Ester Melo
emelo@espol.edu.ec
FCSH – LAB FREE

James Peñafiel
jamalpen@espol.edu.ec
FIMCP – LAB FREE

Julio Barzola-Monteses
julio.barzolam@ug.edu.ec
Universidad de Guayaquil

Mayken Espinoza-Andaluz
masespin@espol.edu.ec
FIMCP - CERA

An initial approach about data preprocessing techniques applied to polymer electrolyte fuel cells: A case study

PROBLEM

A polymer electrolyte fuel cell (PEFC) represents a suitable response to the increasing demand for green energy technologies. Currently, the potential use of this tool is weakened by uncertainty about its durability. Therefore, the most recent studies have focused on developing models to diagnose and predict aging parameters in PEFCs. However, a detailed description of the different preprocessing techniques that can be used when analyzing PEFC data to determine and select the most suitable algorithm needs to be included.

GENERAL OBJECTIVE

Provide the pathway to follow when a fuel cell's collected dataset is used to solve a supervised learning problem such as classification and regression.

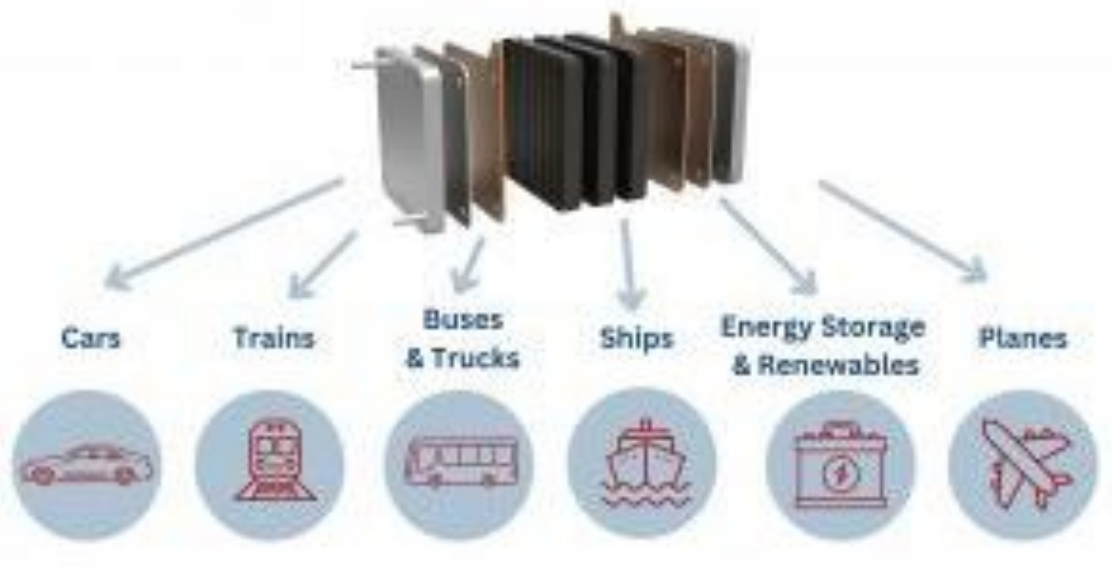

Fig. 1. PEFC's applications

PROPOSAL

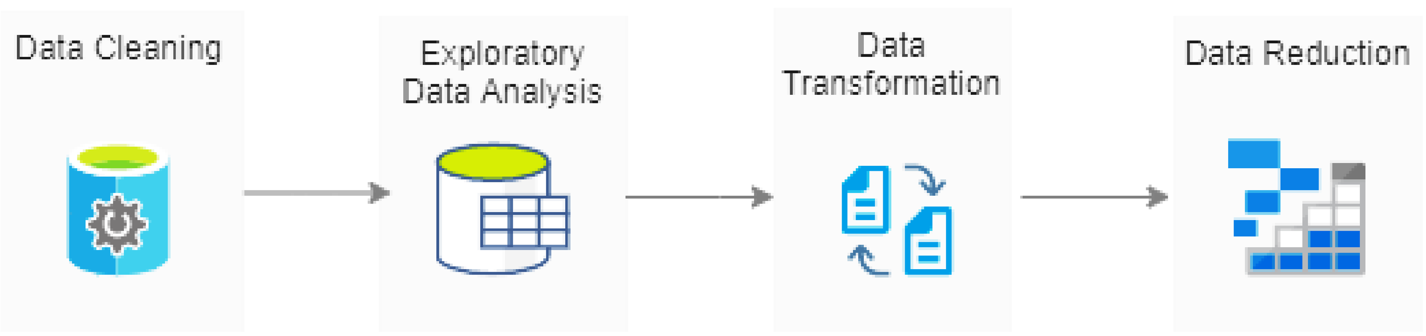

Fig. 2. Stages of data preprocessing applied to PEFC

1. Data cleaning: Missing, noisy, or inconsistent values from 25000 records per state (normal, faulty, or unknown) were analyzed through Python.
2. Exploratory data analysis: Visualizing and extracting the variables' statistics.
3. Data transformation: A new categorical variable named "status" and evaluation data again.
4. Data reduction: The filter method and ANOVA f test.

Assigned name	Description	Unit	Item
Anode out p1	Anode outlet pressure from stack 1	mbar	1
Anode out p2	Anode outlet pressure from stack 2	mbar	2
Cathode out p1	Cathode outlet pressure from stack 1	mbar	3
Cathode out p2	Cathode outlet pressure from stack 2	mbar	4
Current	Current	A	5
Anode react	Anode reactant flow	SLPM	6
Anode in p1	Anode inlet pressure from stack 1	mbar	7
Anode in p2	Anode inlet pressure from stack 2	mbar	8
Cathode air in	Cathode air inlet flow	SLPM	9
Cathode in p1	Cathode inlet pressure from stack 1	mbar	10
Cathode stoi	Cathode stoichiometry	N/A	11
Cathode out t2	Cathode outlet temperature from stack 2	°C	12
Cathode in t2	Cathode inlet temperature from stack 2	°C	13
Cathode out t1	Cathode outlet temperature from stack 1	°C	14
Cathode in t1	Cathode inlet temperature from stack 1	°C	15
Water in p2	Primary water inlet pressure from stack 2	mbar	16
Water in p1	Primary water inlet pressure from stack 1	mbar	17
Water in f2	Primary water inlet flow from stack 2	SLPM	18
Water in f1	Primary water inlet flow from stack 1	SLPM	19
Water in tp	Water inlet temperature	°C	20

Table 1. Recorded measurements from the PEFC database

RESULTS

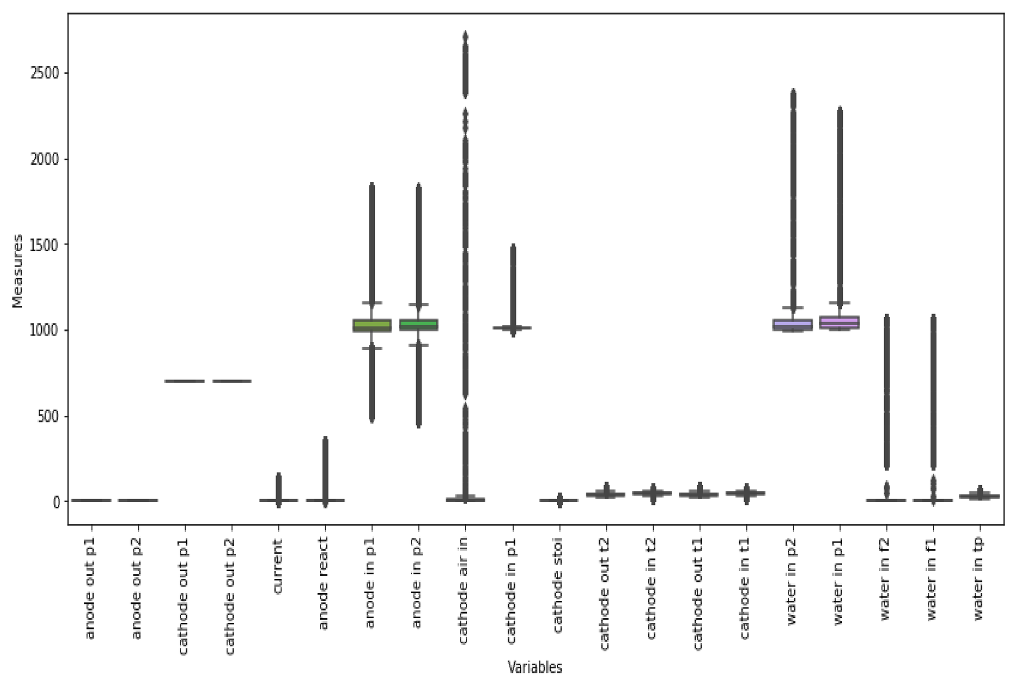

Fig. 3. Data cleaning process from the faulty state data

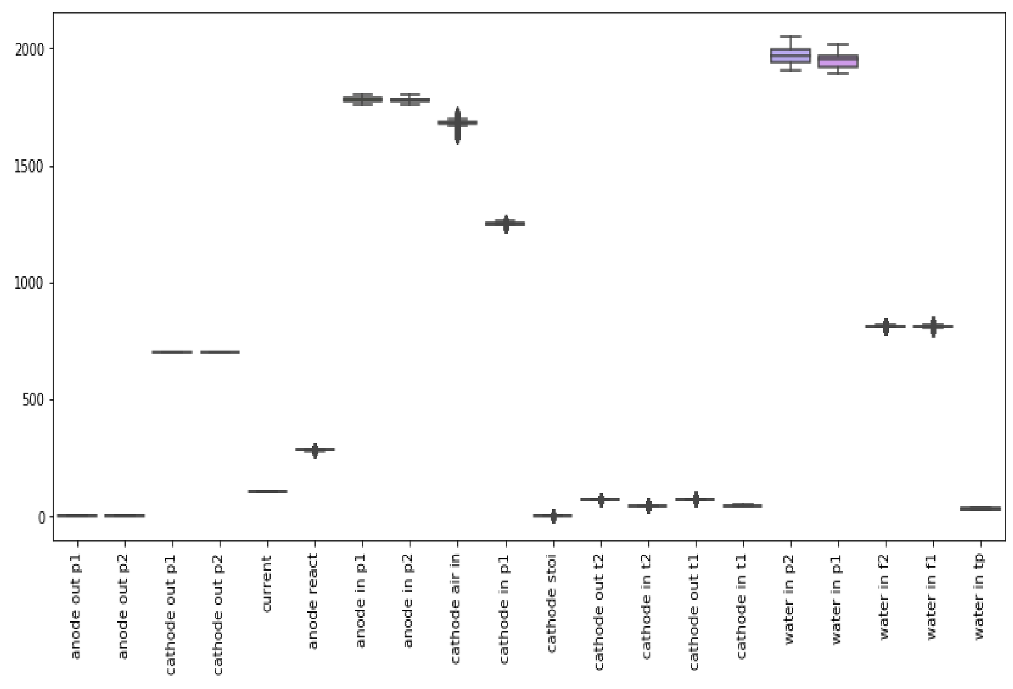

Fig. 4. Data cleaning process from the normal state data

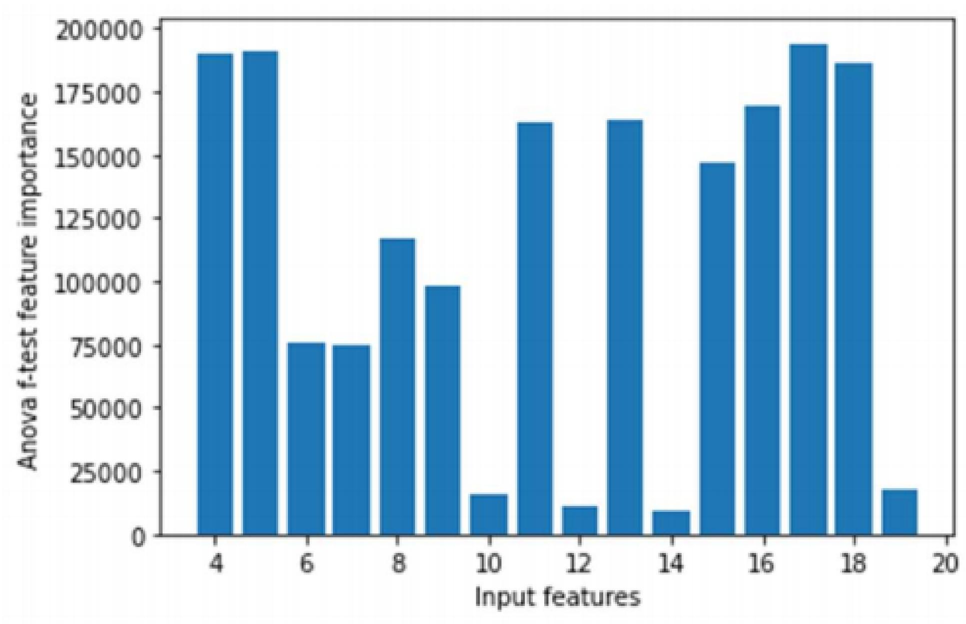

Fig. 5. Feature importance

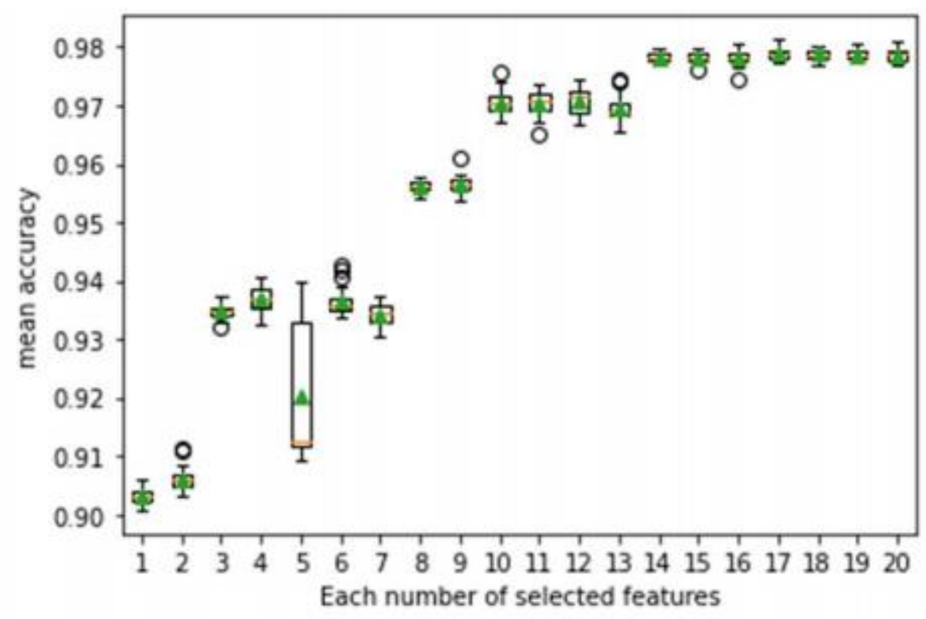

Fig. 6. Classification accuracy for selected features

CONCLUSIONS

- Demonstration of the importance of applying preprocessing techniques to estimate cell status.
- The cell states (normal and failure) do not depend solely on current and voltage.
- Further work is focused on applying ML algorithms in PEFC technologies.

ACKNOWLEDGMENTS

- The authors acknowledge the financial support of the FIMCP-33-2022 project. The physical and computational resources provided by ESPOL are also appreciated. The support from the Dean of Research for Research Assistantships is an important part in the development of this project.