Short-Term Electricity Load Forecasting using Deep Neural Networks

P. Rodrigues I. Serro P. Cavalheiro

Faculdade de Ciências e Tecnologia, Universidade do Algarve

May 5, 2023

Overview

Introduction

Experimental and Computational Analysis
- Data Processing
- Model Architecture
- Training Algorithms

Results

Introduction

- Uncertainty in energy supply and demand can cause grid stability issues
- Accurate electricity load demand (ELD) prediction is crucial for efficient decision-making
- Deep neural networks are well-suited for ELD forecasting due to their ability to learn patterns and extract features
- This study presents a multi-layer perceptron model (MLP) for short-term ELD forecasting

Data Processing

- Dataset: 180 days of electricity consumption in Portugal
- Split: 60% training, 20% validation, and 20% testing
- Data normalization between 0 and 1

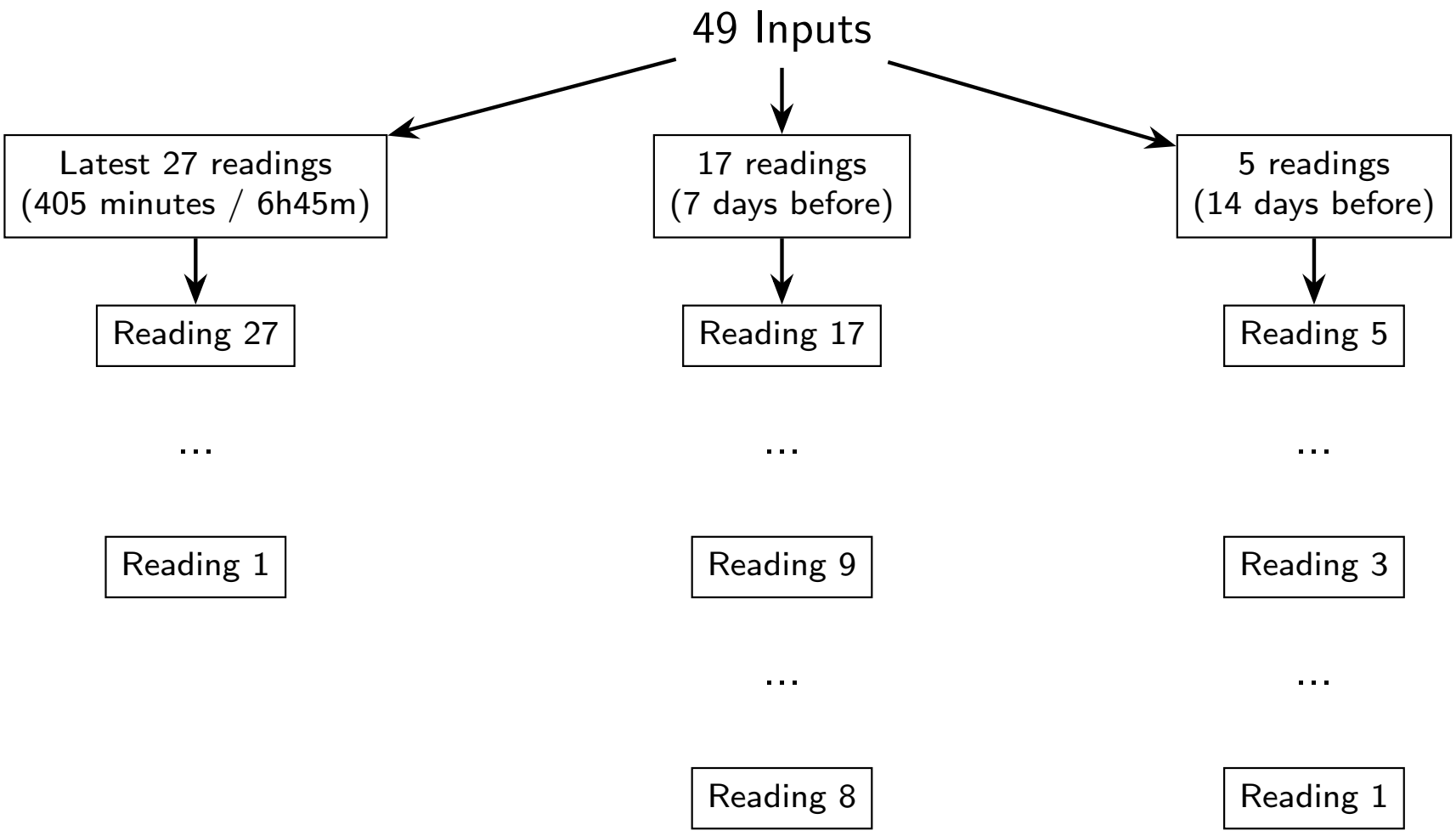
Normalization function:

$$\frac{x_i - \mu}{\sigma}$$

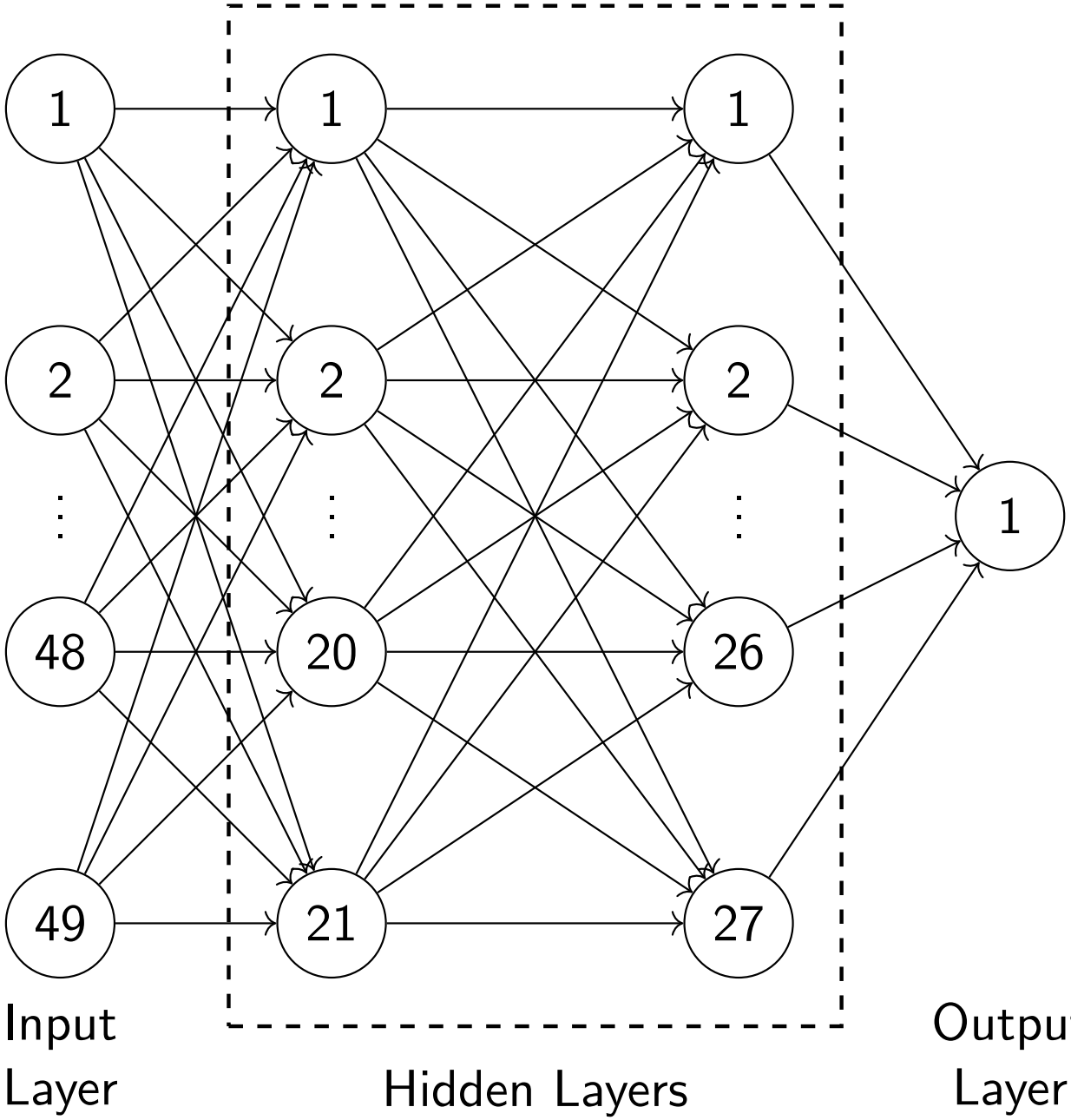
Model Architecture

- Multi-layer perceptron model (MLP) used for forecasting
- Input layer: 49 neurons
- Hidden layers: Randomly searched from 1 to 3
- Hidden layer size: Randomly searched from 1 to 170
- Output layer: 1 neuron

Model Architecture



Model Architecture



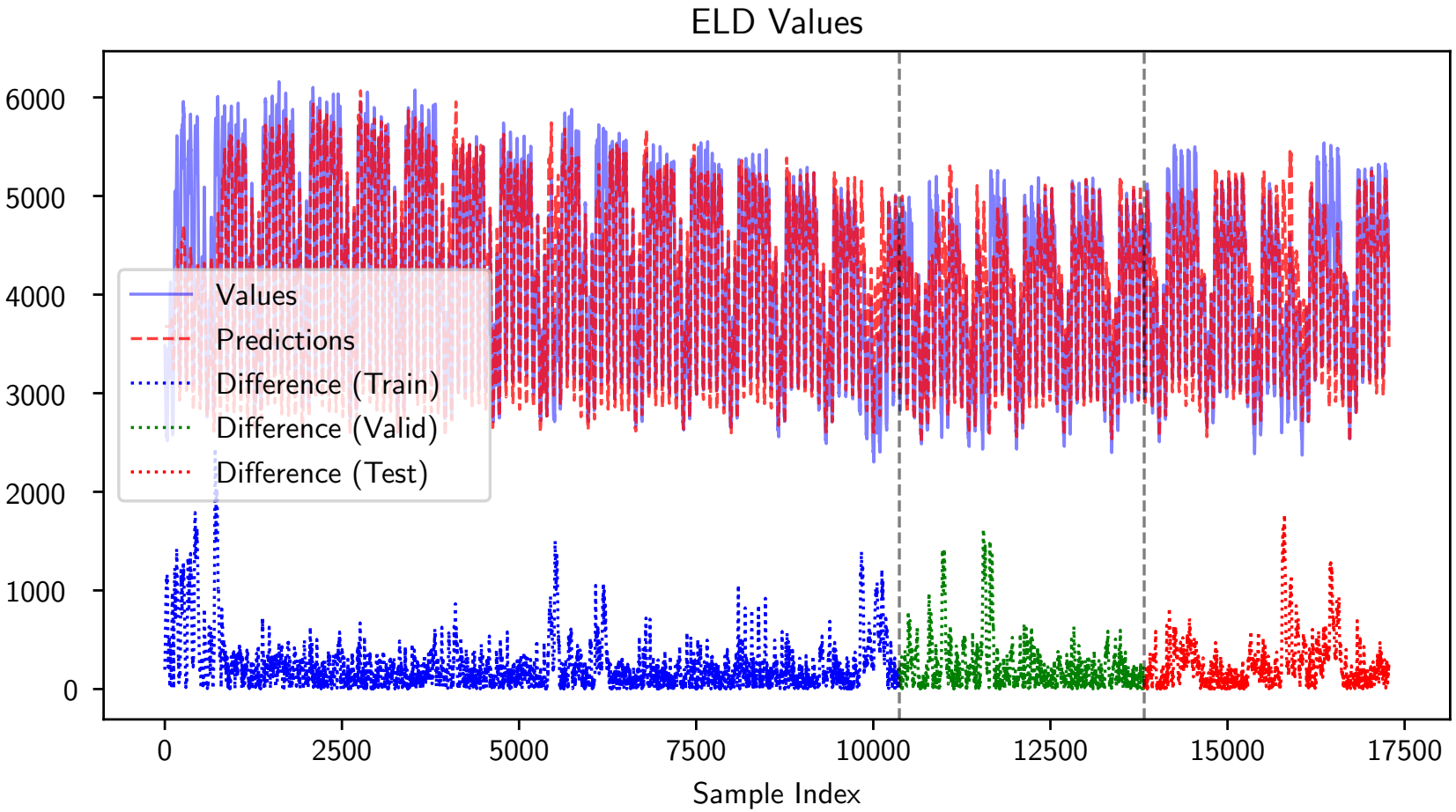
Training Algorithms

- Adaptive Moment Estimation (Adam) algorithm for training
- Mean Squared Error (MSE) as error function
- Random search for training parameters
- Training parameters: learning rate $= 0.0795$, batch size $= 32$
- Training: 72 hours on 12 parallel tasks

Results

- Model tested on test set (unseen data)
- Average MSE for each set: Training: 147.1488 MW Validation: 134.8012 MW Test: 144.3827 MW
- Model able to predict general trend of the load

Results


ELD Values
Values
Predictions
Difference (Train)
Difference (Valid)
Difference (Test)
6000
5000
4000
3000
2000
1000
0
0
2500
5000
7500
10000
12500
15000
17500
Sample Index

Conclusion

- A deep learning model for short-term electricity load forecasting was developed
- The model shows competitive performance compared to the literature
- The model can be employed for a wide range of applications, including grid management and demand-side management