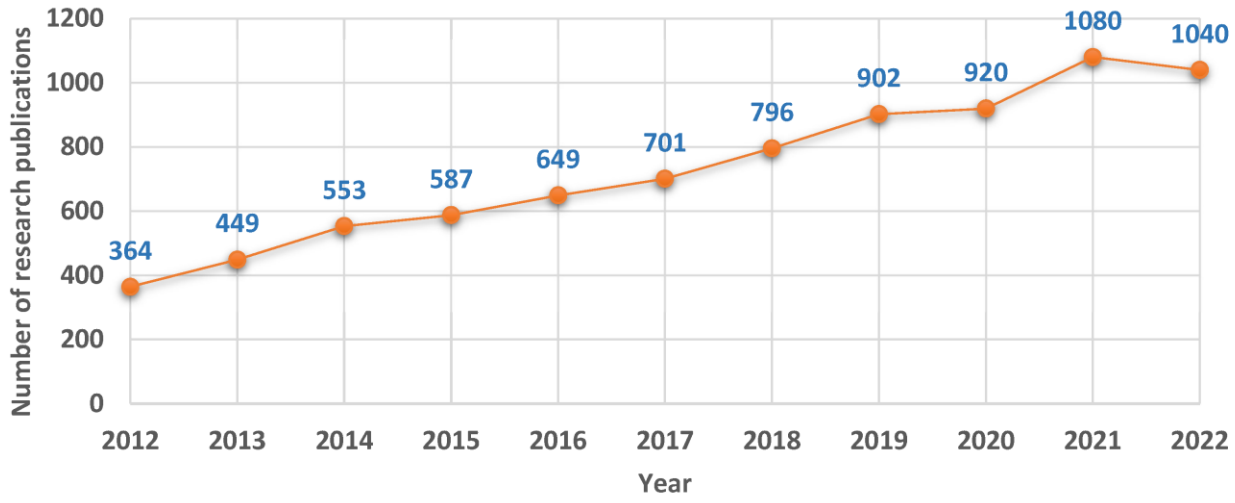
DATA SCIENCE CHALLENGE | ACTIVITY RECOGNITION

Pedro Matias

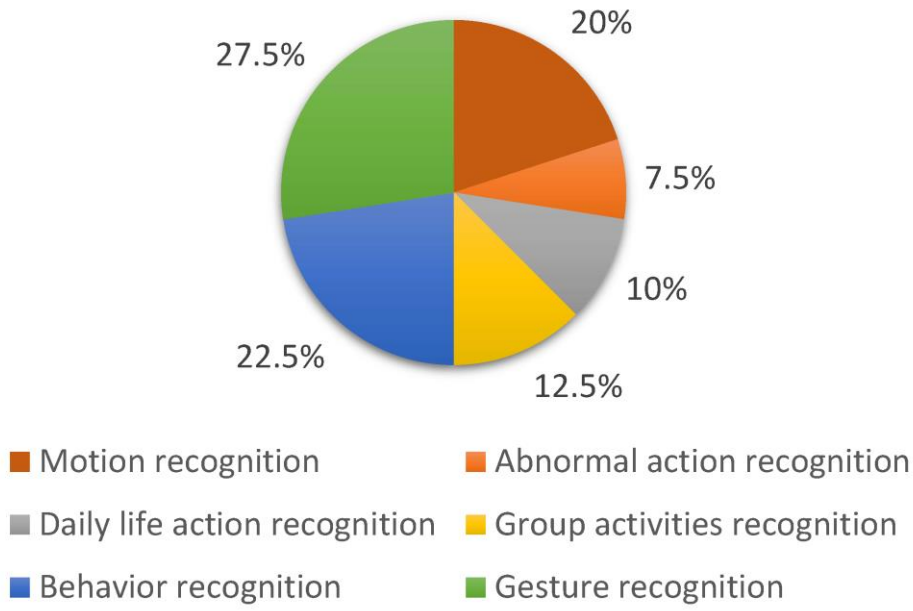
DATA SCIENCE ASSIGNMENT

MOTIVATION

Number of publications over time



Downstream Task



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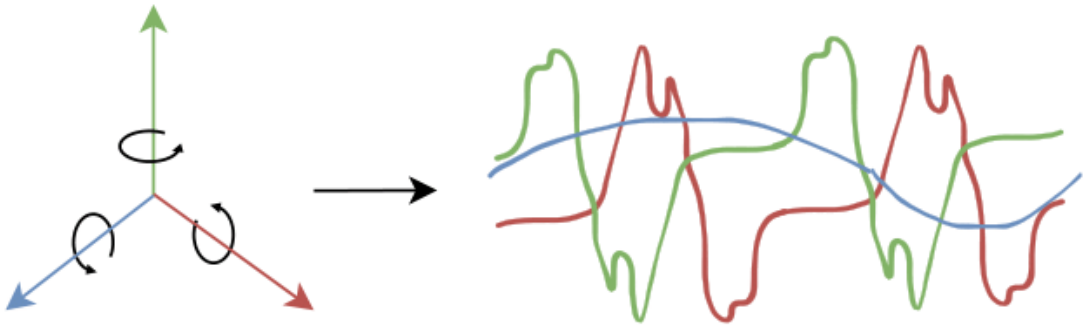
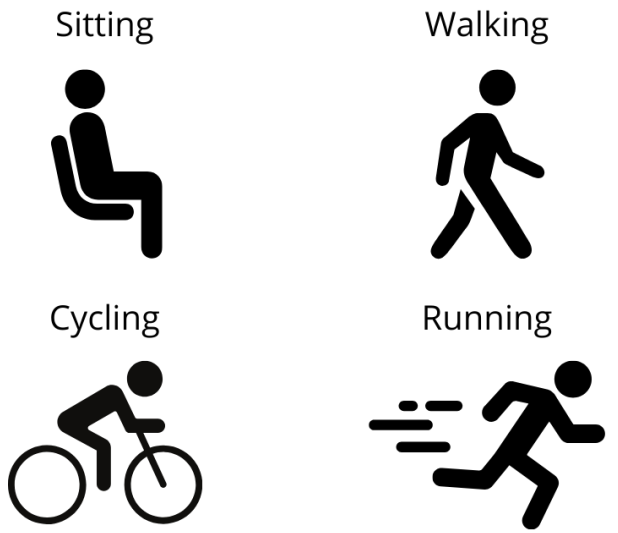
PROBLEM

Accelerometer Data



Target Daily Activities



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DATASET

Characteristics

A. 13 users

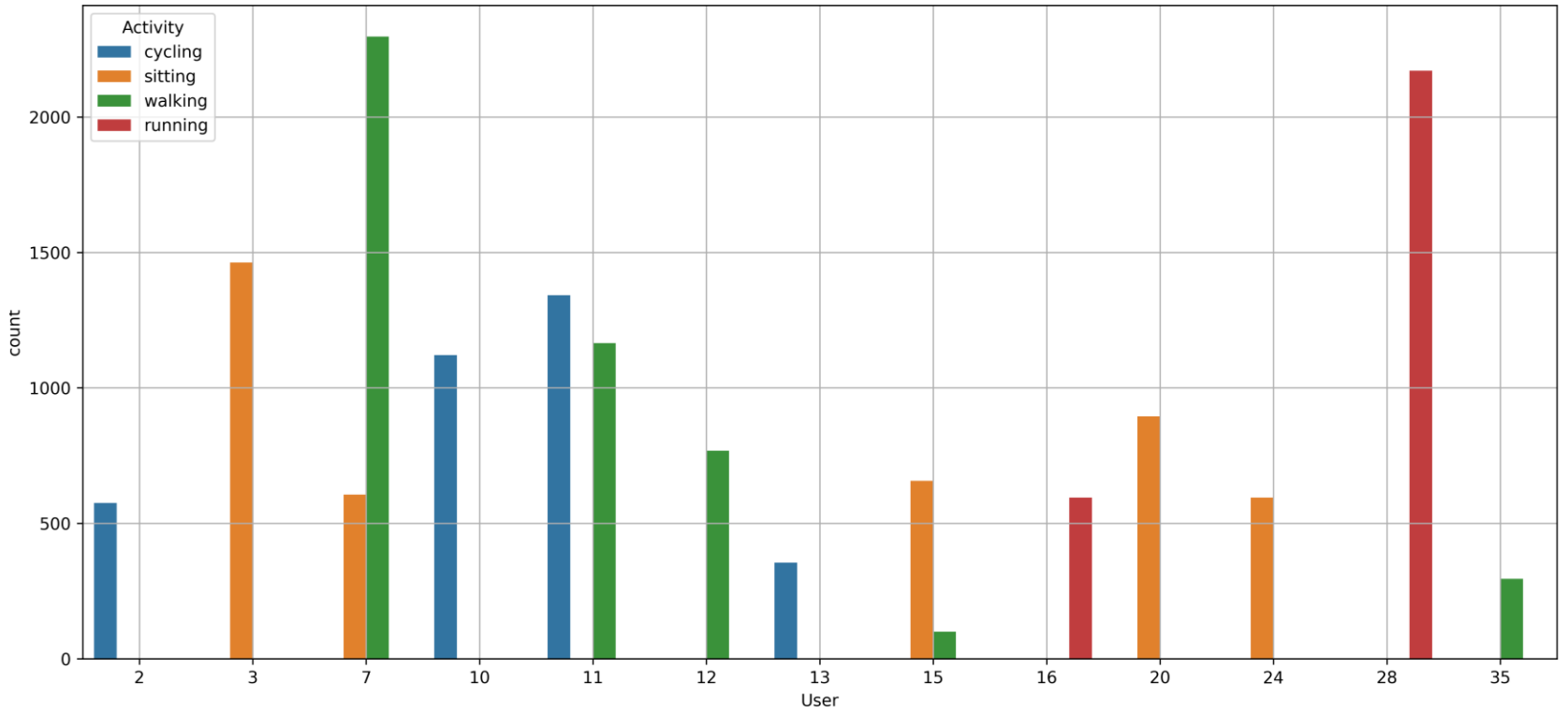
B. 24 sessions

C. 4 human activities

D. 10.7 ± 4.4 min (duration)

E. 15 000 samples

F. 40 features



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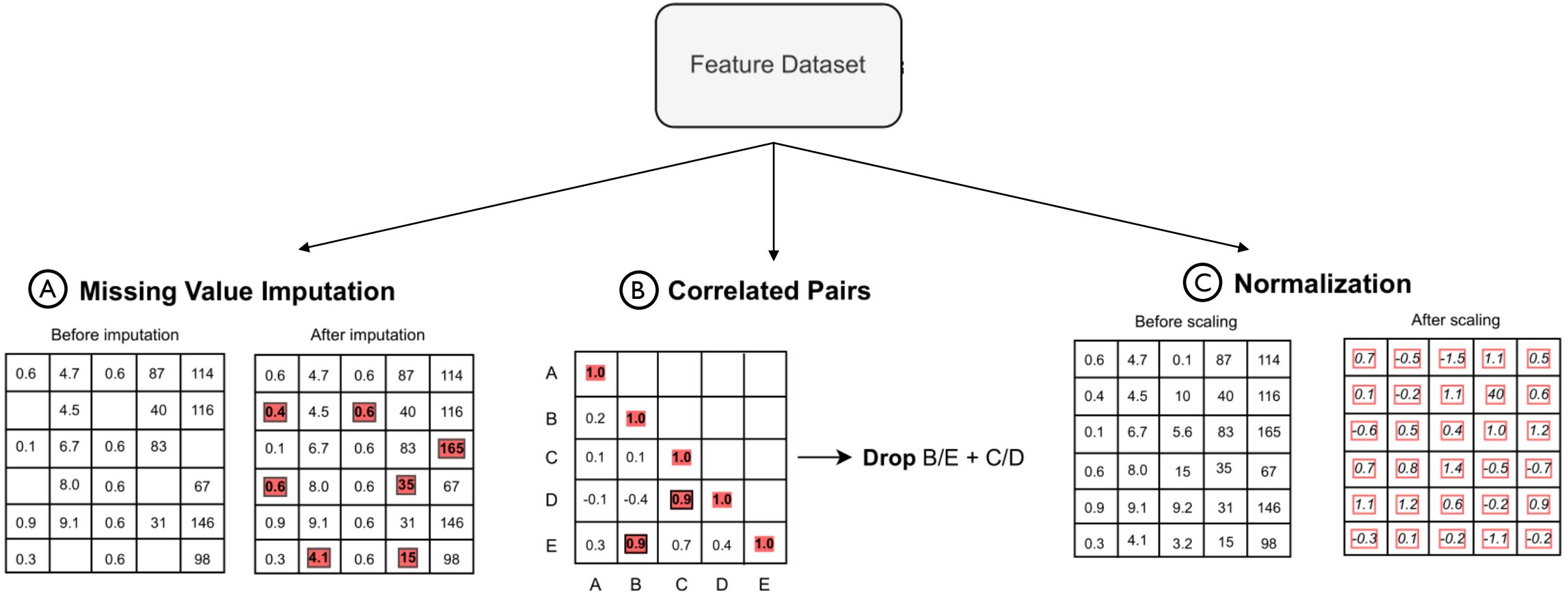
PREPROCESSING PIPELINE



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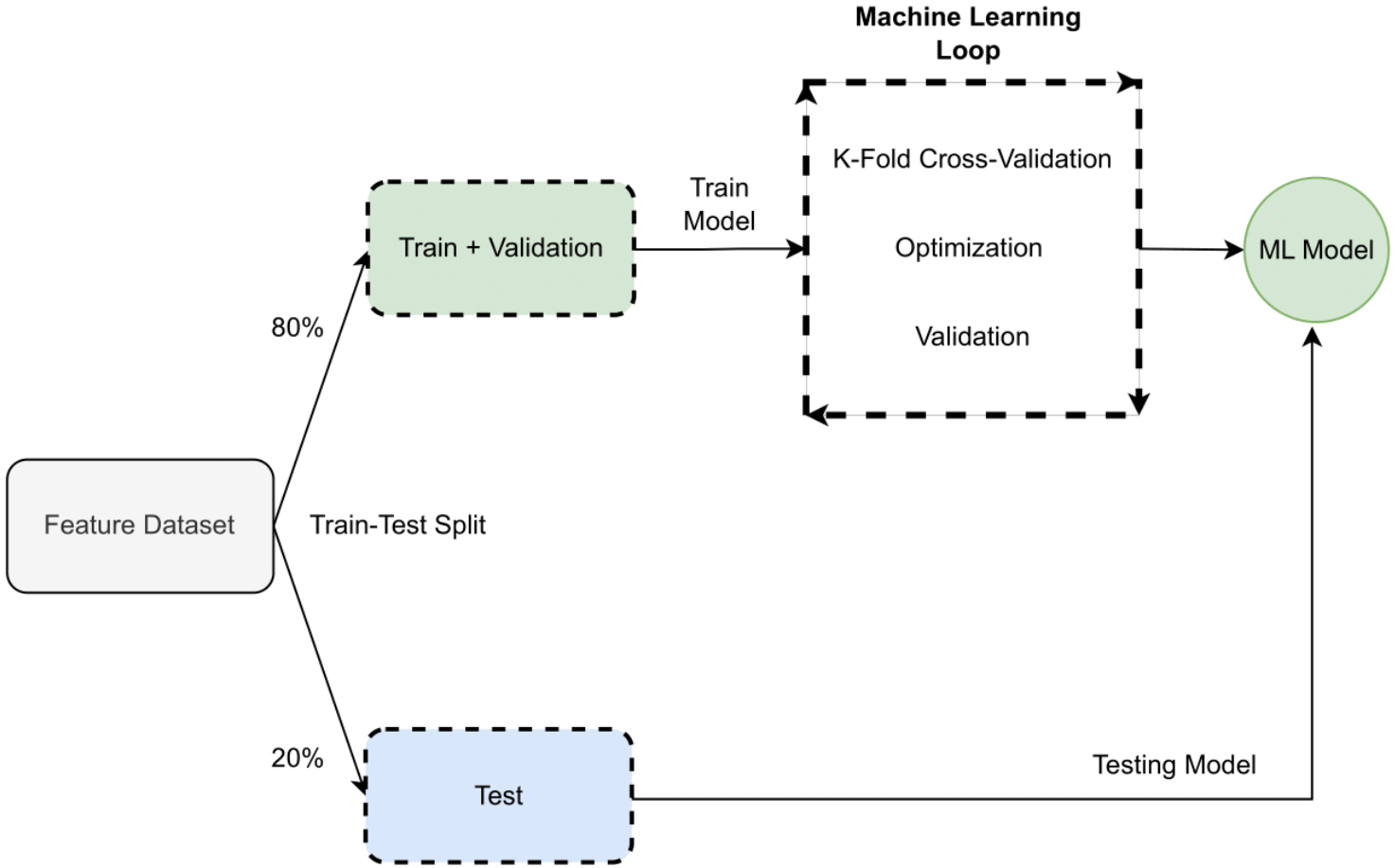
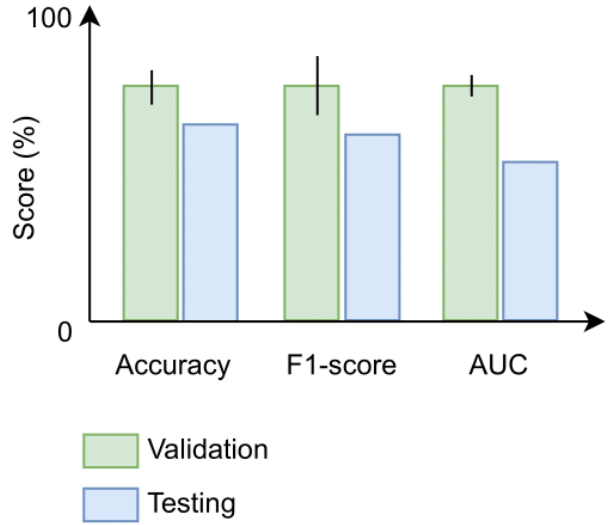
ML PIPELINE





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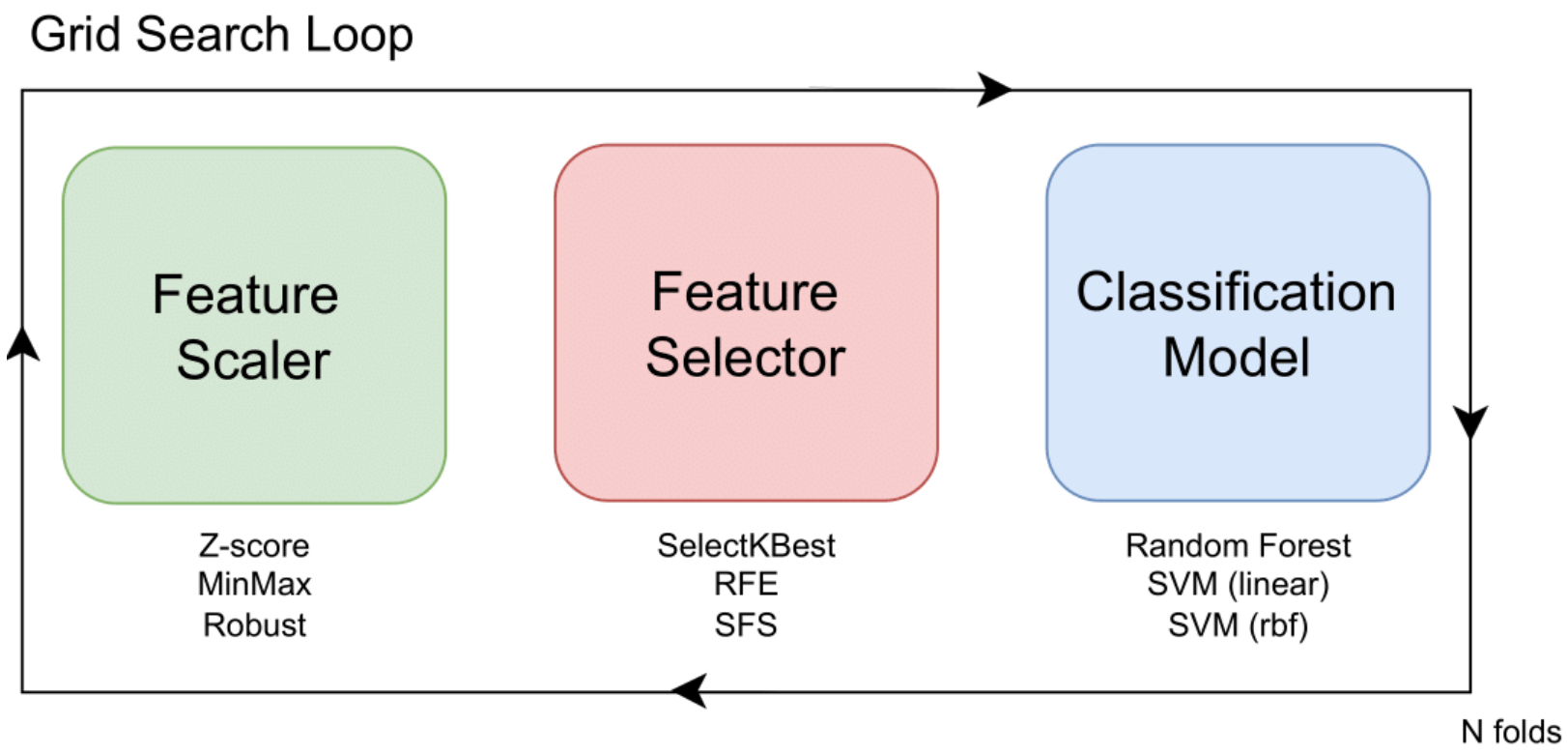
GRID-SEARCH PIPELINE



Notes

5 folds (80/20%)

Split by Session

Optimization by F1-score (macro)

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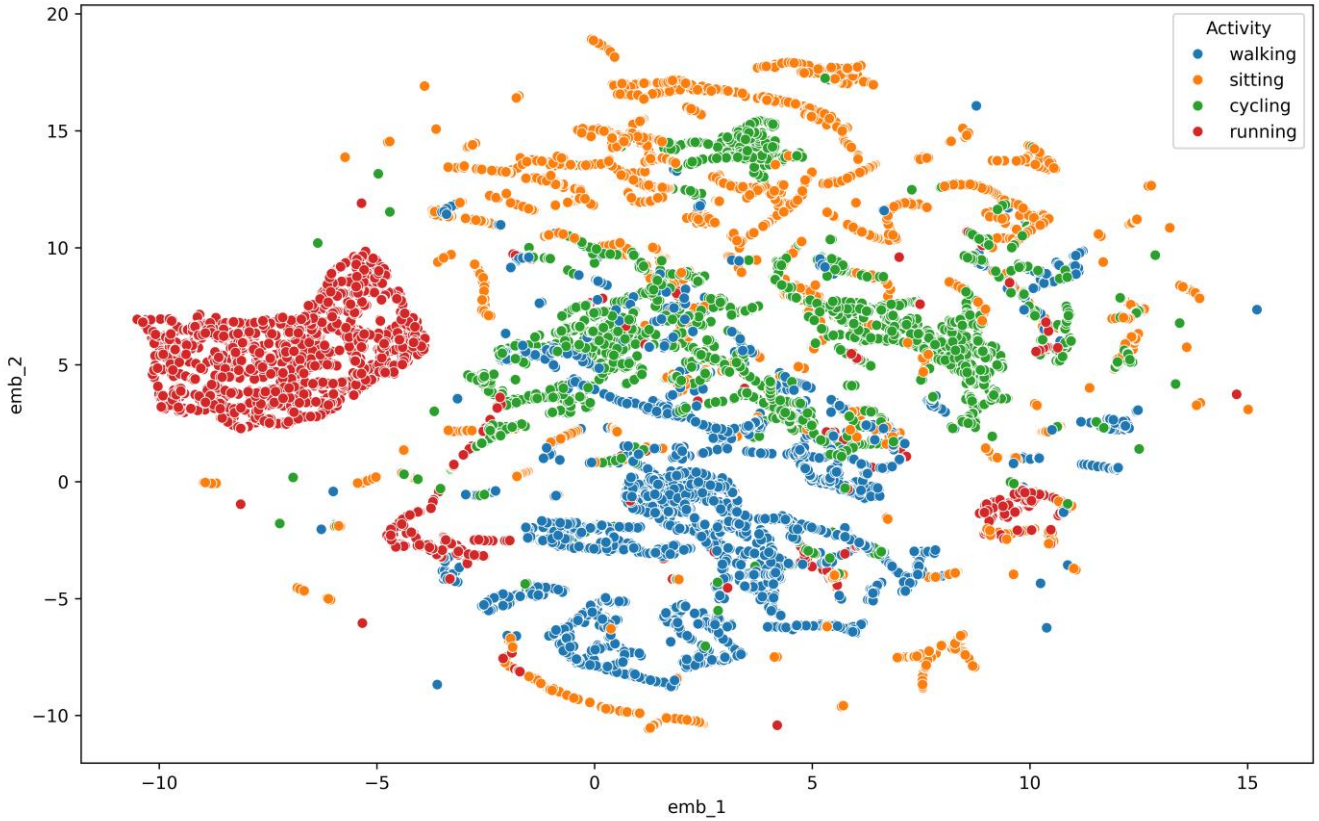
EXPLORATORY DATA ANALYSIS

Normalization + UMAP 2D



Notes

Running potentially easier to identify;

Walking and **Sitting** seem to be distinguishable as well;

Cycling and **Sitting** seem to be more overlapped. Physiological component can play and important role here.

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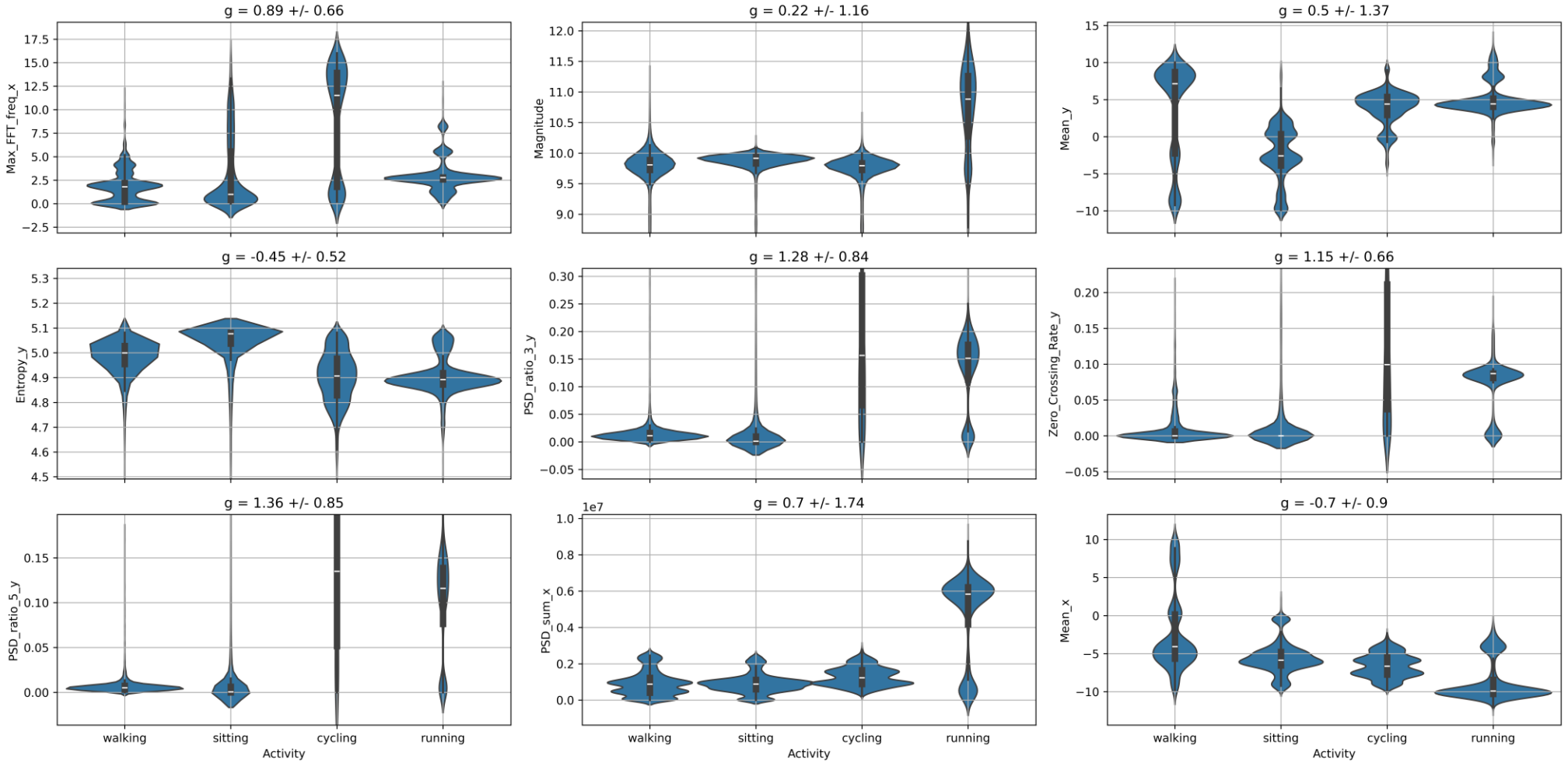
EXPLORATORY DATA ANALYSIS



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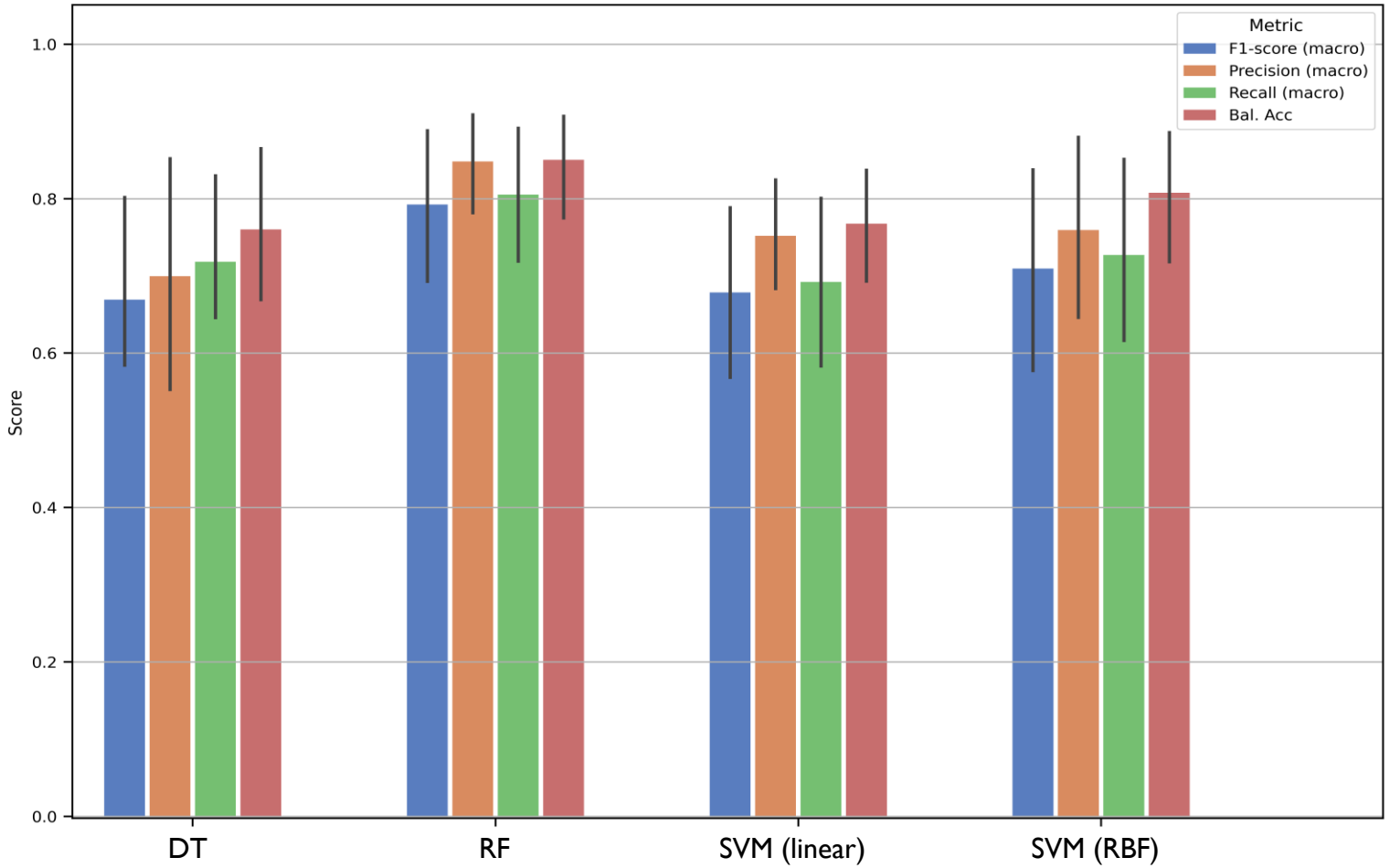
ML CLASSIFICATION RESULTS



Remarks

Random Forest performs better (79.2% ± 12.5% F1-score)

To deploy: model should be trained with all data, and a single external testing set should be used to report.

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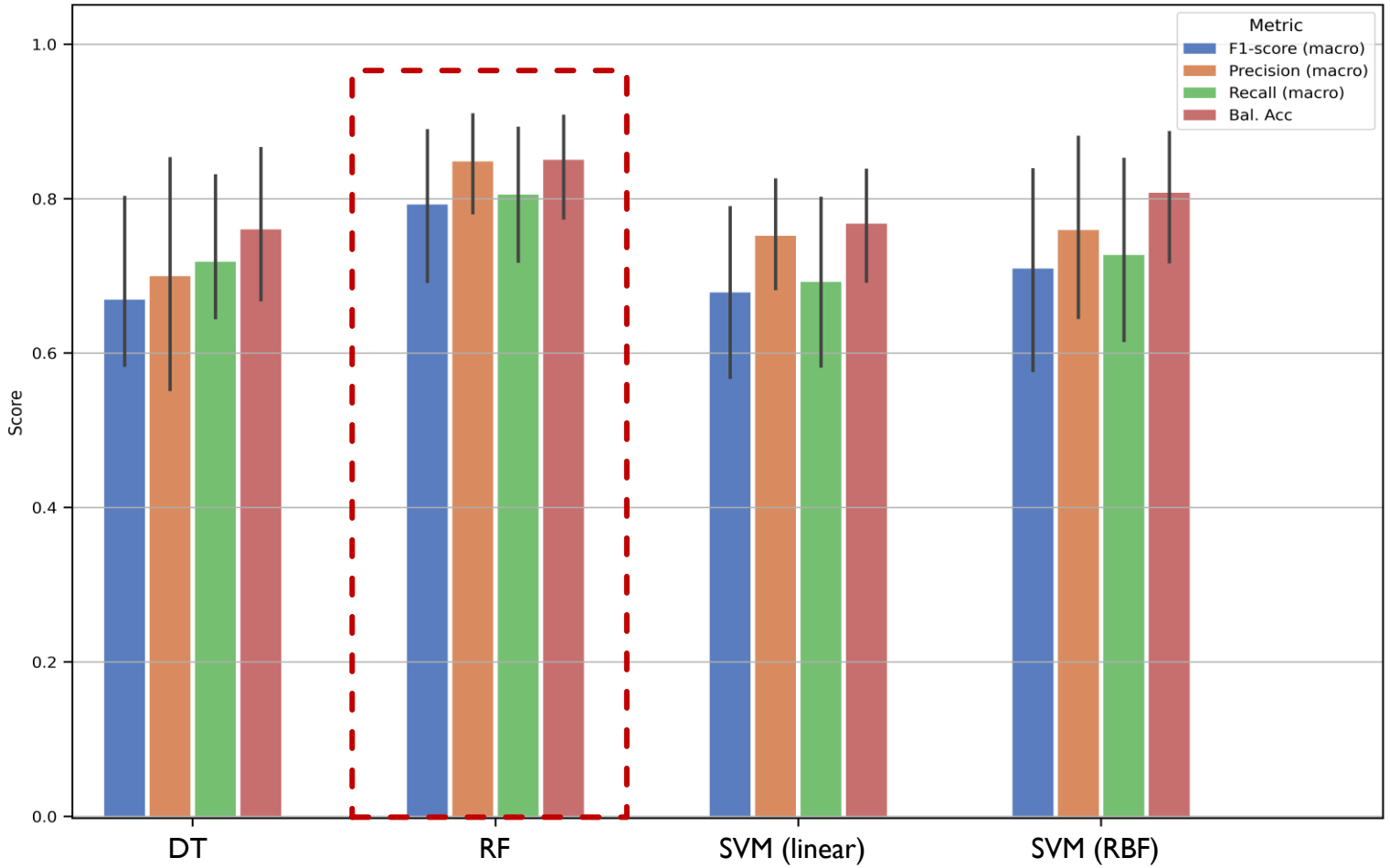
ML CLASSIFICATION RESULTS



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PERFORMANCE IN REAL-WORLD SCENARIOS

- **Performance** of ML models in **free-living** scenarios often **decreases** when compared with validation scores;
- Some **features** are not **position-invariant.** This can affect real-world performances, if new incoming samples are collected with different device orientations;
- **Reporting** model performances **transparently** is crucial when deploying model into the real-world. **Some examples**: female vs male, young vs adult vs elderly, diseased vs healthy, device position, walking style;
- **To improve performance:** opening the context window (post-processing) may help reduce model failures (e.g., classification consistency over N consecutive windows; steps detected in walking windows; intra-user variability may help figure out most likely activities in specific times of day);
- **Other approaches**: **position-invariant** features (e.g., same metrics over signal magnitude), **more activities** (e.g., stand-to-sit/sit-to-stand; jumping; laying; indoors vs outdoors), **ensemble methods** or layered learning (model A to detect activity levels, model B to identify model ensembles), **DL models** (not in real-time but for offline processing).

THANK YOU

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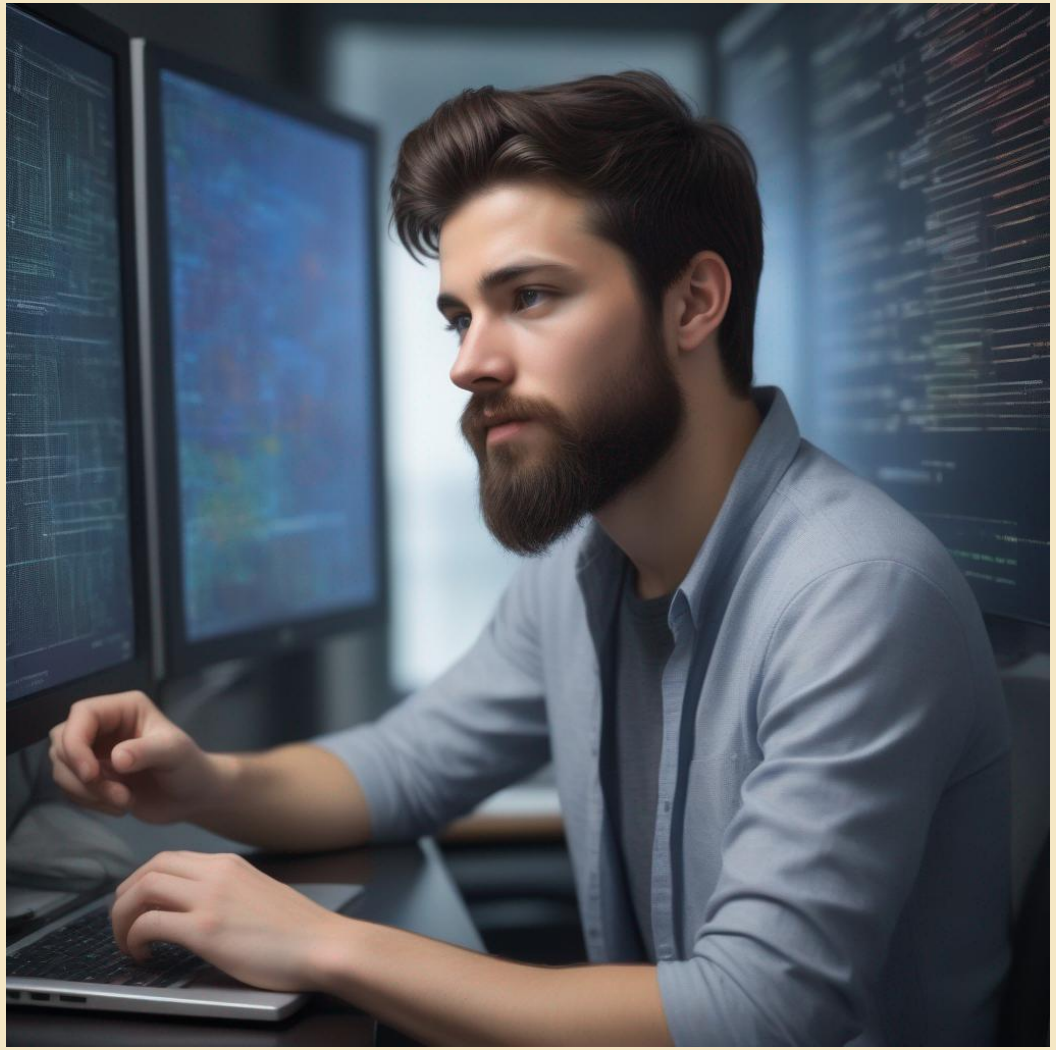

dataautogpt/OpenDalleV1.1