Data Science End to End Project

Rain Prediction Using Machine Learning

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Business Background and Objectives

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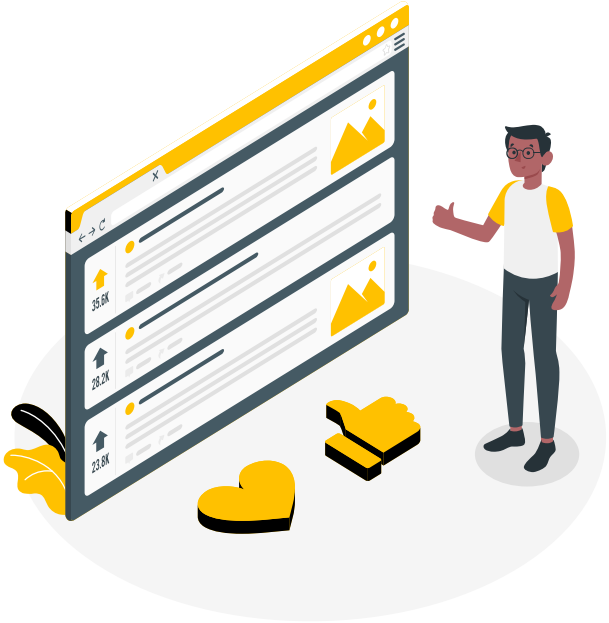
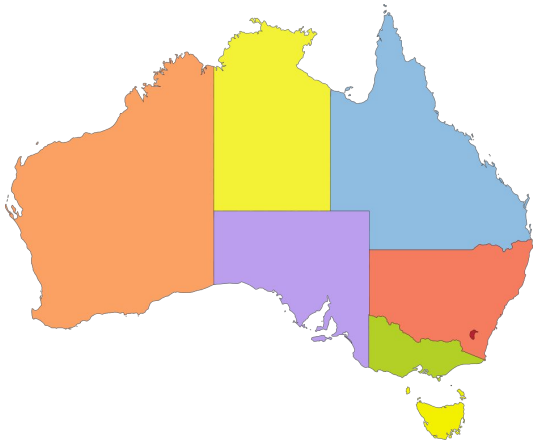


Introduction and Problems

The weather has a significant impact on many life aspects, one of which is agricultural industry and because of that, being able to predict it helps farmers in their day-to-day decisions such as how to plan efficiently, minimize costs and maximize yields.

A major agricultural company needs to have an accurate **rain prediction algorithm** that will improve their decision-making on typical farming activities such as **planting** and **irrigating**.

Using historical rain information from Australia regions in 10 years as research data, it is necessary to **predict** weather(**rain**) in next day.



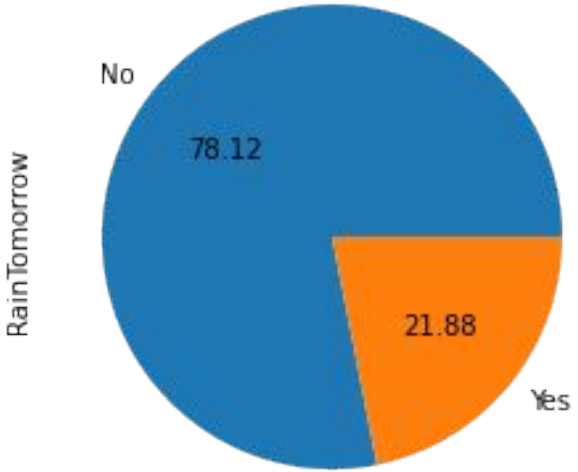
Objectives

- What factors and conditions in current day that will cause rain in the next day?
- What machine learning algorithms are suitable for predicting rain in the next day?
- Where is the location that has the highest frequency of rain?
- What is the impact of the predictive model for business problems that operating in the agricultural sector?

Data Preparation

02

Overview



Target distribution is **imbalance**, I will use **AUC** as model metric evaluation

Data contains **145460 rows** with **22 features** and **1 binary column** with **RainTomorrow** as **target**.

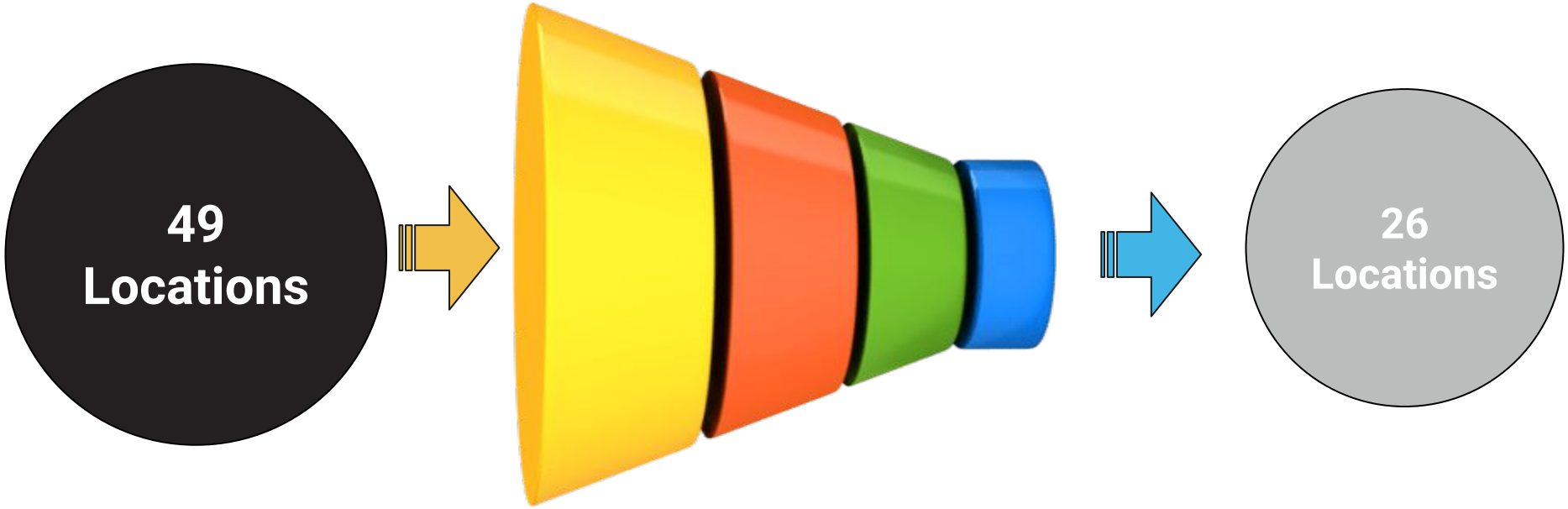
All features are the weather and climate elements that occur on that day in certain location that are used to predict rain in the next day.

Features consist **6 categorical** features, and **16 numerical** features (Date will be transform to datetime format).

Numerical Features		Categorical Features
• MinTemp • MaxTemp • Rainfall • Evaporation • Sunshine • WindGustSpeed • WindSpeed9am • WindSpeed3pm	• Humidity9am • Humidity3pm • Pressure9am • Pressure3pm • Cloud9am • Cloud3pm • Temp9am • Temp3pm	• Date • Location • WindGustDir • WindDir9am • WindDir3pm • RainToday

Dataset obtained from **kaggle**.

Location Feature Filtering

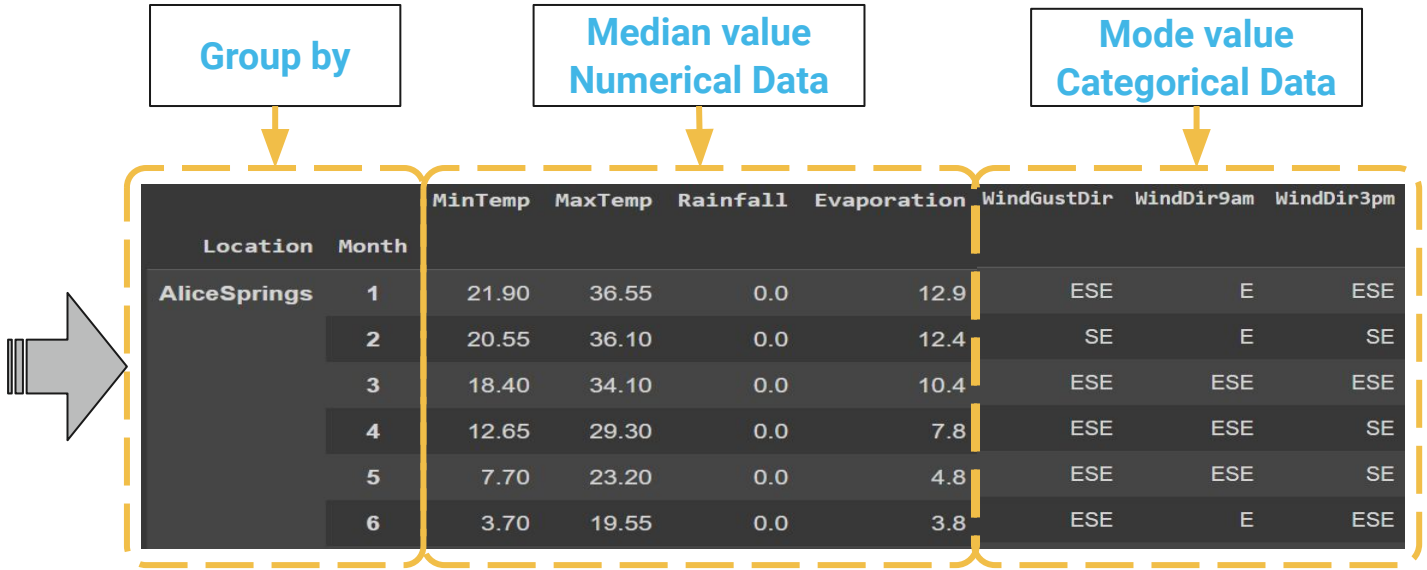


There are some **features** in certains locations that values is **completely missing** in 10 years observation. I decide to drop those locations.

Missing Values Handling

Missing Values Ratio

Location	0.000000
Month	0.000000
Year	0.000000
Day	0.000000
MinTemp	0.705897
MaxTemp	0.688406
Rainfall	2.153923
Evaporation	11.068216
Sunshine	17.833583
WindGustDir	3.445777
WindGustSpeed	3.413293
WindDir9am	3.516992
WindDir3pm	1.136932
WindSpeed9am	0.864568
WindSpeed3pm	0.845827
Humidity9am	1.101949
Humidity3pm	1.014493
Pressure9am	1.444278
Pressure3pm	1.434283
Cloud9am	10.805847
Cloud3pm	12.435032
Temp9am	0.770865
Temp3pm	0.715892
RainToday	2.153923
RainTomorrow	2.160170



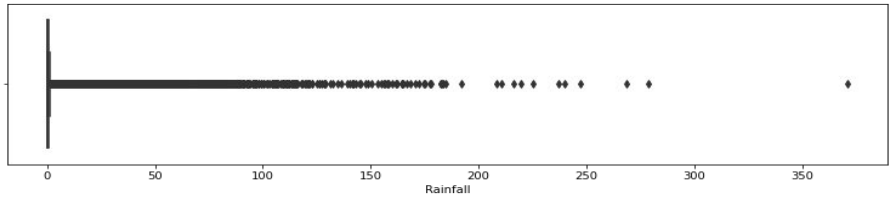
Location	Month	MinTemp	MaxTemp	Rainfall	Evaporation	WindGustDir	WindDir9am	WindDir3pm
AliceSprings	1	21.90	36.55	0.0	12.9	ESE	E	ESE
	2	20.55	36.10	0.0	12.4	SE	E	SE
	3	18.40	34.10	0.0	10.4	ESE	ESE	ESE
	4	12.65	29.30	0.0	7.8	ESE	ESE	SE
	5	7.70	23.20	0.0	4.8	ESE	ESE	SE
	6	3.70	19.55	0.0	3.8	ESE	E	ESE

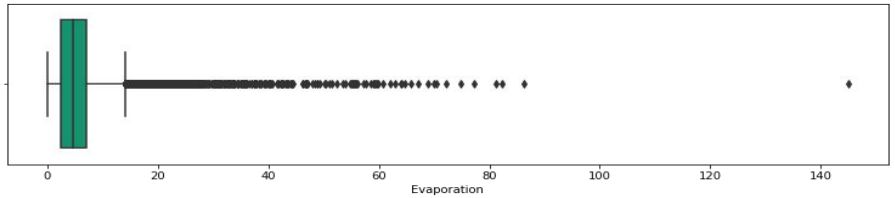
Fill missing value by **median** value for **numerical** data and **mode** value for **categorical** data based on each **Location** and each **Month**.

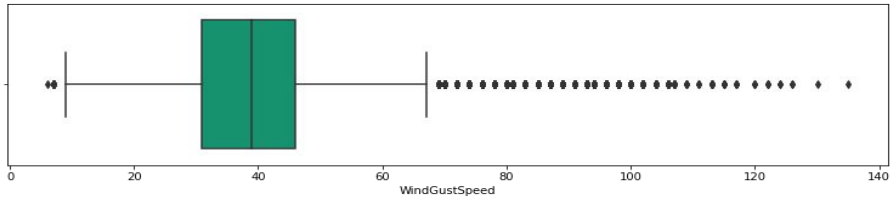
Exploratory Data Analysis (EDA)

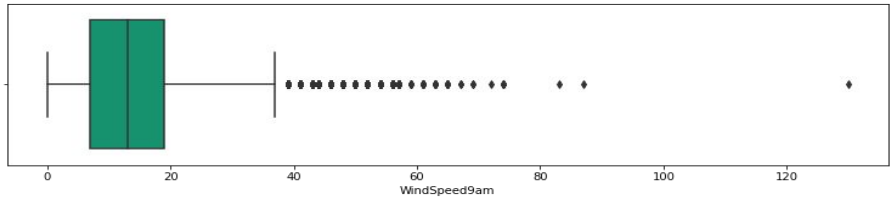
03

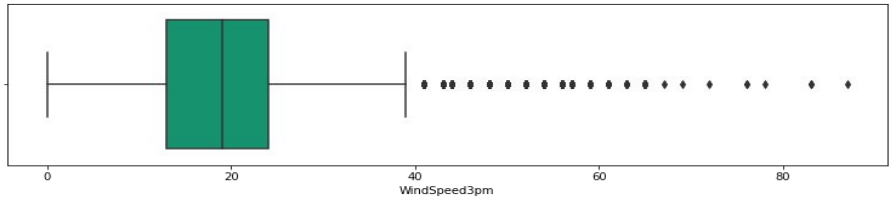
Outliers Detection

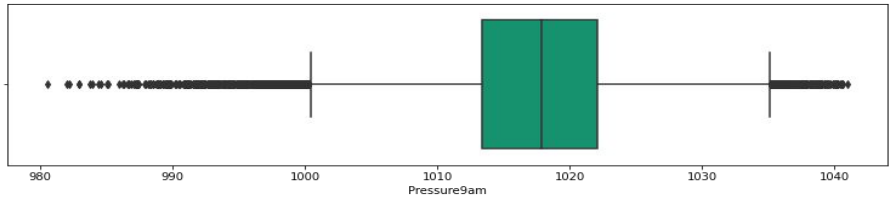


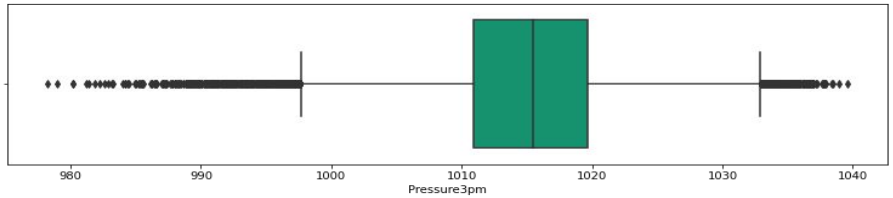






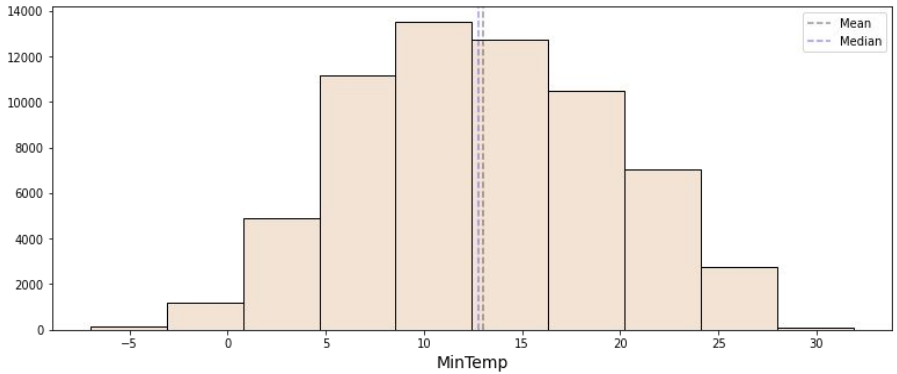


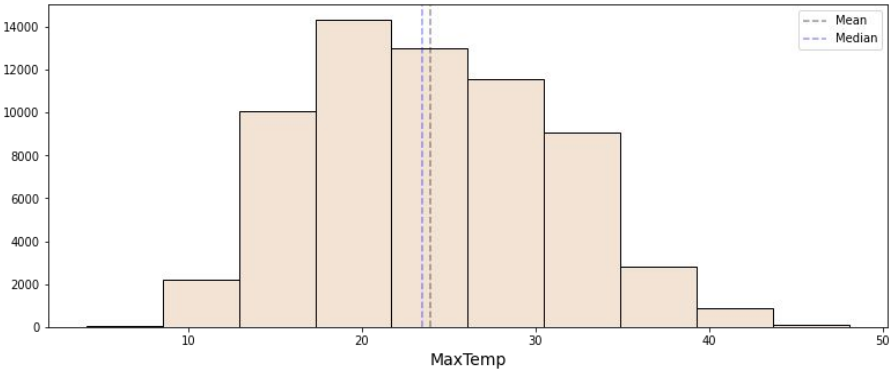


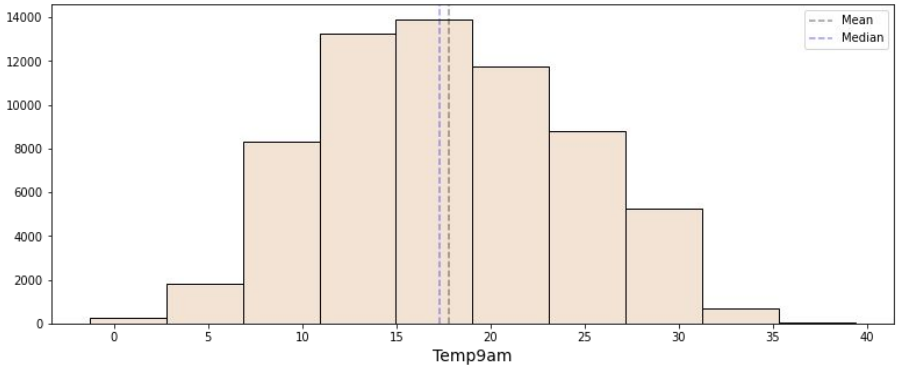


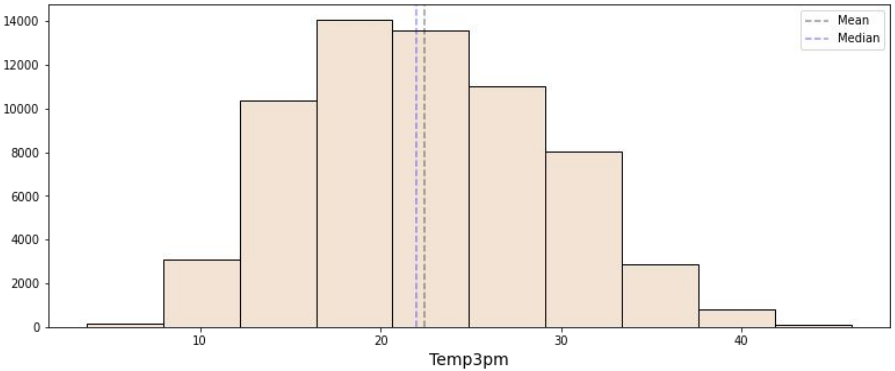
Seven features have extreme **outliers** and need to removed based **IQR** (Interquartile Range) **upper** and **lower** limit.

Temperature Aspects



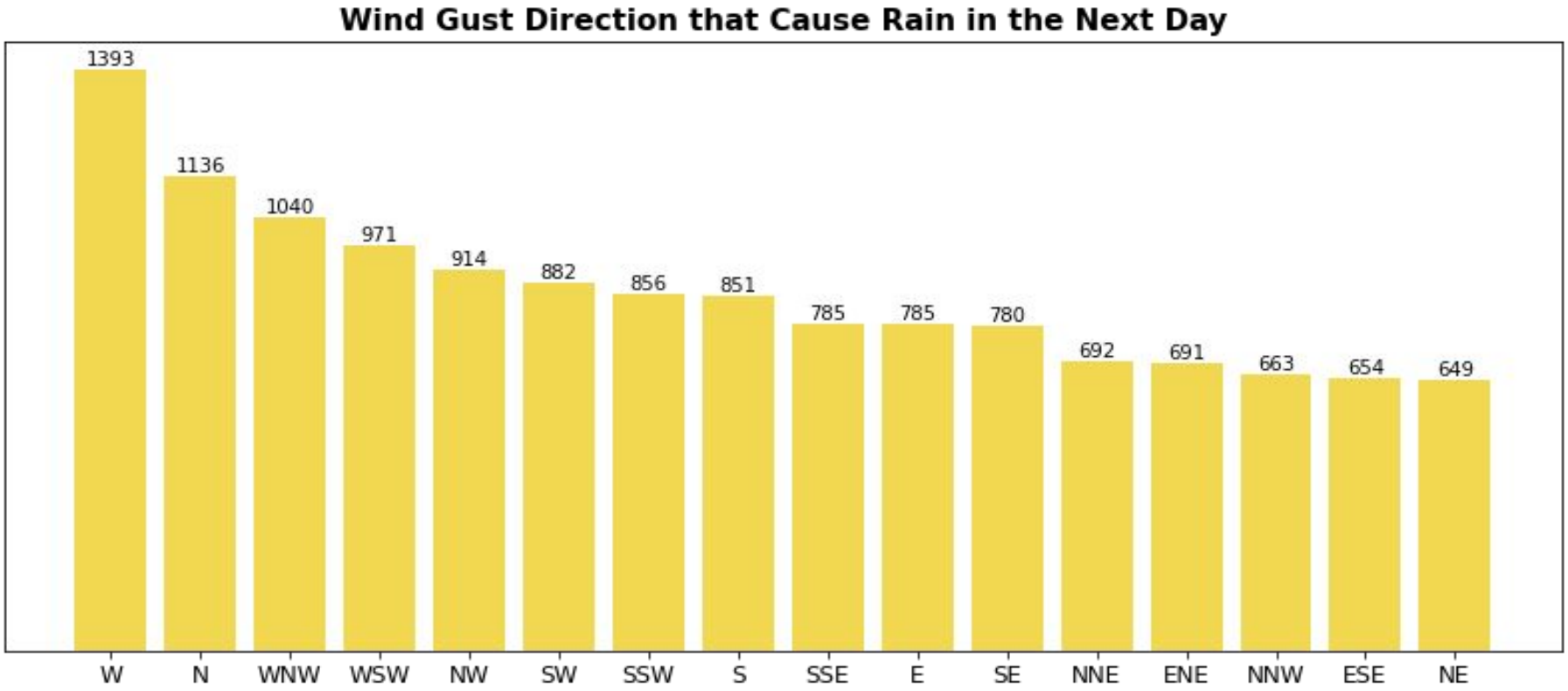






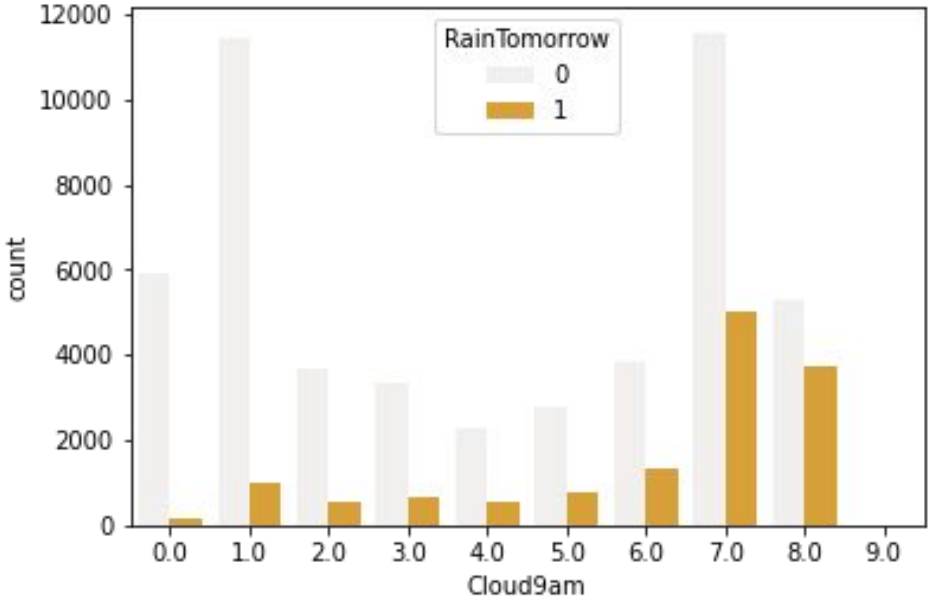
Temperatures in Australia regions have range **around** from **10** until **30 degrees Celsius**. The data **distribution** quietly **normal**. We can conclude temperature in Australia regions relatively **stable**.

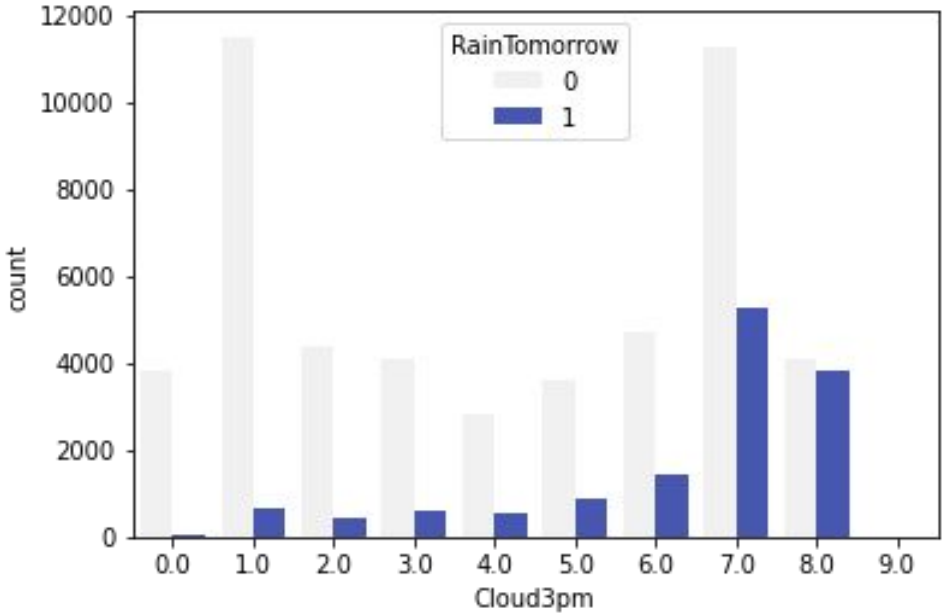
Wind Gust Direction



Rain is tend to happens in the next day majority when direction of **wind gust** in between **West** to **North**.

Fraction of Sky Obscured by Cloud (in Oktas)





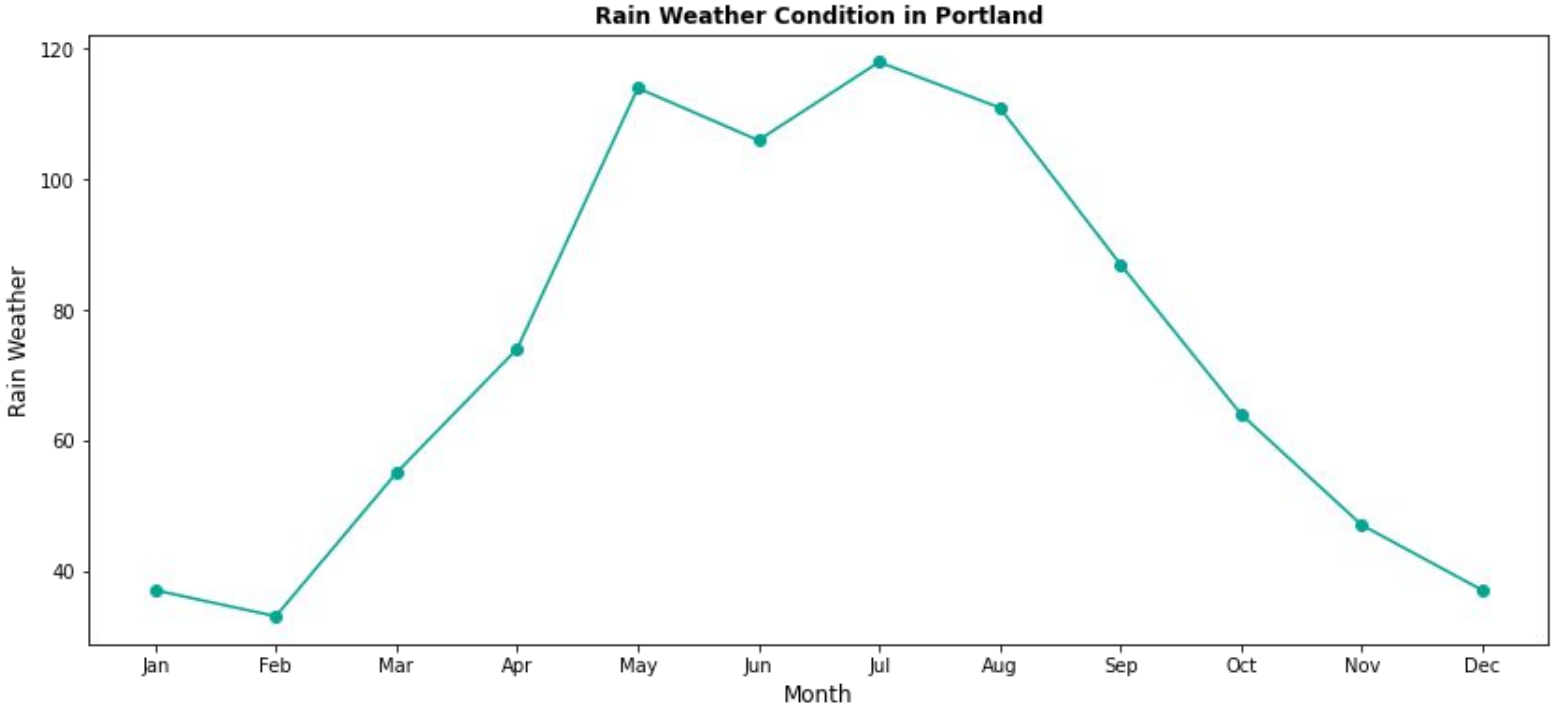
Sky in Australia mostly **cloudy** (Fraction of sky obscured by cloud is **7 oktas**).
Rain in the next day tend to happen when **cloud** in **9am** and **3pm** is **7** or **8 oktas**.

(Reference: Worldweather)

Rain Condition Based on Locations

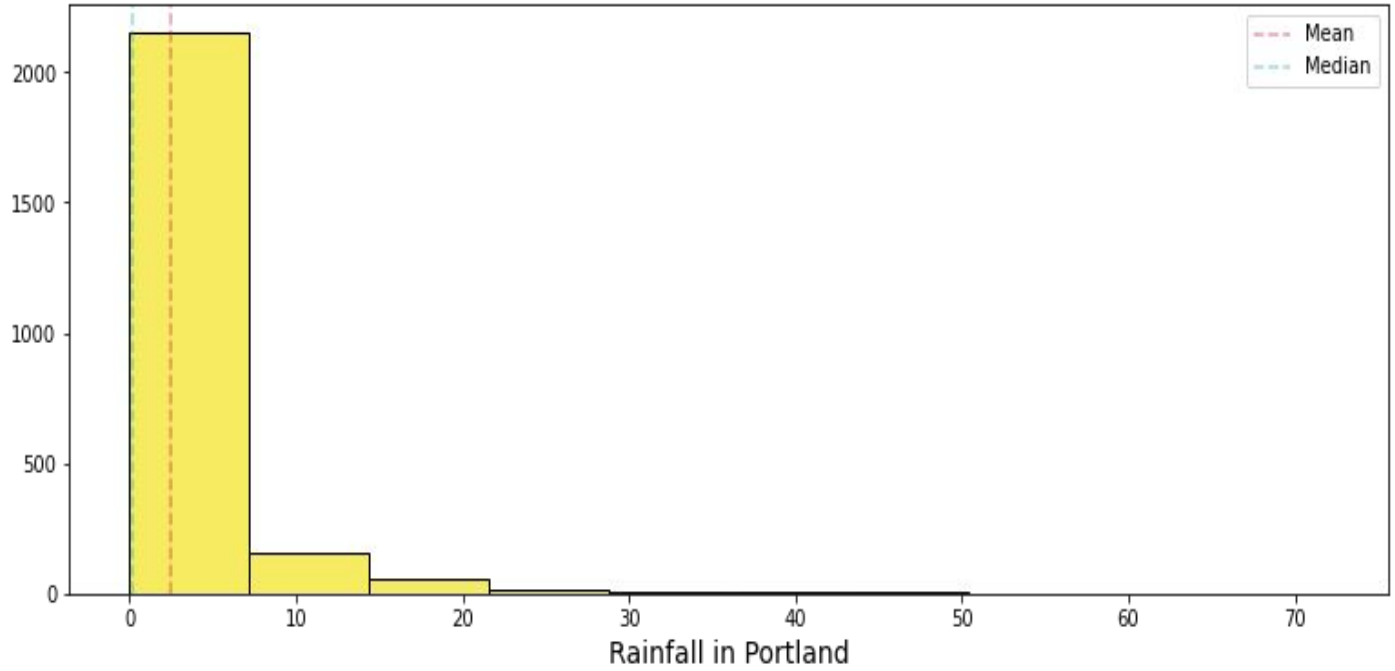
Portland is the location in Australia that **experiences** the **most rain**. It means Portland become the location with the enough water source.

Rain Condition in Portland



Rain in **Portland** is **most common** to happen from **May** to **August**. We can conclude that these period is the **rainy season** in Portland.

Amount Rainfall in Portland

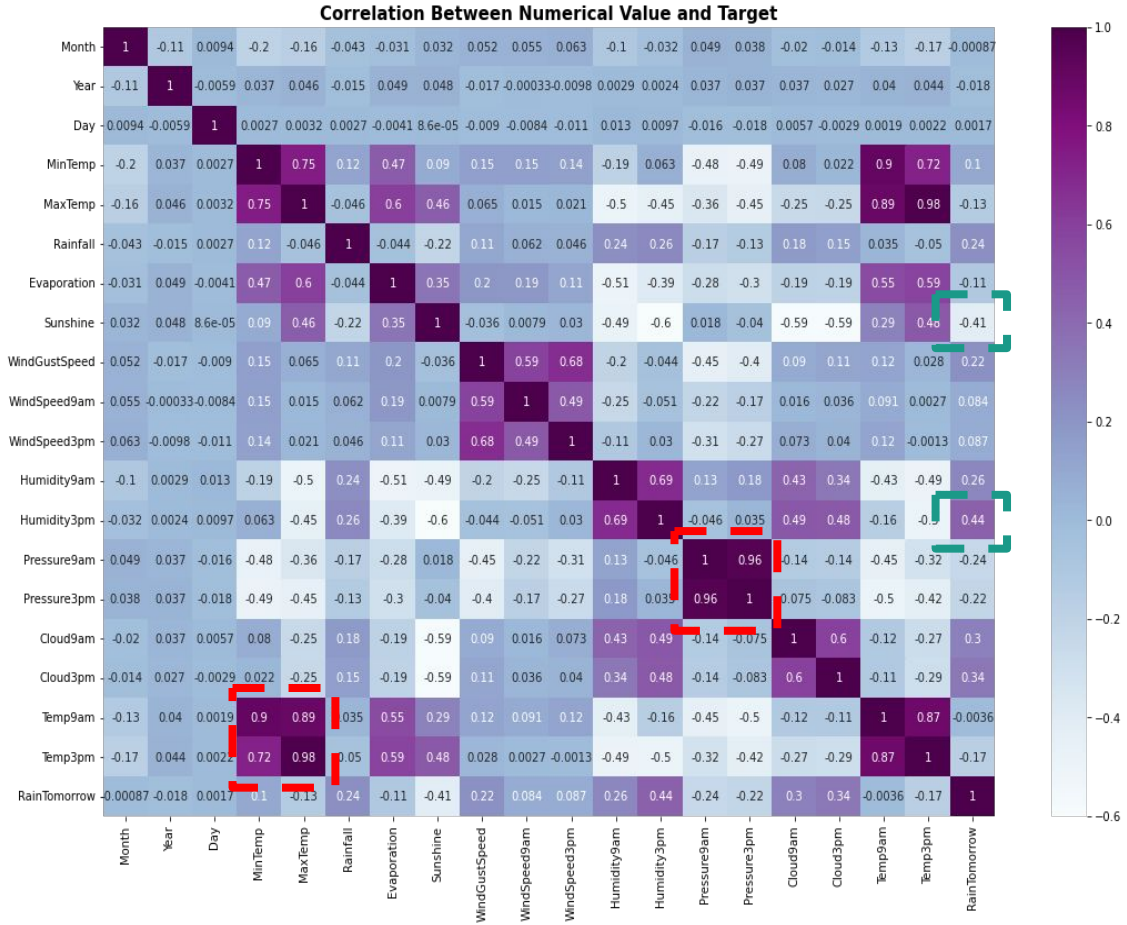


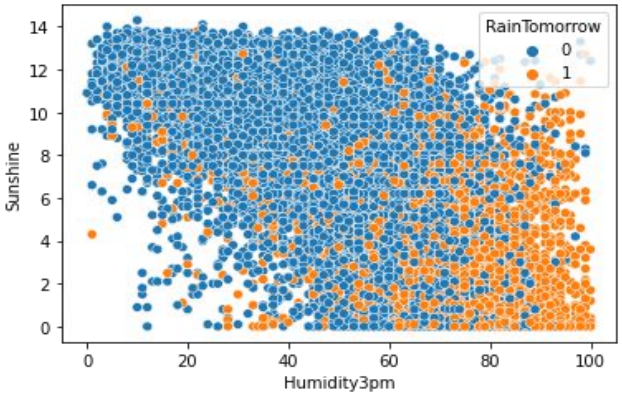
Mean : 2.49 mm

Median : 0.2 mm

Amount of **Rainfall** in Portland majority in range around **0 - 8 mm**
with average of rainfall amount is **2.49 mm**

Multivariate Analysis





- **Humidity3pm** (**positive correlation**), and **Sunshine** (**negative correlation**) are the features that have the **highest correlation** with **target**.
- There are **multicollinearity** that correlated with **Temperature** and **Pressure** aspects.
- **Pressure9am** and **Temp3pm** have **higher correlation** with **target**. These two features will be kept for modelling.
- When **Humidity3pm** ratio is high and number of hours of bright **Sunshine** is low, **rain** in the next day tend to **happen**.

Feature Engineering

04

Feature Engineering

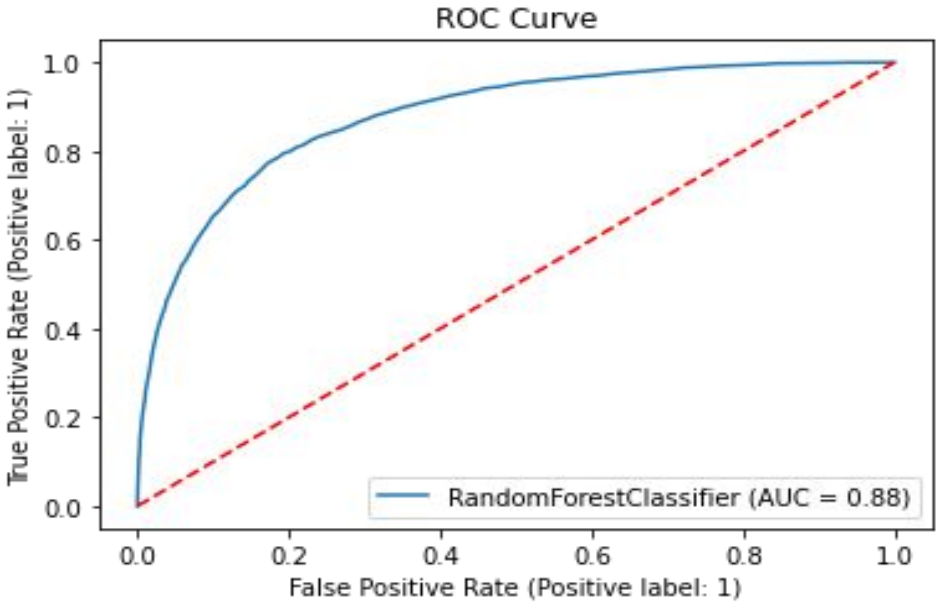
Aspects	Action
Categorical features	Categorical feature with 2 distinct values -> Binary Encoding Categorical with more than 2 distinct values -> One Hot Encoding
Drop Features	Multicollinearity -> Pressure3pm, MinTemp, MaxTemp, and Temp9am Don’t contribute for modelling -> Year
Imbalance Data	Resampling use Undersampling
Scaling	Min-Max Scaler

Modelling and Evaluation

05

Modelling

Model	AUC
K-Nearest Neighbors	78%
Logistic Regression	87%
Decision Tree	71%
Random Forest	**88%**
XG-Boost	87%



I split dataset become **train** and **test** data with **80:20** proportion. Since the data is **imbalance**, I use **AUC** (Area Under Cover) instead.

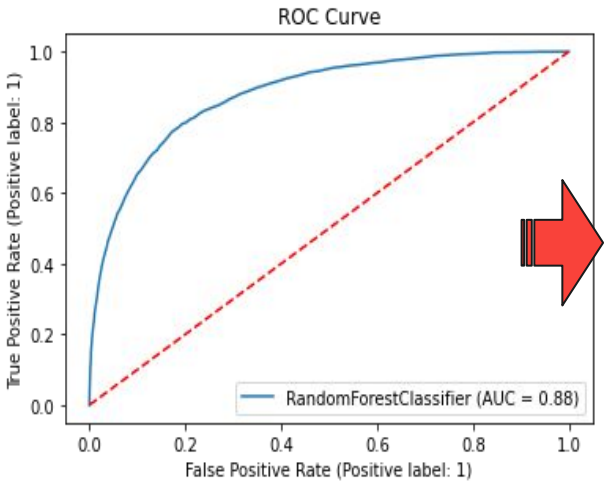
Random Forest have the best **AUC** score compared than other models.

Hyperparameter Tuning

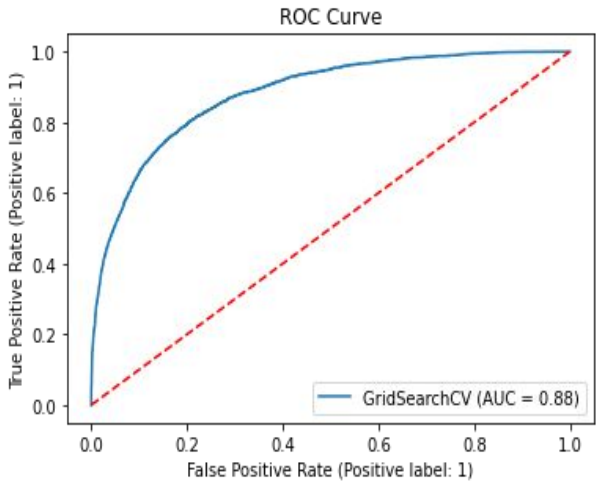
Random Forest Algorithm	AUC
Before Tuned	88%
After Tuned	88%

Overall, the **AUC** score before and after **tuned** is relatively same.

Before Tuned

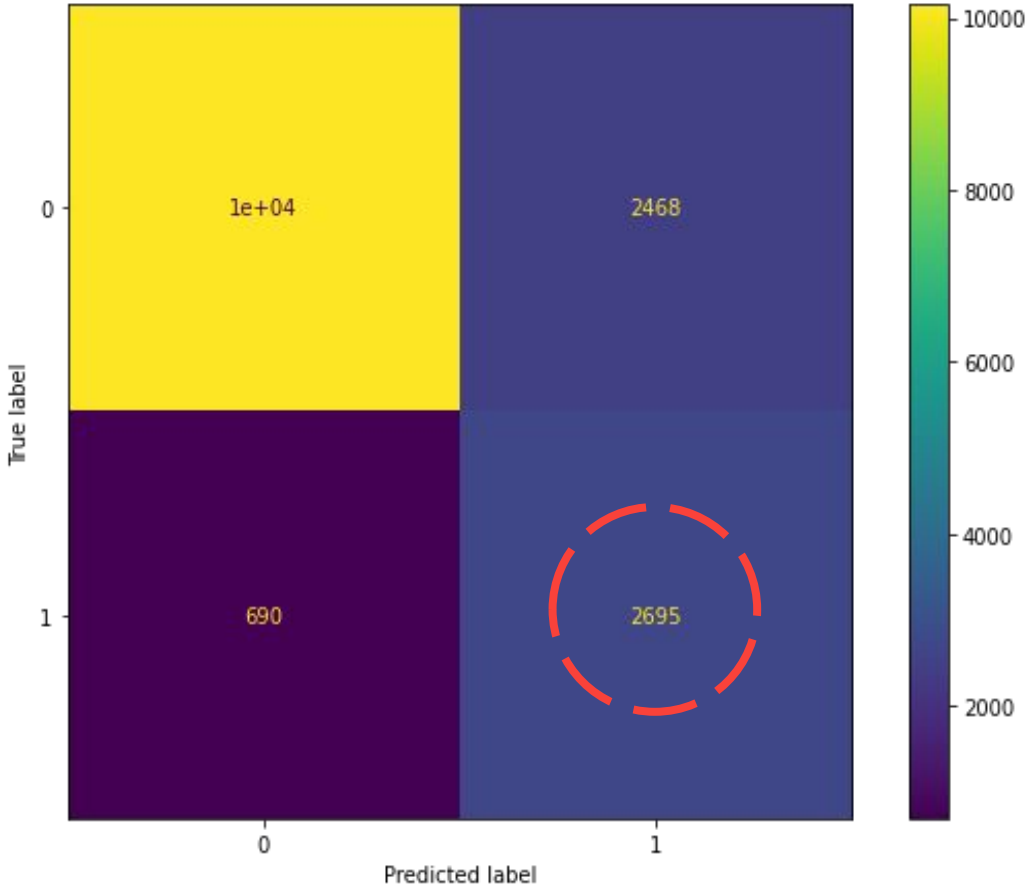


After Tuned



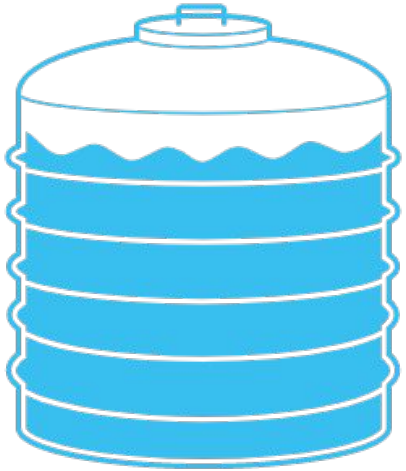
ROC curve from before and after tuned also didn't really have differences. It means before tuned, the model already have optimum performance. But still, **hyperparameter tuning** is essentials part for **controlling model behavior**. It's also very important to **avoid** model **overfitting**.

Confusion Matrix



From confusion matrix we can analyze model have **True Positive Rate** by **80%**. It means, from **3385 days** when our model predict will be rain, **2695 days** it really rained.

Potential Impact in Business



We can do simulation our predictive model for business in the agricultural sector in Australia. For example, water supply costs for irrigation 1000 hectares rice field in dry season.

Before

Water needs = 1917 Liter/month
Price of water = 0.29 USD/m^3
Cost for water = 555,930 USD

After

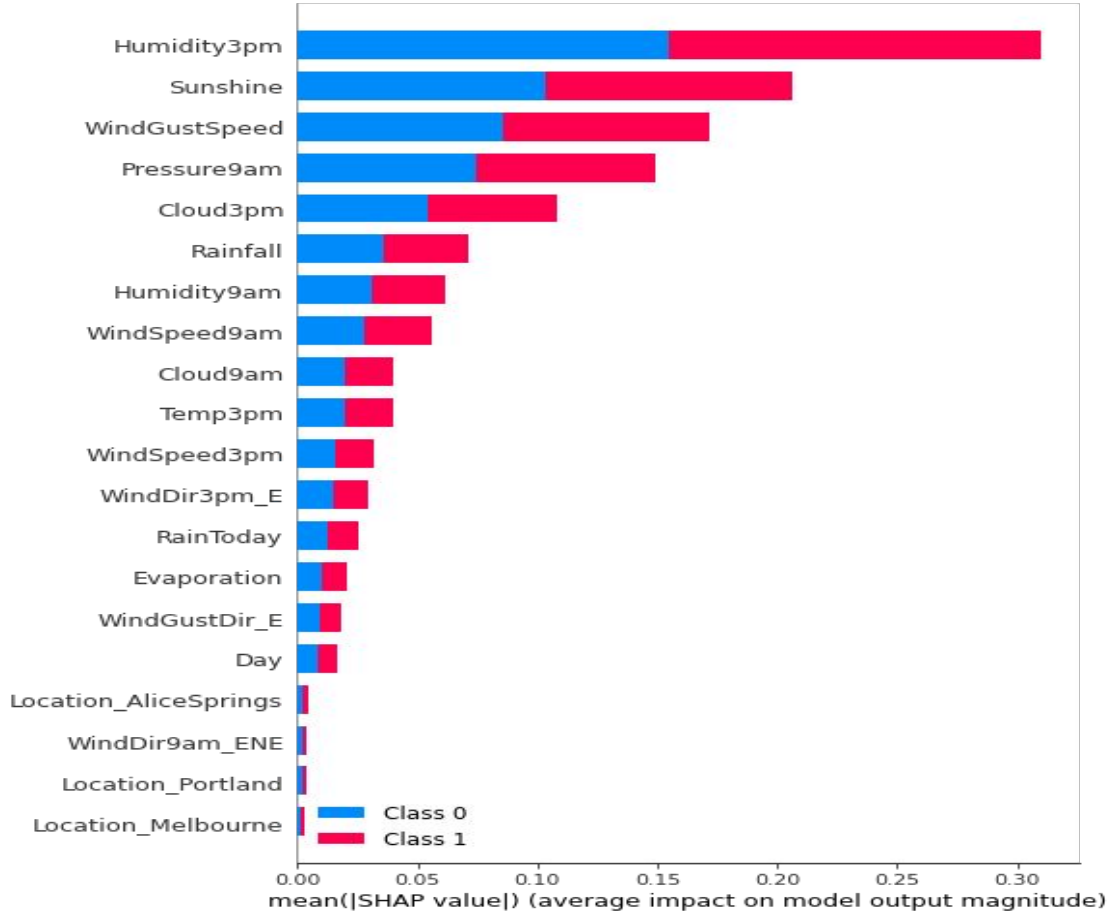
Water needs = 1319 Liter/month
Price of water = 0.29 USD/m^3
Cost for water = 382,626 USD

SAVING

$ 173,304 (31%)

on water supply for irrigation per month

Feature Importances



Based on **SHAP** value, **Humidity3pm** and **Sunshine** feature have the highest effect on the prediction. It's same with heatmap correlation.

Conclusion and Recommendation

06

Conclusion

- Based on Heatmap and SHAP values for feature importances, Humidity at 3pm and Sunshine has the big impact to cause rain in the next day.
- Random Forest classifier is the best model algorithm for predicting rain the next day because have the highest AUC score than other classifier algorithm.
- The location with the most rain frequency is Portland with rain season tend to happen in May until August.
- Based on simulation, model performance can help saving company cost for water supply by 31%.

Recommendation

If we want to start running the company that operating in agricultural sector, I think Australia regions is become one of the good choice since the temperature is relatively stable. Many agricultural products that can grown well based on those temperatures range. Also, I think Portland is the best location due to high rain frequency in a year, because it's very helpful for doing farming activities, such as planting and irrigation.

The best time for harvesting and make as much water stock is May until August. So, when the dry season comes, we won't too worried about lack of water and still can do activities like irrigation and farm will not easily to drought.

As a model evaluation, model have good performance and as performance trial, it would be better if the model was applied in Portland as the location with the highest rainfall frequency.

Thank You

Documentation
https://github.com/aldimeolaalfarisy/Rain-Prediction-Using-Machine-Learning