## Electric Motor Temperature Prediction

### Project Overview

This project aims to predict the **temperature of a permanent magnet (pm) motor** based on various operational parameters. By analyzing features such as voltages, currents, and coolant temperature, the goal is to develop a regression model that can accurately forecast the motor's internal temperature. This is crucial for condition monitoring, preventing overheating, and extending the lifespan of electric motors.

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### Technical Highlights

  * **Dataset**: The project uses a dataset related to electric motor temperature. The specific dataset is titled `measures_v2.csv` and is likely from a Kaggle source related to electric motor temperature prediction, though the specific link is missing from the provided code block.

  * **Size**: 20,000 entries, 13 columns.

  * **Key Features**:

      * **Motor Electrical Signals**: `u_q`, `u_d`, `i_d`, `i_q`.

      * **Temperatures**: `coolant`, `stator_winding`, `stator_tooth`, `stator_yoke`, `ambient`.

      * **Performance Metrics**: `motor_speed`, `torque`.

  * **Approach**:

      * **Data Cleaning**: The dataset appears to be clean, with no missing values or duplicates in the sample used.

      * **Exploratory Data Analysis**: Histograms, boxplots, and a heatmap were used for visualization to understand data distributions and correlations. The heatmap reveals several strong correlations between the features.

      * **Regression Task**: The target variable is `pm`, which likely represents the permanent magnet temperature.

      * **Models Used**:

          * A suite of regression models were trained, including Ridge Regression, XGBoost, Random Forest, AdaBoost, Gradient Boosting, Bagging, Decision Tree, SVR, and K-Nearest Neighbors (KNN).

  * **Best $R^2$ Score**:

      * **0.99992** with Random Forest Regressor.

* **0.99984** with KNN Regressor.

* **0.99983** with XGBoost Regressor.

* The extremely high $R^2$ scores across multiple models indicate that the input features are highly predictive of the motor's temperature.

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### Purpose and Applications

* Enable **predictive maintenance** by forecasting motor temperatures to prevent overheating and component failure.

* Optimize the operation of electric motors in industrial settings to improve efficiency and reduce energy consumption.

* Support the design of more effective cooling systems for motors.

* Provide a foundational model for developing real-time condition monitoring and fault diagnosis systems.

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### Installation

Clone the repository and download the dataset.

Install the necessary libraries:

```bash
pip install pandas numpy seaborn matplotlib scikit-learn xgboost
```

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### Collaboration

We welcome contributions to improve the project. You can help by:

* Performing a deeper analysis of the relationships between the input features and the target variable to understand the underlying physics.

* Investigating the impact of the highly correlated features on the models.

* Exploring more advanced time-series forecasting techniques, as temperature prediction is often a time-dependent problem.

* Adding explainability (e.g., SHAP or LIME) to understand which operational parameters are the most significant drivers of motor temperature.

**Electric Motor Temperature Prediction using Machine Learning**

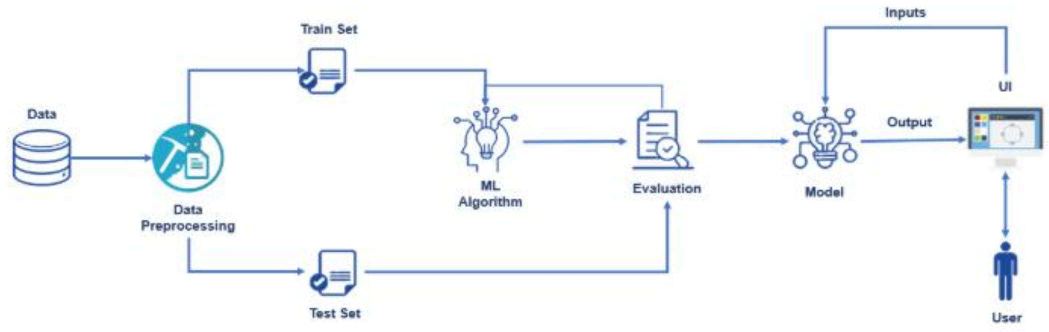
Electric Motor Temperature Prediction using Machine Learning is a predictive maintenance solution aimed at forecasting the temperature of electric motors in industrial settings. By analyzing historical operational data such as motor load, voltage, current, and environmental conditions, combined with machine learning algorithms, this project aims to predict motor temperatures accurately. The goal is to prevent overheating, avoid equipment failures, optimize maintenance schedules, and improve overall operational efficiency.

**Scenario 1: Preventive Maintenance** Manufacturing plants can use the temperature predictions to implement proactive maintenance strategies. By identifying potential overheating issues before they occur, maintenance teams can schedule timely inspections, replace worn-out components, and prevent costly downtime due to motor failures.

**Scenario 2: Energy Efficiency** Facility managers can leverage temperature predictions to optimize energy consumption. By maintaining motors at optimal temperature levels, they can reduce energy wastage, improve equipment performance, and lower operational costs over time.

**Scenario 3: Equipment Reliability** Industries relying heavily on electric motors, such as automotive production or HVAC systems, can benefit from accurate temperature predictions. Ensuring motors operate within safe temperature ranges enhances equipment reliability, prolongs lifespan, and minimizes the risk of unexpected breakdowns during critical operations.

Technical Architecture:


Data
Data Preprocessing
Train Set
Test Set
ML Algorithm
Evaluation
Model
Inputs
Output
UI
User