# Automated Conversion from DC Dispatch to AC Power Flow

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## BACKGROUND

- Power flow computations are fundamental to many power system studies.
- The solutions serve as a base in performing other power system studies such as transient and voltage stability studies.
- Obtaining a converged power flow case is not a trivial task especially in large power grids due to the non-linear nature of the power flow equations
- Newton-Raphson is very sensitive to the initial conditions (voltage magnitude and angle estimates).
- A machine learning initializer based on random forest is designed to provide better initial voltage magnitude and angle guesses towards achieving power flow convergence.

## DATA GENERATION

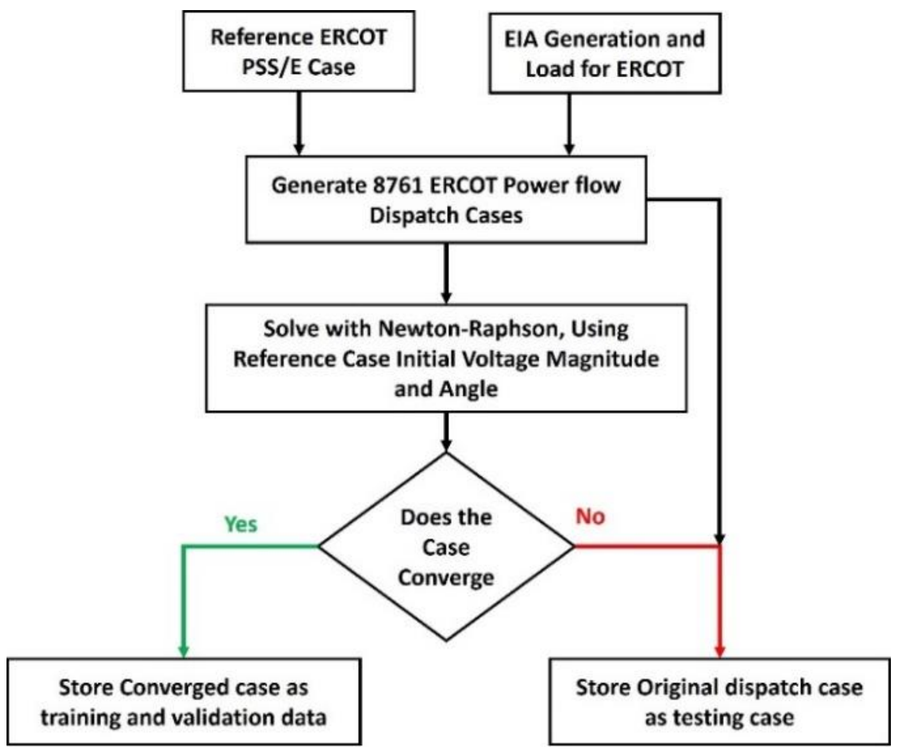


Fig 1: Generation of 8761 Hourly Dispatch Power Flow Cases

## MODEL TRAINING SETUP

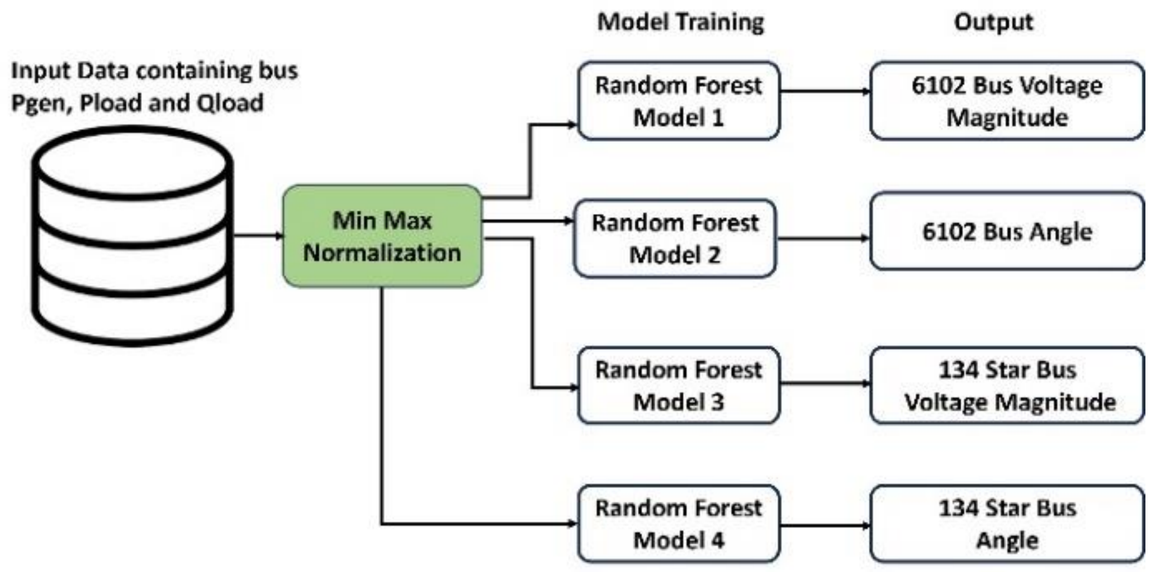


Fig 2: Model Training Setup

## DATA BREAKDOWN

| Parameter | Power Flow Cases |
|---|---|
| Total Cases | 8,761 |
| Training / Validation Cases (converged) | 4,376 / 486 |
| Testing (non-converging) | 3,899 |

## METHODOLOGY

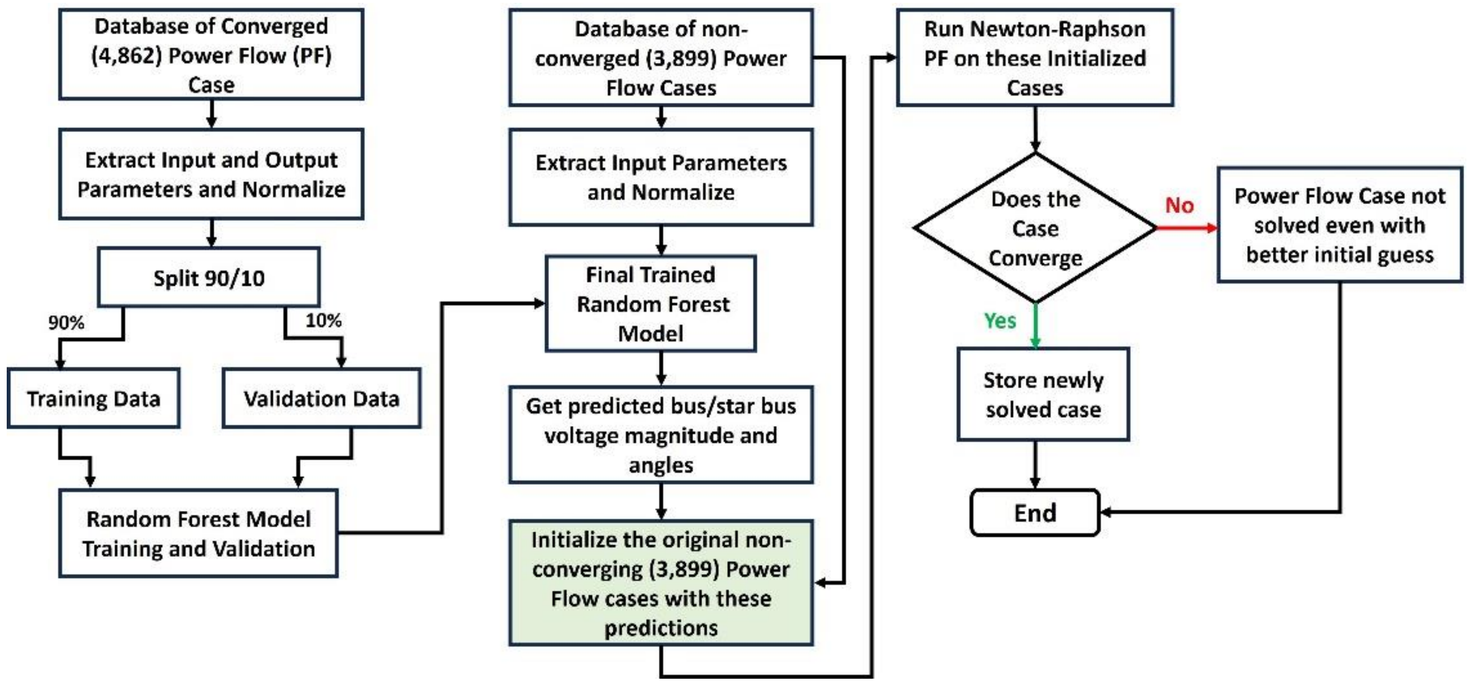


Fig 3: Proposed Framework for Machine Learning Initializer

## RESULTS

| Parameter | Random Forest Initializer | Decision Trees Initializer | DCPF Initializer | Linear Regression Initializer |
|---|---|---|---|---|
| Total (Initial Non-Converged Power Flow Cases) | 3,899 Cases | 3,899 Cases | 3,899 Cases | 3,899 Cases |
| Power Flow Cases Converged by Initialization | 2,106 Cases | 1,783 Cases | 758 Cases | 246 Cases |
| Percentage (%) of Cases Solved by Initialization | 54.01% | 45.73% | 19.44% | 6.31% |
| Remaining Non-Converged Power Flow Dispatch Cases | 1,793 Cases | 2,116 Cases | 3,141 Cases | 3,653 Cases |

## CONCLUSION

- A machine learning was used to predict the initial voltage/angle guesses to initialize Newton-Raphson power flow.
- The developed Random Forest initializer successfully converged 2,106 power flow cases which did not converge originally due to bad initialization.
- The Random Forest initializer performed better when compared with popular analytical methods like DC Power Flow (DCPF) initialization which is used in industry.

## FUTURE WORK

- Retraining the model with more data and varying topology configurations could provide further insights and improve the success rate of the model.
- The capabilities of physics based deep-learning initializers need to be further investigated and compared with already established machine learning methods.