Electrical Fault Prediction using Decision Tree

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The electrical power system consists of many complex, dynamic and interacting elements that are always prone to disturbance or an electrical fault such as short circuit condition.

- Required fault detection system
- Operation of protection equipment in minimum possible time to remain stable.
- Initiate other relays to protect the power system from outages

PROBLEM STATEMENT **EDA** **MODEL DESIGN** **CONCLUSION**

— Output (label) is binary classified

Fault ---> 1

No Fault ---> 0

Features are current and voltages in line a, b and c

|	Output (S)	Ia	Ib	Ic	Va	Vb	Vc	Unnamed: 7	Unnamed: 8
6487	0	10.009379	-43.194571	35.379810	0.597965	-0.275271	-0.322694	NaN	NaN
7445	1	73.138358	-798.340255	727.203438	-0.035802	-0.001706	0.037508	NaN	NaN
1705	0	43.220846	-65.293233	29.318940	0.580671	-0.123633	-0.457038	NaN	NaN
440	0	-29.728845	-33.659446	63.388292	0.462295	-0.570358	0.108063	NaN	NaN
6706	1	765.982618	-772.398070	8.564309	-0.001782	-0.035833	0.037614	NaN	NaN

PROBLEM STATEMENT **EDA** **MODEL DESIGN** **CONCLUSION**

Current and Voltage in line b
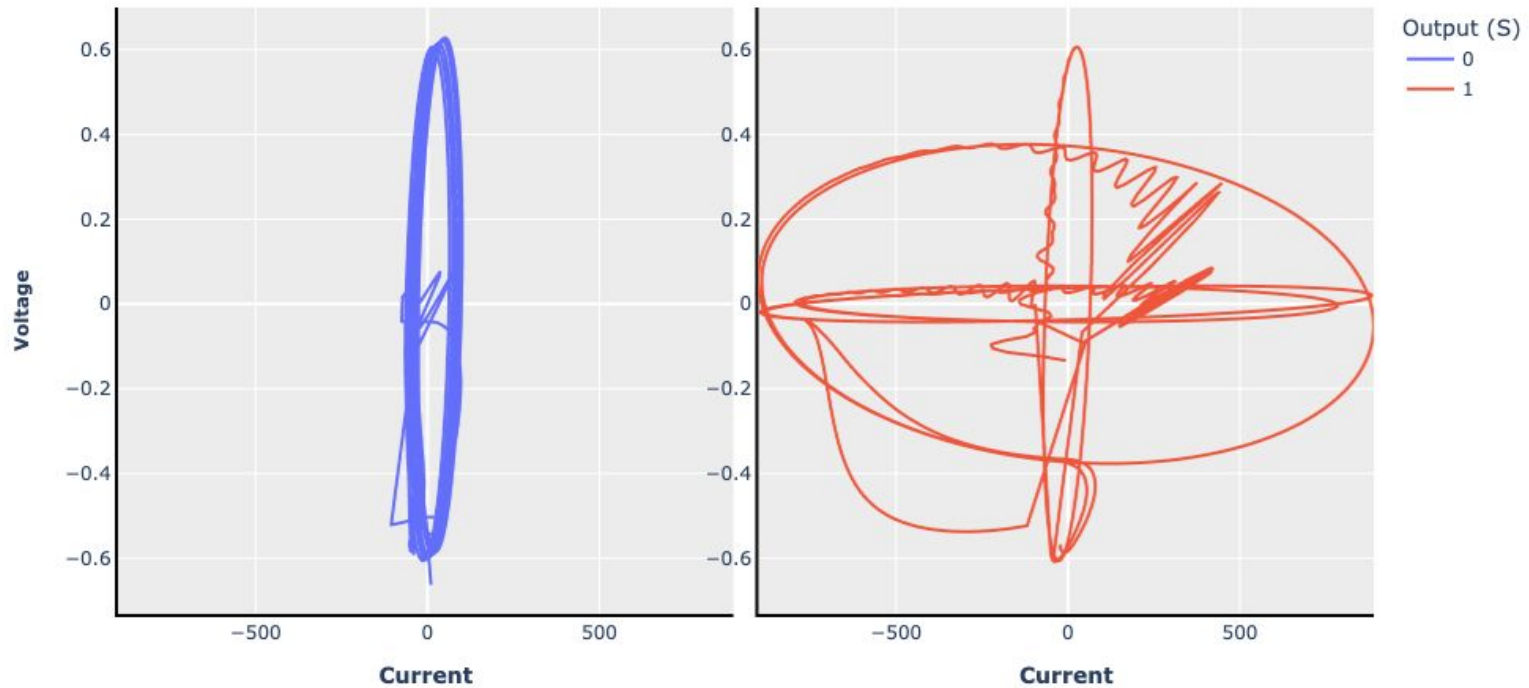
PROBLEM STATEMENT   EDA   MODEL DESIGN   CONCLUSION

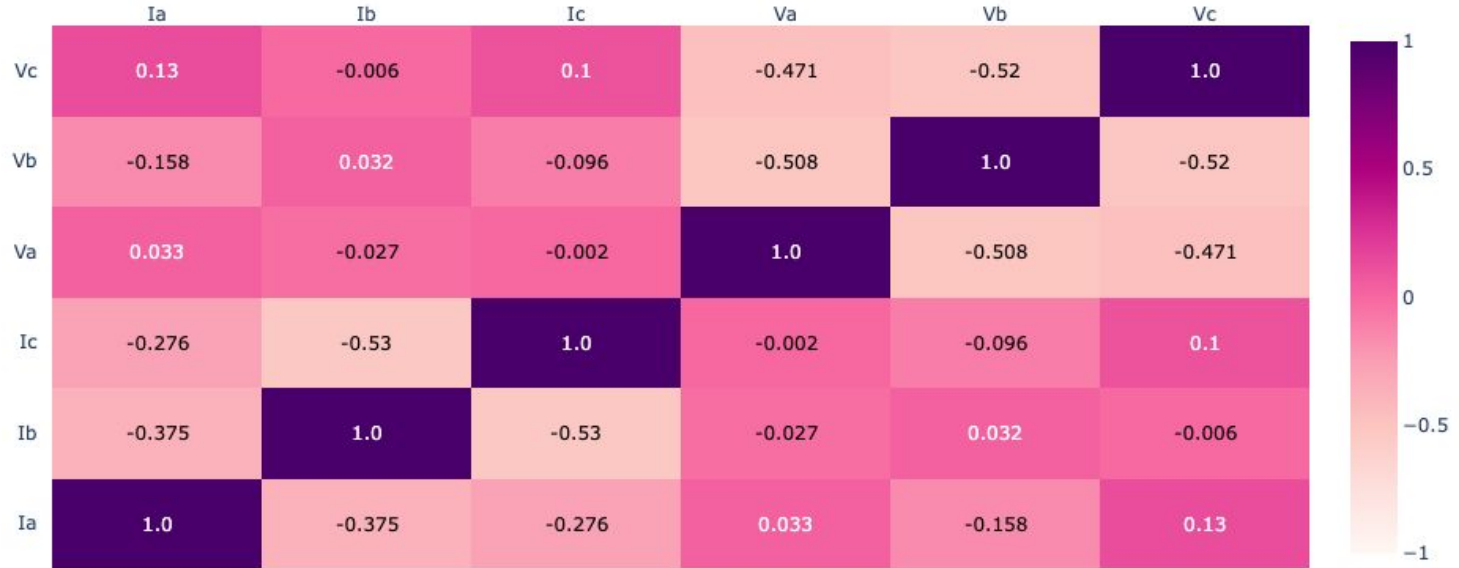Current and Voltage in line a, b, c under no fault condition
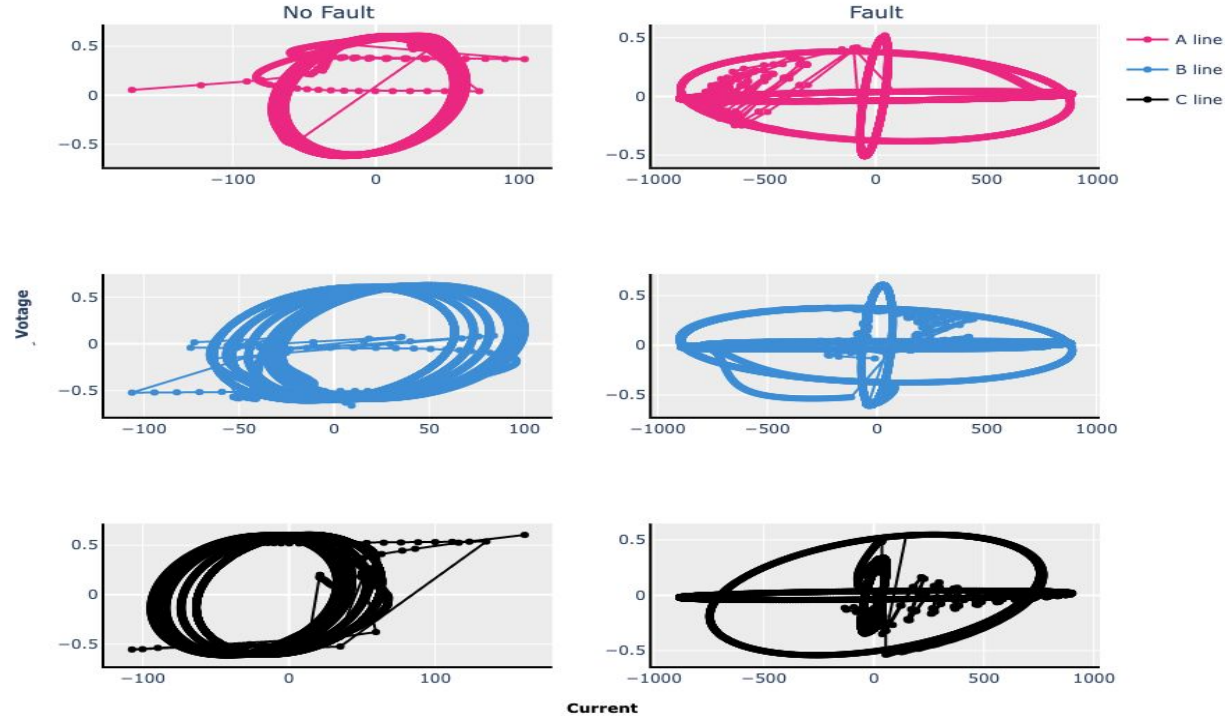
Correlation Heatmap

	Ia	Ib	Ic	Va	Vb	Vc
Vc	0.13	-0.006	0.1	-0.471	-0.52	1.0
Vb	-0.158	0.032	-0.096	-0.508	1.0	-0.52
Va	0.033	-0.027	-0.002	1.0	-0.508	-0.471
Ic	-0.276	-0.53	1.0	-0.002	-0.096	0.1
Ib	-0.375	1.0	-0.53	-0.027	0.032	-0.006
Ia	1.0	-0.375	-0.276	0.033	-0.158	0.13

PROBLEM STATEMENT   **EDA**   **MODEL DESIGN**   **CONCLUSION**

Decision Tree Model

Without Hyperparameter Tuning

With Hyperparameter Tuning

Pre Pruning Technique

Post Pruning Technique
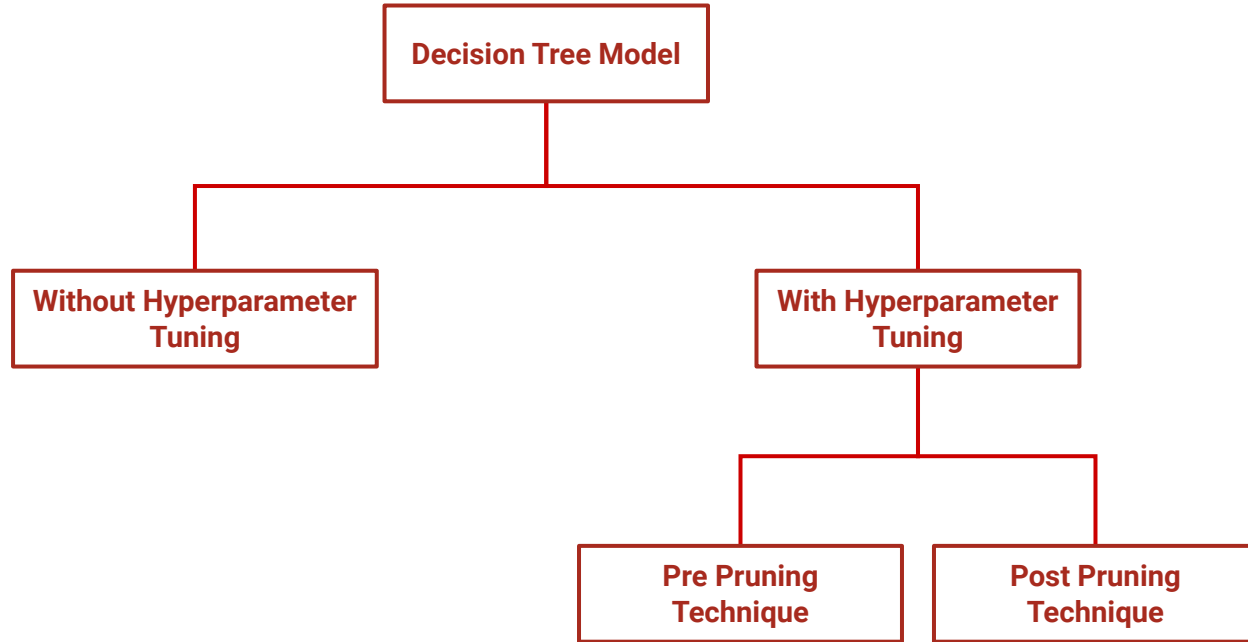
PROBLEM STATEMENT   EDA   MODEL DESIGN   CONCLUSION

MODEL ACCURACY

Without Tuning

Test Accuracy → **99.44%**
Train Accuracy → **100%**

- No hyper parameter tuning

Pre-Pruning

Test Accuracy → **99.30%**
Train Accuracy → **99.92%**

- max_depth
- min_samples_leaf

Post-Pruning

Test Accuracy → **98.83%**
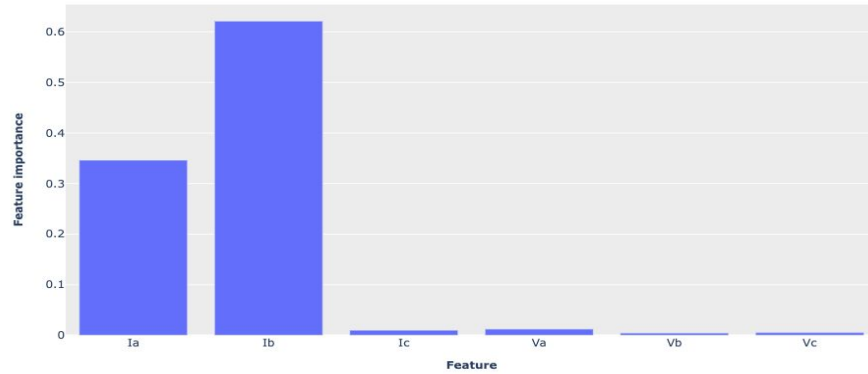Train Accuracy → **98.98%**

- Changing the value of alpha
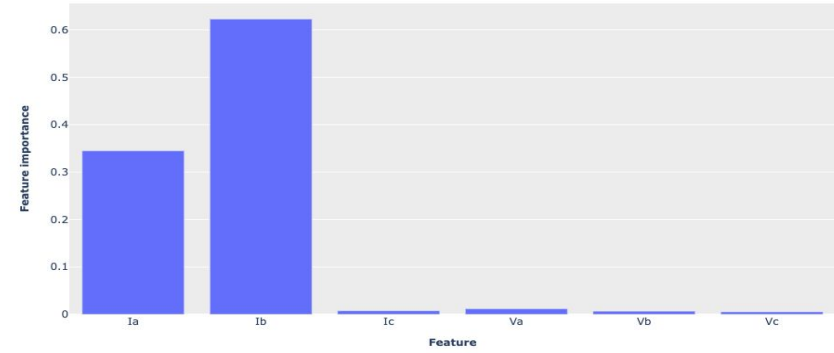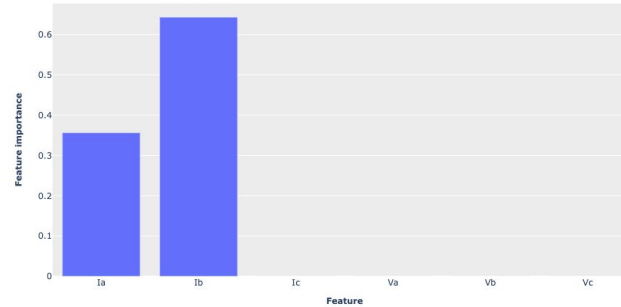
PROBLEM STATEMENT   EDA   MODEL DESIGN   CONCLUSION

Feature Importance (No pruning)

Feature Importance (Pre pruning)

Feature Importance (Post pruning)

PROBLEM STATEMENT   **EDA**   **MODEL DESIGN**   **CONCLUSION**

Without Tuning

Train Data

	Not Fault	Fault
Fault	0	3847
Not Fault	4553	0

Test Data

	Not Fault	Fault
Fault	6	1635
Not Fault	1946	14

PROBLEM STATEMENT EDA MODEL DESIGN CONCLUSION

Pre Pruning Techniques

Train Data

Test Data

Post Pruning Techniques

Train Data

Test Data

PROBLEM STATEMENT | EDA | MODEL DESIGN | CONCLUSION

la <= -65.428
gini = 0.496
samples = 8400
value = [4553, 3847]
class = Not Fault

gini = 0.005
samples = 1735
value = [4, 1731]
class = Fault

la <= 102.4
gini = 0.433
samples = 6665
value = [4549, 2116]
class = Not Fault

Output (S) <= 69.117
gini = 0.288
samples = 5510
value = [4549, 961]
class = Not Fault

gini = 0.0
samples = 1155
value = [0, 1155]
class = Fault

Output (S) <= -90.287
gini = 0.16
samples = 4984
value = [4546, 438]
class = Not Fault

gini = 0.011
samples = 526
value = [3, 523]
class = Fault

gini = 0.006
samples = 362
value = [1, 361]
class = Fault

gini = 0.033
samples = 4622
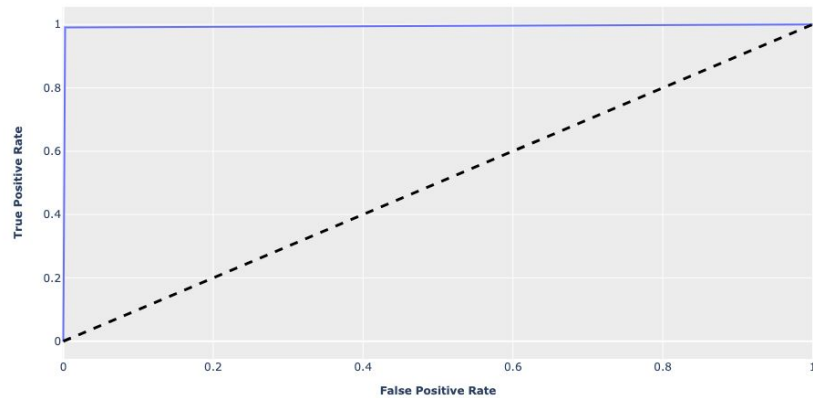value = [4545, 77]
class = Not Fault
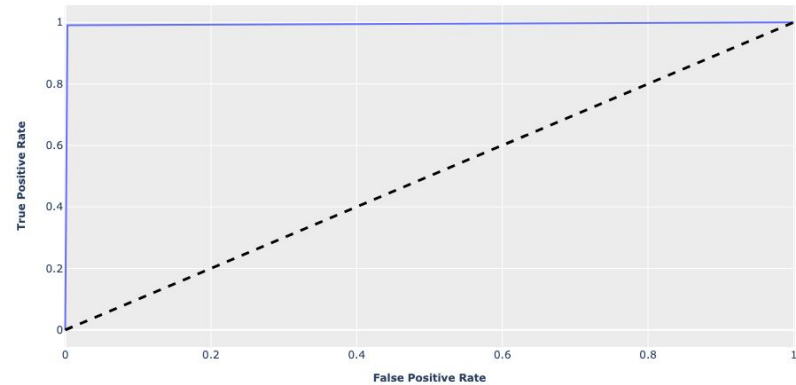
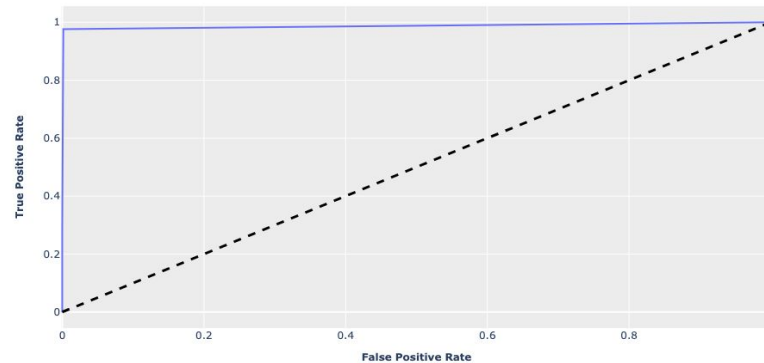**PROBLEM STATEMENT**   **EDA**   **MODEL DESIGN**   **CONCLUSION**

ROC Curve (No Pruning) (AUC=0.9942)

ROC Curve (Pre Pruning) (AUC=0.9943)

ROC Curve (Post Pruning) (AUC=0.9876)

PROBLEM STATEMENT   **EDA**   **MODEL DESIGN**   **CONCLUSION**

➢ We can see that the difference between the accuracy on the train set and test set decreased. This is because hyperparameter tuning smoothens the decision boundary and thus prevents it from overfitting.

➢ The model accuracy is good and can be implemented for production environment.

➢ Following benefits because of model:
  ○ Reduce the frequency of maintenance
  ○ Minimizes cost of maintenance
  ○ Save life
  ○ Avoid and minimize downtime
  ○ Increase availability of the system

Thank You!

Wishing you Happy Autumn