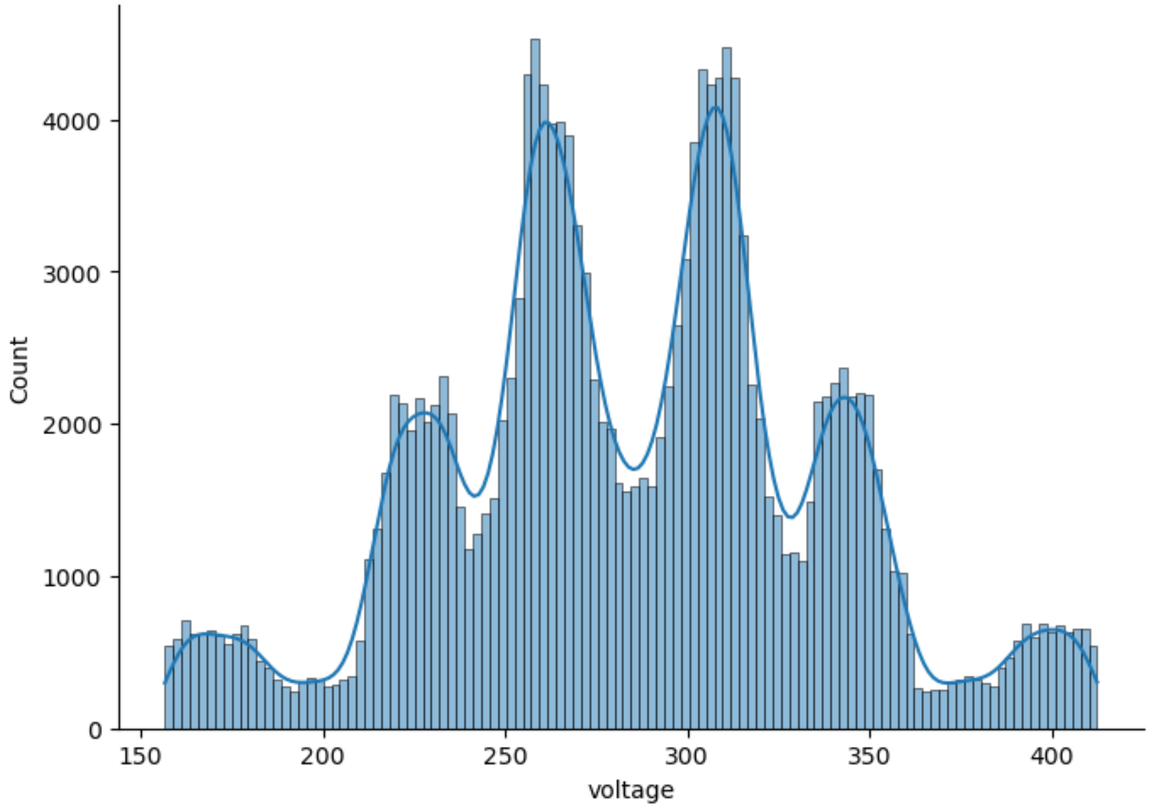
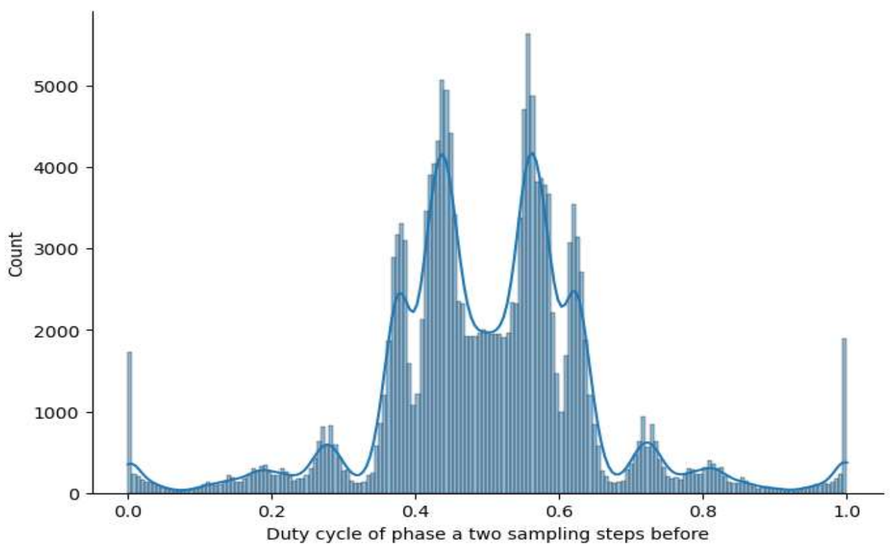
Electronics AI-ML Case Study

In the electronics industry, inverters are widely used to convert DC power to AC power, which is used to power various electronic devices. The voltage produced by an inverter is crucial in determining the performance and efficiency of these devices. However, predicting the voltage output of an inverter can be a complex task due to various factors such as duty cycle, phase-current, and DC-link voltage. Auto-ML can be used to develop a predictive model that can accurately estimate the voltage output of an inverter based on these factors. This can be useful in optimizing the performance and efficiency of electronic devices powered by inverters. In this context, the objective is to develop a model that can accurately predict the voltage output of an inverter based on its operational parameters.

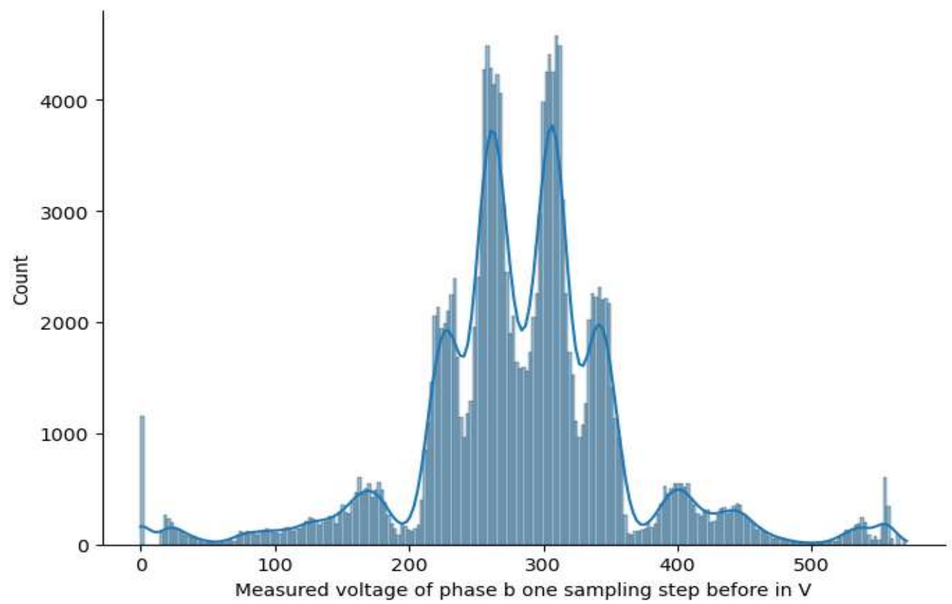


In an inverter, **voltage** refers to the electrical potential difference between two points in a circuit, typically measured in volts (V). An inverter is an electronic device that converts DC (direct current) voltage to AC (alternating current) voltage, enabling the use of electrical devices that require AC voltage from a DC power source such as a battery. The voltage output of an inverter can vary depending on various factors, including the input DC voltage, the type and configuration of the inverter, and the load connected to the output. Accurately predicting the output voltage of an inverter can be important in the design and operation of various electronic systems and devices.

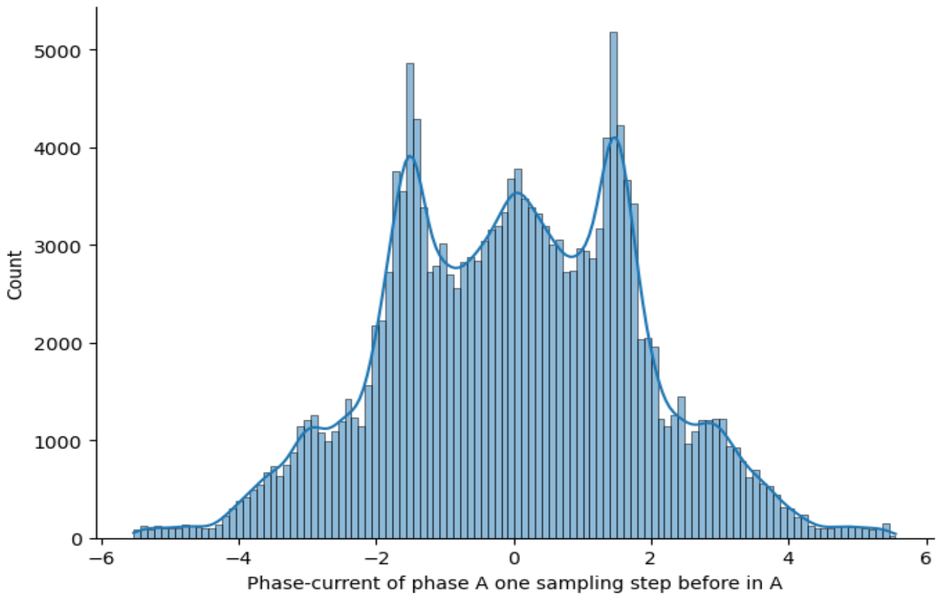
Features Responsible



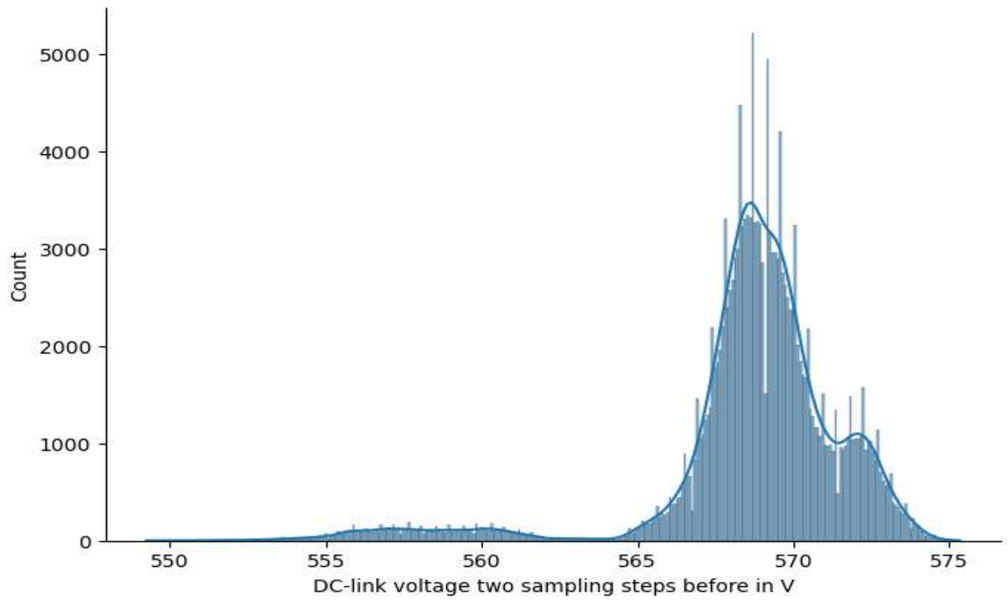
Two sampling steps before refers to a delay in the measurement of the voltage. If the voltage is sampled two steps after the signal is generated, then there will be a delay in the voltage measurement. This delay can cause errors in the voltage measurement, which can affect the performance of the system.



This factor helps in understanding the phase relationship between different phases of the system. The voltage waveform of one phase can be affected by the voltage waveform of other phases at different time instance



If the phase-current of phase A one sampling step before in A is high, it can lead to a voltage drop due to the impedance of the circuit. This is known as voltage sag or dip, and it can cause problems for sensitive equipment that is connected to the circuit.



The DC-link voltage refers to the voltage level of the DC link that connects the rectifier and inverter in a power electronic system. In such a system, the DC voltage is usually regulated to ensure that the inverter output voltage remains constant.

Auto-ML Methodology Results

Case	Percentile	No. of Features	Random Forest	XG-Boost	RNN	MLP	Lasso	Avg. Accuracy
Case 1	25	6	99.90	99.80	97.73	99.40	97.80	**98.92**
Case 2	50	12	100	99.90	79.19	99.60	98.00	**95.33**
Case 3	75	18	100	100	93.40	99.50	98.90	**98.36**
Case 4	90	23	100	100	64.17	98.10	99.00	**92.25**

- Based on our observation, RandomForest and XGBoost was the best performing algorithm with 100% accuracy in 75^{th} and 90^{th} percentile.
- 25^{th} percentile is the best percentile with an average accuracy of 98.92%.

Conclusion

In the electronics industry, inverters are widely used to convert DC power to AC power, which is used to power various electronic devices. The voltage produced by an inverter is crucial in determining the performance and efficiency of these devices. However, predicting the voltage output of an inverter can be a complex task due to various factors such as duty cycle, phase-current, and DC-link voltage. The dataset has 173693 records with 26 Numerical Features.

For regression, models were created with algorithms using Auto-ML techniques like Lasso, Recurrent Neural Network, Multilayer Perceptron, Random forest and XGBoost . With these models, performance measurement values were obtained for feature sets of 6, 12, 18 and 23. The Auto-ML algorithms were able to predict the inverter voltage with an average accuracy between 95% – 99% and helped to identify factors that determining inverter voltage. The major factors include Duty cycle of phase a two sampling steps before, Measured voltage of phase b one sampling step before in V, Phase-current of phase a one sampling step before in A and DC-link voltage two sampling steps before in V. The Random forest with 100 % accuracy in 90th percentile where tree showed a threshold of “Duty cycle of phase c two sampling steps before” >= 0.67 units which leads to high voltage.