**Model Optimization and Tuning Phase Template**

| Date | 15 july 2024 |
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| Team ID | team-740034 |
| Project Title | Predicting the energy output of wind turbine based on weather condition |
| Maximum Marks | 10 Marks |

**Model Optimization and Tuning Phase**

The model optimization and tuning phase in predicting the energy output of wind turbines based on weather conditions is crucial for improving the accuracy and reliability of predictions.and involves refining neural network models for peak performance. It includes optimized model code, fine-tuning hyperparameters, comparing performance metrics, and justifying the final model selection for enhanced predictive accuracy and efficiency.

### Hyperparameter Tuning Documentation (8 Marks):

| **Model** | **Tuned Hyperparameters** |
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| Neural Network (Multi-layer Perceptron) |  hidden\_layer\_sizes: Number of neurons in each hidden layer.   activation: Activation function for the hidden layers.   solver: Optimization algorithm to use.   learning\_rate\_init: Initial learning rate for the optimizer  C:\Users\SRAVAN\AppData\Local\Packages\5319275A.WhatsAppDesktop_cv1g1gvanyjgm\TempState\D28D76B4592325C3BAFC1840D4BB2957\WhatsApp Image 2024-07-15 at 20.38.42_cd3055c6.jpg |
| Gradient boosting Regressor |  n\_estimators: Number of boosting stages to be run.   learning\_rate: Step size shrinkage.   max\_depth: Maximum depth of the individual trees.   subsample: Fraction of samples used for fitting the individual trees.  C:\Users\SRAVAN\AppData\Local\Packages\5319275A.WhatsAppDesktop_cv1g1gvanyjgm\TempState\55B782D9F1C1765AAC3CB3D51AAE2430\WhatsApp Image 2024-07-15 at 20.38.41_ceecbf88.jpg |
| Random Forest Regressor |  n\_estimators: Number of trees in the forest.   max\_depth: Maximum depth of the trees.   min\_samples\_split: Minimum number of samples required to split an internal node.   min\_samples\_leaf: Minimum number of samples required to be at a leaf node  C:\Users\SRAVAN\AppData\Local\Packages\5319275A.WhatsAppDesktop_cv1g1gvanyjgm\TempState\3001EF257407D5A371A96DCD947C7D93\WhatsApp Image 2024-07-15 at 20.38.41_12ffc530.jpg |

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### Final Model Selection Justification (2 Marks):

| **Final Model** | **Reasoning** |
| --- | --- |
| Gradient Boosting regressor | - The Gradient Boosting Regressor was chosen as the final model due to its superior performance in terms of predictive accuracy and robustness during the model optimization phase.  - It effectively handles non-linearity and complex relationships between weather variables (such as wind speed, temperature, humidity) and wind turbine energy output.  - Hyperparameter tuning using RandomizedSearchCV revealed optimal settings that minimized mean squared error and generalized well across different cross-validation folds.  - Compared to other models tested (such as Random Forest and Neural Network), it consistently demonstrated better performance metrics on both training and validation datasets. |