# Weather Prediction using Machine Learning Classification Models by exploring the influencing factors using Python.

Here, we imported the data set and previewed the data.

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Run Code

```
In [266]: import pandas as pd
          import numpy as np
          import matplotlib.pyplot as plt
          import seaborn as sns; sns.set()
          from sklearn.metrics import classification_report
```

```
In [267]: my_data = pd.read_csv("/Users/mac/Library/CloudStorage/OneDrive-TeessideUniversity/MACHINE LEARNING/ICA/Seattle-weat
          print(my_data) #Here we import and view our dataset
          #/Users/mac/Library/CloudStorage/OneDrive-TeessideUniversity/MACHINE LEARNING/ICA/Seattle-weather.csv
          #C:/Users/d3663842/OneDrive - Teesside University/MACHINE LEARNING/ICA/Seattle-weather.csv
```

```
            date  precipitation  temp_max  temp_min  wind  weather
0     01/01/2012            0.0      12.8       5.0   4.7  drizzle
1     02/01/2012           10.9      10.6       2.8   4.5     rain
2     03/01/2012            0.8      11.7       7.2   2.3     rain
3     04/01/2012           20.3      12.2       5.6   4.7     rain
4     05/01/2012            1.3       8.9       2.8   6.1     rain
...          ...            ...       ...       ...   ...      ...
1456  27/12/2015            8.6       4.4       1.7   2.9     rain
1457  28/12/2015            1.5       5.0       1.7   1.3     rain
1458  29/12/2015            0.0       7.2       0.6   2.6      fog
1459  30/12/2015            0.0       5.6      -1.0   3.4      sun
1460  31/12/2015            0.0       5.6      -2.1   3.5      sun

[1461 rows x 6 columns]
```

```
In [268]: pd.isnull(my_data) ##This returns true if a null value is found and false if otherwise
```

Out[268]:

| | date | precipitation | temp_max | temp_min | wind | weather |
|---|---|---|---|---|---|---|
| 0 | False | False | False | False | False | False |

Here we begin running some checks on the data like checking if there are null values.

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Run Code

| | date | precipitation | temp_max | temp_min | wind | weather |
|---|---|---|---|---|---|---|
| 0 | False | False | False | False | False | False |
| 1 | False | False | False | False | False | False |
| 2 | False | False | False | False | False | False |
| 3 | False | False | False | False | False | False |
| 4 | False | False | False | False | False | False |
| ... | ... | ... | ... | ... | ... | ... |
| 1456 | False | False | False | False | False | False |
| 1457 | False | False | False | False | False | False |
| 1458 | False | False | False | False | False | False |
| 1459 | False | False | False | False | False | False |
| 1460 | False | False | False | False | False | False |

1461 rows × 6 columns

```
In [269]: my_data.isna().sum() #This gives a summary of the number of null values in the dataset
```

```
Out[269]: date             0
          precipitation    0
          temp_max         0
          temp_min         0
          wind             0
          weather          0
          dtype: int64
```

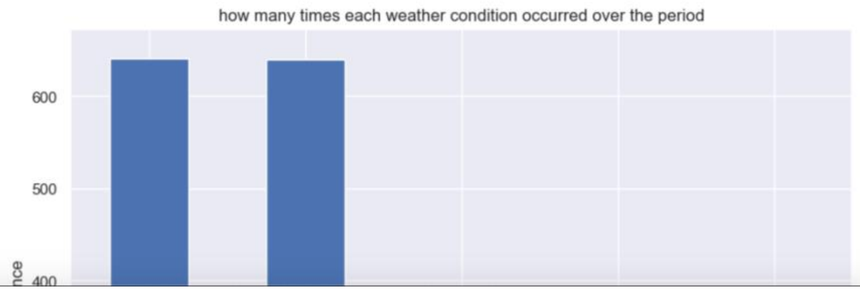
```
In [270]: my_data.nunique()
```

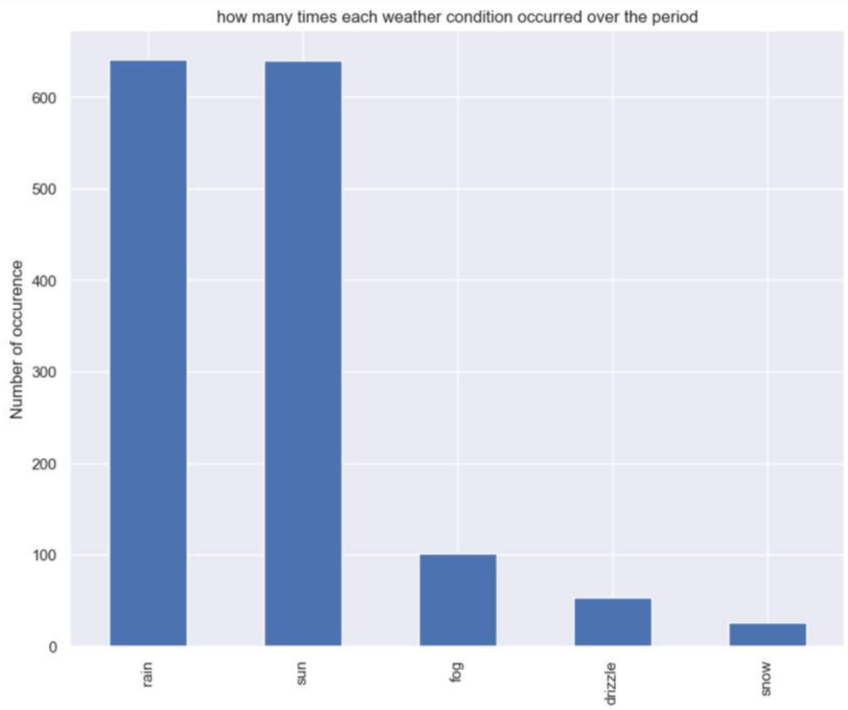
Here we begin doing some plots to visualize our data and some exploratory data analysis

```
In [270]: my_data.nunique()
```

```
Out[270]: date            1461
          precipitation    111
          temp_max          67
          temp_min          55
          wind              79
          weather            5
          dtype: int64
```

```
In [271]: occurence = my_data['weather'].value_counts()[:10] #visualizing how the different weather conditions occurred over t
          occurence.plot(kind='bar',figsize=(10,8))
          plt.title('how many times each weather condition occurred over the period')
          plt.ylabel('Number of occurence')
          plt.show()
```



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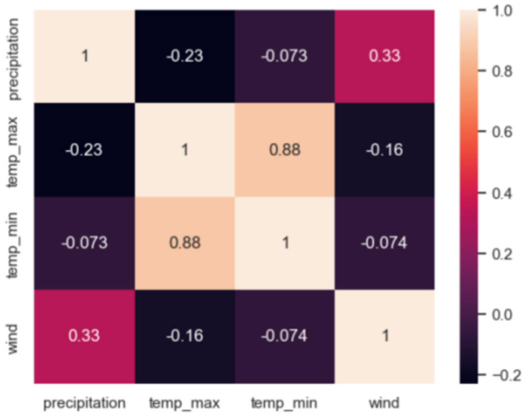
Run Code

In [272]:
```
heatmap = my_data.corr()  # Compute correlation matrix
sns.heatmap(heatmap, annot=True)  # Plot heatmap with annotations
plt.show()  # Show the plot
```




In [273]:
```
plt.figure(figsize=(13,17)) #pairplot to compare the correlation and relationship between features
sns.pairplot(data = my_data, hue='weather')
plt.show()
```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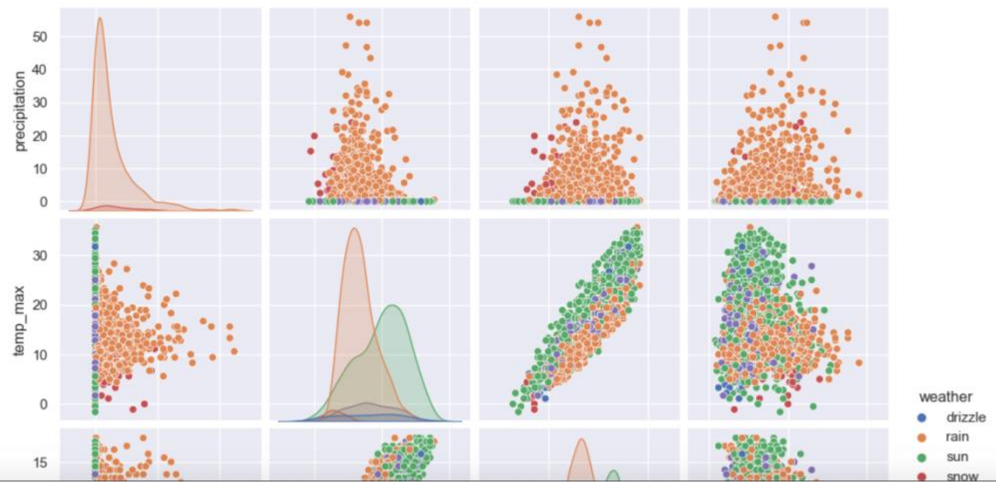
Run Code

In [273]:
```
plt.figure(figsize=(13,17)) #pairplot to compare the correlation and relationship between features
sns.pairplot(data = my_data, hue='weather')
plt.show()
```


```
<Figure size 1300x1700 with 0 Axes>
```



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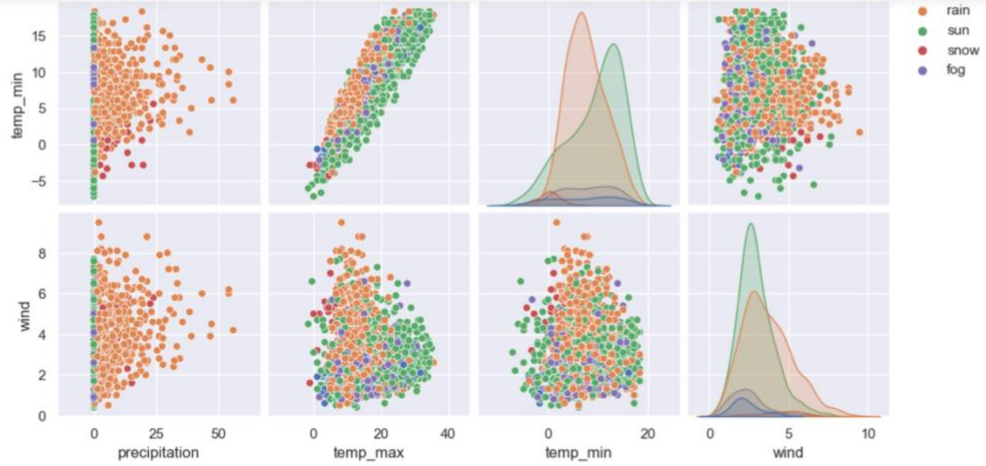
Run Code




In [274]:

```
data = my_data
numeric = ['wind', 'precipitation', 'temp_max', 'temp_min']
sns.set(style="whitegrid")
plt.figure(figsize=(13,17))
for i, var in enumerate(numeric, 1):
```

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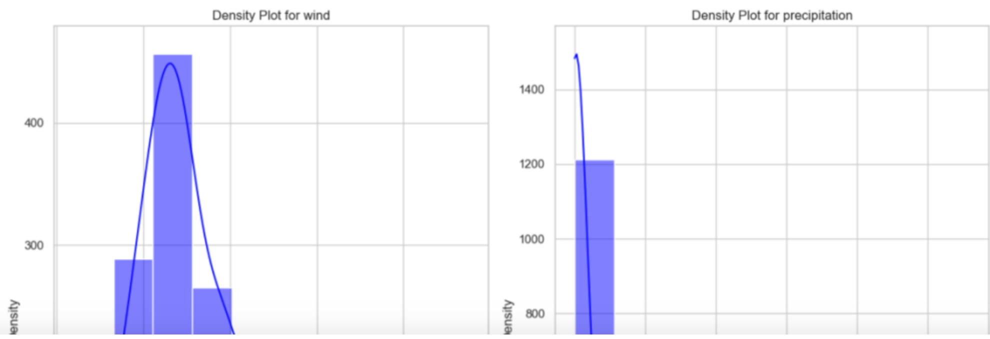
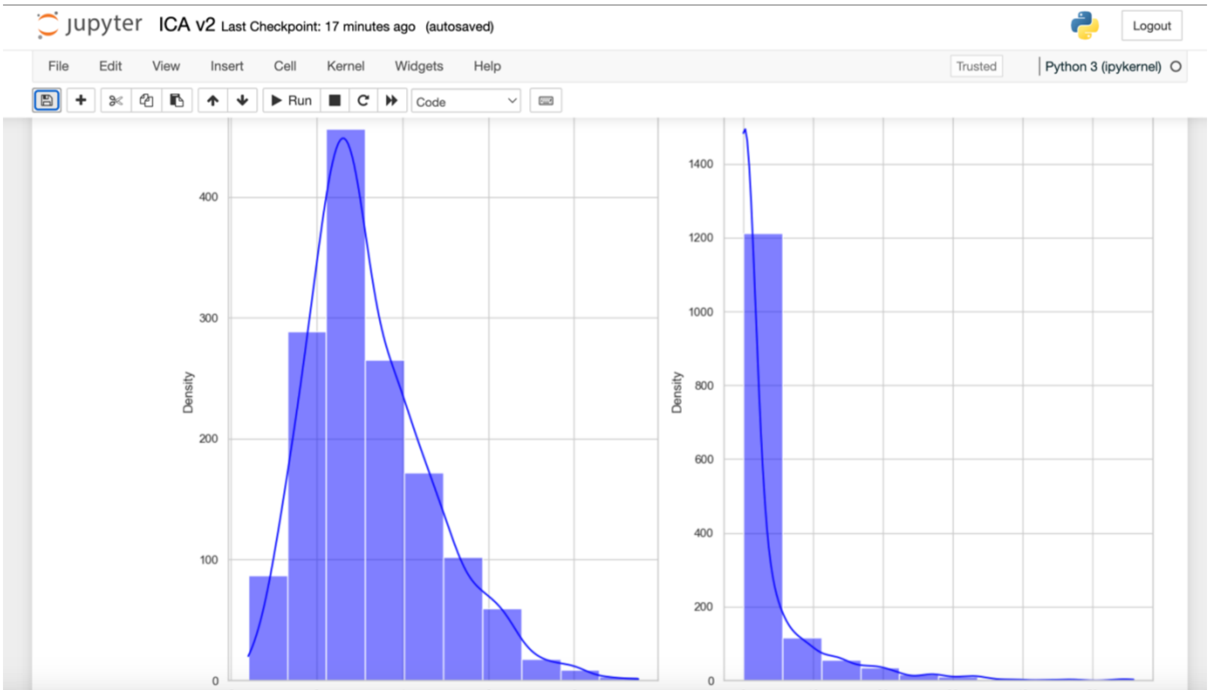
Run Code

In [274]:

```
data = my_data
numeric = ['wind', 'precipitation', 'temp_max', 'temp_min']
sns.set(style="whitegrid")
plt.figure(figsize=(13,17))
for i, var in enumerate(numeric, 1):
 plt.subplot(2, 2, i)
 sns.histplot(data[var], kde=True, color='blue', bins=10)
 plt.title(f'Density Plot for {var}')
 plt.xlabel(var)
 plt.ylabel('Density')

plt.tight_layout()
plt.show()
```

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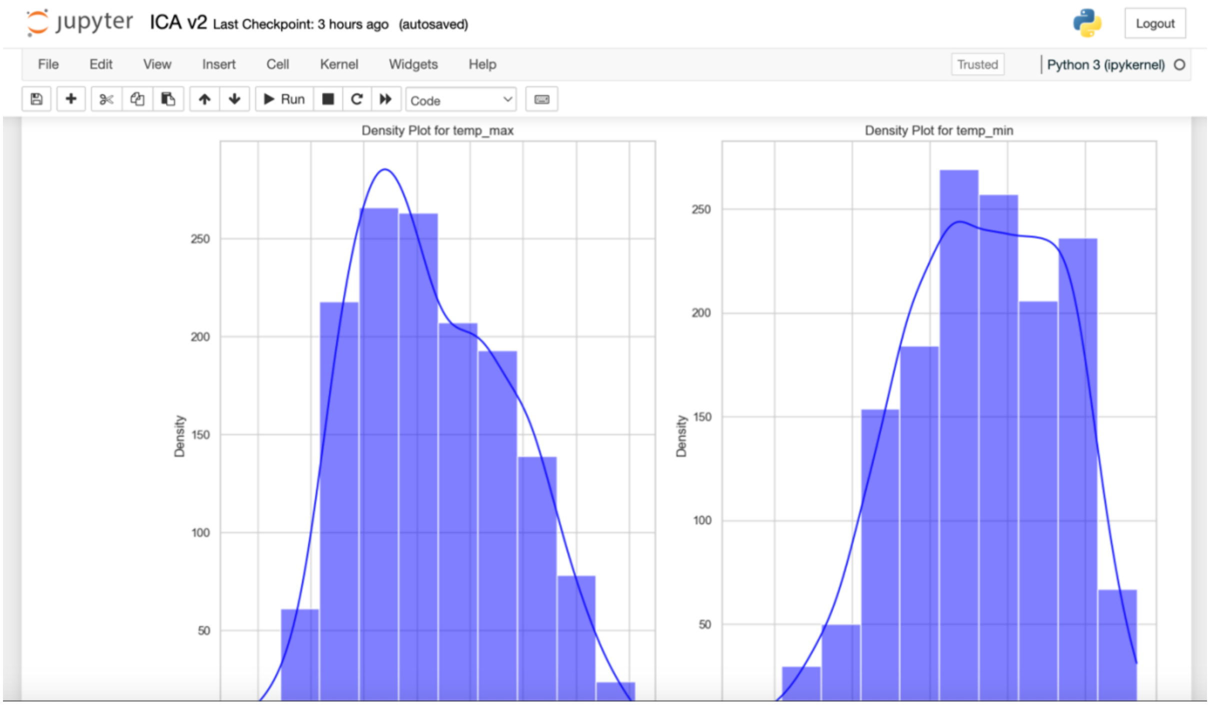
File Edit View Insert Cell Kernel Widgets Help
Trusted
Python 3 (ipykernel)
Run
Code
Density
Density


jupyter ICA v2 Last Checkpoint: 3 hours ago (autosaved)
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File Edit View Insert Cell Kernel Widgets Help
Trusted
Python 3 (ipykernel)
Run
Code
Density Plot for temp_max
Density Plot for temp_min
Density
Density

Here we scale and normalize the data:

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In [275]:
```python
from sklearn.preprocessing import MinMaxScaler
def dataset_minmax(my_data): #finding the minimum and maximum values for each column
    minmax = list()
    for i in range(len(my_data[0])):
        col_values = [row[i] for row in my_data]
        value_min = min(col_values)
        value_max = max(col_values)
        minmax.append([value_min, value_max])
        return minmax
```

In [276]:
```python
from sklearn.preprocessing import MinMaxScaler #Normalizing the data
scaler = MinMaxScaler()
data_scaled = (scaler.fit_transform(my_data[numeric]))
print(data_scaled)
```

```
[[0.47252747 0.         0.38709677 0.47637795]
 [0.45054945 0.19499106 0.32795699 0.38976378]
 [0.20879121 0.01431127 0.35752688 0.56299213]
 ...
 [0.24175824 0.         0.23655914 0.30314961]
 [0.32967033 0.         0.19354839 0.24015748]
 [0.34065934 0.         0.19354839 0.19685039]]
```

In [277]:
```python
def cross_validation_split(my_data, n_folds): #split the data into n-folds
    my_data_split = list()
    my_data_copy = list(my_data)
    fold_size = int(len(my_data) / n_folds)
    for _ in range(n_folds):
        fold = list()
        while len(fold) < fold_size:
            index = randrange(len(my_data_copy))
```

Here we split the data for training and testing and begin applying the models

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In [278]:
```python
def accuracy_metric(actual, predicted):
    correct = 0
    for i in range(len(actual)):
        if actual[i] == predicted[i]:
            correct += 1
            return correct / float(len(actual)) * 100.0
```

In [279]:
```python
from sklearn.model_selection import train_test_split #Split the dataset for training and testing using a 60-30 ratio
Y = my_data['weather']
X = my_data.drop(columns=['weather', 'date'])
X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size=0.3, random_state=42)

print('X train shape: ', X_train.shape)
print('Y train shape: ', Y_train.shape)
print('X test shape: ', X_test.shape)
print('Y test shape: ', Y_test.shape)
```

```
X train shape:  (1022, 4)
Y train shape:  (1022,)
X test shape:  (439, 4)
Y test shape:  (439,)
```

## K-Nearest Neighbour

In [280]:
```python
from sklearn.neighbors import KNeighborsClassifier
neighbors = np.arange(1, 9) #plotting to find the n_neighbors
train_accuracy = np.empty(len(neighbors))
for i, k in enumerate(neighbors):
    knn = KNeighborsClassifier(n_neighbors=k)
    knn.fit(X_train, Y_train)
```

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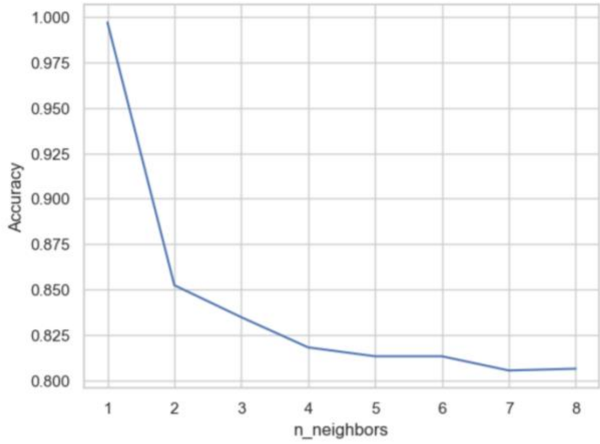
Run Code

```
plt.xlabel('n_neighbors')
plt.ylabel('Accuracy')
plt.show()
```




In [281]:
```
%pip install scikit-learn
```

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Run Code

In [283]:
```
from sklearn.model_selection import GridSearchCV #using Grid search for hyper-parameter tuning
weight_options = ['uniform', 'distance']
metric_options = ['euclidean', 'minkowski']
number = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
# create a parameter grid to map the parameter names to the values that should be searched using Grid search
param_grid = dict(n_neighbors=number, weights=weight_options, metric=metric_options)
#param_grid = dict(n_neighbors=number)
print(param_grid)
grid = GridSearchCV(knn, param_grid, cv=10, scoring='accuracy', return_train_score=False)
grid.fit(X_train, Y_train)
print(grid.best_score_)
print(grid.best_params_)
pd.DataFrame(grid.cv_results_)[['mean_test_score', 'std_test_score', 'params']]
```

```
{'n_neighbors': [1, 2, 3, 4, 5, 6, 7, 8, 9, 10], 'weights': ['uniform', 'distance'], 'metric': ['euclidean', 'minko
wski']}
0.7563011612411955
{'metric': 'euclidean', 'n_neighbors': 7, 'weights': 'distance'}
```

Out[283]:

| | mean_test_score | std_test_score | params |
|---|---|---|---|
| 0 | 0.711289 | 0.039655 | {'metric': 'euclidean', 'n_neighbors': 1, 'wei... |
| 1 | 0.711289 | 0.039655 | {'metric': 'euclidean', 'n_neighbors': 1, 'wei... |
| 2 | 0.666324 | 0.034778 | {'metric': 'euclidean', 'n_neighbors': 2, 'wei... |
| 3 | 0.711289 | 0.039655 | {'metric': 'euclidean', 'n_neighbors': 2, 'wei... |
| 4 | 0.721083 | 0.038843 | {'metric': 'euclidean', 'n_neighbors': 3, 'wei... |
| 5 | 0.725976 | 0.032004 | {'metric': 'euclidean', 'n_neighbors': 3, 'wei... |
| 6 | 0.728898 | 0.028955 | {'metric': 'euclidean', 'n_neighbors': 4, 'wei... |
| 7 | 0.736741 | 0.034421 | {'metric': 'euclidean', 'n_neighbors': 4, 'wei... |

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```
In [284]: knn_model = KNeighborsClassifier(metric = 'euclidean', n_neighbors = 7, weights = 'distance')
          knn_model.fit(X_train, Y_train) #Applying KNN algorithm to the data

Out[284]:  KNeighborsClassifier
           KNeighborsClassifier(metric='euclidean', n_neighbors=7, weights='distance')

In [285]: y_pred = knn_model.predict(X_test)

In [286]: from sklearn.metrics import accuracy_score, classification_report, confusion_matrix
          accuracy_score(Y_test, y_pred) #printing the accuracy score

Out[286]: 0.7608200455580866

In [287]: confusion_matrix(Y_test, y_pred) #printing confusion matrix to check for data balance and distribution

Out[287]: array([[  1,   1,   0,   0,  12],
                 [  1,   1,   2,   0,  28],
                 [  1,   0, 164,   0,  27],
                 [  0,   1,   4,   0,   3],
                 [  3,   9,  13,   0, 168]])

In [288]: print(Y_train.value_counts())

          rain       449
          sun        447
          fog         69
          drizzle     39
          snow        18
          Name: weather, dtype: int64
```

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# Balancing the dataset using SMOTETOMEK

```
In [291]: from imblearn.combine import SMOTETomek #importing smote tomek library
          from sklearn.model_selection import train_test_split
          from sklearn.neighbors import KNeighborsClassifier

In [292]: # Applying Smote Tomek to balance the data
          smote_tomek = SMOTETomek()
          X_resampled, Y_resampled = smote_tomek.fit_resample(X_train, Y_train)

In [293]: # Split the resampled data into train and test sets
          X_train_resampled, X_test_resampled, Y_train_resampled, Y_test_resampled = train_test_split(X_resampled, Y_resampled

In [294]: # performing grid search on the resampled data
          weight_options = ['uniform', 'distance']
          metric_options = ['euclidean', 'minkowski']
          number = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
          # create a parameter grid: map the parameter names to the values that should be searched
          param_grid = dict(n_neighbors=number, weights=weight_options, metric=metric_options)
          #param_grid = dict(n_neighbors=number)
          print(param_grid)
          grid = GridSearchCV(knn, param_grid, cv=10, scoring='accuracy', return_train_score=False)
          grid.fit(X_train_resampled, Y_train_resampled)
          print(grid.best_score_)
          print(grid.best_params_)
          pd.DataFrame(grid.cv_results_)[['mean_test_score', 'std_test_score', 'params']]

          {'n_neighbors': [1, 2, 3, 4, 5, 6, 7, 8, 9, 10], 'weights': ['uniform', 'distance'], 'metric': ['euclidean', 'minko
          wski']}
          0.8520547945205479
          {'metric': 'euclidean', 'n_neighbors': 1, 'weights': 'uniform'}
```

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| | mean_test_score | std_test_score | params |
|---|---|---|---|
| 0 | 0.852055 | 0.024734 | {'metric': 'euclidean', 'n_neighbors': 1, 'wei... |
| 1 | 0.852055 | 0.024734 | {'metric': 'euclidean', 'n_neighbors': 1, 'wei... |
| 2 | 0.805479 | 0.023368 | {'metric': 'euclidean', 'n_neighbors': 2, 'wei... |
| 3 | 0.852055 | 0.024734 | {'metric': 'euclidean', 'n_neighbors': 2, 'wei... |
| 4 | 0.806849 | 0.025774 | {'metric': 'euclidean', 'n_neighbors': 3, 'wei... |
| 5 | 0.831507 | 0.024543 | {'metric': 'euclidean', 'n_neighbors': 3, 'wei... |
| 6 | 0.791096 | 0.025490 | {'metric': 'euclidean', 'n_neighbors': 4, 'wei... |
| 7 | 0.838356 | 0.023766 | {'metric': 'euclidean', 'n_neighbors': 4, 'wei... |
| 8 | 0.788356 | 0.031603 | {'metric': 'euclidean', 'n_neighbors': 5, 'wei... |
| 9 | 0.826027 | 0.026385 | {'metric': 'euclidean', 'n_neighbors': 5, 'wei... |
| 10 | 0.773288 | 0.025892 | {'metric': 'euclidean', 'n_neighbors': 6, 'wei... |
| 11 | 0.826027 | 0.026207 | {'metric': 'euclidean', 'n_neighbors': 6, 'wei... |
| 12 | 0.764384 | 0.034952 | {'metric': 'euclidean', 'n_neighbors': 7, 'wei... |
| 13 | 0.821918 | 0.027906 | {'metric': 'euclidean', 'n_neighbors': 7, 'wei... |
| 14 | 0.758219 | 0.040987 | {'metric': 'euclidean', 'n_neighbors': 8, 'wei... |
| 15 | 0.819178 | 0.031566 | {'metric': 'euclidean', 'n_neighbors': 8, 'wei... |
| 16 | 0.746575 | 0.032848 | {'metric': 'euclidean', 'n_neighbors': 9, 'wei... |
| 17 | 0.813014 | 0.033562 | {'metric': 'euclidean', 'n_neighbors': 9, 'wei... |
| 18 | 0.743836 | 0.037665 | {'metric': 'euclidean', 'n_neighbors': 10, 'we... |
| 19 | 0.806164 | 0.037271 | {'metric': 'euclidean', 'n_neighbors': 10, 'we... |

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In [295]:
```
# Applying the knn model on the resampled data using grid search for hyper parameter tuning
knn_model = KNeighborsClassifier(metric = 'euclidean', n_neighbors = 1, weights = 'distance')
knn_model.fit(X_train_resampled, Y_train_resampled)
```
Out[295]:
```
KNeighborsClassifier
KNeighborsClassifier(metric='euclidean', n_neighbors=1, weights='distance')
```

In [296]:
```
y_pred = knn_model.predict(X_test_resampled)
```

In [297]:
```
from sklearn.metrics import accuracy_score, classification_report, confusion_matrix
accuracy_score(Y_test_resampled, y_pred)
print(classification_report(Y_test_resampled, y_pred))
```
```
              precision    recall  f1-score   support

     drizzle       0.76      0.93      0.84       107
         fog       0.81      0.89      0.85       137
        rain       0.91      0.80      0.85       127
        snow       0.98      0.99      0.98       130
         sun       0.80      0.64      0.71       126

    accuracy                           0.85       627
   macro avg       0.85      0.85      0.85       627
weighted avg       0.86      0.85      0.85       627
```

In [298]:
```
print(Y_test_resampled.value_counts())
```
```
fog        137
snow       130
```

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Run Code

In [298]:
```
print(Y_test_resampled.value_counts())
```

```
fog        137
snow       130
rain       127
sun        126
drizzle    107
Name: weather, dtype: int64
```

In [299]:
```
confusion_matrix(Y_test_resampled, y_pred) #confirming that the data is balanced
```

Out[299]:
```
array([[100,   1,   4,   0,   2],
       [ 10, 122,   2,   0,   3],
       [  3,   4, 102,   3,  15],
       [  0,   0,   1, 129,   0],
       [ 18,  24,   3,   0,  81]])
```

## Random Forest Classifier

In [300]:
```
%pip install -U scikit-learn
```

```
Requirement already satisfied: scikit-learn in /Users/mac/opt/anaconda3/lib/python3.9/site-packages (1.4.2)
Requirement already satisfied: numpy>=1.19.5 in /Users/mac/opt/anaconda3/lib/python3.9/site-packages (from scikit-l
earn) (1.21.5)
Requirement already satisfied: joblib>=1.2.0 in /Users/mac/opt/anaconda3/lib/python3.9/site-packages (from scikit-l
earn) (1.3.2)
Requirement already satisfied: scipy>=1.6.0 in /Users/mac/opt/anaconda3/lib/python3.9/site-packages (from scikit-le
arn) (1.9.1)
Requirement already satisfied: threadpoolctl>=2.0.0 in /Users/mac/opt/anaconda3/lib/python3.9/site-packages (from s
cikit-learn) (2.2.0)
```

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File Edit View Insert Cell Kernel Widgets Help Trusted Python 3 (ipykernel)

Run Code

## Random Forest Classifier

In [300]:
```
%pip install -U scikit-learn
```

```
Requirement already satisfied: scikit-learn in /Users/mac/opt/anaconda3/lib/python3.9/site-packages (1.4.2)
Requirement already satisfied: numpy>=1.19.5 in /Users/mac/opt/anaconda3/lib/python3.9/site-packages (from scikit-l
earn) (1.21.5)
Requirement already satisfied: joblib>=1.2.0 in /Users/mac/opt/anaconda3/lib/python3.9/site-packages (from scikit-l
earn) (1.3.2)
Requirement already satisfied: scipy>=1.6.0 in /Users/mac/opt/anaconda3/lib/python3.9/site-packages (from scikit-le
arn) (1.9.1)
Requirement already satisfied: threadpoolctl>=2.0.0 in /Users/mac/opt/anaconda3/lib/python3.9/site-packages (from s
cikit-learn) (2.2.0)
```


```
Note: you may need to restart the kernel to use updated packages.
```

In [301]:
```
from sklearn.ensemble import RandomForestClassifier #importing random forest classifier
from sklearn import metrics
```

In [302]:
```
#creating a random forest classifier
rfc = RandomForestClassifier()

forest_params = [{'max_depth': list(range(10, 15)), 'max_features': list(range(1,14))}]

clf = GridSearchCV(rfc, forest_params, cv = 10, scoring='accuracy')

y_pred_rfc = clf.fit(X_train_resampled, Y_train_resampled)

# Get the best estimator from the grid search
best_rfc = clf.best_estimator_
```

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```
clf = GridSearchCV(rfc, forest_params, cv = 10, scoring='accuracy')

y_pred_rfc = clf.fit(X_train_resampled, Y_train_resampled)

# Get the best estimator from the grid search
best_rfc = clf.best_estimator_

# Make predictions using the best estimator
y_pred_best_rfc = best_rfc.predict(X_test_resampled)

# Print the best parameters and score
print(clf.best_params_)
print(clf.best_score_)

# Print the classification report using the actual predictions
print(classification_report(Y_test_resampled, y_pred_best_rfc))
```

```
{'max_depth': 13, 'max_features': 2}
0.8760273972602739
              precision    recall  f1-score   support

     drizzle       0.74      0.94      0.83       107
         fog       0.82      0.85      0.84       137
        rain       0.97      0.92      0.94       127
        snow       0.98      0.98      0.98       130
         sun       0.82      0.63      0.71       126

    accuracy                           0.86       627
   macro avg       0.86      0.86      0.86       627
weighted avg       0.87      0.86      0.86       627
```

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# GRADIENT BOOSTING CLASSIFIER

In [303]:
```
#Gradient-Boosting Classifier
%pip install -U scikit-learn
from sklearn.ensemble import GradientBoostingClassifier
```

```
Requirement already satisfied: scikit-learn in /Users/mac/opt/anaconda3/lib/python3.9/site-packages (1.4.2)
Requirement already satisfied: scipy>=1.6.0 in /Users/mac/opt/anaconda3/lib/python3.9/site-packages (from scikit-le
arn) (1.9.1)
Requirement already satisfied: numpy>=1.19.5 in /Users/mac/opt/anaconda3/lib/python3.9/site-packages (from scikit-l
earn) (1.21.5)
Requirement already satisfied: threadpoolctl>=2.0.0 in /Users/mac/opt/anaconda3/lib/python3.9/site-packages (from s
cikit-learn) (2.2.0)
Requirement already satisfied: joblib>=1.2.0 in /Users/mac/opt/anaconda3/lib/python3.9/site-packages (from scikit-l
earn) (1.3.2)
Note: you may need to restart the kernel to use updated packages.
```

In [ ]:
```
#creating the gradient boosting classifier
```

In [304]:
```
gbc=GradientBoostingClassifier(n_estimators=500,learning_rate=0.05,random_state=100,max_features=5)
gbc.fit(X_train_resampled,Y_train_resampled)

# Generate predictions using the fitted model
y_pred_gbc = gbc.predict(X_test_resampled)

print("GBC accuracy is %2.2f" % accuracy_score(Y_test_resampled, y_pred_gbc))
print(classification_report(Y_test_resampled, y_pred_gbc))
```

```
GBC accuracy is 0.87
              precision    recall  f1-score   support
```

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In [304]:
```
gbc=GradientBoostingClassifier(n_estimators=500,learning_rate=0.05,random_state=100,max_features=5)
gbc.fit(X_train_resampled,Y_train_resampled)

# Generate predictions using the fitted model
y_pred_gbc = gbc.predict(X_test_resampled)

print("GBC accuracy is %2.2f" % accuracy_score(Y_test_resampled, y_pred_gbc))
print(classification_report(Y_test_resampled, y_pred_gbc))
```

```
GBC accuracy is 0.87
              precision    recall  f1-score   support

     drizzle       0.81      0.85      0.83       107
         fog       0.81      0.82      0.82       137
        rain       0.94      0.93      0.93       127
        snow       0.98      0.98      0.98       130
         sun       0.80      0.75      0.78       126

    accuracy                           0.87       627
   macro avg       0.87      0.87      0.87       627
weighted avg       0.87      0.87      0.87       627
```

## Naive Bayes Classification

In [305]:
```
from sklearn.naive_bayes import GaussianNB
from sklearn.metrics import accuracy_score
```

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Naive Bayes Classification

In [305]:
from sklearn.naive_bayes import GaussianNB
from sklearn.metrics import accuracy_score

In [306]:
```
#creating and evaluating the GNB classifier
gnb = GaussianNB()
y_pred = gnb.fit(X_train_resampled, Y_train_resampled).predict(X_test_resampled)
print("Number of mislabeled points out of a total %d points : %d" % (X_test.shape[0], (Y_test_resampled != y_pred).s
```

```
Number of mislabeled points out of a total 439 points : 230
```

In [307]:
```
from sklearn.metrics import accuracy_score

#We run the model on the train data

# Here we train the model using the resampled training data
gnb.fit(X_train_resampled, Y_train_resampled)

# then proceed to make predictions on the training data
predict_train = gnb.predict(X_train_resampled)

# before evaluating the accuracy on the training data
accuracy_train = accuracy_score(Y_train_resampled, predict_train)
print('accuracy_score on train dataset: ', accuracy_train)
```

```
accuracy_score on train dataset:  0.6267123287671232
```

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In [308]:
```python
#we run the model on the test data
# then proceed to make predictions on the training data
# predict the target on the test dataset
predict_test = gnb.predict(X_test_resampled)

# Accuracy Score on test dataset
accuracy_test = accuracy_score(Y_test_resampled,predict_test)
print('accuracy_score on test dataset : ', accuracy_test)
print(classification_report(Y_test_resampled, y_pred))
```

```
accuracy_score on test dataset :  0.6331738437001595
              precision    recall  f1-score   support

     drizzle       0.38      0.41      0.40       107
         fog       0.40      0.47      0.43       137
        rain       0.97      0.85      0.91       127
        snow       0.91      0.98      0.94       130
         sun       0.54      0.43      0.48       126

    accuracy                           0.63       627
   macro avg       0.64      0.63      0.63       627
weighted avg       0.65      0.63      0.64       627
```

In [ ]:

In [309]:
```python
# check for overfitting
print('Training score: {0:0.4f}'. format(gnb.score(X_train_resampled, Y_train_resampled)))
print('Testing score: {0:0.4f}'. format(gnb.score(X_test_resampled, Y_test_resampled)))
```

```
Training score: 0.6267
Testing score: 0.6332
```

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# SUPPORT VECTOR MACHINE

In [310]:
```python
from sklearn.svm import SVC
svc = SVC()
svc.fit(X_train_resampled, Y_train_resampled)
# print prediction results
predictions = svc.predict(X_test_resampled)
print(classification_report(Y_test_resampled, predictions))

print("Accuracy on training set: {:.3f}".format(svc.score(X_train_resampled, Y_train_resampled)))
print("Accuracy on test set: {:.3f}".format(svc.score(X_test_resampled, Y_test_resampled)))
```

```
              precision    recall  f1-score   support

     drizzle       0.55      0.25      0.35       107
         fog       0.42      0.79      0.55       137
        rain       0.95      0.72      0.82       127
        snow       0.95      0.95      0.95       130
         sun       0.54      0.40      0.46       126

    accuracy                           0.64       627
   macro avg       0.68      0.62      0.62       627
weighted avg       0.68      0.64      0.63       627

Accuracy on training set: 0.645
Accuracy on test set: 0.638
```

In [311]:
```python
#apply grid search to find the best parameter combination
from sklearn.model_selection import GridSearchCV

# defining parameter range
param_grid = {'C': [0.1, 1, 10, 100, 1000]
```

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In [311]:

```
#apply grid search to find the best parameter combination
from sklearn.model_selection import GridSearchCV

# defining parameter range
param_grid = {'C': [0.1, 1, 10, 100, 1000],
              'gamma': [1, 0.1, 0.01, 0.001, 0.0001],
              'kernel': ['rbf']}

grid = GridSearchCV(SVC(), param_grid, refit = True, verbose = 3)

# fitting the model for grid search
grid.fit(X_train_resampled, Y_train_resampled)

# print best parameter after tuning
print(grid.best_params_)

# print how our model looks after hyper-parameter tuning
print(grid.best_estimator_)
```

```
[CV 2/5] END ........C=0.1, gamma=1, kernel=rbf;, score=0.503 total time=   0.2s
[CV 3/5] END ........C=0.1, gamma=1, kernel=rbf;, score=0.476 total time=   0.2s
[CV 4/5] END ........C=0.1, gamma=1, kernel=rbf;, score=0.558 total time=   0.2s
[CV 5/5] END ........C=0.1, gamma=1, kernel=rbf;, score=0.459 total time=   0.2s
[CV 1/5] END ......C=0.1, gamma=0.1, kernel=rbf;, score=0.668 total time=   0.1s
[CV 2/5] END ......C=0.1, gamma=0.1, kernel=rbf;, score=0.702 total time=   0.1s
[CV 3/5] END ......C=0.1, gamma=0.1, kernel=rbf;, score=0.702 total time=   0.1s
[CV 4/5] END ......C=0.1, gamma=0.1, kernel=rbf;, score=0.634 total time=   0.1s
[CV 5/5] END ......C=0.1, gamma=0.1, kernel=rbf;, score=0.661 total time=   0.1s
[CV 1/5] END .....C=0.1, gamma=0.01, kernel=rbf;, score=0.568 total time=   0.1s
[CV 2/5] END .....C=0.1, gamma=0.01, kernel=rbf;, score=0.558 total time=   0.1s
[CV 3/5] END .....C=0.1, gamma=0.01, kernel=rbf;, score=0.562 total time=   0.1s
[CV 4/5] END .....C=0.1, gamma=0.01, kernel=rbf;, score=0.534 total time=   0.1s
[CV 5/5] END .....C=0.1, gamma=0.01, kernel=rbf;, score=0.623 total time=   0.1s
```

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```
[CV 4/5] END ...C=1000, gamma=0.001, kernel=rbf;, score=0.675 total time=   0.2s
[CV 5/5] END ...C=1000, gamma=0.001, kernel=rbf;, score=0.709 total time=   0.2s
[CV 1/5] END ..C=1000, gamma=0.0001, kernel=rbf;, score=0.695 total time=   0.1s
[CV 2/5] END ..C=1000, gamma=0.0001, kernel=rbf;, score=0.682 total time=   0.1s
[CV 3/5] END ..C=1000, gamma=0.0001, kernel=rbf;, score=0.640 total time=   0.1s
[CV 4/5] END ..C=1000, gamma=0.0001, kernel=rbf;, score=0.582 total time=   0.1s
[CV 5/5] END ..C=1000, gamma=0.0001, kernel=rbf;, score=0.664 total time=   0.1s
{'C': 1000, 'gamma': 0.1, 'kernel': 'rbf'}
SVC(C=1000, gamma=0.1)
```

In [312]:

```
grid_predictions = grid.predict(X_test_resampled)

# print classification report
print(classification_report(Y_test_resampled, grid_predictions))
```

```
              precision    recall  f1-score   support

     drizzle       0.75      0.96      0.84       107
         fog       0.83      0.91      0.86       137
        rain       0.93      0.85      0.89       127
        snow       0.98      0.99      0.98       130
         sun       0.82      0.60      0.69       126

    accuracy                           0.86       627
   macro avg       0.86      0.86      0.85       627
weighted avg       0.86      0.86      0.86       627
```

In [313]:

```
#print accuracy score after grid search tuning
print(accuracy_score(Y_test_resampled, grid_predictions)*100)
```

```
85.96491228070175
```

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Logout

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Run Code

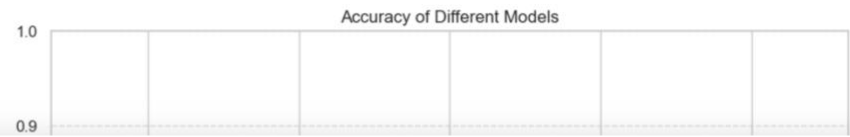
In [314]:

```
import matplotlib.pyplot as plt

# Calculate accuracy for each model
knn_accuracy = accuracy_score(Y_test_resampled, knn_model.predict(X_test_resampled))
rf_accuracy = accuracy_score(Y_test_resampled, clf.predict(X_test_resampled))
gbc_accuracy = accuracy_score(Y_test_resampled, gbc.predict(X_test_resampled))
gnb_accuracy = accuracy_score(Y_test_resampled, gnb.predict(X_test_resampled))
svm_accuracy = accuracy_score(Y_test_resampled, svc.predict(X_test_resampled))

# Define the models and their corresponding accuracy scores
models = ['KNN', 'Random Forest', 'Gradient Boosting', 'Naive Bayes', 'SVM']
accuracies = [knn_accuracy, rf_accuracy, gbc_accuracy, gnb_accuracy, svm_accuracy]

# Plot the bar plot
plt.figure(figsize=(10, 6))
plt.bar(models, accuracies, color='skyblue')
plt.xlabel('Model')
plt.ylabel('Accuracy')
plt.title('Accuracy of Different Models')
plt.ylim(0.5, 1.0)  # Adjust ylim if necessary
plt.xticks(rotation=45)  # Rotate x-axis labels for better readability
plt.grid(axis='y', linestyle='--', alpha=0.7)
plt.show()
```

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Run Code