### Modeling Methodology and Results Interpretation

**Objective 1:** Learn the power usage of physical machines as a function of 3 inputs.

**Methodology:**

**1. Data Filtering:** We filtered the data to include only rows where the 'check' value is between 90 and 110. This helps ensure we’re using only relevant data.

**2. Train-Test Split:** We split the data into training and testing sets, using 90% for training and 10% for testing. This is important for evaluating how well the model performs on unseen data.

**3. Model Training:** We used a K-Nearest Neighbors (KNN) model and fine-tuned it by testing different settings to find the best fit for our data.

**4. Model Evaluation:** We measured the model's performance using RMSE, MAE, and R² scores to see how accurately it predicts the target variable.

**Results Interpretation:**

**- Model 1:** It explains about 75.6% of the variance in the data. The prediction errors are moderate, which is good, but there is still a chance the model might not generalize well to new data.

**- Model 2:** This model performs even better, explaining 96.4% of the variance. However, the prediction errors are higher, suggesting that it may be overfitting, meaning it learned the training data too well and might struggle with new data.

**Conclusion:**

Both models perform reasonably well, but the small size of the datasets makes it hard to draw definitive conclusions. Model 1 shows a good balance between accuracy and generalization, while Model 2 achieves high accuracy but may overfit. More data would help validate these findings and improve model performance.

### Optimal GPH Settings and Power Consumption

**Objective 2:** Formulate and solve an optimization problem to reduce the overall power consumption of the machines running together, and save energy.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Machine Type** | **Input 1** | **Input 2** | **GPH** | **Power** |
| Machine Type #1 | 25 | 6 | 180 | 71.27635139 |
| Machine Type #1 | 25 | 6 | 180 | 71.27635139 |
| Machine Type #1 | 25 | 6 | 180 | 71.27635139 |
| Machine Type #1 | 25 | 6 | 180 | 71.27635139 |
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| Machine Type #1 | 25 | 6 | 180 | 71.27635139 |
| Machine Type #1 | 25 | 6 | 180 | 71.27635139 |
| Machine Type #1 | 25 | 6 | 180 | 71.27635139 |
| Machine Type #1 | 25 | 6 | 180 | 71.27635139 |
| Machine Type #2 | 25 | 6 | 300 | 79.4188493 |
| Machine Type #2 | 25 | 6 | 300 | 79.4188493 |
| Machine Type #2 | 25 | 6 | 300 | 79.4188493 |
| Machine Type #2 | 25 | 6 | 300 | 79.4188493 |
| Machine Type #2 | 25 | 6 | 1000 | 167.8314814 |
| Machine Type #2 | 25 | 6 | 1000 | 167.8314814 |
| Machine Type #2 | 25 | 6 | 1000 | 167.8314814 |
| Machine Type #2 | 25 | 6 | 1000 | 167.8314814 |
| Machine Type #2 | 25 | 6 | 1000 | 167.8314814 |
| Machine Type #2 | 25 | 6 | 1000 | 167.8314814 |

**1. Optimal GPH Values for Each Machine**

2. **Total Power Consumption:** Total power of 20 machines: 2037.43 Units

3. **Methodology and Interpretation:** In this optimization problem, we aimed to determine the optimal goods production per hour (GPH) for 20 machines in a factory, balancing power consumption with the need to achieve a target total GPH of 9,000. The methodology involved utilizing previously trained KNN models to predict the power usage of each machine type based on their GPH settings. By systematically adjusting the GPH values within specified limits for both machine types, we identified the settings that would yield the lowest total power consumption while meeting the target production requirement. The results indicated that for Machine Type #1, all machines should operate at the minimum GPH of 180.00 to conserve energy. In contrast, for Machine Type #2, a mix of lower (300.00 GPH) and higher (1000.00 GPH) settings was optimal to meet the total GPH requirement.