PRE-PROJECT PRESENTATION

SOLAR RADIATION PREDICTION

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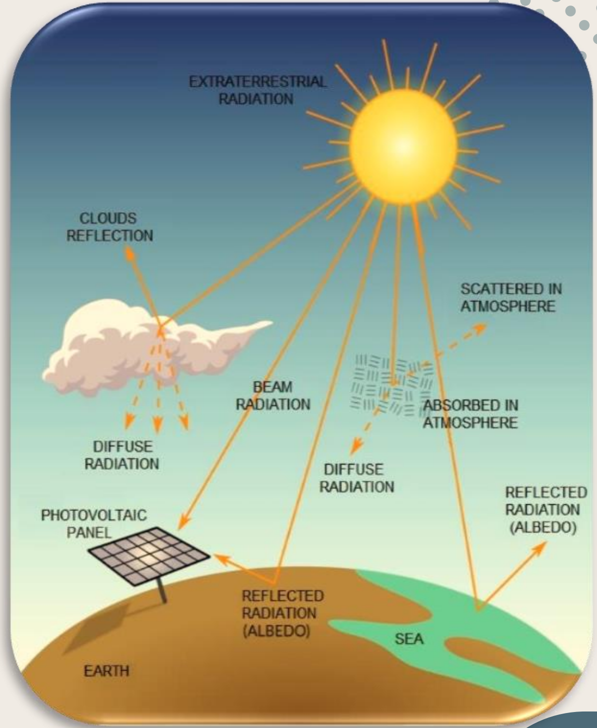
CONTENTS

INTRODUCTION

- Solar radiation plays a crucial role in various aspects of our lives, from powering renewable energy systems to influencing agricultural productivity and climate patterns.
- However, accurately predicting solar radiation levels is challenging due to the complex interplay of weather conditions, geographical factors, and atmospheric dynamics.
- In this project, we aim to develop a model that can predict solar radiation levels with high accuracy.
- we hope to contribute to the advancement of renewable energy technologies and enhance our understanding of Earth's energy balance."



IMPORTANCE OF SOLAR RADIATION PREDICTION

01 Optimizing energy prediction

* Solar radiation prediction helps solar power plants optimize their energy production by anticipating fluctuations in sunlight.

02 GRID MANAGEMENT

* grid operators to manage the integration of solar energy into the grid. Accurate predictions enable them to balance supply and demand, reduce the need for backup power sources, and prevent grid instability.

03 Cost Reduction

* predicting solar radiation more accurately, energy producers can reduce costs associated with inefficient energy production and grid management.

04 Urban Planning and Agriculture

* It can help optimize the design of buildings for energy efficiency, as well as assist farmers in planning crop planting and harvesting times based on sunlight availability

CURRENT METHODS AND CHALLENGES

Solar radiation prediction methods include:

- Satellite data,
- Ground-based sensors,
- Numerical models.

Challenges:

- due to cloud cover variability,
- atmospheric complexity
- data accuracy issues.

OUR APPROACH

- We collect various datasets, including historical solar radiation data, satellite imagery, weather data, and atmospheric conditions, and preprocess them to ensure quality and standardization.
- We then select the most relevant variables for predicting solar radiation levels using feature selection techniques.
- We carefully choose machine learning algorithms and train them using cross-validation techniques.
- We evaluate the trained models using validation data and deploy them for real-world use, continuously monitoring and updating them to ensure their effectiveness.

DATA COLLECTION

01 SATELLITE IMAGERY

We use high-resolution satellite imagery to capture spatial patterns of cloud cover, atmospheric conditions, and surface characteristics.

02 WHEATHER DATA

real-time weather data from ground-based weather stations to supplement satellite data. This includes information on temperature, humidity, wind speed, and precipitation

03 SOLAR-RADIATION DATA

Historical solar radiation data is essential for training our models and validating their performance. We gather this data from reliable sources to ensure accuracy and consistency

04 ATMOSPHERIC CONDITIONS

Data on atmospheric conditions, such as air pressure, moisture content, and aerosol levels, are collected to improve the accuracy of our predictions

Technical Approach

● Solar radiation relies on weather patterns.

● The dataset has a total of 32,686 samples.

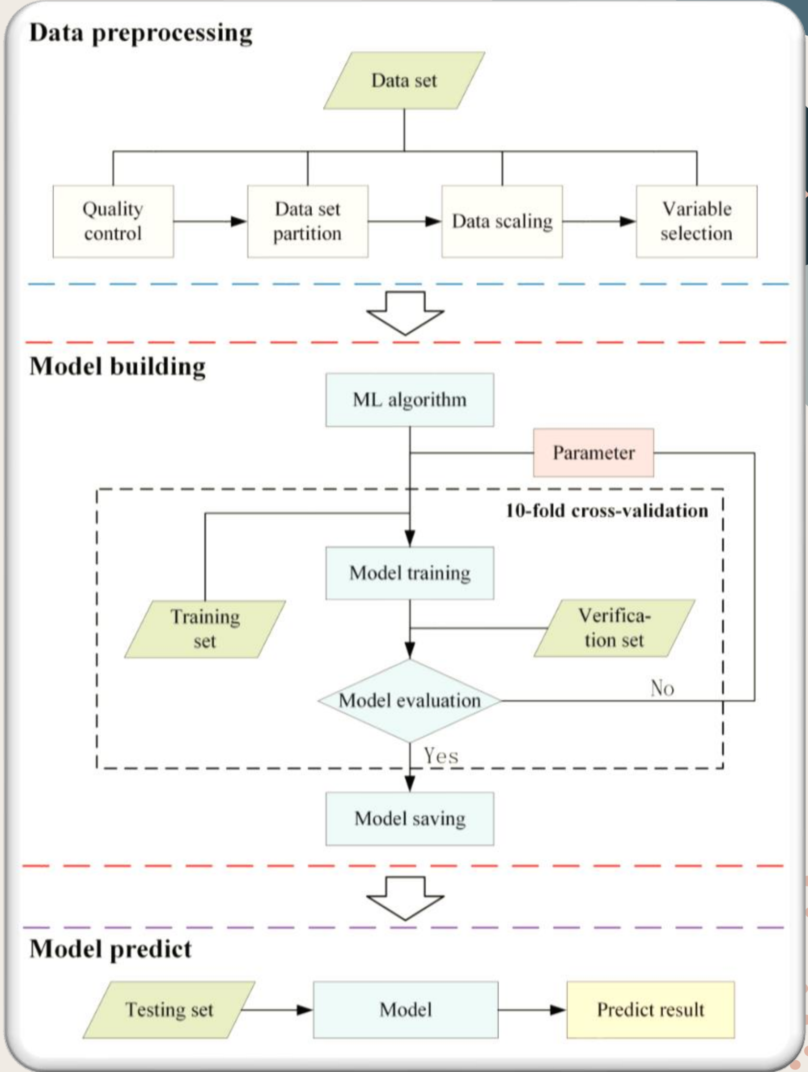
● 11 attributes are corresponding to each sample.

● Radiation is the response variable and the rest of the 10 attributes are the predictor variable.

● We plan to perform an 80-20 split to generate the train and test set.

-Standard models:

1. Linear Regression 2. SVR 3. MLP Regressor 4. Decision Tree Regressor 5. Gradient Boost 6. XGBoost 7. Random Forest



DATA PROCESSING

→Data preprocessing is crucial in data science to clean, transform, and prepare data for analysis.
→It ensures data quality, improves model accuracy, and helps in extracting meaningful insights from the data.
→A real world data generally contains noise, missing value and may be in unusable format.

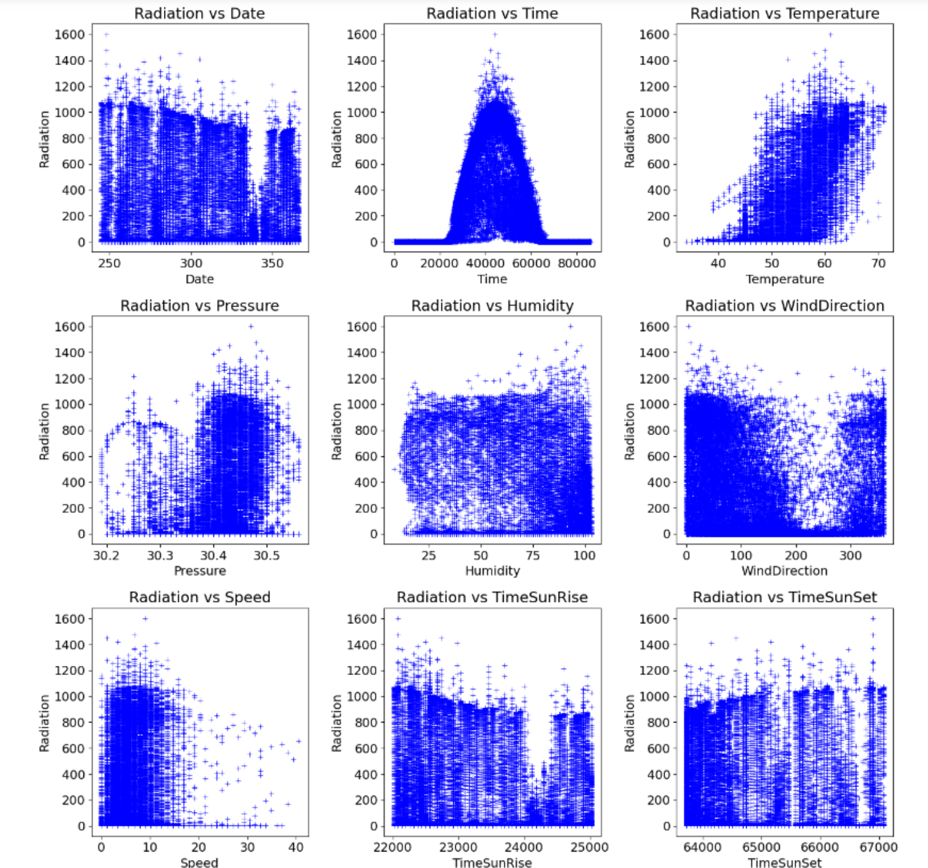
Fig: Solar Data Set after Pre Processing

	Date	Time	Radiation	Temperature	Pressure	Humidity	WindDirection	Speed	TimeSunRise	TimeSunSet
0	273	86126	1.21	48	30.46	59	177.39	5.62	22380	65580
1	273	85823	1.21	48	30.46	58	176.78	3.37	22380	65580
2	273	85526	1.23	48	30.46	57	158.75	3.37	22380	65580
3	273	85221	1.21	48	30.46	60	137.71	3.37	22380	65580
4	273	84924	1.17	48	30.46	62	104.95	5.62	22380	65580
...	...	...	...	...	...	...	...	...	...	...
32681	336	1204	1.22	44	30.43	102	145.42	6.75	24060	63720
32682	336	901	1.17	44	30.42	102	117.78	6.75	24060	63720
32683	336	601	1.20	44	30.42	102	145.19	9.00	24060	63720
32684	336	302	1.23	44	30.42	101	164.19	7.87	24060	63720
32685	336	2	1.20	44	30.43	101	83.59	3.37	24060	63720

32686 rows × 10 columns

Scatter Plot

```
In [75]: plt.rcParams["figure.figsize"] = (14, 14)
         plt.rcParams["font.size"] = 14

         ylabel = 'Radiation'
         columns = ['Date', 'Time', 'Temperature', 'Pressure', 'Humidity', 'WindDirection'

         for index, xlabel in enumerate(columns):
           plt.subplot(3, 3, index+1)
           plt.scatter(df[xlabel], df[ylabel],color='blue',marker='+',linewidth=0.5
           plt.xlabel(xlabel)
           plt.ylabel(ylabel)
           plt.title(ylabel + ' vs ' + xlabel)

         plt.tight_layout()
```



-high correlation between temperature, pressure, humidity, Wind Direction with radiation.

- plot indicates that radiation depends on the time of the day.

low →early morning,

maximum → noon, and

gra creases →end of the day.

Scatterplot of different features of dataset against Radiation

In [79]:
```python
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split
```

Train-Test split

In [80]:
```python
Y = df['Radiation'].values
df.drop(['Radiation'], axis=1, inplace=True)

X = df.values

RS = 1811
```

In [81]:
```python
X_train, X_test, Y_train, Y_test = train_test_split(X,Y,test_size=0.2, random_state=RS)
```

Predictions using standard models

In [82]:
```python
lr=LinearRegression()
lr.fit(X_train, Y_train)
```

Out[82]:
```
▾ LinearRegression
LinearRegression()
```

Multiple linear regression is a statistical method used to model the relationship between multiple independent variables and a dependent variable.

Independent var: Temp, speed. Pressure, humidity, wind direction etc.….

Dependent var: Radiation

Results:

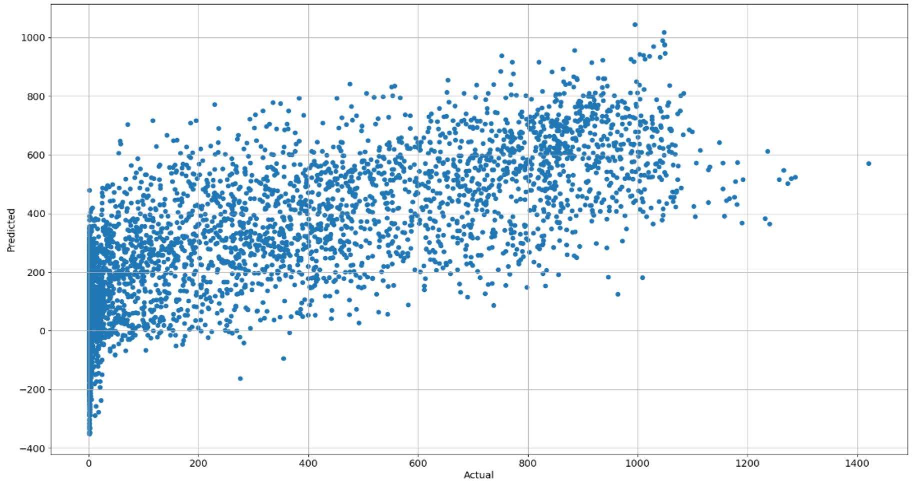
```
In [83]: pred=lr.predict(X_test)

         m=lr.coef_
         m
```

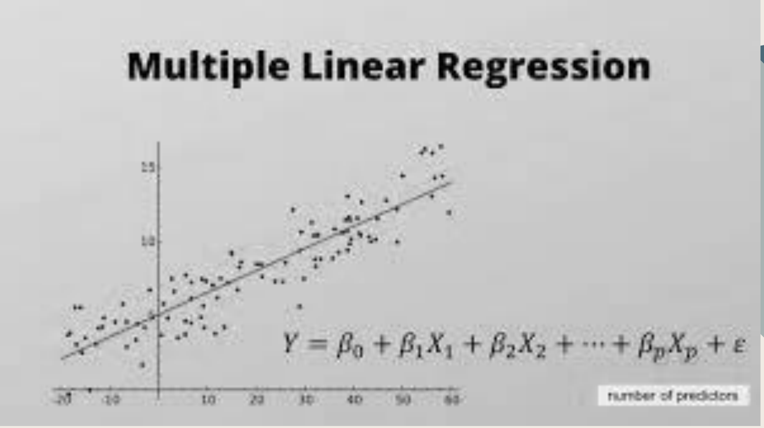
```
Out[83]: array([ 1.98104301e+00, -2.07962649e-03,  4.38422669e+01, -3.59256338e+02,
                 5.47659755e-01, -2.74759504e-01,  5.44636736e+00])
```

```
In [84]: c=lr.intercept_
         c
```

```
Out[84]: 8343.381813532798
```

```
In [85]: plt.scatter(Y_test,pred);
         plt.xlabel('Actual');
         plt.ylabel('Predicted');
         plt.grid()
```






```
In [86]: print("Accuracy for Train data sets")
         print( lr.score(X_train, Y_train)*100,'%')
```

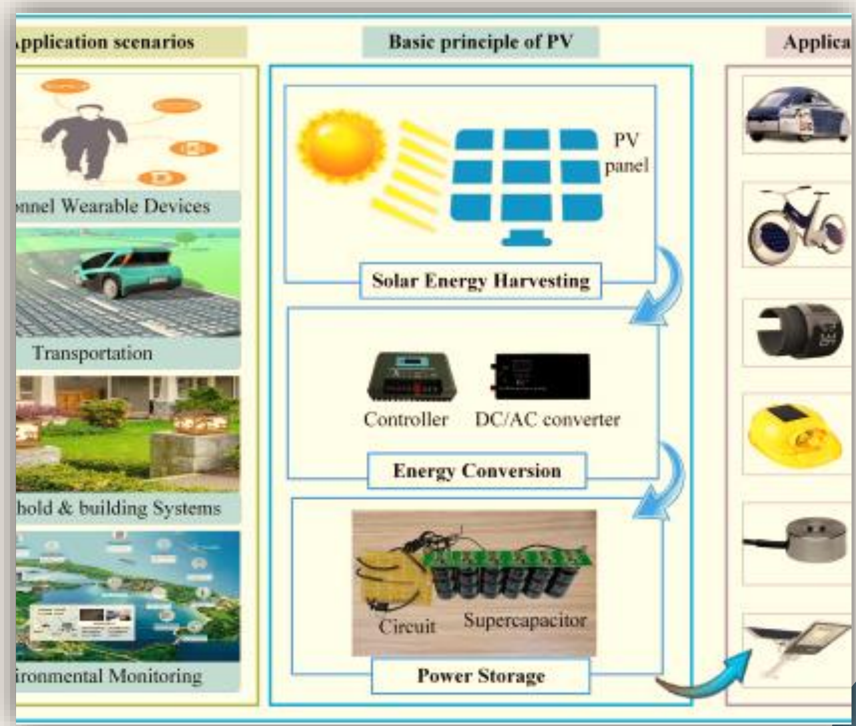
```
Accuracy for Train data sets
61.90414543792242 %
```

```
In [87]: print("Accuracy for Test data sets")
         print( lr.score(X_test, Y_test)*100,'%')
```

```
Accuracy for Test data sets
62.5918994079995 %
```

APPLICATIONS OF SOLAR RADIATION PREDICTION

1. **Renewable Energy Planning**: The accurate prediction can help solar power plants optimize their energy production and improve overall efficiency.
2. **Grid Management**: It enables grid to operates to better integrate solar energy into the grid, reduce reliance on fossil fuels, and improve grid stability.
3. **Climate Research**: Our model can contribute to climate research by providing valuable insights into solar variability and its impact on the Earth's climate system.
4. **Agricultural Management**: Farmers can use solar radiation predictions to optimize crop planting and harvesting times, leading to improved agricultural productivity.



FUTURE WORK OF SOLAR RADIATION PREDICTION

1. **Enhanced Data Collection**: Continuously improve our data collection methods to incorporate new sources of data and enhance the quality and reliability of our predictions.
2. **Model Refinement**: Refine our machine learning algorithms to improve prediction accuracy, particularly in challenging weather conditions.
3. **Global Scalability**: Further refine our model to make it more scalable and adaptable to different regions and climates around the world.
4. **Integration with Energy Systems**: Explore ways to integrate our solar radiation prediction model with energy systems to optimize energy production and consumption.

CONCLUSIONS

-A significant advancement in the field of renewable energy planning and grid management.

-By machine learning algorithms and high-resolution satellite data, we have developed a model that can accurately forecast solar radiation levels, even in complex weather conditions.

-This model has numerous practical applications, including optimizing energy production, improving grid stability, and advancing climate research.

-Through our project, we have demonstrated the potential of data-driven approaches to enhance the reliability and efficiency of solar energy systems.

However, there is still much work to be done to further refine our model and expand its capabilities.

-Future efforts will focus on enhancing data collection methods, refining machine learning algorithms, and integrating our model with energy systems to maximize its impact.

REFERENCES

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THANK YOU!