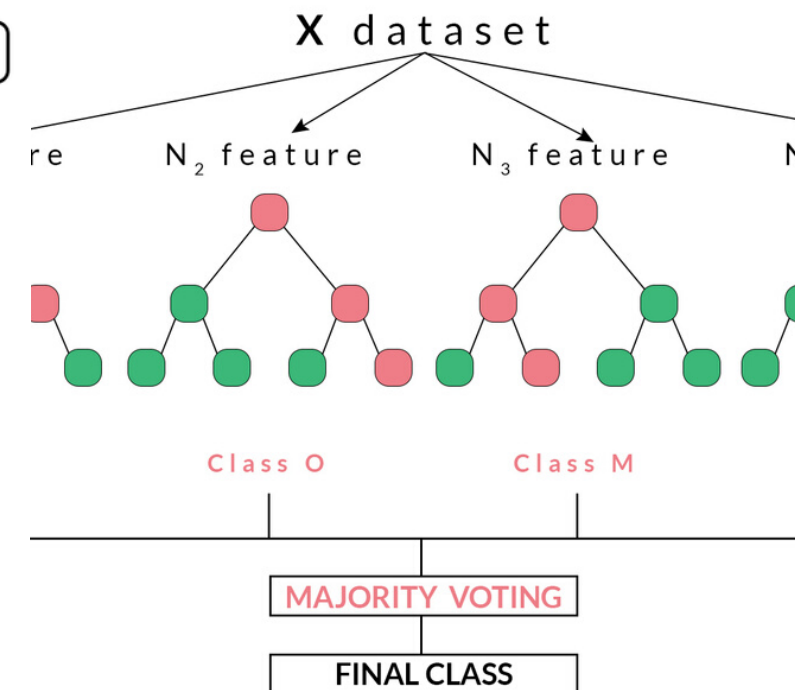
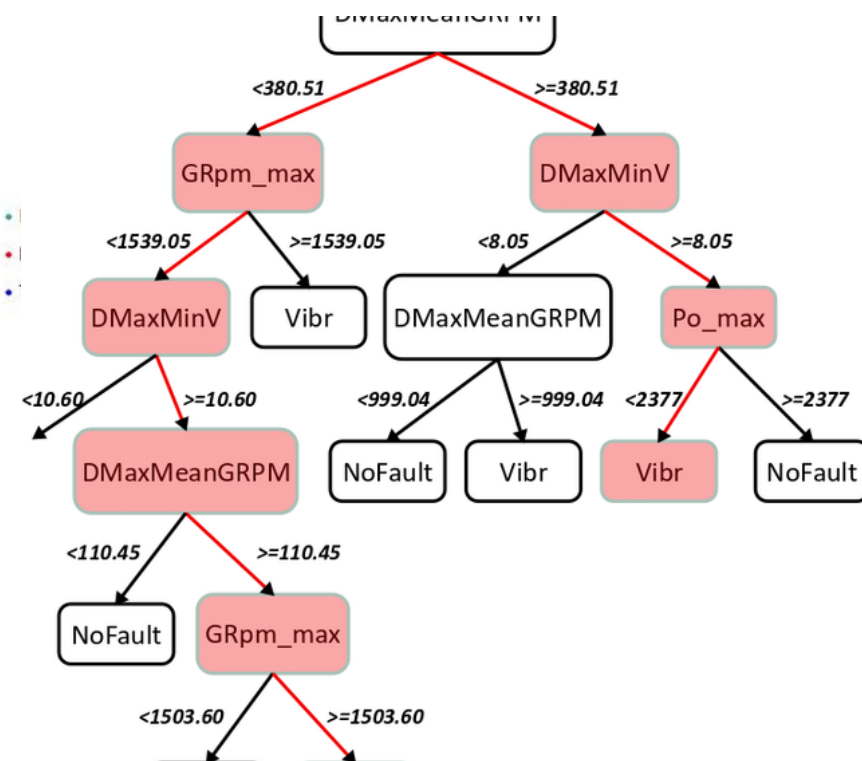
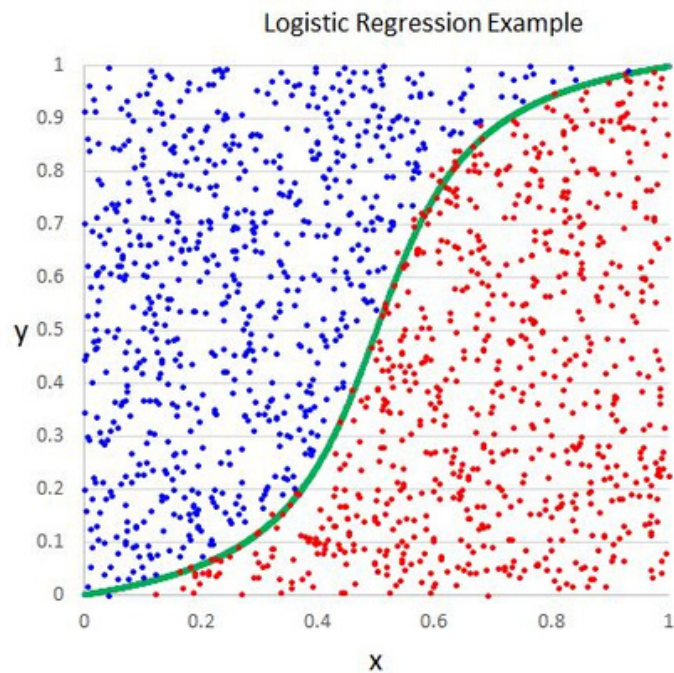


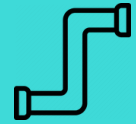
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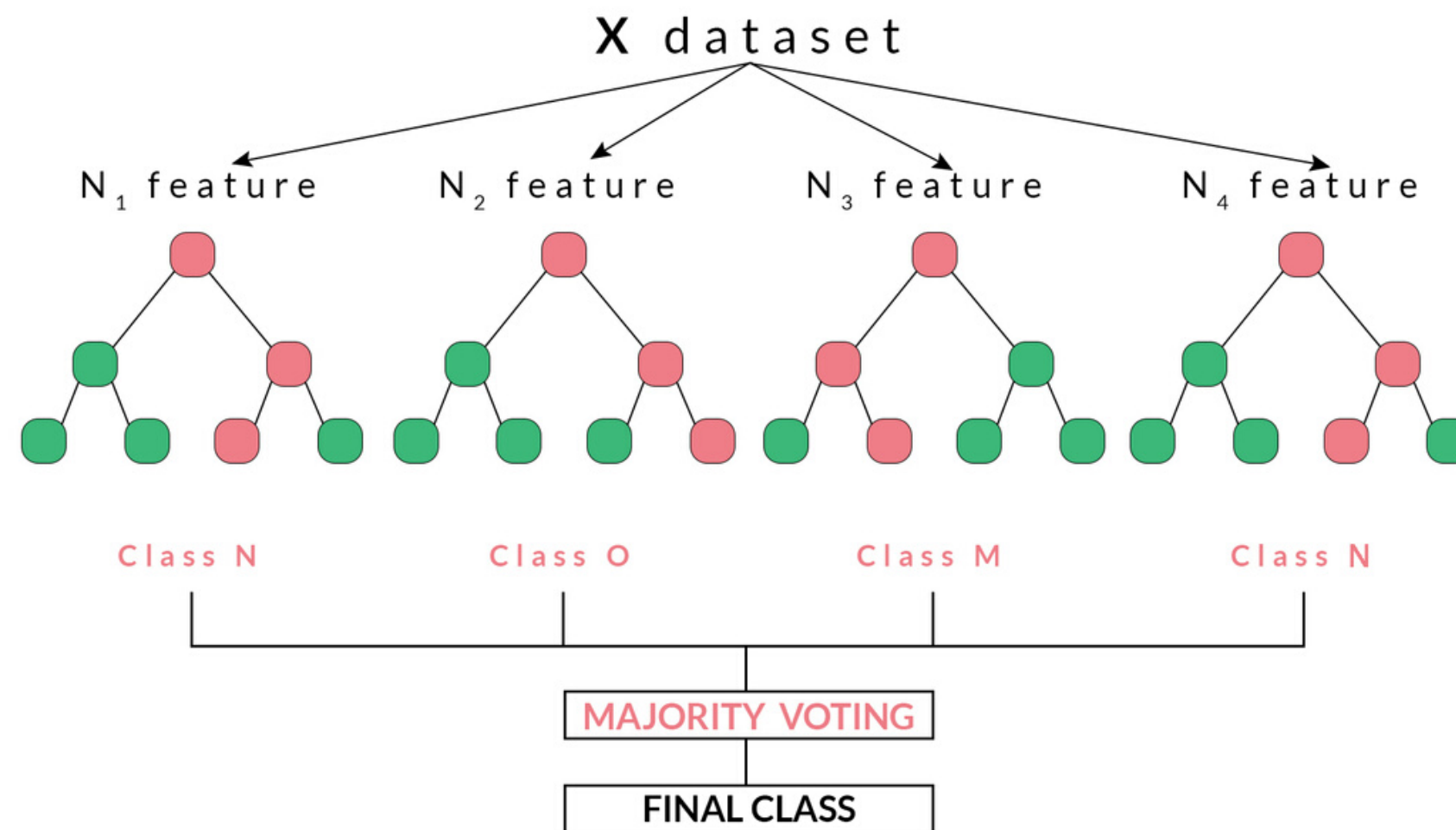
Pipeline with different classification models (Stratified KFold cross-validation, RandomizedSearch strategy)





2) TRAIN BEST PERFORMING MODELS

Reduced pipeline with best performing models: Random Forests (Stratified KFold cross-validation, GridSearch strategy)



Best parameters output

Original model

```
{'clf__criterion': 'gini',  
'clf__max_depth': 2,  
'clf__min_samples_leaf': 2,  
'clf__min_samples_split': 2}
```

Oversampled model

```
{'clf__criterion': 'entropy',  
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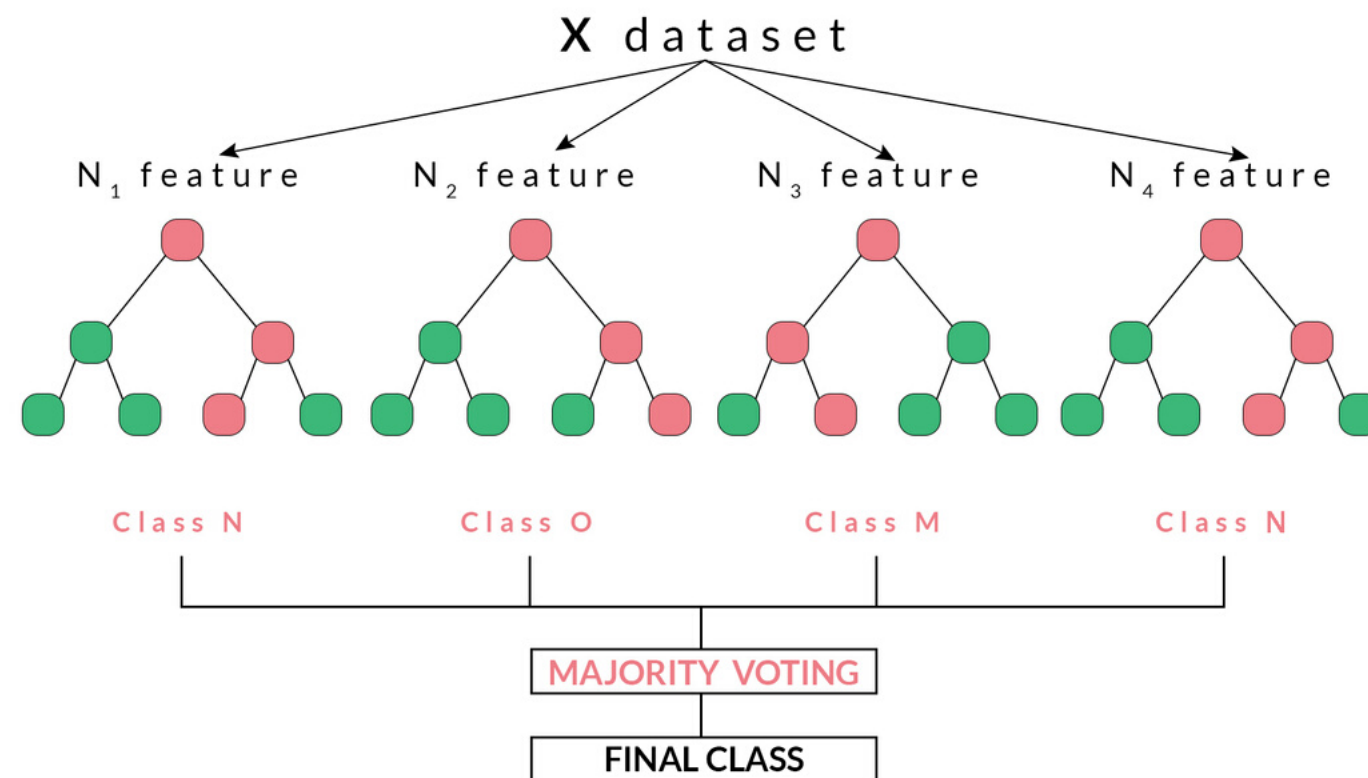

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3) GLOBAL SURROGATE METHOD

Modelling of Decision Trees on Random Forest model predictions



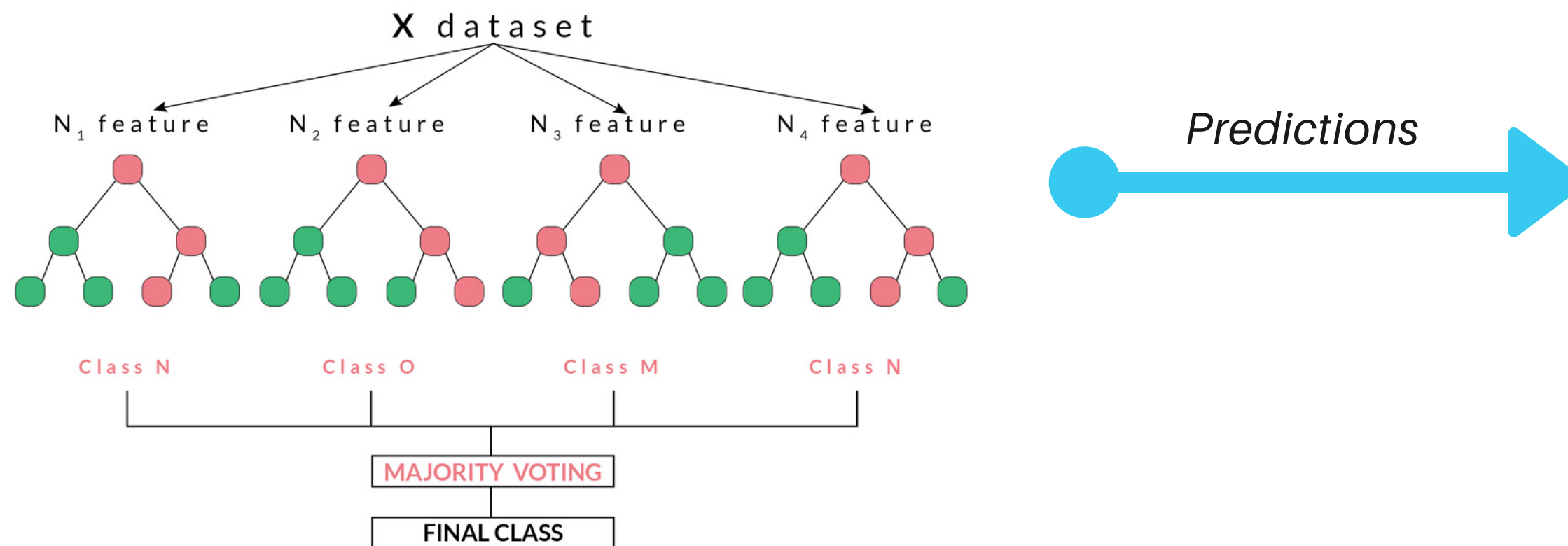
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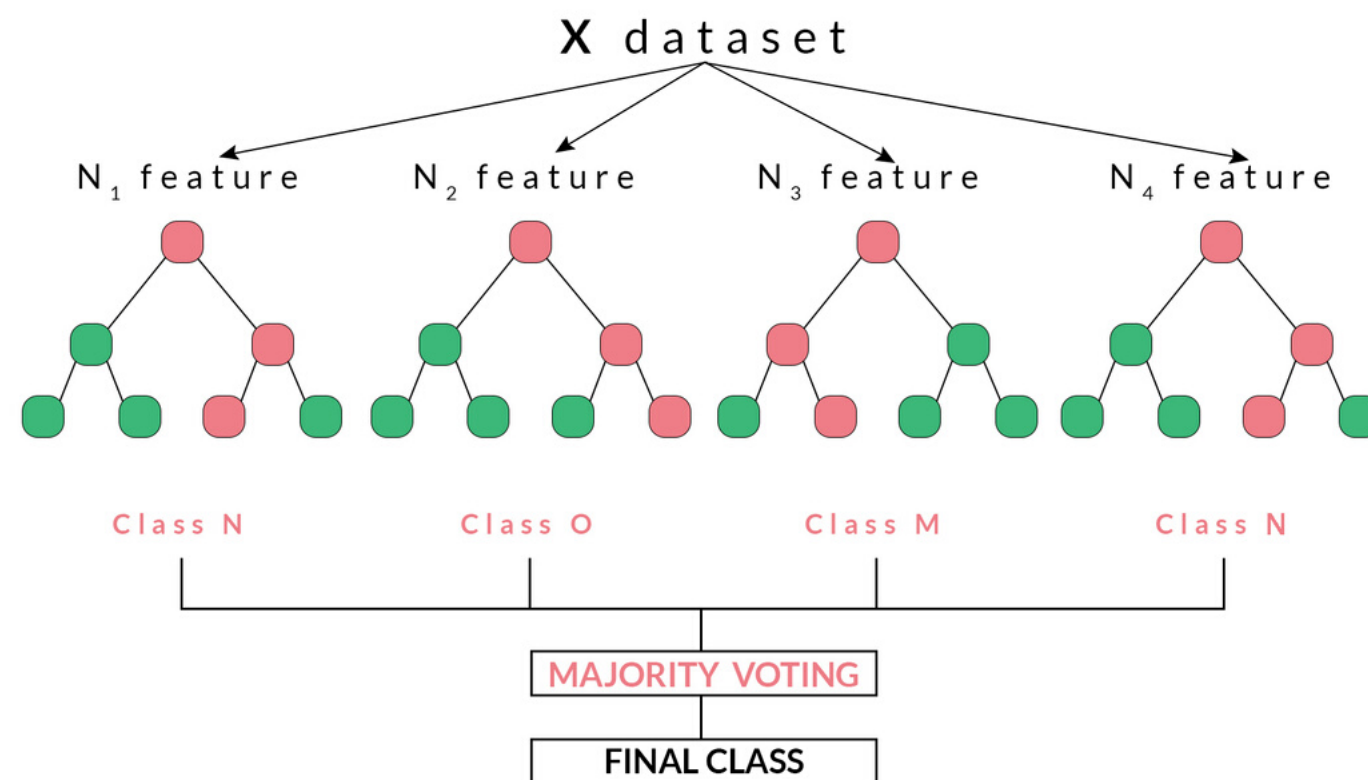
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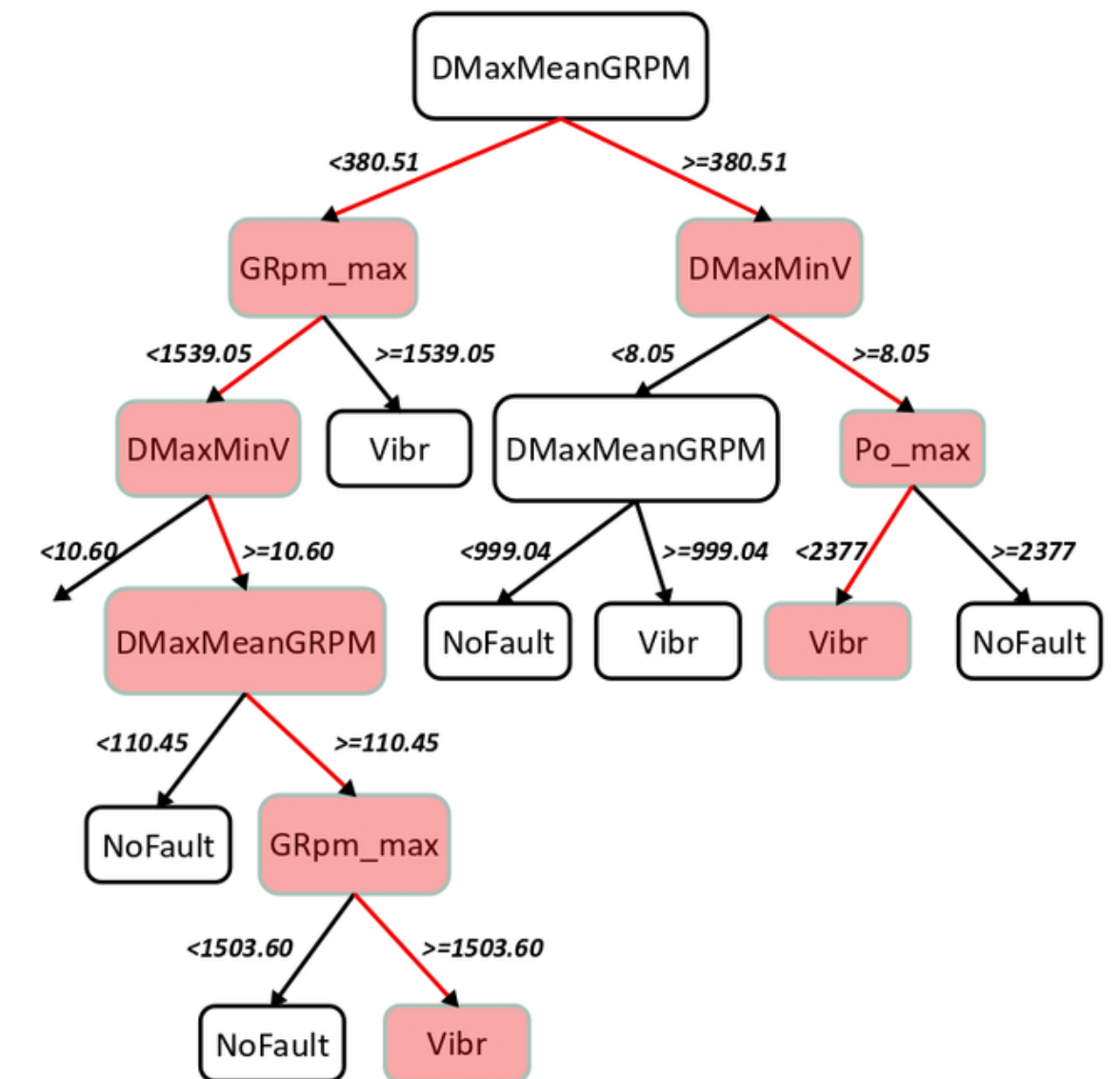


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Predictions



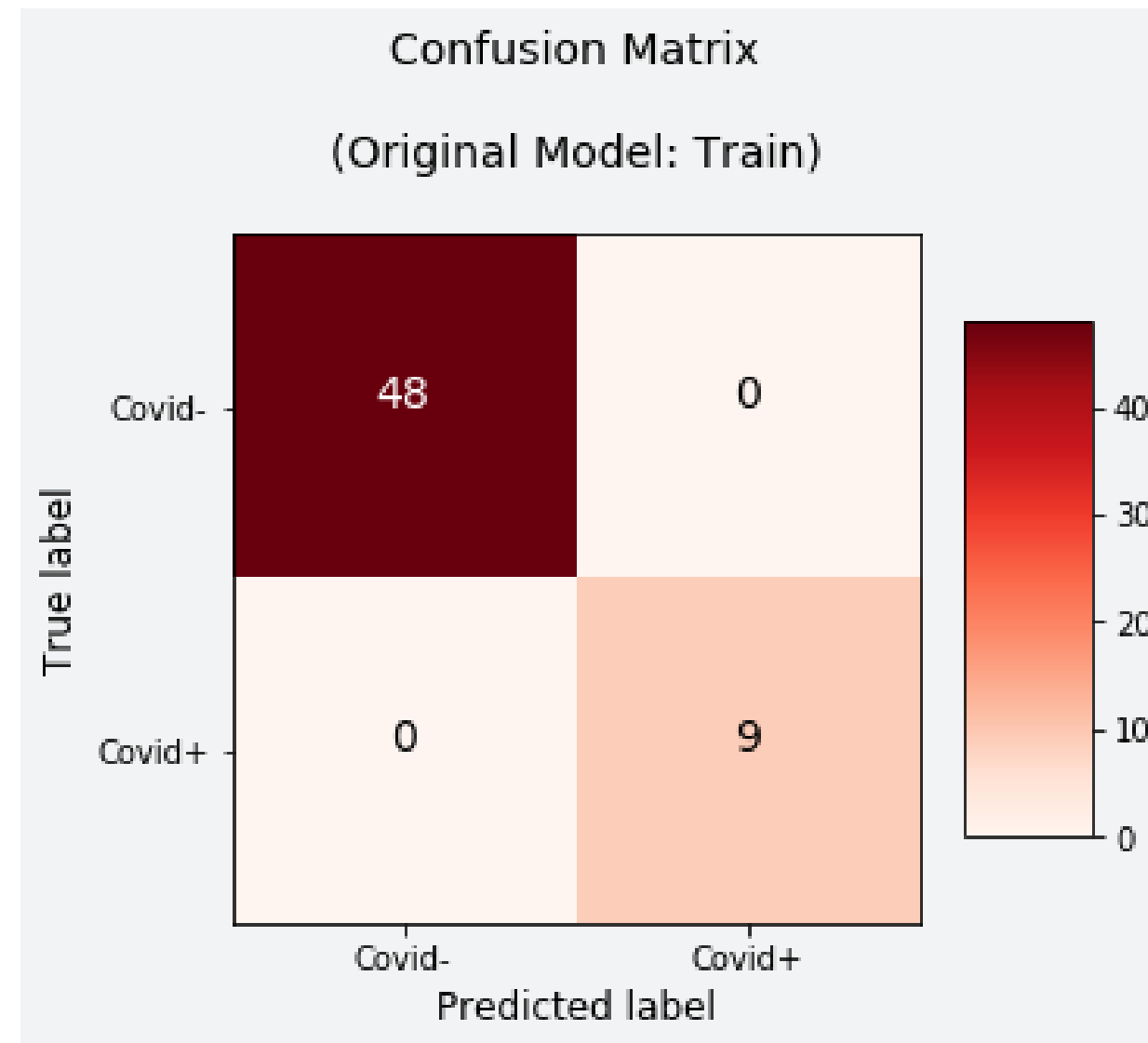
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4) MODEL PERFORMANCE EVALUATION

Accuracy, Precision, Recall, F1 Score, AUC Score, Confusion Matrix

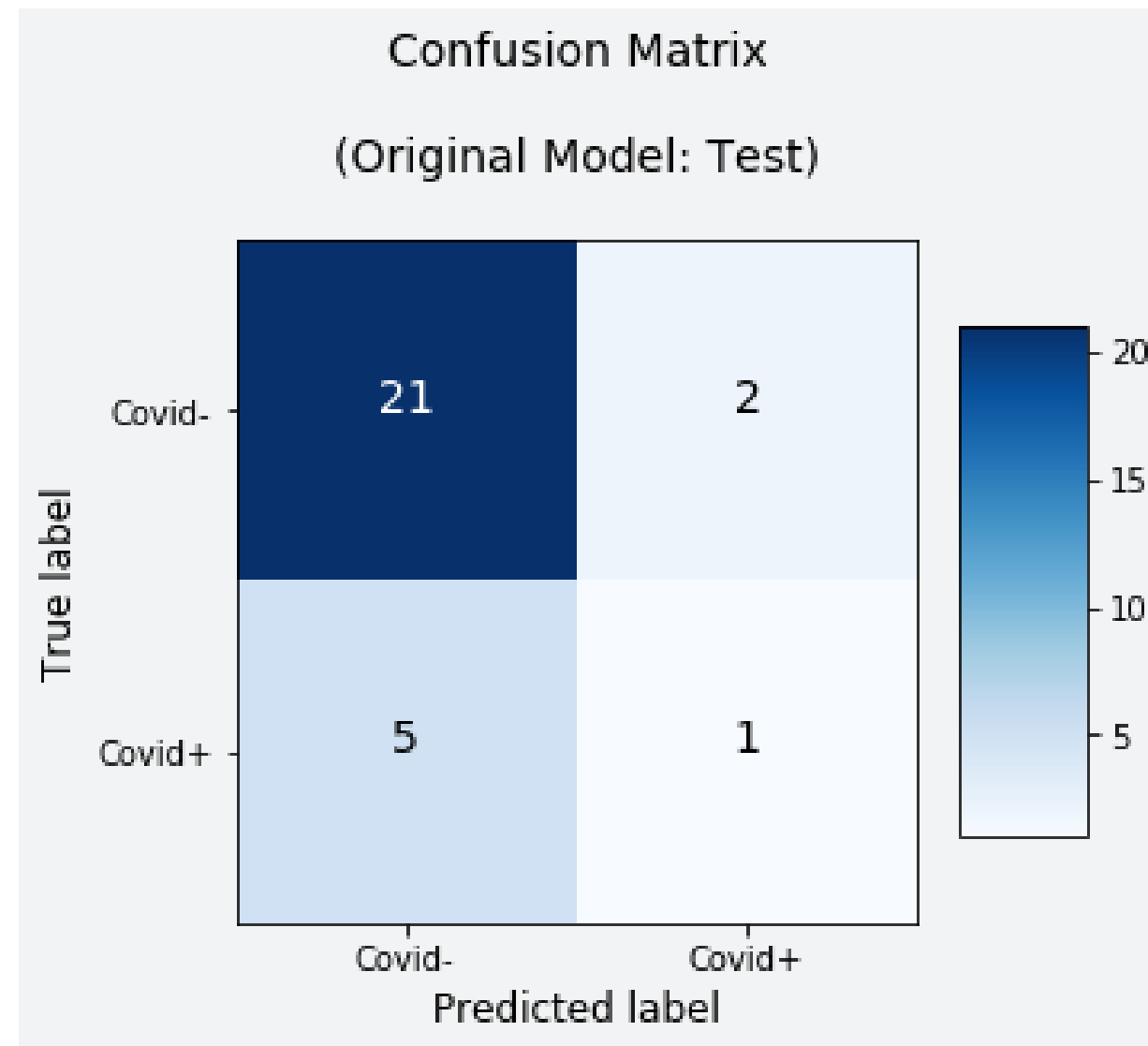


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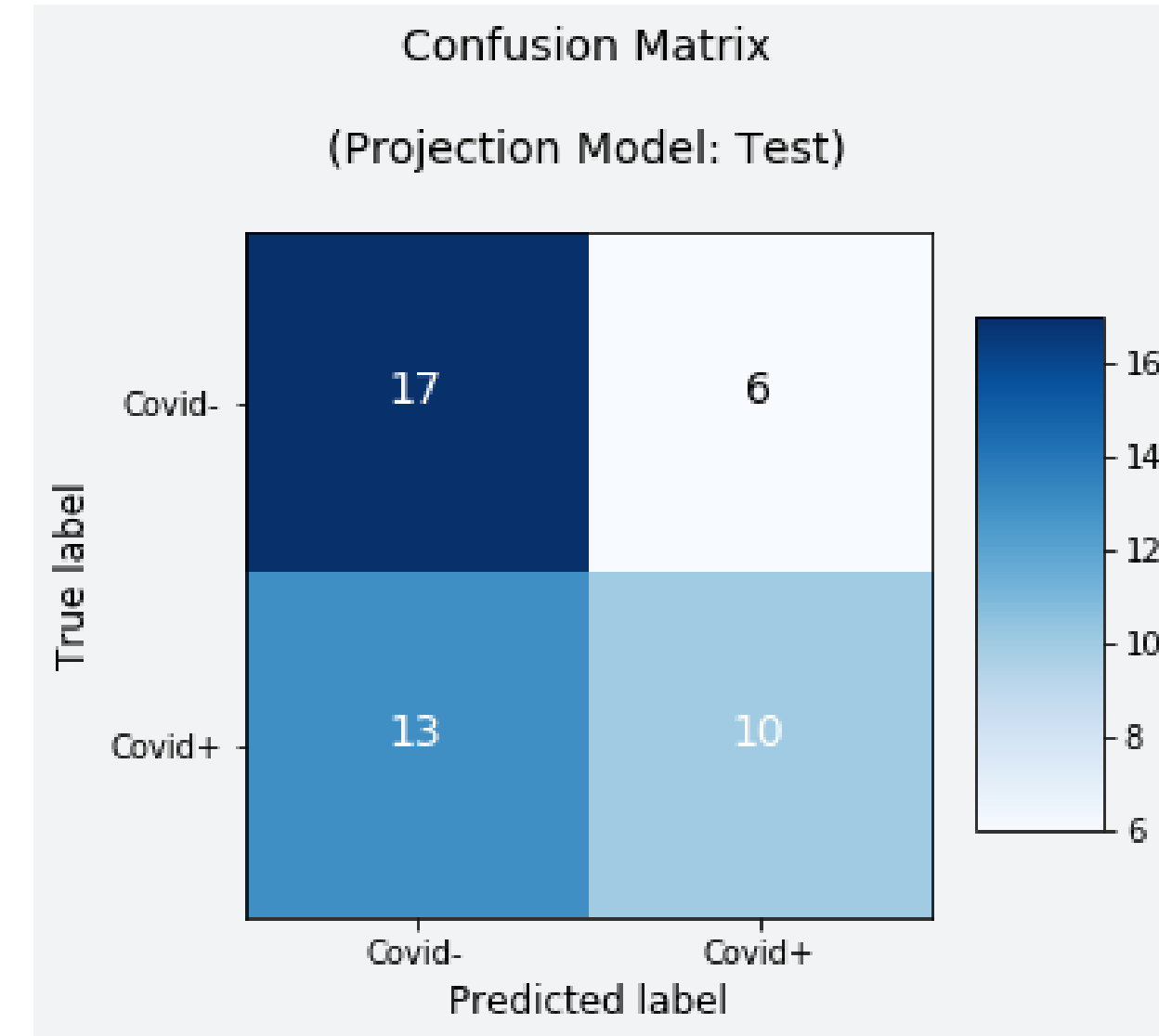
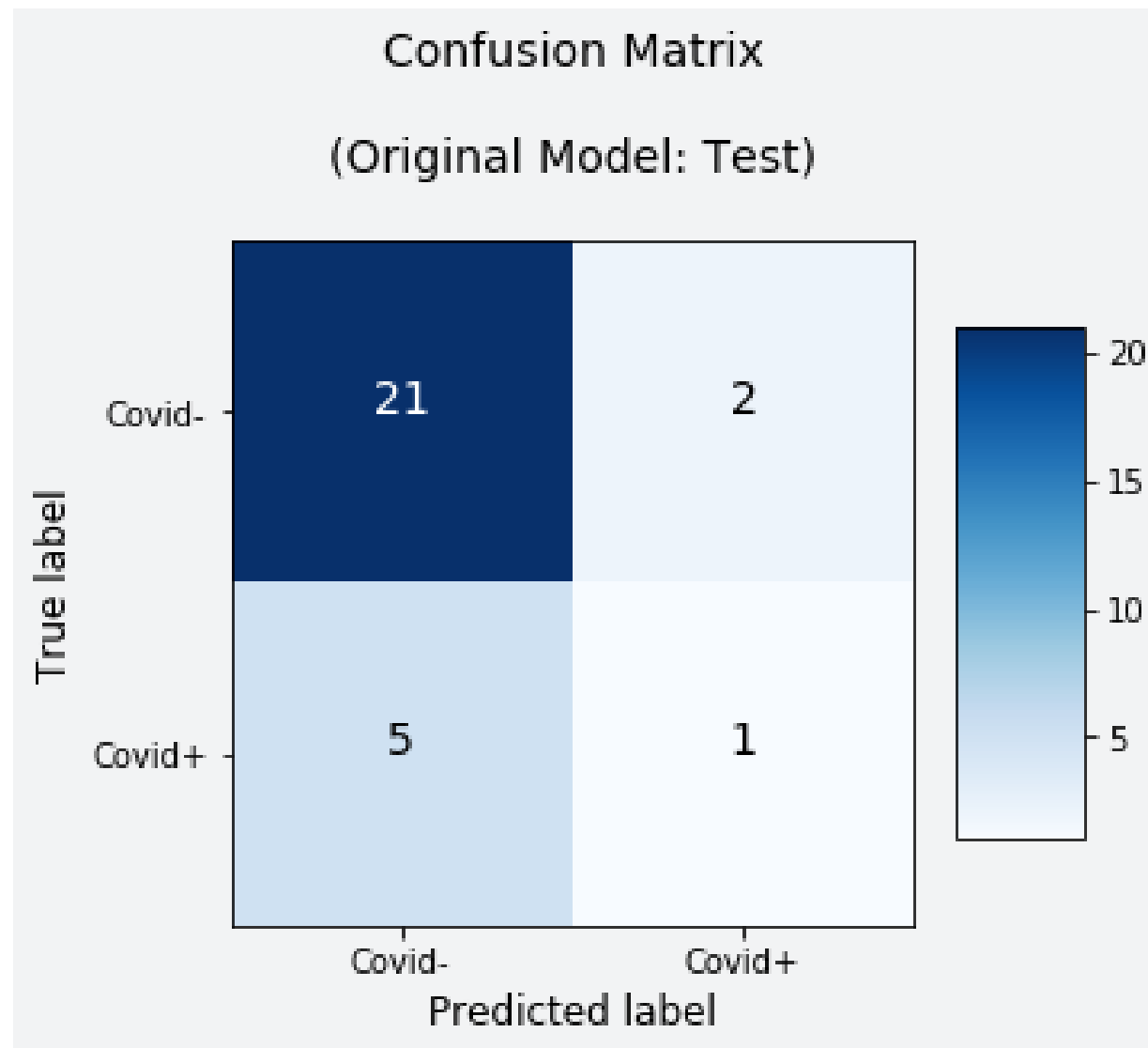
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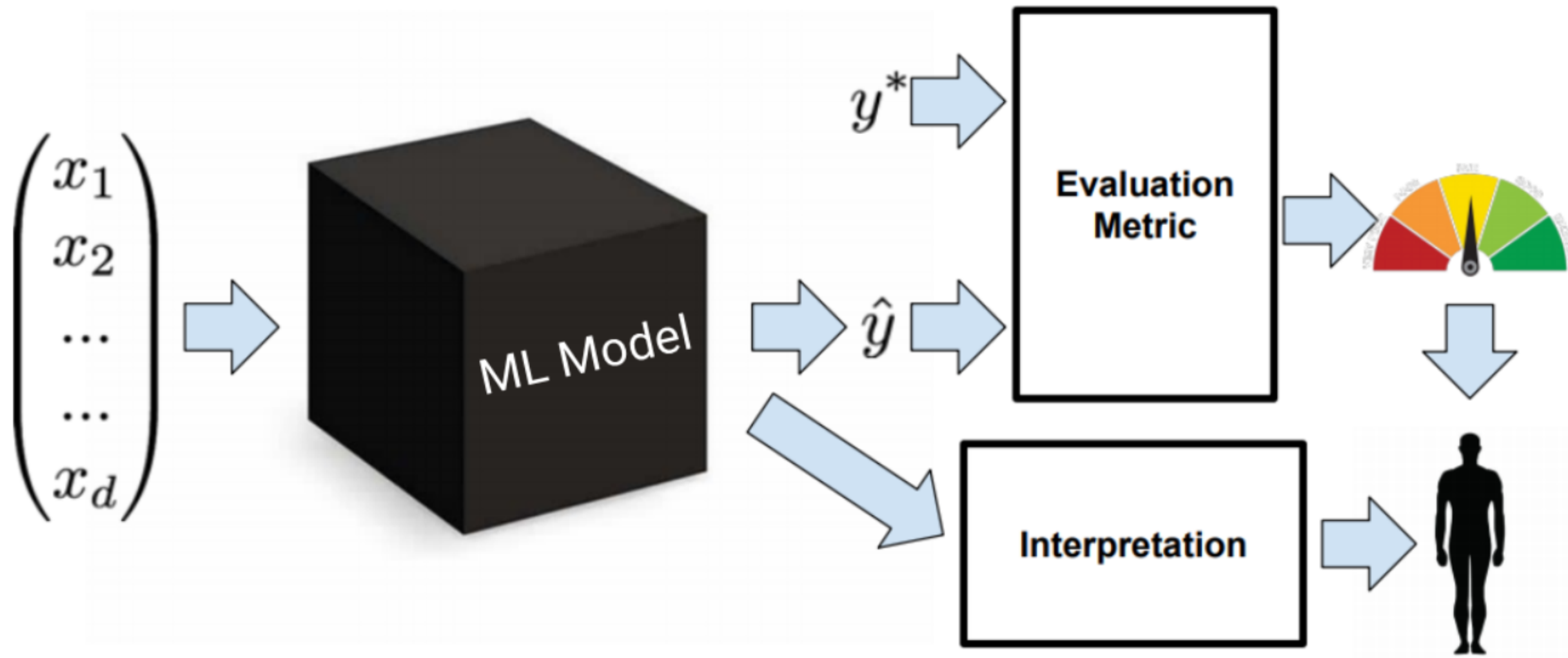
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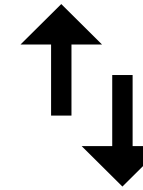


5



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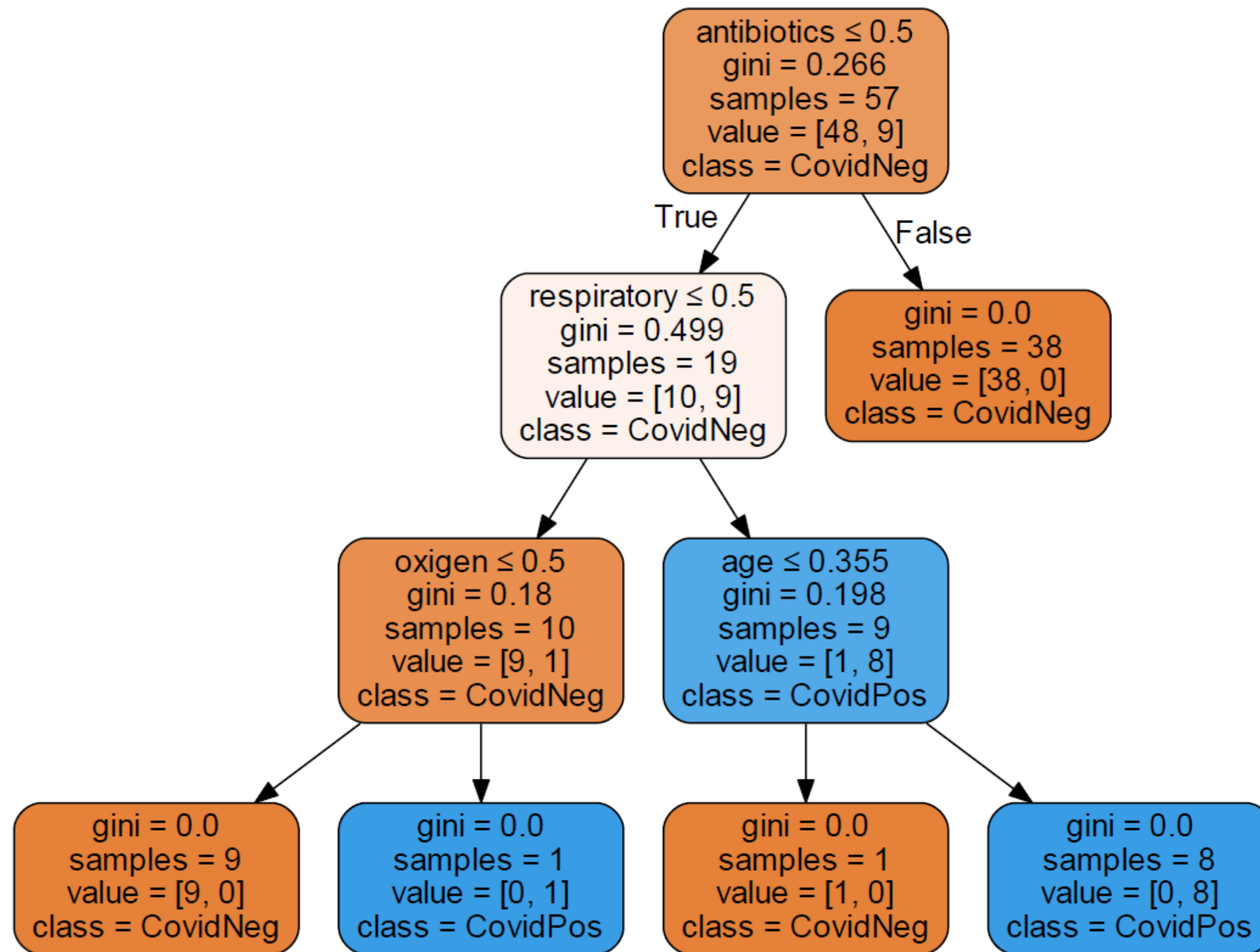
Decision Tree
visualisations



Feature importance
analyses &
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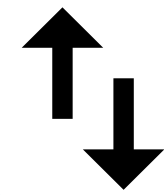
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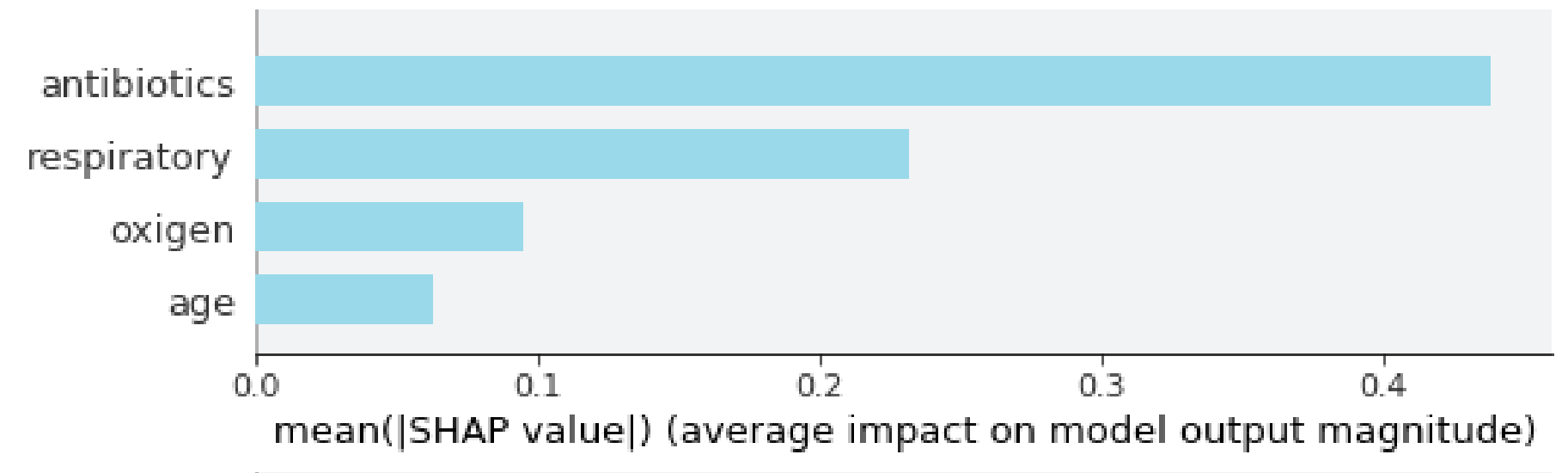
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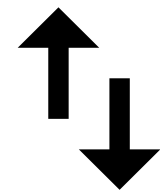


Feature importance
analyses &
visualisations

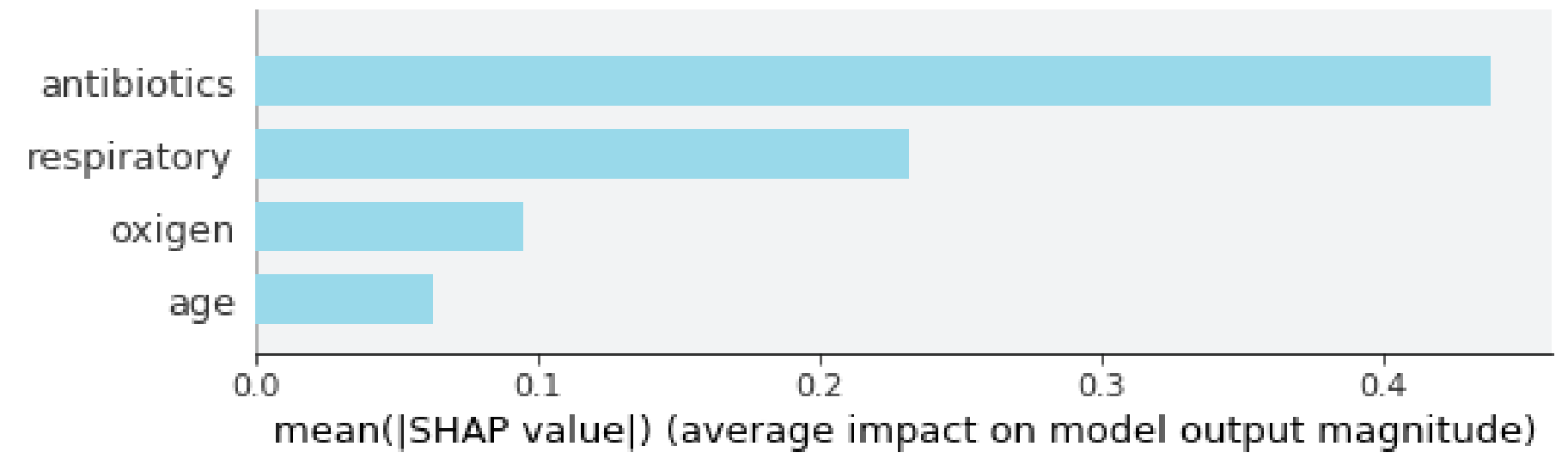


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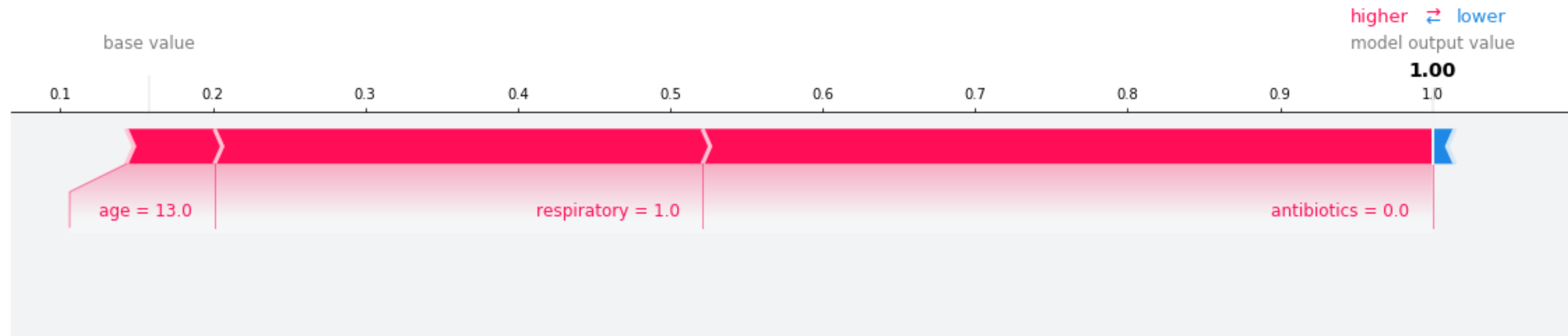
WHAT IS THE DATA TELLING ME?



Feature importance
analyses &
visualisations

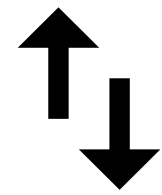


COVID POSITIVE CASE

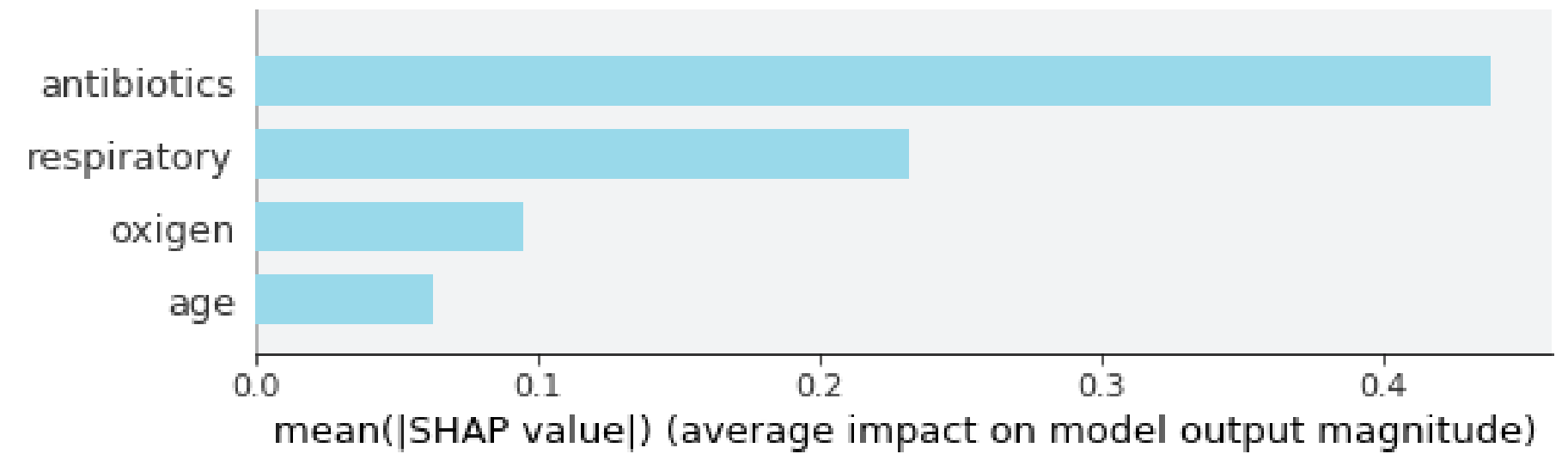


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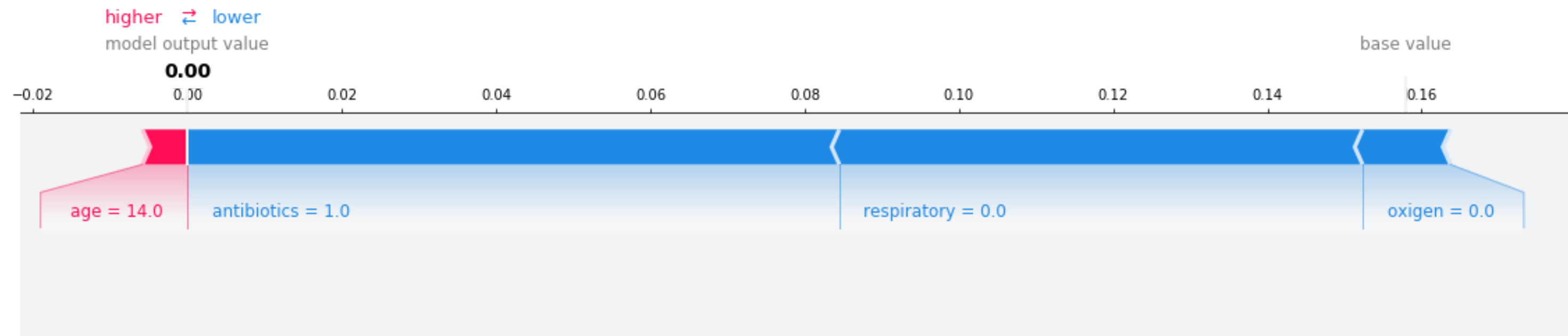
WHAT IS THE DATA TELLING ME?



Feature importance
analyses &
visualisations



COVID NEGATIVE CASE

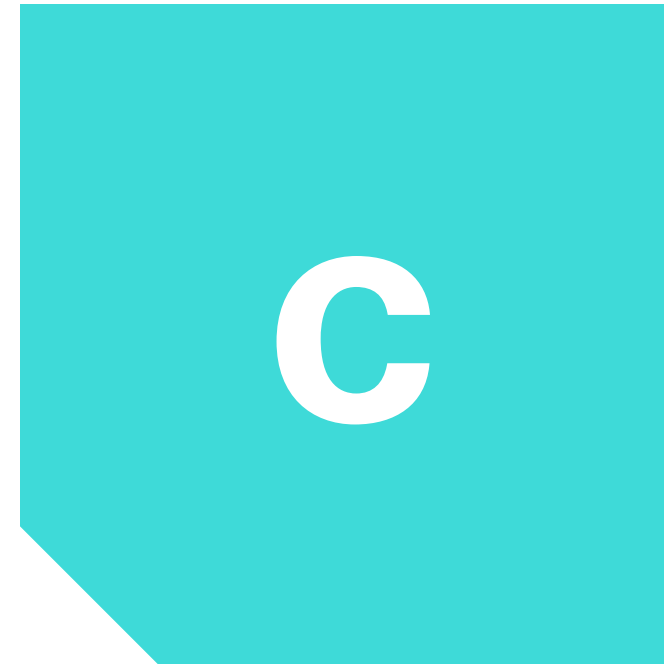




CONCLUSIONS & NEXT STEPS

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- Intricacy and difficulties of real data
- Need to be resourceful and find solutions to data shortcomings
- Promising results despite small sample size
- **Potential of Machine Learning techniques in clinical settings and public health**



CONCLUSIONS

- Intricacy and difficulties of real data
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NEXT STEPS

- **Gather more data!**
- Improve model
- Develop predictive models of paediatric COVID-19 severity
- Get in touch with stakeholders that could make good use of the generated knowledge
- Further projects and collaborations in the area (e.g. *in talks*: develop predictive models of adult COVID-19 diagnosis of a Barcelona GP)

THANKS!

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