Acoustic Fire Extinguisher

Supervised Learning

IA – Project 2

PROJECT SPECIFICATION

The work to develop is a classification problem related to acoustic fire extinguishers.

It will be supported by machine learning models in order to correctly classify the extinguishing status of fuel flames when subjected to an acoustic fire extinguishers' sound waves.

Results are to be plotted for ease of visualization and comparison.

All the work developed in this project will be supported by Jupyter notebooks.

RELATED WORK

The dataset for this problem can be found in: https://www.kaggle.com/datasets/muratkokludataset/acoustic-extinguisher-fire-dataset

This dataset's data card includes several links related to existing work which aims to solve the same problem, some of which are:

https://www.sciencedirect.com/science/article/pii/S2214157X21007243 (Open Access)
https://www.sciencedirect.com/sdfe/reader/pii/S2214157X21007243/pdf
https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9452168

TOOLS USED

PANDAS

Tabular data manipulation

SCIKITLEARN

AI and machine learning models

MATPLOTLIB/SEABORN

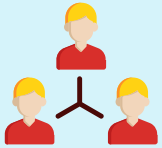
Graphs and data visualization

ALGORITHMS USED

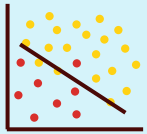
DECISION TREE

RANDOM FOREST

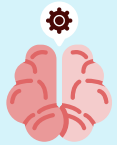
NAIVE BAYES



K-NEAREST NEIGHBORS



SUPPORT VECTOR MACHINE



NEURAL NETWORKS

Data Pre-Processing

- Importance of Data Pre-processing:
  - Data preprocessing is an important aspect of data analysis since it prevents outliers and data that could negatively impact the results from being fed into the training model.
- Steps Taken for Data Pre-processing:
  - Handle missing values: No missing values found.
  - Data type conversion: Fixed data type errors and renamed columns.
  - Categorical variable encoding: Mapped fuel and size categories to numerical values.

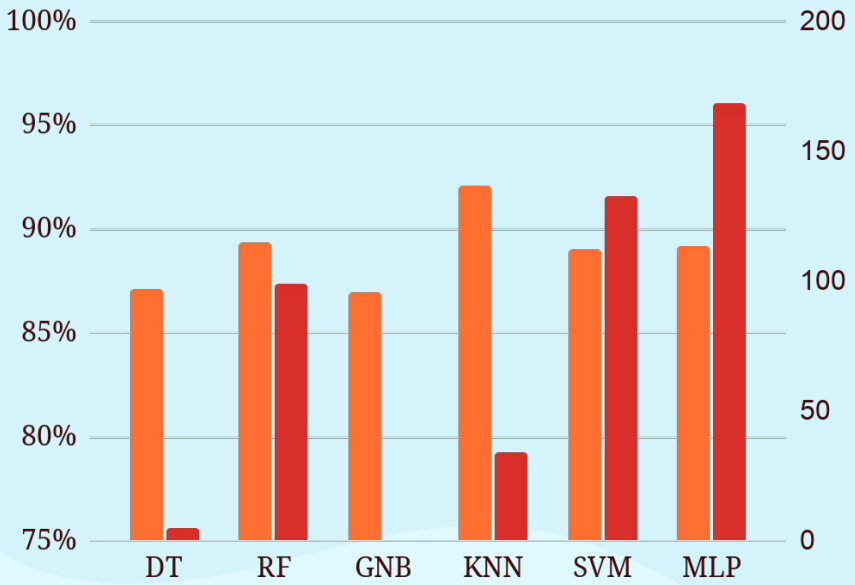
Data Pre-Processing

```
dataset.rename(columns={"DESIBEL": "DECIBEL"}, inplace=True)

dataset["FUEL"] = dataset["FUEL"].map({
    "gasoline": 1,
    "kerosene": 2,
    "thinner": 3,
    "lpg": 4,
})

dataset = dataset.astype({
    "SIZE": "category",
    "FUEL": "category",
    "DISTANCE": "float64",
    "DECIBEL": "float64",
    "AIRFLOW": "float64",
    "FREQUENCY": "float64",
    "STATUS": "bool",
})
```

Developed Models and Evaluation

- Overview of Developed Models:
  - Decision Tree, Random Forest, K-Nearest Neighbors, Support Vector Machine, Neural Network (Multilayer Perceptron).
- Evaluation Metrics:
  - Accuracy, Precision, Recall, F1 measure.
- Model Performance:
  - Decision Tree: Accuracy = 0.8716
  - Random Forest: Accuracy = 0.8940
  - K-Nearest Neighbors: Accuracy = 0.9205

RESULTS



ACCURACY
How effective each model was

RUNTIME (s)
How long each model took to train

Conclusion

- **Future work:** exploration of optimization techniques and more advanced algorithms (Genetic Algorithms, Reinforcement Learning, Simulated Annealing, Particle Swarm Optimization, etc.)
- **Significance:** Demonstrates the effectiveness of machine learning in fire safety systems.
- **K-Nearest Neighbors** had the **most accurate** extinguishing status classification (92.05% accuracy)
- **Other models:** Random Forest (89.40%), Decision Tree, SVM, and Neural Network showed valuable insights.
- **Learnings:** Effective supervised learning relies on data pre-processing, algorithm selection, and evaluation metrics to ensure accurate results and gain insights into model performance.