Sunshine Sleuth

SAT 16/2/2024

Skibidi Dopdop, Direct Director

Skibidi dop dop yes yes Company

Team Member

65110131	65110141	65110145	65110149
Akesit	Kunlanith	Paveetida	Rattapol
Akkharasaksiri	Busabong	Tiranatwittayakul	Kittirak

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Skidi Dop Dop, Marketing Director
Skibidi dop dop yes yes Company

Motivation

The global shift towards sustainable energy necessitates optimizing renewable sources, solar power is one of them. Solar cell efficiency is significantly impacted by environmental variables such as wind speed, atmospheric pressure, temperature, and sunlight duration. Predictive models leveraging historical meteorological data can enhance solar energy system performance, making them more reliable and economically viable.

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Scope

This project involves gathering and analyzing historical meteorological data to develop predictive models for solar cell power output. The focus is on designing, validating, and implementing these models into solar power systems for real-time optimization.
Additionally, the project explores opportunities for optimization, scalability, and evaluates the environmental and economic impact of integrating predictive models. The overarching goal is to enhance the efficiency and reliability of solar power systems, contributing to the advancement of renewable energy technologies.

Objective

To develop predictive models utilizing historical meteorological data for optimizing solar cell power output and integrating these models into solar power systems for real-time optimization, with a focus on enhancing efficiency, reliability, and economic viability. Additionally, to explore opportunities for optimization, scalability, and assess the environmental and economic impact of integrating predictive models, thereby contributing to the advancement of renewable energy technologies in alignment with the global shift towards sustainable energy.

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Evalutaion Methods

Data Collection

Collect historical weather data from reliable sources and gather solar cell efficiency records.

Model Selection

Use all model to appropriate machine learning models (linear regression, logistic regression, KNN, SVM, decision tree) and choose the best model. If there is more than one, weight the results.

Model Training

Train the selected models on the historical data to learn the relationships between weather parameters and solar cell efficiency.

Forecasting

Use the trained models to predict solar cell efficiency based on weather forecasts.

Result Interpretation

Interpret the results to understand the impact of weather parameters on solar cell efficiency.

Documentation

Document the entire process, including data collection, preprocessing, model selection, training, evaluation, and results, to facilitate reproducibility and future improvements.

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Weather Predictions ± 20%

Dataset

Number of solar

Watt per solar can produce

AVG. Temperature(°F)

AVG. Humanity

AVG. Wind speed

AVG. Pressure

Hours between sunrise & sunset

Suvarnabhumi Airport (bkk) Weather Forecast - Bangkok
Click here to visit the page.

Sunrise and sunset times in Bangkok, February 2024

Calculations of sunrise and sunset in Bangkok – Thailand for February 2024. Generic astronomy calculator to calculate times for sunrise, sunset, moonrise, moonset for many cities, with daylight saving time and time...

timeanddate.com

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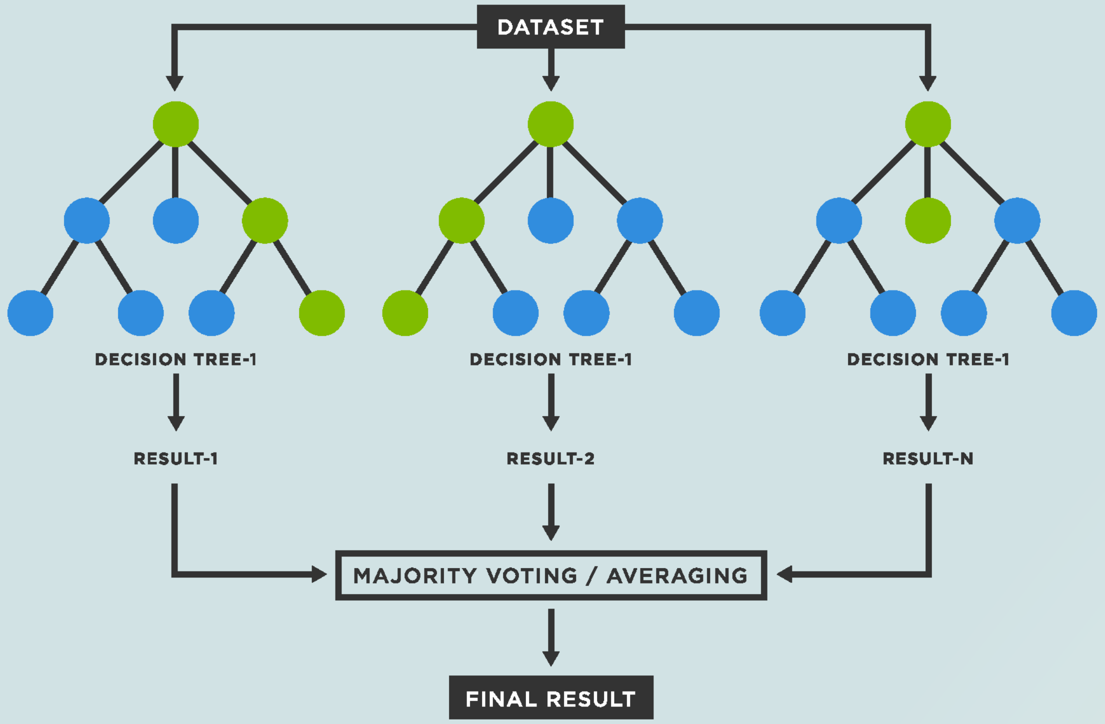
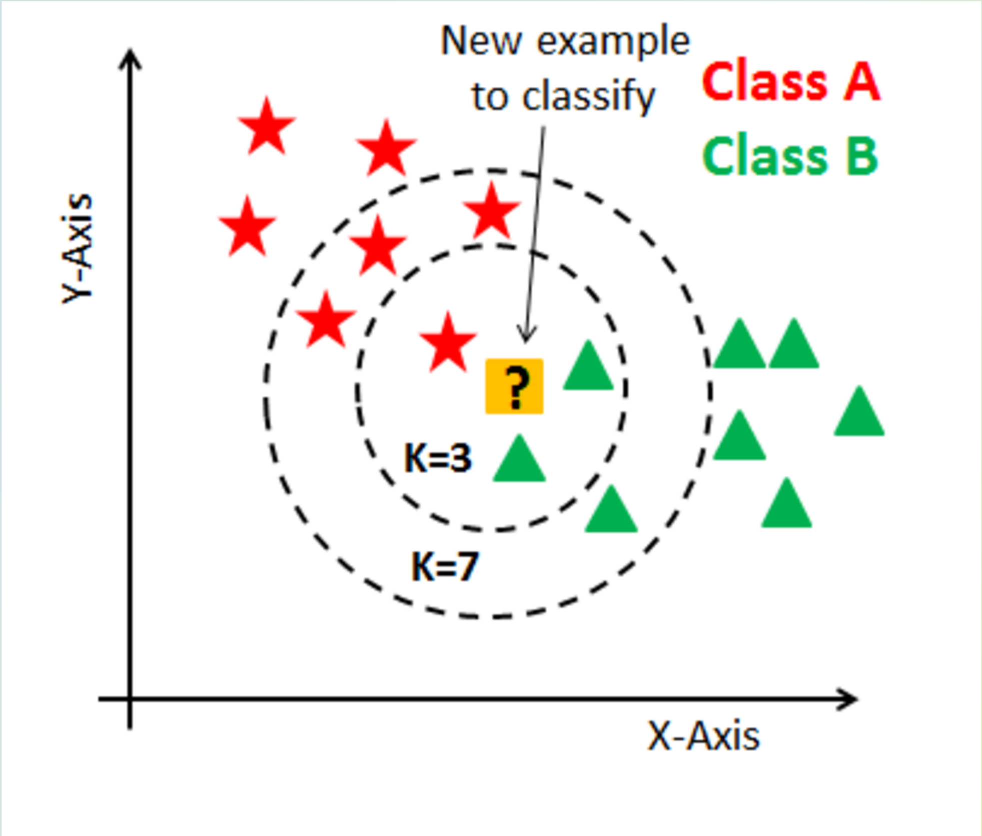
AI Techniques





k-nearest Neighbors Algorithm

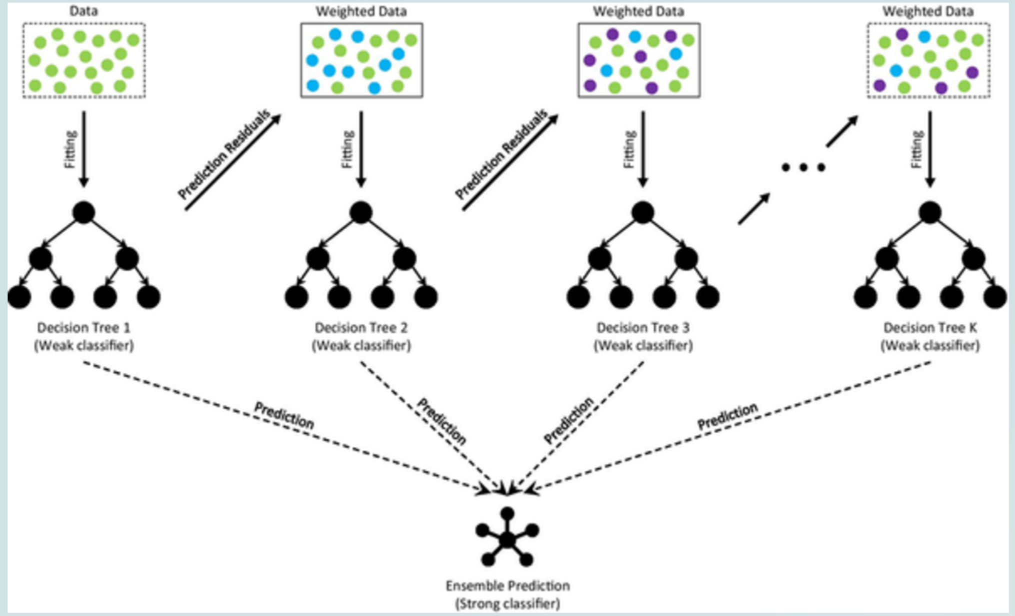
Random Forest Regressor

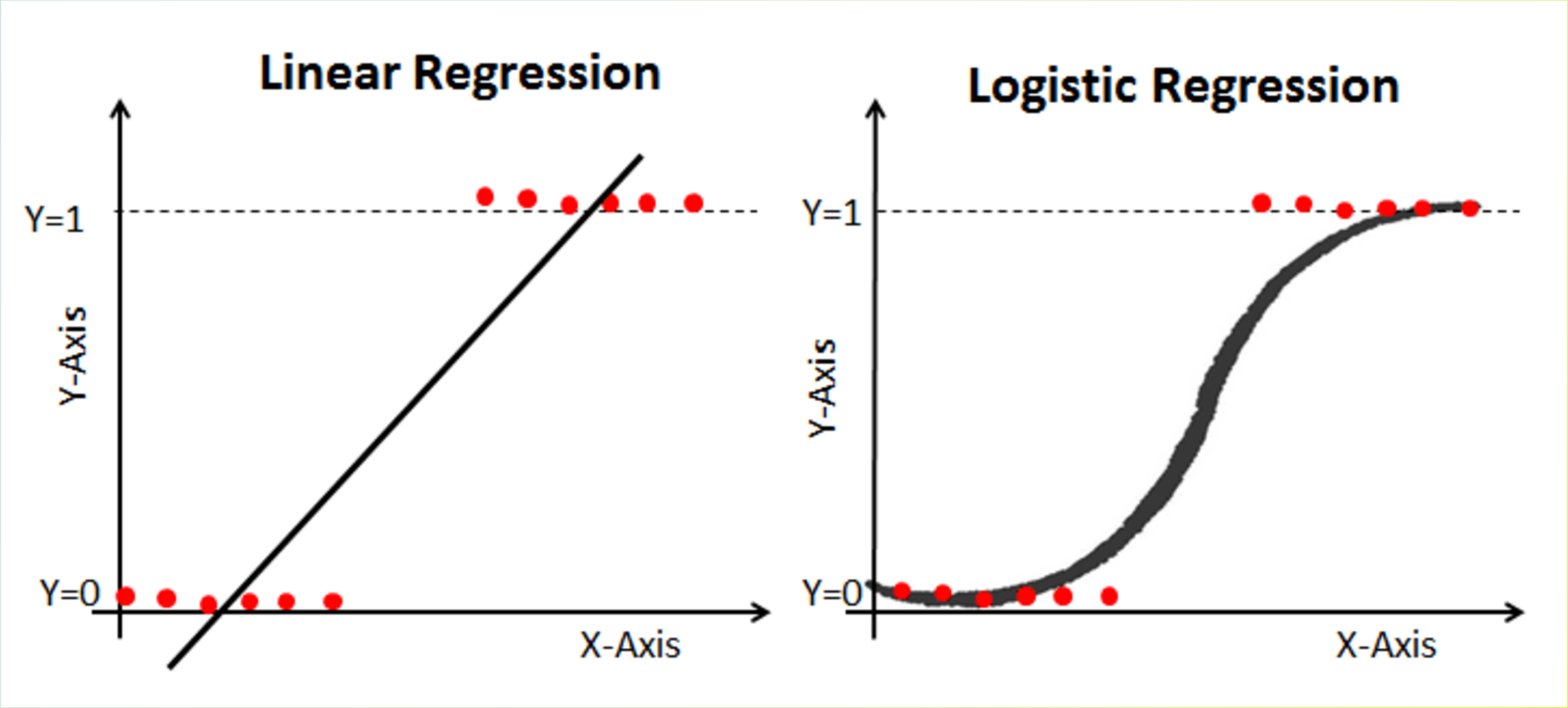
Gradient Boosting Regressor

Linear Regression

Decision Tree

Logistic regression





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AI Techniques

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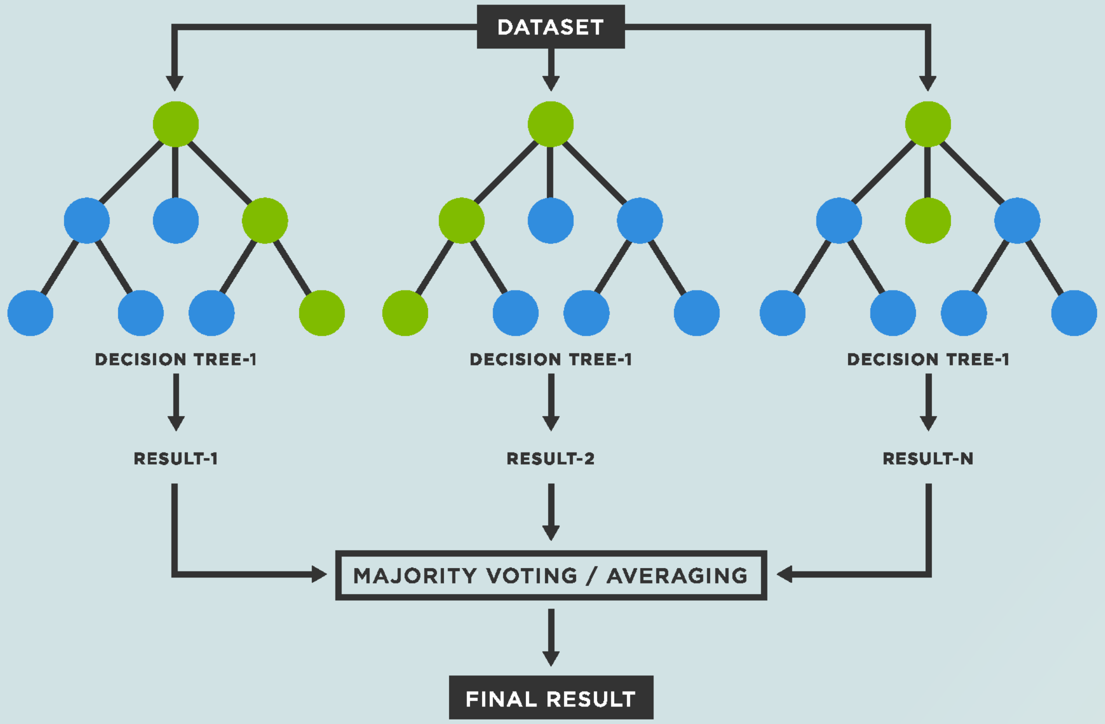

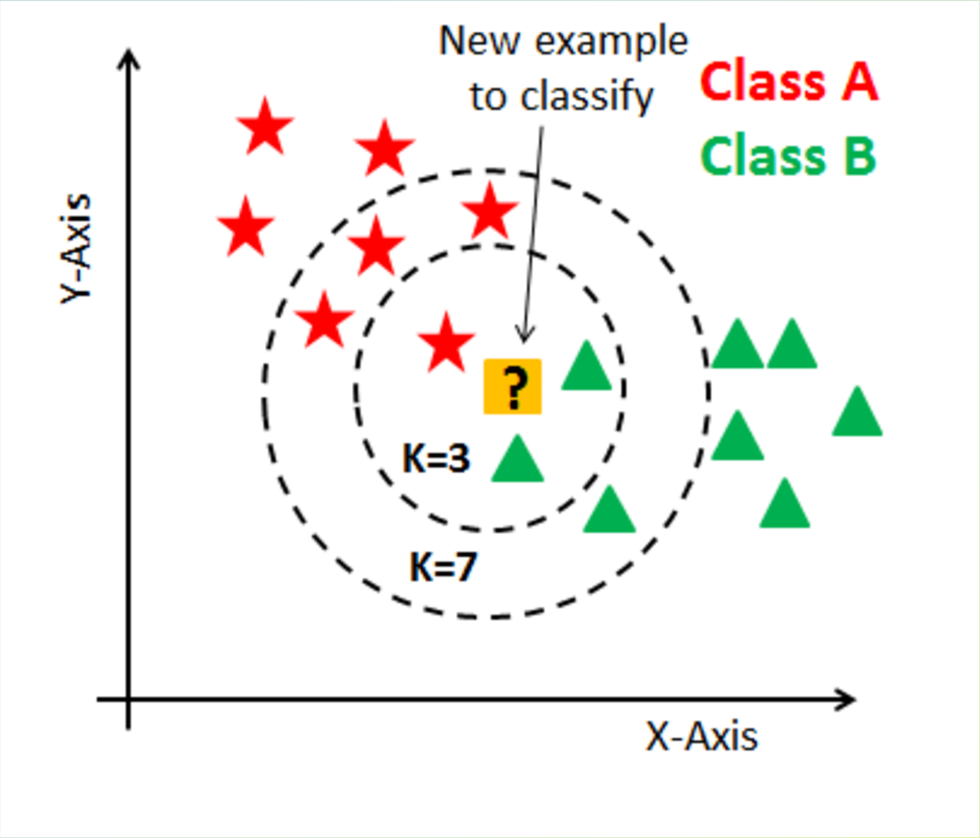

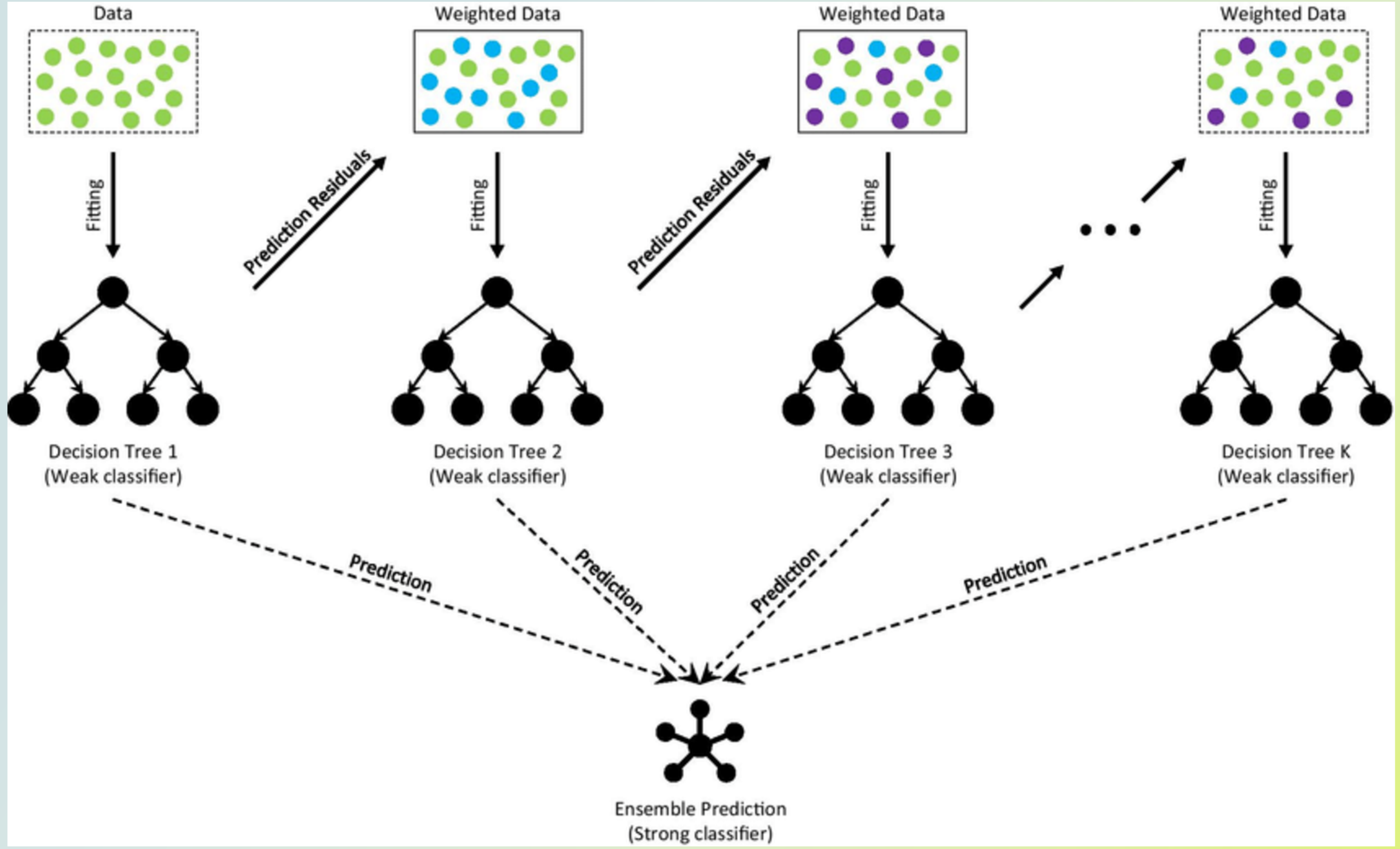

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AI Techniques

k-nearest neighbors algorithm

supervised learning method used for both classification and regression tasks. It operates by identifying the 'k' nearest neighbors to a new data point in the feature space and classifies or predicts its value based on the majority vote or average of these neighbors, respectively.

Random Forest Regressor

supervised learning algorithm designed for regression tasks. It builds multiple decision trees on different subsets of the dataset and combines their predictions to produce a more accurate and robust result.

Gradient Boosting Regressor

powerful ensemble technique used for regression. It constructs a series of decision trees sequentially, where each tree aims to correct the errors of its predecessor, resulting in a strong predictive model that optimizes a loss function.

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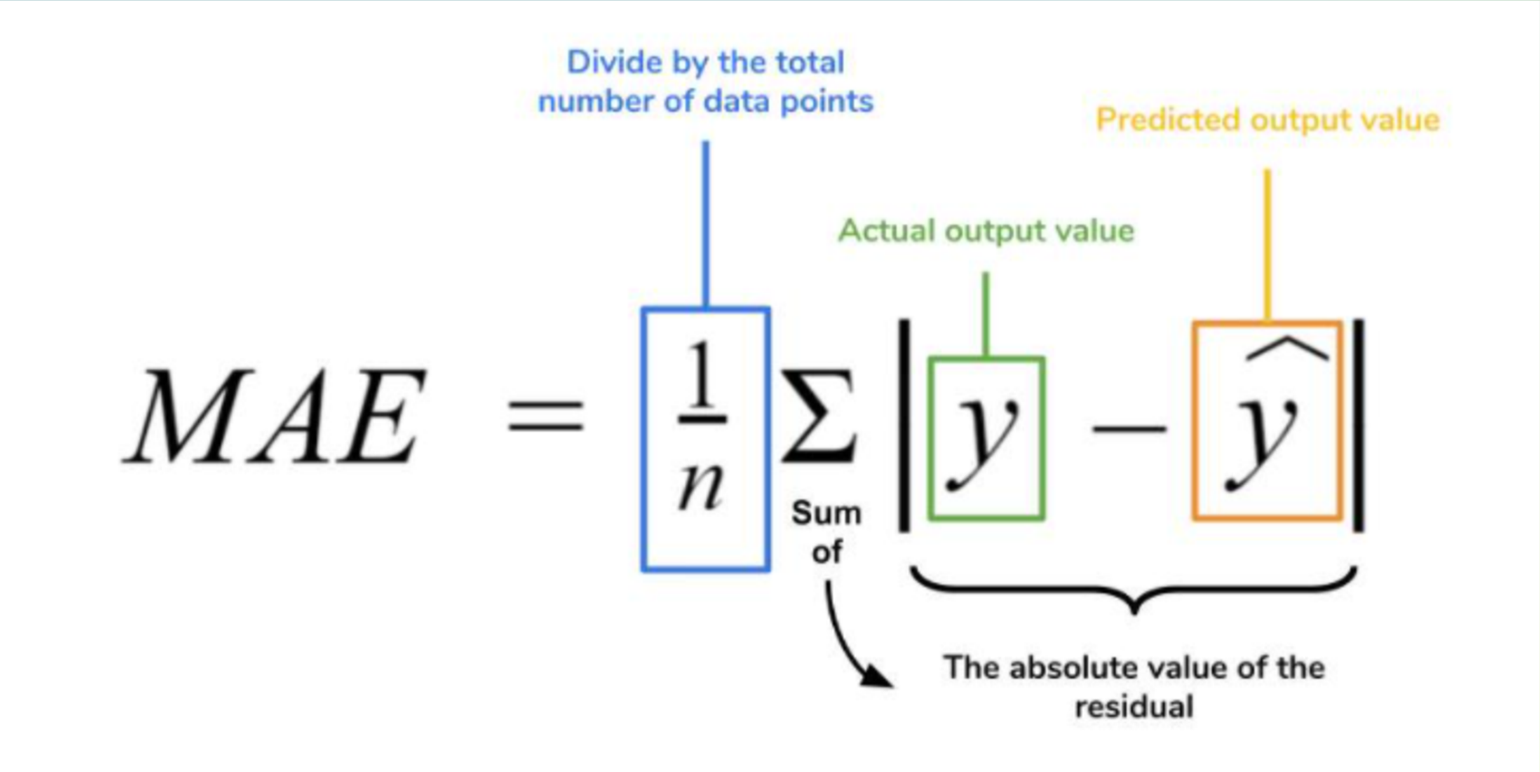
Weighting Techniques

Mean absolute error

It measures the average magnitude of the errors between the predicted values and the actual values, without considering their direction. It is calculated as the average of the absolute differences between the predicted values and the actual values.



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Result

	solar	watt	temp	humid	wind	pressure	hour	actual	pred	accuracy
1/2	24,	500,	84.1,	71,	6.6,	29.9,	11.32,	17.28	19.32	88.21%
2/2	24,	500,	85.1,	67.8,	8,	29.9,	11.33,	15.97	18.17	86.24%
3/2	24,	500,	85.3,	70.5,	9.7,	29.9,	11.33,	20.28	19.47	103.99%
4/2	24,	500,	85.9,	69.6,	8.7,	29.9,	11.34,	18.62	18.57	100.28%
5/2	24,	500,	86.5,	69.5,	7,	29.9,	11.34,	15.14	18.90	75.20%
6/2	24,	500,	86.3,	70.3,	8.1,	29.9,	11.35,	24.54	19.34	121.20%
7/2	24,	500,	85.7,	69.8,	7.7,	29.9,	11.36,	25.93	20.35	121.52%
8/2	24,	500,	85.7,	69.3,	9.5,	29.8,	11.36,	25.45	18.68	126.62%
9/2	24,	500,	85.9,	68.2,	10.1,	29.9,	11.37,	25.30	22.10	112.64%
10/2	24,	500,	86.3,	64.7,	7.7,	30,	11.38,	17.86	21.50	79.62%
11/2	24,	500,	82.9,	49.8,	9.7,	30,	11.38,	24.21	22.66	106.41%
12/2	24,	500,	82,	50.9,	8.1,	30,	11.39,	23.25	22.82	101.84%
13/2	24,	500,	83.8,	50.8,	7.4,	30,	11.4,	24.86	23.29	106.30%
14/2	24,	500,	85.5,	54.8,	5.5,	29.9,	11.4,	23.75	24.40	97.28%
15/2	24,	500,	86.3,	66.2,	7.2,	29.9,	11.41,	18.59	20.76	88.34%
16/2	24,	500,	86.2,	68.4,	7.7,	29.9,	11.42,	19.46	21.52	89.43%
17/2	24,	500,	84.4,	71.6,	9.5,	29.9,	11.42,	21.82	22.09	98.76%
18/2	24,	500,	85,	66.3,	11.4,	29.9,	11.43,	21.2	24.36	85.11%
19/2	24,	500,	84.9,	68.3,	10.5,	29.9,	11.44,	23.31	25.50	90.59%
20/2	24,	500,	85.9,	67.5,	11.6,	29.9,	11.44,	25.90	25.99	99.66%
21/2	24,	500,	86.2,	64.7,	14.2,	29.8,	11.45,	27.11	26.16	103.50%
22/2	24,	500,	86.7,	64.5,	12.3,	29.9,	11.46,	22.85	25.96	86.37%
23/2	24,	500,	86.7,	66,	10.8,	29.9,	11.47	23.27	24.66	94.03%
24/2	24,	500,	86,	49.6,	12.06,	29.9,	11.47,	22.37	27.38	77.61%
25/2	24,	500,	86.5,	50,	11.43,	29.9,	11.48,	19.91	22.24	88.27%
26/2	24,	500,	86.5,	47.2,	12.43,	29.9,	11.49,	19.06	18.92	100.72%
27/2	24,	500,	88.3,	70.20	6.20	29.9,	11.50,	21.59	23.18	92.62%
28/2	24,	500,	84,	69,	11,	29.8,	11.50,	19.84	25.62	70.89%
29/2	24,	500,	84,	74,	11,	29.8,	11.51,	23.29	20.31	112.80%

CODE + EXAMPLE

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