Classification of Stingless Bee Honey

Data Science Project

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INTRODUCTION

Stingless Bee, *Meliponini*

Stingless bee genus contains 500 species, most of which are found in Latin America, mainland Australia, Africa, Eastern and Southern Asia, and the Middle East (Abd Jalil, 2017)

Very crucial to the environment, the economy, and culture with the role of the primary pollinators for a variety of tropical wild and domesticated plants

As Antioxidant

Phenolic acids found in stingless bee honey, potent antioxidant that can accelerate the healing of wounds by promoting the proliferation of new cells.

As Antimicrobial

Non-peroxide activity affects the antibacterial impact of stingless bee honey that is responsible for preventing microbial growth.

As Anti-inflammatory

An enzyme named 5-LOX which is necessary for the production of proinflammatory mediators, is inhibited by the cerumen of honeys.

BACKGROUND

While there are numerous researches conducted internationally, further researches specifically in the domain of local stingless bee honey are needed to strengthen the local commercial industry of biological consumables in terms of purity and authenticity. Additionally, there are still no standards of general practise and/or quality for this kind of honey. (Pimentel et al., 2021).

This project aims to deliver an interactive dashboard which could assist potential customers of stingless bee honeys.

PROBLEM STATEMENTS

Influence of chemical composition in stingless bee honey

Unsure of the correlation between chemical compositions of honey and the antioxidant activities in samples.

Acknowledge regarding different species of stingless bee honey

The physicochemical and antioxidant characteristics of stingless bee honey were different from those of Apis mellifera honey. (Shamsudin et al., 2019)

DATA SCIENCE QUESTIONS

1. How different antioxidant activities of honey can affect chemical composition in them.

2. What does each species of stingless bee contain that differs from one another.

OBJECTIVES

Objective 01

To identify the correlation between different chemical compositions with different antioxidant activities.

Objective 02

To develop a classification model to classify species of stingless bee based on samples of honey.

Objective 03

To contrsuct an interactive application that allows user to predict species of stingless bees based on multiple honey attributes.

STAKEHOLDERS

Consumers

Scientists

Students

Researchers

TOOLS & SOFTWARE USED

Programming Language

Programming Platform

Graphical User Interface

DATA SCIENCE METHODOLOGY

Project Definition

Understanding problems realated to domain and topic. Setting up objectives to ahcieve.

Data Collection

Dataset made available by stingless bee honey reseach team.

Data Preprocessing

Includes data cleaning, and data reduction.

Exploratory Data Analysis

Plot several graphs to have a general overview of dataset for better understanding.

Predictive Modelling

Build different classfication models to predict species of stingless bee honey.

Model Evaluation

Have the best model with the highest accuracy set as the main model for deployment.

Model Deployment

Develop an interactive graphical user interface to deploy classification model.

DATA COLLECTION

Data collected from the Centre for Natural Products Research and Drug Discovery (CENAR) research team.

Contains structured data of 158 samples of stingless bee honeys from across 5 state in Malaysia

	A	B	C	D	E	F	G	H	I	J	K
1	No	Sample	PH	TPC (µg GA	TFC (µg QE	ABTS (% in	FRAP (µg F	Water con	Fructose c	Glucose cc	Remark
2	1	A itama i	3.1	147.11	40.43	12.43	7.62	29.1	71.2	70.9	
3	2	A itama ii	3.1	158.81	43.36	15.31	11.41	29.8	70.5	70.2	
4	3	A itama iii	3	152.83	44.57	15.21	14.63	30.5	69.7	69.4	
5	4	A itama iv	3.2	203.06	43.97	20.4	20.21	28.8	71.5	71.3	
6	5	A itama v	3.3	178.09	44.59	17.5	16.19	26.1	74.3	74.1	
7	6	A thoracic	3	156.04	35.08	11.57	8.57	30	70.6	70.4	
8	7	A thoracic	2.9	149.63	38.56	12.25	9.63	30.1	70.1	69.8	
9	8	A thoracic	2.9	139.86	37.25	11.28	7.02	30.9	69.3	69	
10	9	A thoracic	3.1	164.17	39.59	13.38	11.23	30	70.2	70	
11	10	A thoracic	3.1	148.37	37.52	12.61	11.43	30.2	70	69.8	
12	11	B itama i	3	164.75	58.27	12.95	21.23	28.3	72.4	72.1	
13	12	B itama ii	3	156.89	53.73	13.86	13.82	26.8	73.6	73.4	
14	13	B itama iii	2.9	149.51	45.23	11.42	8.97	28	72.3	72.1	
15	14	B itama iv	3.3	159.21	45.95	14.21	13.78	28.9	71.3	71.1	
16	15	B itama v	3.3	189.66	52.88	16.34	18.92	26.1	74.3	74.1	
17	16	B thoracic	3.3	139.3	32.26	11.42	8.2	26.3	72.4	73.7	
18	17	B thoracic	3.2	141.62	32.48	12.57	6.43	25.6	73.6	74.5	
19	18	B thoracic	3.2	134.36	31.9	10.66	7.04	27.6	72.3	72.4	
20	19	B thoracic	3.4	148.45	32.67	12.94	11.83	27.1	73.2	73.1	

SCIENTIFIC TERMINOLOGIES

Potential of Hydrogen, pH

Indicates if the sample is acidic or basic.

Total Phenolic Content, TPC

Chemical compound.

Total Flavonoid Content, TFC

Chemical compound.

2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid, ABTS

To test antioxidant activity.

Ferric Reducing Antioxidant Power , FRAP

To test antioxidant activity.

Water Content

Moisture level present in sample.

Fructose Content

Content of sugar (Fructose) in sample.

Glucose Content

Content of sugar (Glucose) in sample.

DATA PREPROCESSING

DATA CLEANING STEPS

1. Renaming columns for better understanding
2. Separate sample extract location from sample name to a new column
3. Change the value of state codes to real state names
4. Remove unnecessary species iteration
5. Impute missing values
6. Change incorrect data types
7. Remove unnecessary / unused columns
8. Randomize dataset

RENAMING COLUMNS

	No	Sample	PH	TPC (µg GAE/mg honey)	TFC (µg QE/mg honey)	ABTS (% inhibition)	FRAP (µg FeSO4/mg honey)	Water content (% weight/weight)	Fructose content (% weight/weight)	Glucose content (% weight/weight)	Remark
0	1	A itama i	3.1	147.11	40.43	12.43	7.62	29.1	71.2	70.9	NaN
1	2	A itama ii	3.1	158.81	43.36	15.31	11.41	29.8	70.5	70.2	NaN
2	3	A itama iii	3.0	152.83	44.57	15.21	14.63	30.5	69.7	69.4	NaN
3	4	A itama iv	3.2	203.06	43.97	20.40	20.21	28.8	71.5	71.3	NaN
4	5	A itama v	3.3	178.09	44.59	17.50	16.19	26.1	74.3	74.1	NaN

	Sample_ID	Sample_Name	PH	TPC	TFC	ABTS	FRAP	Water	Fructose	Glucose	Remark
0	1	A itama i	3.1	147.11	40.43	12.43	7.62	29.1	71.2	70.9	NaN
1	2	A itama ii	3.1	158.81	43.36	15.31	11.41	29.8	70.5	70.2	NaN
2	3	A itama iii	3.0	152.83	44.57	15.21	14.63	30.5	69.7	69.4	NaN
3	4	A itama iv	3.2	203.06	43.97	20.40	20.21	28.8	71.5	71.3	NaN
4	5	A itama v	3.3	178.09	44.59	17.50	16.19	26.1	74.3	74.1	NaN

SPLIT INTO NEW COLUMNS

```
honey[["State" , "Sample_Name"]] = honey.Sample_Name.str.split(" ", 1, expand=True,)
```

	Sample_ID	Sample_Name	PH	TPC	TFC	ABTS	FRAP	Water	Fructose	Glucose	Remark	State
0	1	itama i	3.1	147.11	40.43	12.43	7.62	29.1	71.2	70.9	NaN	A
1	2	itama ii	3.1	158.81	43.36	15.31	11.41	29.8	70.5	70.2	NaN	A
2	3	itama iii	3.0	152.83	44.57	15.21	14.63	30.5	69.7	69.4	NaN	A
3	4	itama iv	3.2	203.06	43.97	20.40	20.21	28.8	71.5	71.3	NaN	A
4	5	itama v	3.3	178.09	44.59	17.50	16.19	26.1	74.3	74.1	NaN	A

REPLACE VALUES

```
honey["State"] = honey["State"].replace(["A","B","C"], "Kedah")
honey["State"] = honey["State"].replace(["D","E"], "Selangor")
honey["State"] = honey["State"].replace(["F","G","H"], "Johor")
honey["State"] = honey["State"].replace(["I","J"], "Pahang")
honey["State"] = honey["State"].replace(["K","L"], "Terengganu")
```

	Sample_ID	Sample_Name	PH	TPC	TFC	ABTS	FRAP	Water	Fructose	Glucose	Remark	State
0	1	itama i	3.1	147.11	40.43	12.43	7.62	29.1	71.2	70.9	NaN	A
1	2	itama ii	3.1	158.81	43.36	15.31	11.41	29.8	70.5	70.2	NaN	A
2	3	itama iii	3.0	152.83	44.57	15.21	14.63	30.5	69.7	69.4	NaN	A
3	4	itama iv	3.2	203.06	43.97	20.40	20.21	28.8	71.5	71.3	NaN	A
4	5	itama v	3.3	178.09	44.59	17.50	16.19	26.1	74.3	74.1	NaN	A

REMOVE VALUES

itama i	itama
itama ii	itama
itama iii	itama
itama iv	itama
itama v	itama

IMPUTE MISSING VALUES

```
honey = honey.replace("OOR", "0.0")
```

```
honey["Water"] = honey["Water"].replace(0.0, 32.00)
```

CHANGE DATA TYPE

```
convert_dict = {"Water" : float}
honey = honey.astype(convert_dict)
```

REMOVE UNUSED COLUMNS

```
honey=honey.drop(columns={"Remark","Sample_ID", "State"})
```

	Species	PH	TPC	TFC	ABTS	FRAP	Water	Fructose	Glucose
0	itama	3.1	147.11	40.43	12.43	7.62	29.1	71.2	70.9
1	itama	3.1	158.81	43.36	15.31	11.41	29.8	70.5	70.2
2	itama	3.0	152.83	44.57	15.21	14.63	30.5	69.7	69.4
3	itama	3.2	203.06	43.97	20.40	20.21	28.8	71.5	71.3
4	itama	3.3	178.09	44.59	17.50	16.19	26.1	74.3	74.1

STANDARDIZE VALUES & RANDOMIZE DATASET

```
honey.Species = honey.Species.str.capitalize()
```

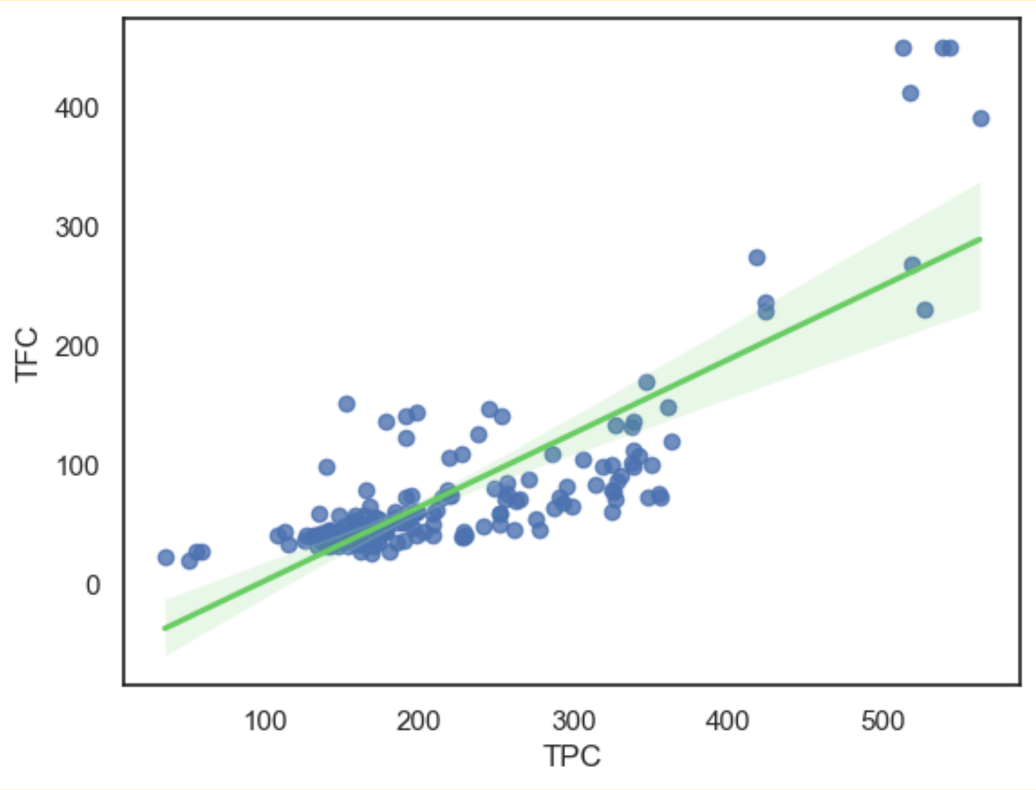
```
honey = honey.sample(frac=1)
```

Species
itama
itama
itama

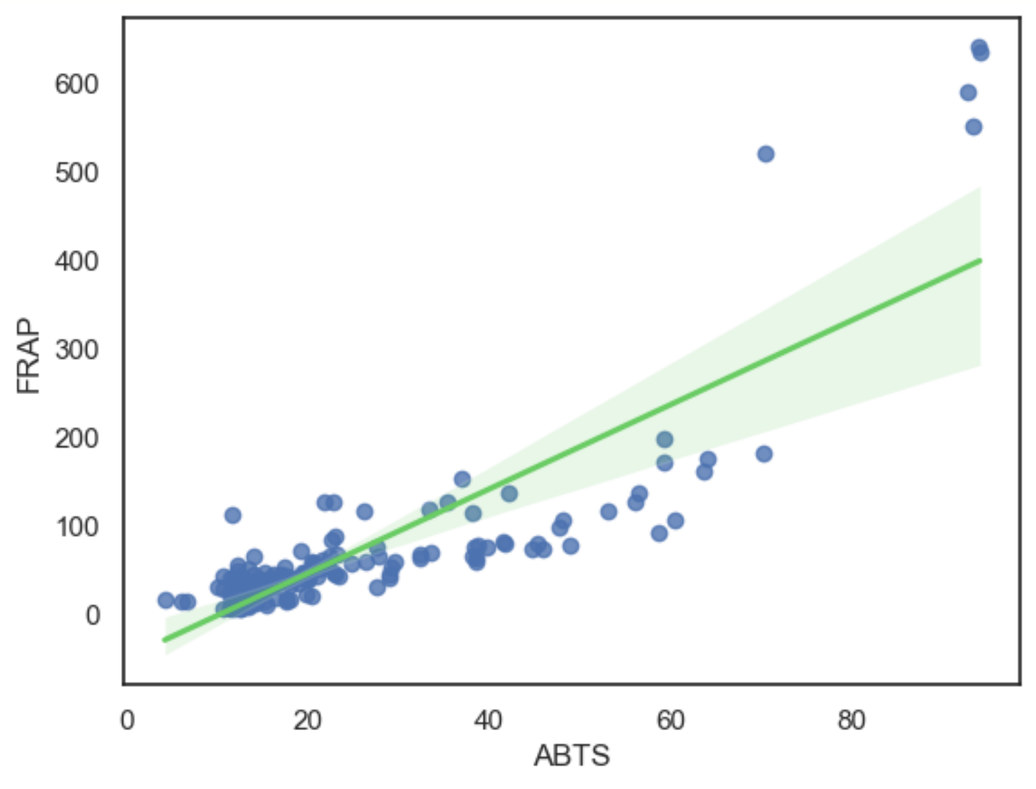
Species
Itama
Thoracica
Itama

EXPLORATORY DATA ANALYSIS

Objective 1 : To identify the correlation between different chemical compositions with different antioxidant activities.



TPC vs TFC
(chemical compounds)

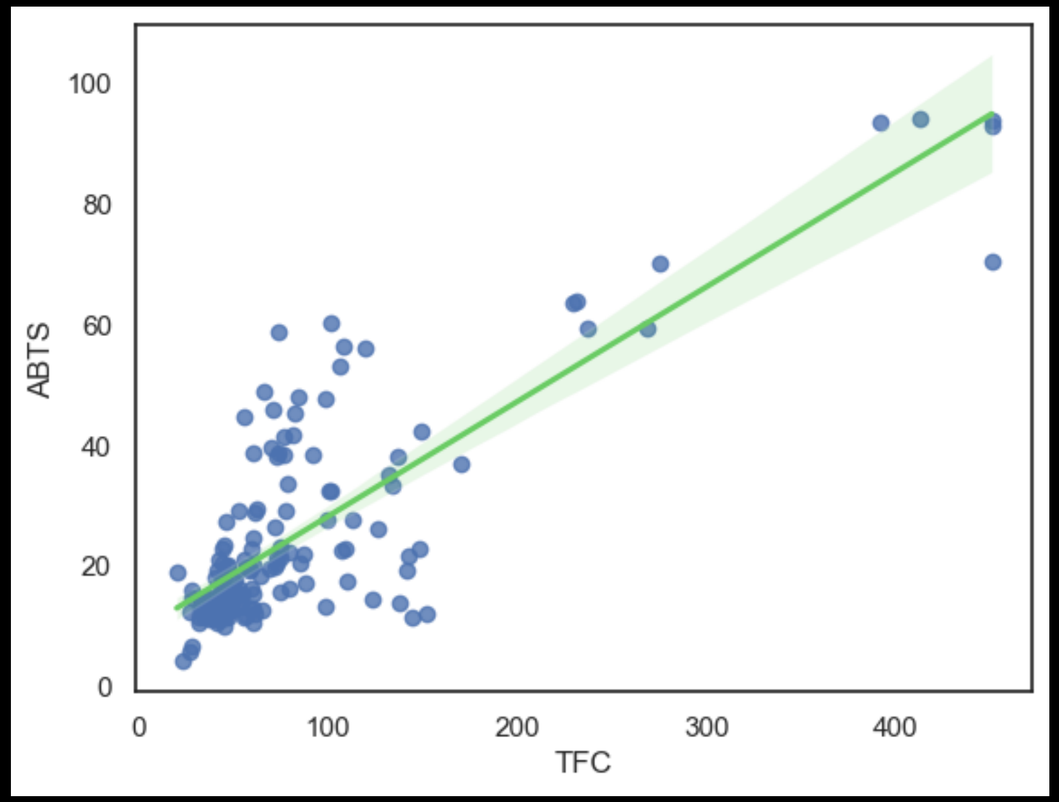


ABTS vs FRAP
(antioxidant activities)

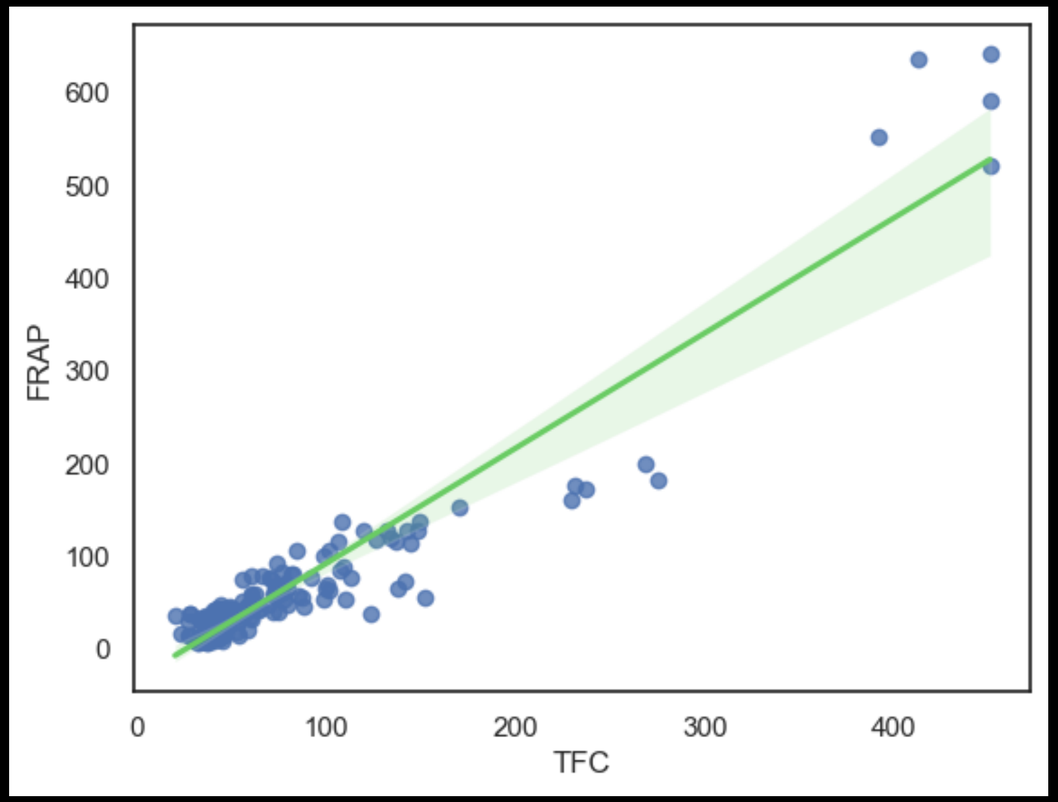
EXPLORATORY DATA ANALYSIS

Objective 1 : To identify the correlation between different chemical compositions with different antioxidant activities.

Total Flavonoid Content vs antioxidant assays



TFC vs ABTS

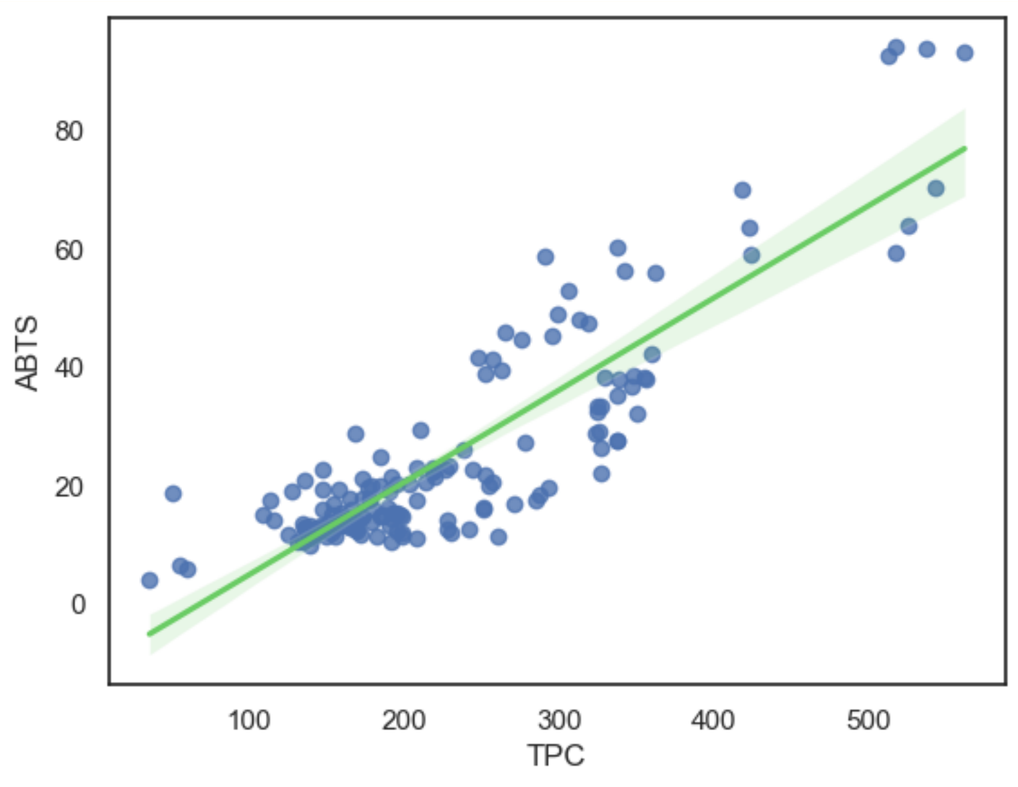


TFC vs FRAP

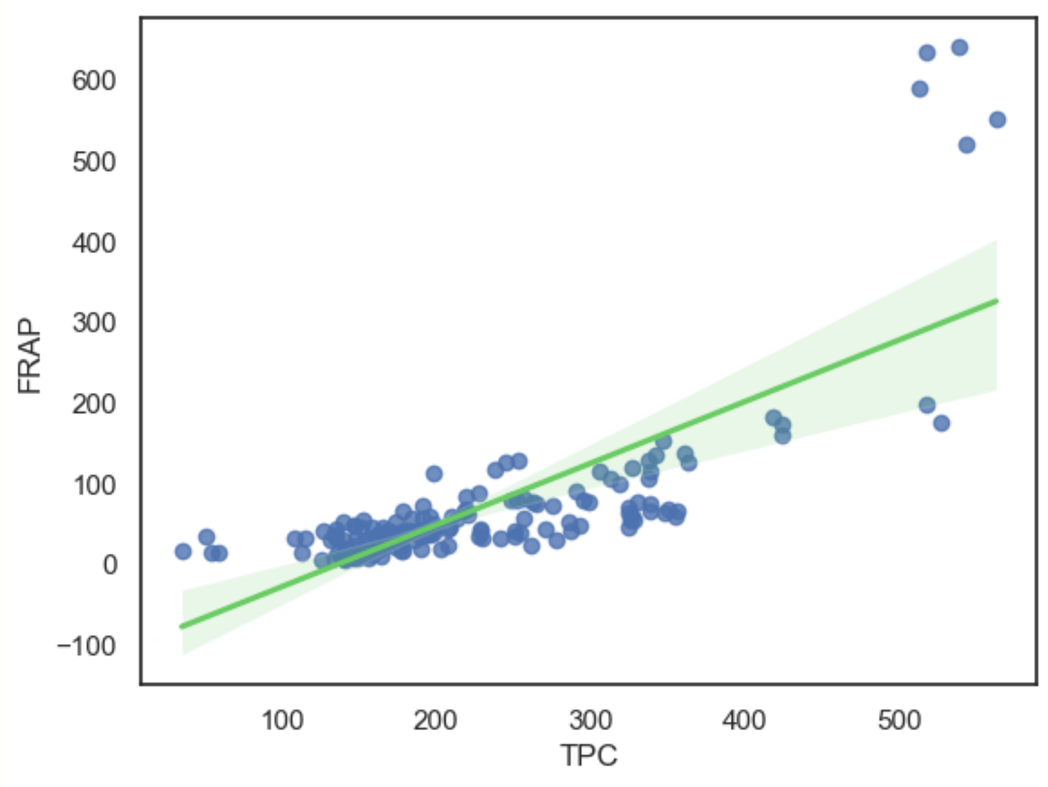
EXPLORATORY DATA ANALYSIS

Objective 1 : To identify the correlation between different chemical compositions with different antioxidant activities.

Total Phenolic Content vs antioxidant assays



TPC vs ABTS



TPC vs FRAP

PREDICTIVE MODELLING

Objective 2 : To develop a classification model to classify species of stingless bee based on samples of honey.

PREDICTIVE MODELLING

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```python
from sklearn.linear_model import LogisticRegression

classifier = LogisticRegression()
classifier.fit(X_train, y_train)

# predict
y_pred = classifier.predict(X_test)
```

```python
from sklearn.neighbors import KNeighborsClassifier

classifier = KNeighborsClassifier(n_neighbors=11)
classifier.fit(X_train, y_train)

# predict
y_pred = classifier.predict(X_test)
```

```python
from sklearn.svm import SVC

classifier = SVC()
classifier.fit(X_train, y_train)

# Predict
y_pred = classifier.predict(X_test)
```

PREDICTIVE MODELLING

Objective 2 : To develop a classification model to classify species of stingless bee based on samples of honey.

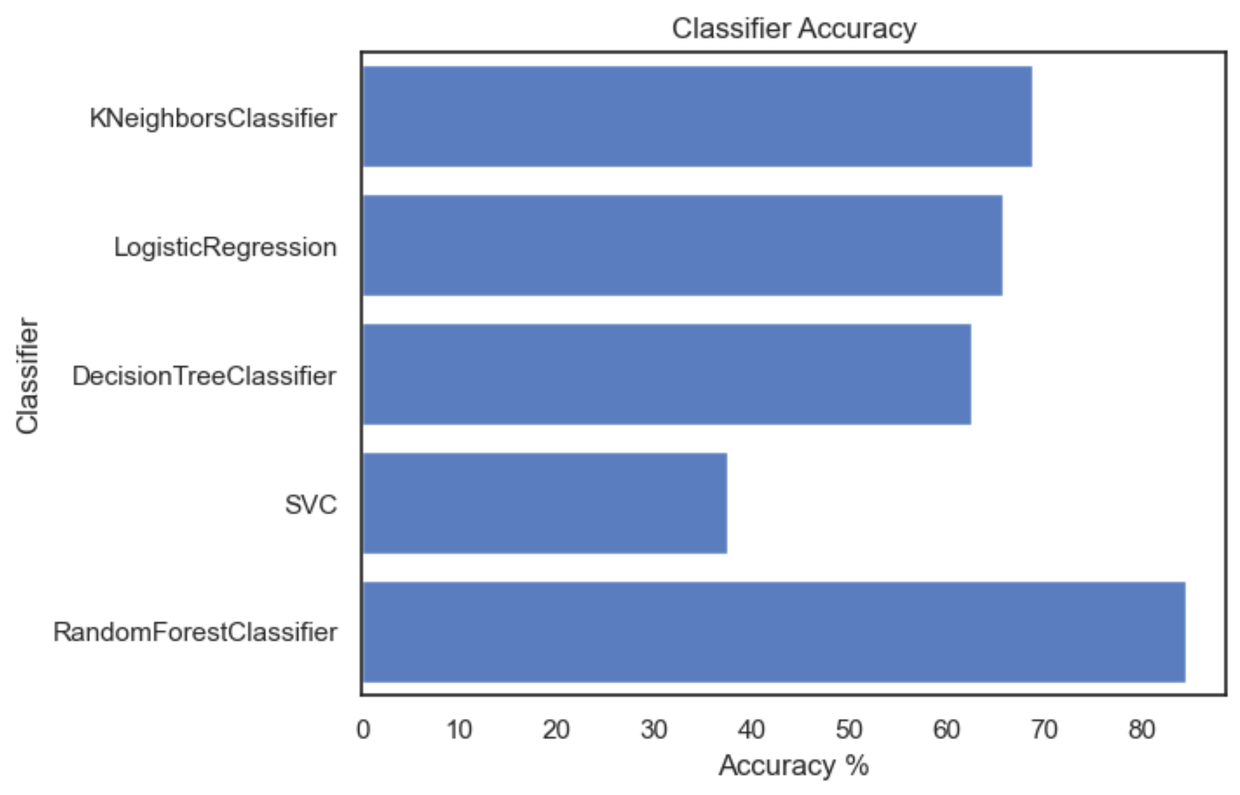
```python
from sklearn.tree import DecisionTreeClassifier

classifier = DecisionTreeClassifier()
classifier.fit(X_train, y_train)

# Predict
y_pred = classifier.predict(X_test)
```

```python
from sklearn.ensemble import RandomForestClassifier

classifier = RandomForestClassifier(n_estimators = 100)
classifier.fit(X_train, y_train)

# Predict
y_pred = classifier.predict(X_test)
```

```python
from sklearn.linear_model import LogisticRegression

classifier = LogisticRegression()
classifier.fit(X_train, y_train)

# predict
y_pred = classifier.predict(X_test)

# Summary
print(classification_report(y_test, y_pred))
print(confusion_matrix(y_test, y_pred))

# Accuracy score
from sklearn.metrics import accuracy_score
print("accuracy is", accuracy_score(y_pred, y_test))
```

MODEL EVALUATION

Objective 2 : To develop a classification model to classify species of stingless bee based on samples of honey.



Random Forest will be chosen as the main model for classification with the accuracy of 84.38%

MODEL DEPLOYMENT

Objective 3 : To contrsuct an interactive application that allows user to predict species of stingless bees based on multiple honey attributes.

```
import pickle

# save the fitted model
with open("RandomForest.pkl", "wb") as f:
    pickle.dump(classifier, f)

# load
with open("RandomForest.pkl",  "rb") as f:
    classifier = pickle.load(f)
```

Save & Load Model

Stingless Bee Honey Classifier

Utilize this classifier to determine which species of stingless bee is your honey from! Note that if you do not know the value of a specific component/attribute, just leave it as it is. The default value corresponds to the mean of the attribute.

pH value 3.3

Total Phenolic Content, TPC 139.3

Total Flavonoid Content, TFC 198.3

ABTS 30.65

FRAP 432.43

Water Content 29.38

Fructose Content 72.4

Glucose Content 73.7

☐ Does it contain other kinds of sugar e.g cane sugar, corn syrup, palm sugar, etc.?

Clear

Result

This honey is from the Itama species

Honey Description

Honey from H.itama can reverse the weight gained from a high-fat diet. In addition, it can significally reduce BMI, adiposity index, and relative organ weight

Flag

MODEL DEPLOYMENT

Objective 3 : To contrsuct an interactive application that allows user to predict species of stingless bees based on multiple honey attributes.

REFERENCES

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THANK YOU