The Effect of Sunlight on Water Evaporation

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1. Abstract

This paper presents an investigation into the effects of sunlight on water evaporation over a period of 39 days. The experiment involved placing a glass of water in direct sunlight and measuring the amount of water evaporated twice a day. Additionally, the average temperature of each day was recorded. The objective was to examine the relationship between temperature and water evaporation and determine if a direct correlation exists.

The results of the experiment revealed that there is no direct relationship between temperature and water evaporation. Surprisingly, the findings showcased that days with higher temperatures did not necessarily result in increased water evaporation, and vice versa. This implies that factors other than temperature may significantly influence the rate of water evaporation under sunlight exposure.

To further investigate the relationship between temperature and water evaporation, a correlation matrix was constructed. The analysis indicated a positive correlation between the two variables, albeit with varying degrees of strength. However, when employing linear regression predictive modeling, the relationship was found to be relatively weak.

These findings highlight the complex nature of water evaporation and suggest that temperature alone may not be the sole determinant of evaporation rates under sunlight exposure. Further research is

needed to explore the additional factors that could contribute to the observed variations in water evaporation and to develop more accurate predictive models.

Keywords: sunlight, water evaporation, temperature, correlation matrix, linear regression, predictive modeling.

2. Data Health Review

2.1 Importing Libraries

In [2]:
```
import pandas as pd
import numpy as np

import matplotlib.pyplot as plt
import seaborn as sns
```

2.2 Importing the Data

In [3]:
```
df = pd.read_excel('The Effect of Sunlight on Water Evaporation.xlsx')
df.head(5)
```

Out[3]:

	Date	From (in ml)	To (in ml)	Difference (in ml)	Temperature (in °C)
0	2023-03-14	400	370	30	25
1	2023-03-15	400	380	20	21
2	2023-03-16	400	370	30	23
3	2023-03-17	400	390	10	21
4	2023-03-18	400	380	20	23

2.3 Data Cleaning and Preprocessing

In [3]:
```
df.duplicated().sum()
```

Out[3]:
```
0
```

In [4]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 39 entries, 0 to 38
Data columns (total 5 columns):
 #   Column               Non-Null Count  Dtype
---  ------               --------------  -----
 0   Date                 39 non-null     datetime64[ns]
 1   From (in ml)         39 non-null     int64
 2   To (in ml)           39 non-null     int64
 3   Difference (in ml)   39 non-null     int64
 4   Temperature (in °C)  39 non-null     int64
dtypes: datetime64[ns](1), int64(4)
memory usage: 1.6 KB
```

In [5]:
```python
# renaming the names of column to make it more
df.rename(columns = {'From (in ml)':'Water@9am_ml','To (in ml)':'Water@8pm_ml','Difference (i
df.head(3)
```

Out[5]:

	Date	Water@9am_ml	Water@8pm_ml	Diff_ml	Temp_C
0	2023-03-14	400	370	30	25
1	2023-03-15	400	380	20	21
2	2023-03-16	400	370	30	23

In [6]:
```python
df.isnull().sum()
```

Out[6]:
```
Date            0
Water@9am_ml    0
Water@8pm_ml    0
Diff_ml         0
Temp_C          0
dtype: int64
```

2.4 Data Statistical Summary

In [7]:
```python
df.describe()
```

Out[7]:

	Water@9am_ml	Water@8pm_ml	Diff_ml	Temp_C
count	39.0	39.000000	39.000000	39.000000
mean	400.0	348.461538	51.538462	33.615385
std	0.0	26.009964	26.009964	5.402803
min	400.0	290.000000	10.000000	21.000000
25%	400.0	335.000000	35.000000	33.000000
50%	400.0	350.000000	50.000000	35.000000
75%	400.0	365.000000	65.000000	37.000000
max	400.0	390.000000	110.000000	39.000000

3. Exploratory Data Analysis

3.1 Data Frequency Understanding

In [8]:
```python
for i in df.columns:
    nunique = df[i].nunique()
    print('The nunique feature in '+ i + 'is: ', nunique)
```

```
The nunique feature in Dateis:  39
The nunique feature in Water@9am_mlis:  1
The nunique feature in Water@8pm_mlis:  11
The nunique feature in Diff_mlis:  11
The nunique feature in Temp_Cis:  11
```

3.2 Univariate Analysis

In [9]:

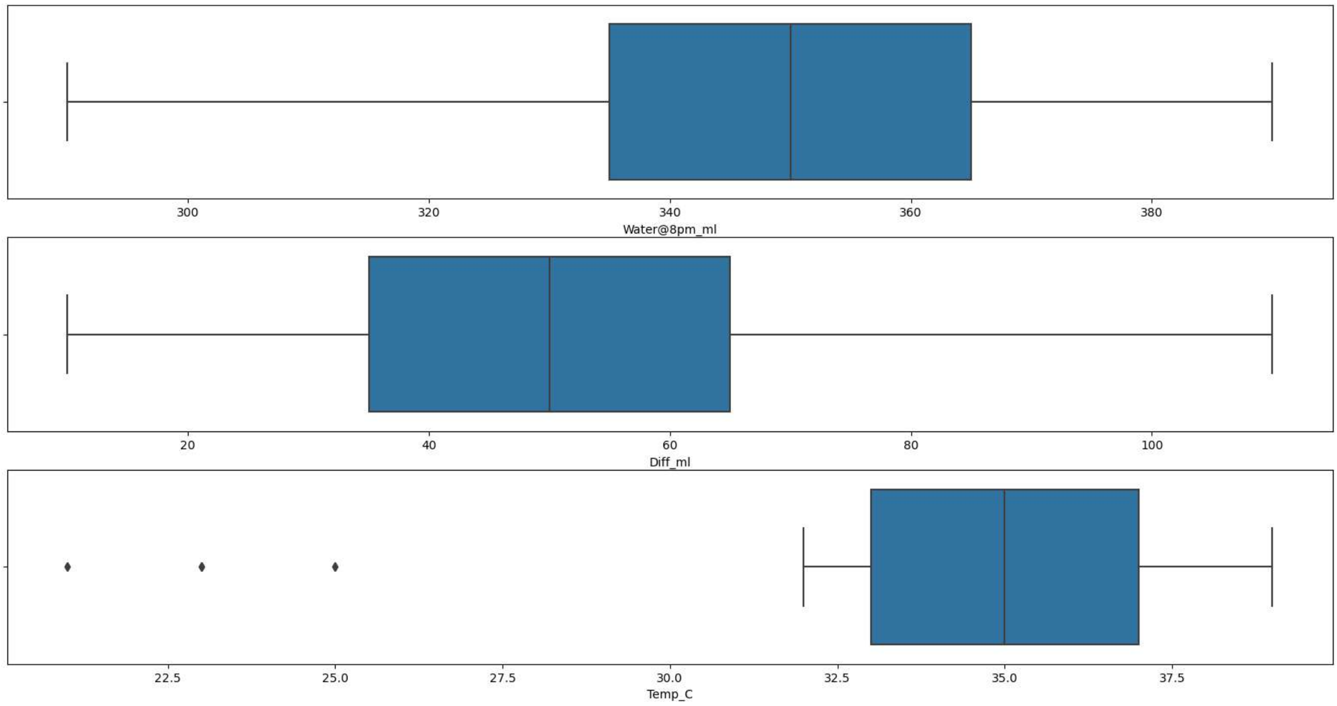
```
df.columns
```

Out[9]:

```
Index(['Date', 'Water@9am_ml', 'Water@8pm_ml', 'Diff_ml', 'Temp_C'], dtype='object')
```

In [10]:

```
plt.figure(figsize = (20,10))

plt.subplot(3,1,1)
sns.boxplot(data = df, x = 'Water@8pm_ml')

plt.subplot(3,1,2)
sns.boxplot(data = df, x = 'Diff_ml')

plt.subplot(3,1,3)
sns.boxplot(data = df, x = 'Temp_C')

plt.show()
```



3.2.1 Treatment of Outliers

In [11]:

```
df[df['Temp_C']<30]
```

Out[11]:

	Date	Water@9am_ml	Water@8pm_ml	Diff_ml	Temp_C
0	2023-03-14	400	370	30	25
1	2023-03-15	400	380	20	21
2	2023-03-16	400	370	30	23
3	2023-03-17	400	390	10	21
4	2023-03-18	400	380	20	23
5	2023-03-19	400	390	10	23
6	2023-03-20	400	360	40	25

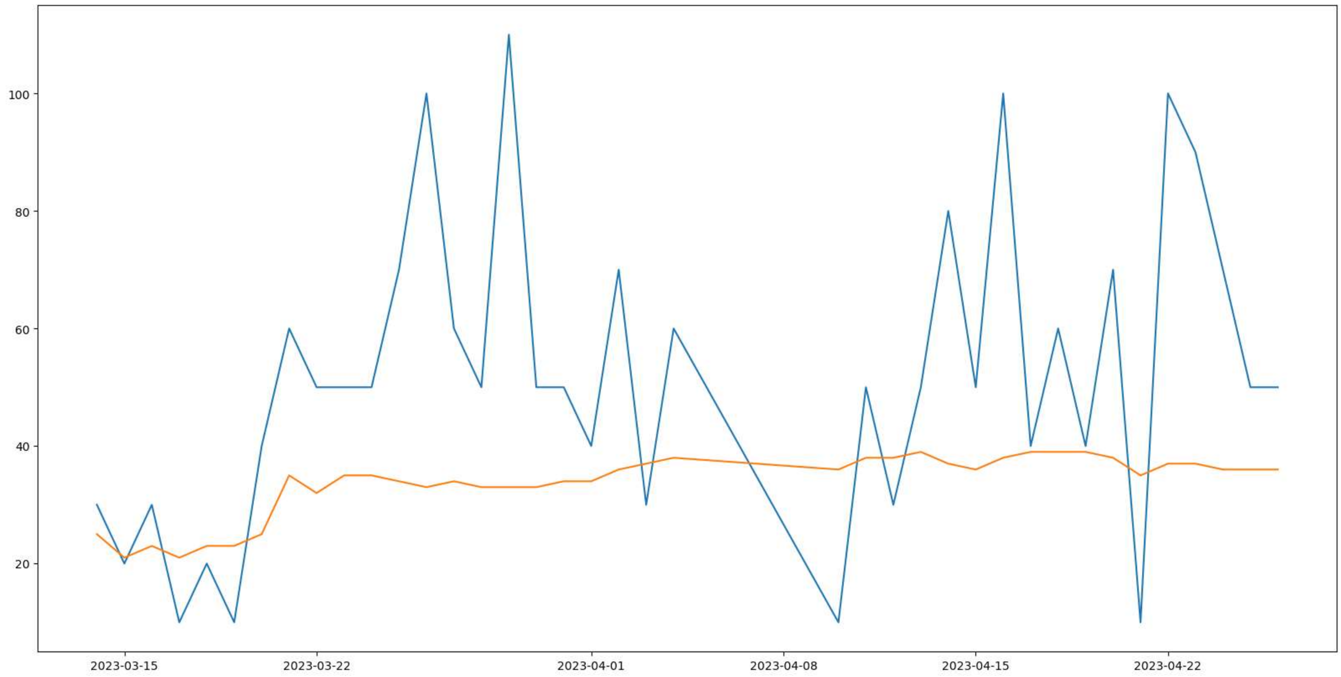
In [12]:

```
# Retaining the outliers
```

3.3 Bivariate Analysis

In [13]:

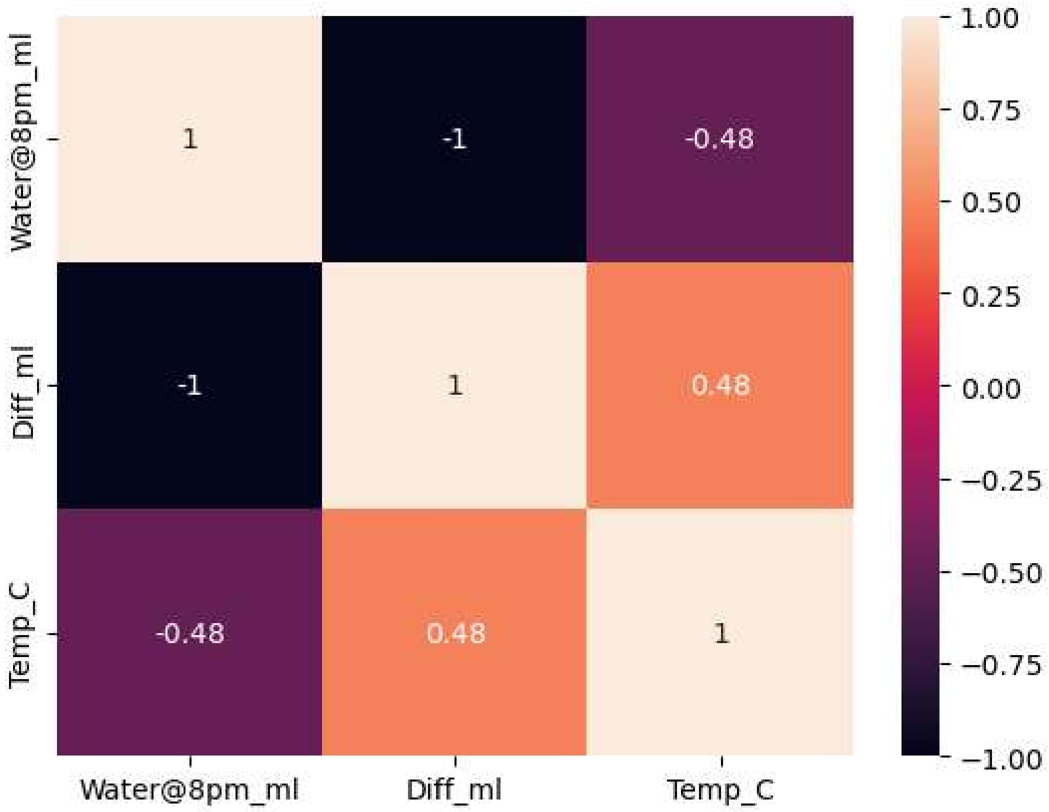
```
plt.figure(figsize = (20,10))

plt.plot(df['Date'], df['Diff_ml'])
plt.plot(df['Date'], df['Temp_C'])

plt.show()
```



In [14]:

```
sns.heatmap(df[['Water@8pm_ml', 'Diff_ml', 'Temp_C']].corr(), annot = True)
```

Out[14]: <Axes: >



4. Spliting the data and Fitting the Model

Using Simple Linear Regression to find the relation between the Difference in water evaporation and Temperature

In [15]:
```
df.head(2)
```

Out[15]:

	Date	Water@9am_ml	Water@8pm_ml	Diff_ml	Temp_C
0	2023-03-14	400	370	30	25
1	2023-03-15	400	380	20	21

In [16]:
```
X = df['Diff_ml']
y = df['Temp_C']
```

In [17]:
```
# Spliting the Data
from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X,y,train_size = .8, random_state = 25)
X_train = X_train.values.reshape(-1,1)
X_test = X_test.values.reshape(-1,1)
y_train = y_train.values.reshape(-1,1)
y_test = y_test.values.reshape(-1,1)
```

In [18]:
```
# Fitting the model

from sklearn.linear_model import LinearRegression
```

```
lr = LinearRegression()
lr.fit(X_train, y_train)
```

Out[18]:

```
▾ LinearRegression
LinearRegression()
```

In [19]:

```
predict = lr.predict(X_test)
predict.shape
```

Out[19]:

```
(8, 1)
```

In [20]:

```
y_test
```

Out[20]:

```
array([[36],
       [37],
       [25],
       [34],
       [34],
       [36],
       [35],
       [38]], dtype=int64)
```

In [21]:

```
predict
```

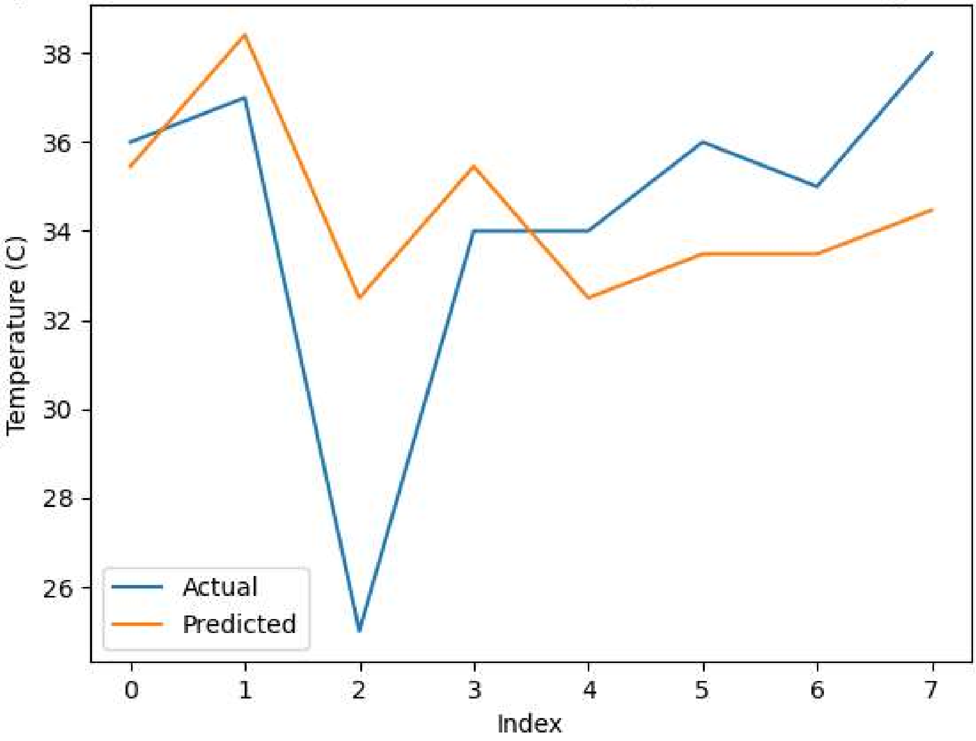
Out[21]:

```
array([[35.45565571],
       [38.41465542],
       [32.496656  ],
       [35.45565571],
       [32.496656  ],
       [33.48298924],
       [33.48298924],
       [34.46932248]])
```

In [22]:

```
x_range = [x for x in range(len(predict))]

plt.xlabel('Index')
plt.ylabel('Temperature (C)')

plt.plot(x_range, y_test)
plt.plot(x_range, predict)

plt.legend(['Actual', 'Predicted'])

plt.title('Graph depicting the correlation between water evaporation and temperature predicti
plt.show();
```

Graph depicting the correlation between water evaporation and temperature prediction.



5. Reading Using SKLearn and Statsmodel Metrics

In [ ]:
```
# Using Sklearn Metrics to get the score

from sklearn import metrics

print('The r2_score for the given data:: ', round(metrics.r2_score(y_test, predict),2))
print('The mean_squared_error for the given data:: ', round(metrics.mean_squared_error(y_test
```

In [ ]:
```
# Intecept and coeff of the line
print('Intercept of the model:',lr.intercept_)
print('Coefficient of the line:',lr.coef_)
```

In [ ]:
```
# using statsmodels to get the score
import statsmodels.formula.api as smf

result = smf.ols(formula = 'Temp_C ~ Diff_ml', data = df).fit()

print(result.summary())
```

Using K Fold Cross Validation

In [ ]:
```
from sklearn.model_selection import KFold
kf = KFold(n_splits = 3)
kf
```

In [ ]:
```
for train_index, test_index in kf.split([1,2,3,4,5,6,7,8,9]):
    print(train_index, test_index)
```

In [ ]:
```
def get_score(model, X_train, X_test, y_train, y_test):
    model.fit(X_train, y_train)
```

```
    return model.score(X_test, y_test)
```

In [ ]:

```
get_score(lr, X_train, X_test, y_train, y_test)
```

6. Conclusion

These findings highlight the complex nature of water evaporation and suggest that temperature alone may not be the sole determinant of evaporation rates under sunlight exposure. Further research is needed to explore the additional factors that could contribute to the observed variations in water evaporation and to develop more accurate predictive models.

In [ ]:

```
print('*'*100)
```

by

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Thank You

In [ ]:

```

```