Data Analysis Project Report

Team: I love data analysis
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1 Contributions

The following contributions were made by each team member:

- Peter Felber:
  - Data preprocessing tasks
  - Initial visualization development
- Andreas Heindl:
  - Statistical analysis implementation
  - Regression analysis
- Jakob Hütter:
  - Advanced visualizations
  - Report writing and documentation

2 Dataset Description

- Dataset name and source: Solar Power Generation Data by Ani Kannal from Kaggle
- Time period and sampling frequency: data has been collected over a period of 34 days with a sampling frequency of 15 minutes
- Key variables analyzed: DC_Power, AC_Power, Ambient Temperature, Module Temperature, Irradiation
- Basic statistical properties:
  - Number of observations: 3134
  - Missing values: 130 (should be 34 days * 24 hours * 4 observations per hour = 3264)
  - Key statistics of cleaned dataset:

Variable	Mean	Median	Min	Max	Std
DC_Power in MW	67.540	8.632	0.000	269.097	85.798
AC_Power in MW	66.060	8.344	0.000	262.392	83.858
Ambient Temperature in °C	25.5	24.7	21.1	33.8	3.3
Module Temperature in °C	31.1	24.8	19.2	60.3	12.1
Irradiation kW/m^2	0.2273	0.0289	0.0000	0.999	0.2950

3 Methods and Analysis

3.1 Data Preprocessing

- Cleaning procedures: Fix AC_Power wrong factor to get correct kW values, synchronize Datetime format
- Outlier handling: Replace outliers with missing values, but remove rows with 6 consecutive outliers, to decrease time frame of interpolation
- Missing value treatment: Interpolate them with plausible values
- Data transformations: Split original dataframe to seperate inverters to different columns

3.2 Exploratory Data Analysis

- Distribution analysis: For total power we can observe a lean towards lower values, possible due to night time. This represents an inverse gaussian distribution. This of course correlates with the IR-Radiation distribution. The ambient temperature shows multi-modal tendencies, with clear bumps around 23 and 28 degrees. For the module temperatures this is less pronounced, with the bumps at 22 and 45 degrees.
- Time series patterns:
- Correlation analysis:
- Key visualizations:

3.3 Statistical Analysis

- Probability analysis:
  - The probability of Total_AC exceeding the threshold valu of 120 MW is approximately 0.15.
    - This value changes: the higher the threshold, the lower the probability.
  - The cross tabulation analysis shows the distribution of Total_AC exceeding the threshold across different levels of Irradiation.
    - Depending on the set threshold level, the distribution changes. When set to a higher Total_AC, the more likely it is with a higher irradiation level to be over the threshold.
  - The conditional probability analysis reveals the likelihood of Total_AC exceeding the threshold given different Irradiation levels.
    - For this analysis, only the probabilities around the threshold have a probability not to be 1 or 0. Higher levels have a probability of 1, and lower levels have a probability of 0.
- Law of Large Numbers demonstration: The Law of Large Numbers states that as the number of trials increases, the sample mean will tend to be closer to the population mean. In this case, the Law of Large Numbers is demonstrated by calculating the sample mean of Total_AC exceeding the threshold value of 90,000 for different sample sizes. As the sample size increases, the sample mean tends to be closer to the population mean, which is the probability of Total_AC exceeding the threshold value of 90,000.
- Central Limit Theorem application: The Central Limit Theorem states that the sampling distribution of the sample mean will be approximately normally distributed, regardless of the population distribution, as the sample size increases. In this case, the Central Limit Theorem is applied by calculating the sample mean of Total_AC exceeding the threshold value of 90,000 for different sample sizes and plotting the sampling distribution. As the sample size increases, the sampling distribution tends to be closer to a normal distribution.
  - Q-Q plot analysis (if applicable):
- Regression analysis:
  - Model selection:
  - Model fitting and validation:
  - Cross-validation (if applicable):

4 Key Findings

4.1 Statistical Insights

- Distribution characteristics:
- Significant correlations:
- Probability analysis results:

4.2 Pattern Analysis

- Temporal patterns:
- Variable relationships:
- Identified anomalies:

4.3 Advanced Analysis Results

- Interactive visualization insights:
- Regression performance:
- Additional findings:

5 Summary and Conclusions

- Main insights:
- Limitations:
- Future analysis suggestions: