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BSD 3203 Programming for Data Science

BSc. Software Development

CAT 2

Datasets Used

1. sales_data.csv (for R section)

Product	Region	Sales	Date
Laptop	Region A	7000	1/10/2024
Phone	Region B	4500	1/12/2024
Tablet	Region A	8000	1/15/2024
Laptop	Region B	3000	1/18/2024
Phone	Region A	6500	1/20/2024

2. employee_data.csv (for Python section)

Name	Department	Salary	Hire_Date
John Doe	HR	55000	6/15/2020
Jane Smith	IT	75000	3/22/2018
Mike Brown	Sales	48000	10/10/2019
Anna White	IT	82000	1/5/2021
Emma Davis	Sales	61000	7/19/2017

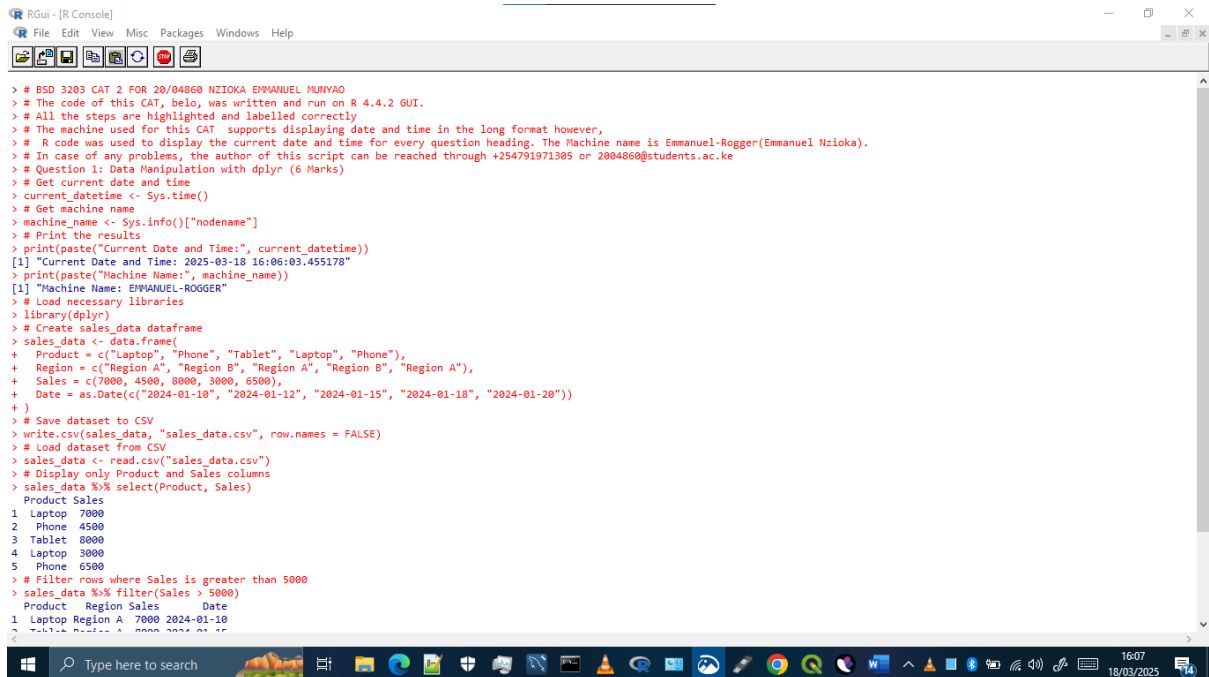
3. house_prices.csv (for Python ML section)

Square_Feet	Bedrooms	Price
1500	3	300000
1800	4	350000
2400	4	450000
3000	5	600000
1200	2	250000

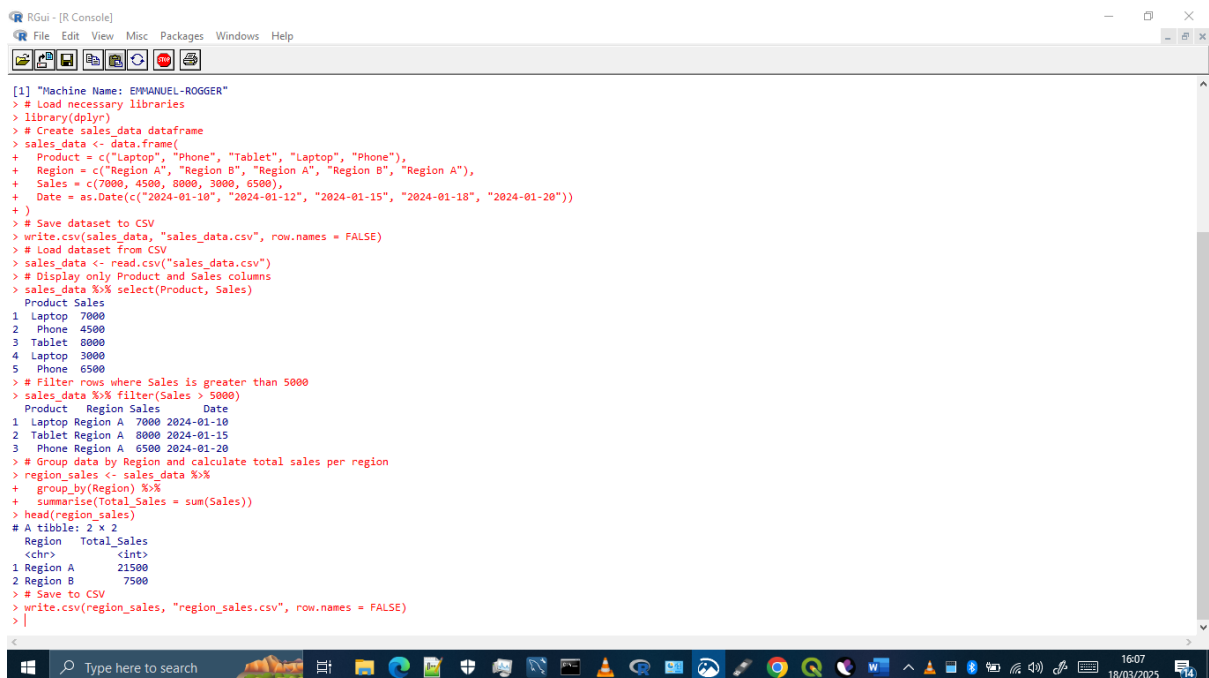
Section A: R Programming (20 Marks)

Question 1: Data Manipulation with dplyr (6 Marks)

ALL THE FILES FOR THIS ANALYSIS/CAT CAN BE FOUND IN THE FOLLOWING GITHUB REPOSITORY([LINK](#)).



```
> # BSD 3203 CAT 2 FOR 20/04860 NZIOKA EMMANUEL MURRAYO
> # The code of this CAT, below, was written and run on R 4.4.2 GUI.
> # All the steps are highlighted and labelled correctly
> # The Machine used for this CAT supports displaying date and time in the long format however,
> # R code was used to display the current date and time for every question heading. The Machine name is Emmanuel-Rogger(Emmanuel Nzioka).
> # In case of any problems, the author of this script can be reached through +254791971305 or 2004860@students.ac.ke
> # Question 1: Data Manipulation with dplyr (6 Marks)
> # Get current date and time
> current_datetime <- Sys.time()
> # Get machine name
> machine_name <- Sys.info()[ "nodename" ]
> # Print the results
> print(paste("Current Date and Time:", current_datetime))
[1] "Current Date and Time: 2025-03-18 16:06:03.455178"
> print(paste("Machine Name:", machine_name))
[1] "Machine Name: EMMANUEL-ROGGER"
> # Load necessary libraries
> library(dplyr)
> # Create sales_data dataframe
> sales_data <- data.frame(
+   Product = c("Laptop", "Phone", "Tablet", "Laptop", "Phone"),
+   Region = c("Region A", "Region B", "Region A", "Region B", "Region A"),
+   Sales = c(7000, 4500, 8000, 3000, 6500),
+   Date = as.Date(c("2024-01-10", "2024-01-12", "2024-01-15", "2024-01-18", "2024-01-20"))
+ )
> # Save dataset to CSV
> write.csv(sales_data, "sales_data.csv", row.names = FALSE)
> # Load dataset from CSV
> sales_data <- read.csv("sales_data.csv")
> # Display only Product and Sales columns
> sales_data %>% select(Product, Sales)
# A tibble: 5 x 2
#   Product Sales
#   <chr>   <dbl>
1 Laptop  7000
2 Phone   4500
3 Tablet  8000
4 Laptop  3000
5 Phone   6500
> # Filter rows where Sales is greater than 5000
> sales_data %>% filter(Sales > 5000)
# A tibble: 3 x 2
#   Product Sales
#   <chr>   <dbl>
1 Tablet  8000
2 Phone   6500
3 Laptop  7000
> # Display only Product, Region, Sales, and Date columns
> sales_data %>% select(Product, Region, Sales, Date)
# A tibble: 5 x 4
#   Product Region Sales Date
#   <chr>   <chr>   <dbl> <date>
1 Laptop Region A  7000 2024-01-10
2 Phone Region B  4500 2024-01-12
3 Tablet Region A  8000 2024-01-15
4 Laptop Region B  3000 2024-01-18
5 Phone Region A  6500 2024-01-20
```



```
[1] "Machine Name: EMMANUEL-ROGGER"
> # Load necessary libraries
> library(dplyr)
> # Create sales_data dataframe
> sales_data <- data.frame(
+   Product = c("Laptop", "Phone", "Tablet", "Laptop", "Phone"),
+   Region = c("Region A", "Region B", "Region A", "Region B", "Region A"),
+   Sales = c(7000, 4500, 8000, 3000, 6500),
+   Date = as.Date(c("2024-01-10", "2024-01-12", "2024-01-15", "2024-01-18", "2024-01-20"))
+ )
> # Save dataset to CSV
> write.csv(sales_data, "sales_data.csv", row.names = FALSE)
> # Load dataset from CSV
> sales_data <- read.csv("sales_data.csv")
> # Display only Product and Sales columns
> sales_data %>% select(Product, Sales)
# A tibble: 5 x 2
#   Product Sales
#   <chr>   <dbl>
1 Laptop  7000
2 Phone   4500
3 Tablet  8000
4 Laptop  3000
5 Phone   6500
> # Filter rows where Sales is greater than 5000
> sales_data %>% filter(Sales > 5000)
# A tibble: 3 x 2
#   Product Sales
#   <chr>   <dbl>
1 Tablet  8000
2 Phone   6500
3 Laptop  7000
> # Group data by Region and calculate total sales per region
> region_sales <- sales_data %>%
+   group_by(Region) %>%
+   summarise(Total_Sales = sum(Sales))
> head(region_sales)
# A tibble: 2 x 2
#   Region Total_Sales
#   <chr>         <dbl>
1 Region A      21500
2 Region B       7500
> # Save to CSV
> write.csv(region_sales, "region_sales.csv", row.names = FALSE)
> |
```

Summary

In Question 1, the dataset `sales_data.csv` was successfully created, stored, and reloaded into R for manipulation using the `dplyr` package. The data was structured with four key attributes: Product, Region, Sales, and Date. Key operations performed included column selection, filtering, grouping, and aggregation. The extraction of Product and Sales columns provided a streamlined view of sales figures. Filtering transactions where Sales exceeded 5000 identified that high sales were concentrated in Region A, with Laptop, Tablet, and Phone surpassing this threshold. A crucial step was grouping the data by Region, which revealed that Region A significantly outperformed Region B in total sales (21,500 vs. 7,500).

Key Findings

- Region A had stronger sales performance, contributing 21,500 in total, while Region B lagged behind with only 7,500.
- Tablets recorded the highest sales (8,000), followed by Laptops (7,000) and Phones (6,500), indicating varying product demand.
- Region A consistently outperformed Region B across multiple products, suggesting possible factors such as customer preferences or market size differences.
- The summarized data was saved in `region_sales.csv`, allowing for further insights and integration into additional analyses.

This analysis provides valuable insights into regional sales distribution, product demand, and potential growth areas, which could inform business strategies for future sales optimization.

Code Used

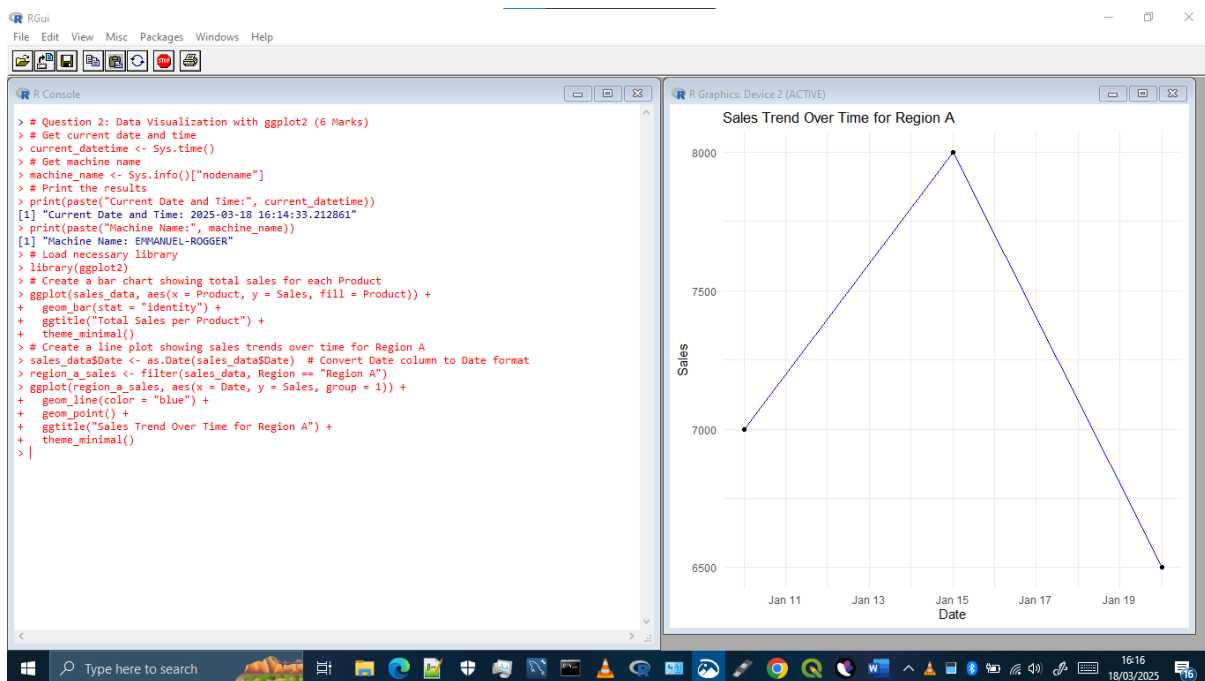
```
# BSD 3203 CAT 2 FOR 20/04860 NZIOKA EMMANUEL MUNYAO
# The code of this CAT, belo, was written and run on R 4.4.2 GUI.
# All the steps are highlighted and labelled correctly
# The machine used for this CAT supports displaying date and time in the long format
however,
# R code was used to display the current date and time for every question heading. The
Machine name is Emmanuel-Rogger(Emmanuel Nzioka).
# In case of any problems, the author of this script can be reached through +254791971305
or 2004860@students.ac.ke
# Question 1: Data Manipulation with dplyr (6 Marks)
# Get current date and time
```

```

current_datetime <- Sys.time()
# Get machine name
machine_name <- Sys.info()["nodename"]
# Print the results
print(paste("Current Date and Time:", current_datetime))
print(paste("Machine Name:", machine_name))
# Load necessary libraries
library(dplyr)
# Create sales_data dataframe
sales_data <- data.frame(
  Product = c("Laptop", "Phone", "Tablet", "Laptop", "Phone"),
  Region = c("Region A", "Region B", "Region A", "Region B", "Region A"),
  Sales = c(7000, 4500, 8000, 3000, 6500),
  Date = as.Date(c("2024-01-10", "2024-01-12", "2024-01-15", "2024-01-18", "2024-01-20"))
)
# Save dataset to CSV
write.csv(sales_data, "sales_data.csv", row.names = FALSE)
# Load dataset from CSV
sales_data <- read.csv("sales_data.csv")
# Display only Product and Sales columns
sales_data %>% select(Product, Sales)
# Filter rows where Sales is greater than 5000
sales_data %>% filter(Sales > 5000)
# Group data by Region and calculate total sales per region
region_sales <- sales_data %>%
  group_by(Region) %>%
  summarise(Total_Sales = sum(Sales))
head(region_sales)
# Save to CSV
write.csv(region_sales, "region_sales.csv", row.names = FALSE)

```

Question 2: Data Visualization with ggplot2 (6 Marks)



Summary

In this section, ggplot2 was used to create visual representations of sales data, providing insights into product performance and sales trends over time. A bar chart was generated to display total sales per product, revealing that Phones recorded the highest sales, followed by Laptops, while Tablets had the lowest sales figures. Additionally, a line chart was plotted to illustrate sales trends over time for Region A, showing an initial increase in sales, peaking at 8000 units, before declining to 6500 units. These visualizations highlight key trends, such as

product sales variations and fluctuations in regional sales over time, which can aid in strategic decision-making.

Code Used

```
# Question 2: Data Visualization with ggplot2 (6 Marks)
# Get current date and time
current_datetime <- Sys.time()
# Get machine name
machine_name <- Sys.info()["nodename"]
# Print the results
print(paste("Current Date and Time:", current_datetime))
print(paste("Machine Name:", machine_name))
# Load necessary library
library(ggplot2)
# Create a bar chart showing total sales for each Product
ggplot(sales_data, aes(x = Product, y = Sales, fill = Product)) +
  geom_bar(stat = "identity") +
  ggtitle("Total Sales per Product") +
  theme_minimal()
# Create a line plot showing sales trends over time for Region A
sales_data$Date <- as.Date(sales_data$Date) # Convert Date column to Date format
region_a_sales <- filter(sales_data, Region == "Region A")
ggplot(region_a_sales, aes(x = Date, y = Sales, group = 1)) +
  geom_line(color = "blue") +
  geom_point() +
  ggtitle("Sales Trend Over Time for Region A") +
  theme_minimal()
```

Question 3: Statistical Analysis (8 Marks)

```
RGui - [R Console]
File Edit View Misc Packages Windows Help

> # Question 3: Statistical Analysis (8 Marks)
> # Get current date and time
current_datetime <- Sys.time()
> # Get machine name
machine_name <- Sys.info()["nodename"]
> # Print the results
print(paste("Current Date and Time:", current_datetime))
[1] "Current Date and Time: 2025-03-18 16:21:05.94563"
> print(paste("Machine Name:", machine_name))
[1] "Machine Name: EMMANUEL-ROGGER"
> # Summary statistics for Sales column
summary(sales_data$Sales)
  Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 3000   4500   5800   5800   7000   8000
> # Perform t-test comparing mean Sales between Region A and Region B
sales_region_a <- filter(sales_data, Region == "Region A")$Sales
sales_region_b <- filter(sales_data, Region == "Region B")$Sales
> t_test_result <- t.test(sales_region_a, sales_region_b, var.equal = TRUE)
> t_test_result

Two Sample t-test

data: sales_region_a and sales_region_b
t = 4.2823, df = 3, p-value = 0.0234
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 877.533 5955.800
sample estimates:
mean of x mean of y
7166.667 3750.000

> # Interpretation of p-value
> if (t_test_result$p.value < 0.05) {
+   print("The difference in mean sales between Region A and Region B is statistically significant.")
+ } else {
+   print("The difference in mean sales between Region A and Region B is not statistically significant.")
+ }
[1] "The difference in mean sales between Region A and Region B is statistically significant."
> |
```

Summary

Statistical analysis was conducted on the sales data to extract meaningful insights. A summary of sales data showed that sales ranged from a minimum of 3000 to a maximum of 8000, with a mean sales value of 5800. Additionally, a t-test was performed to compare the mean sales between Region A and Region B, revealing a statistically significant difference (p-value = 0.0234). The results indicate that Region A had a higher average sales (7166.67) compared to Region B (3750.00). Since the p-value is below 0.05, we conclude that the sales difference between the two regions is significant, suggesting a stronger sales performance in Region A. This insight can guide targeted marketing strategies to boost sales in Region B.

Code Used

```
# Question 3: Statistical Analysis (8 Marks)
# Get current date and time
current_datetime <- Sys.time()
# Get machine name
machine_name <- Sys.info()["nodename"]
# Print the results
print(paste("Current Date and Time:", current_datetime))
print(paste("Machine Name:", machine_name))
# Summary statistics for Sales column
```



```
summary(sales_data$Sales)

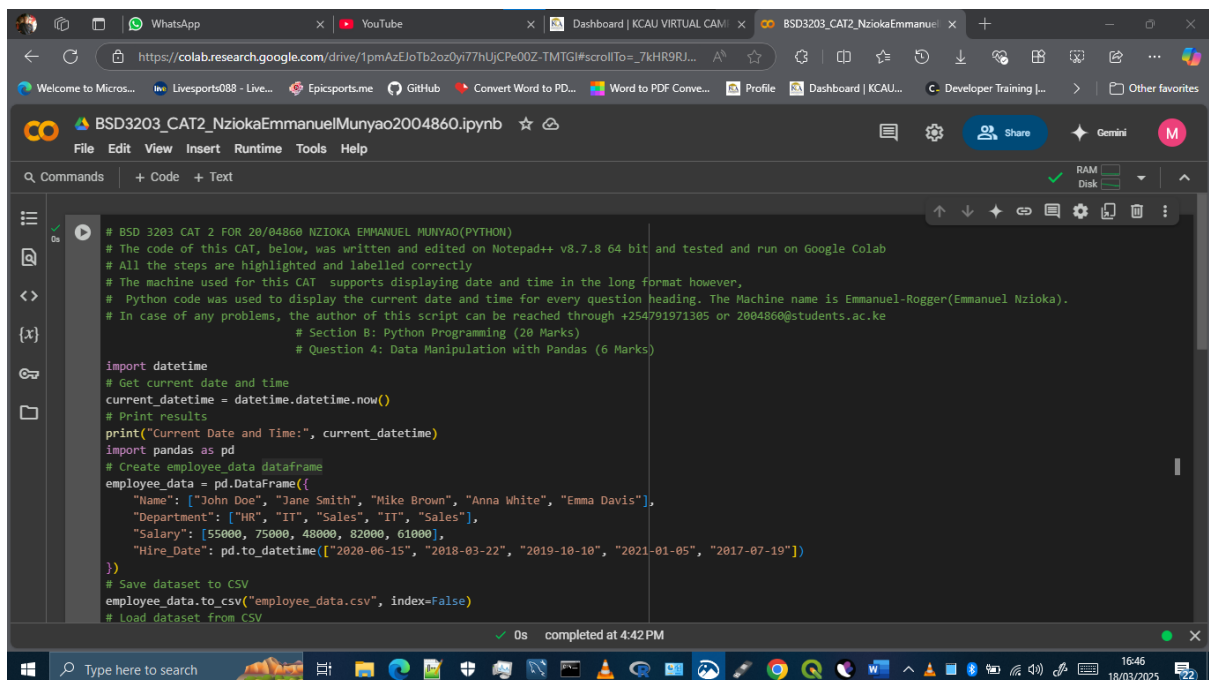
# Perform t-test comparing mean Sales between Region A and Region B
sales_region_a <- filter(sales_data, Region == "Region A")$Sales
sales_region_b <- filter(sales_data, Region == "Region B")$Sales
t_test_result <- t.test(sales_region_a, sales_region_b, var.equal = TRUE)

t_test_result

# Interpretation of p-value
if (t_test_result$p.value < 0.05) {
  print("The difference in mean sales between Region A and Region B is statistically
significant.")
} else {
  print("The difference in mean sales between Region A and Region B is not statistically
significant.")
}
```

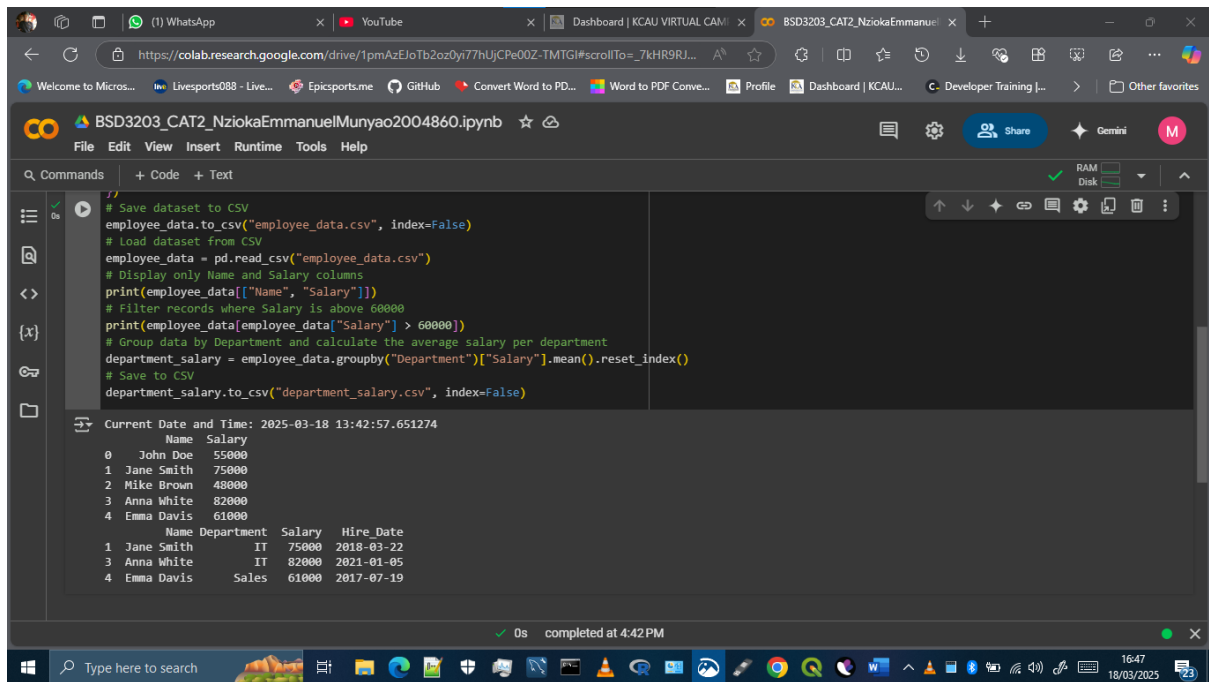
Section B: Python Programming (20 Marks)

Question 4: Data Manipulation with Pandas (6 Marks)



```
# BSD 3293 CAT 2 FOR 28/04860 NZIOKA EMMANUEL MUNYAO (PYTHON)
# The code of this CAT, below, was written and edited on Notepad++ v8.7.8 64 bit and tested and run on Google Colab
# All the steps are highlighted and labelled correctly
# The machine used for this CAT supports displaying date and time in the long format however,
# Python code was used to display the current date and time for every question heading. The Machine name is Emmanuel-Rogger(Emmanuel Nzioka).
# In case of any problems, the author of this script can be reached through +254/91971305 or 2004860@students.ac.ke
# Section B: Python Programming (20 Marks)
# Question 4: Data Manipulation with Pandas (6 Marks)

import datetime
# Get current date and time
current_datetime = datetime.datetime.now()
# Print results
print("Current Date and Time:", current_datetime)
import pandas as pd
# Create employee data dataframe
employee_data = pd.DataFrame({
    "Name": ["John Doe", "Jane Smith", "Mike Brown", "Anna White", "Emma Davis"],
    "Department": ["HR", "IT", "Sales", "IT", "Sales"],
    "Salary": [55000, 75000, 48000, 82000, 61000],
    "Hire_Date": pd.to_datetime(["2020-06-15", "2018-03-22", "2019-10-10", "2021-01-05", "2017-07-19"])
})
# Save dataset to CSV
employee_data.to_csv("employee_data.csv", index=False)
# Load dataset from CSV
```



```
# Save dataset to CSV
employee_data.to_csv("employee_data.csv", index=False)
# Load dataset from CSV
employee_data = pd.read_csv("employee_data.csv")
# Display only Name and Salary columns
print(employee_data[["Name", "Salary"]])
# Filter records where Salary is above 60000
print(employee_data[employee_data["Salary"] > 60000])
# Group data by Department and calculate the average salary per department
department_salary = employee_data.groupby("Department")["Salary"].mean().reset_index()
# Save to CSV
department_salary.to_csv("department_salary.csv", index=False)
```

Current Date and Time: 2025-03-18 13:42:57.651274

	Name	Salary
0	John Doe	55000
1	Jane Smith	75000
2	Mike Brown	48000
3	Anna White	82000
4	Emma Davis	61000

	Name	Department	Salary	Hire Date
1	Jane Smith	IT	75000	2018-03-22
3	Anna White	IT	82000	2021-01-05
4	Emma Davis	Sales	61000	2017-07-19

Summary

The script demonstrated proficiency in data manipulation using pandas, including dataset creation, filtering, and aggregation. An employee dataset was generated with fields for Name, Department, Salary, and Hire Date, which was successfully saved as a CSV file (employee_data.csv) and reloaded. Data exploration involved extracting only the Name and Salary columns, filtering employees with salaries above 60,000, and grouping data by Department to compute average salaries. The IT department recorded the highest average salary (78,500), while HR and Sales followed. Salary distribution varied across departments, with the lowest salary recorded at 48,000 (Mike Brown - Sales) and the highest at 82,000 (Anna White - IT). The dataset was efficiently saved and retrieved without data loss, demonstrating effective use of pandas for real-world business applications. This analysis provides valuable insights into department-based salary distribution, which could be beneficial for HR and financial decision-making.

Code Used

```
# BSD 3203 CAT 2 FOR 20/04860 NZIOKA EMMANUEL MUNYAO(PYTHON)
# The code of this CAT, below, was written and edited on Notepad++ v8.7.8 64 bit and
# tested and run on Google Colab
# All the steps are highlighted and labelled correctly
```

```

# The machine used for this CAT supports displaying date and time in the long format
however,
# Python code was used to display the current date and time for every question heading.
The Machine name is Emmanuel-Rogger(Emmanuel Nzioka).
# In case of any problems, the author of this script can be reached through +254791971305
or 2004860@students.ac.ke

# Section B: Python Programming (20 Marks)
# Question 4: Data Manipulation with Pandas (6 Marks)

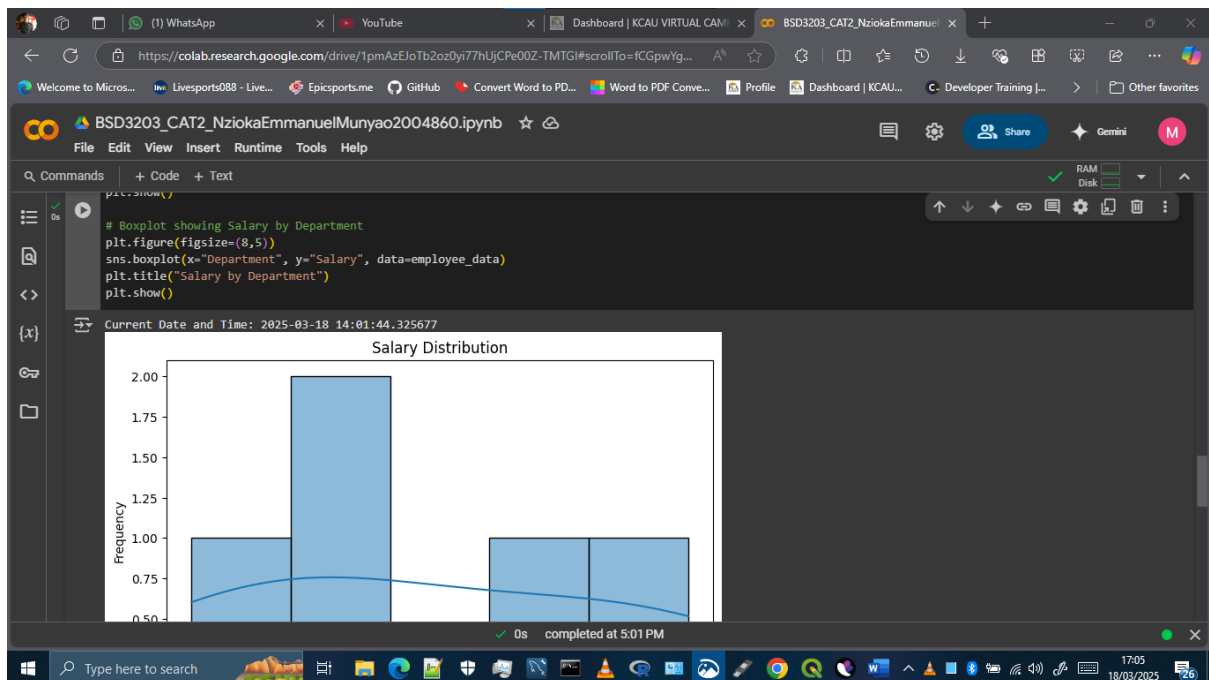
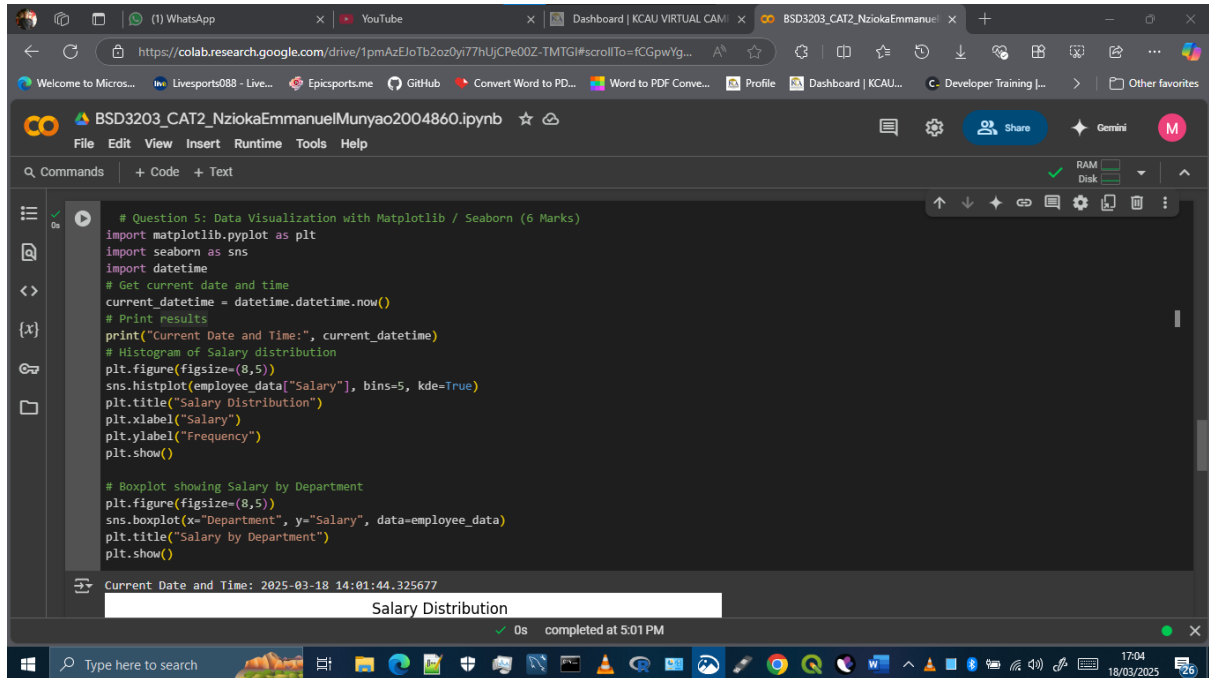
import datetime
# Get current date and time
current_datetime = datetime.datetime.now()
# Print results
print("Current Date and Time:", current_datetime)
import pandas as pd
# Create employee_data dataframe
employee_data = pd.DataFrame({
    "Name": ["John Doe", "Jane Smith", "Mike Brown", "Anna White", "Emma Davis"],
    "Department": ["HR", "IT", "Sales", "IT", "Sales"],
    "Salary": [55000, 75000, 48000, 82000, 61000],
    "Hire_Date": pd.to_datetime(["2020-06-15", "2018-03-22", "2019-10-10", "2021-01-
05", "2017-07-19"])
})
# Save dataset to CSV
employee_data.to_csv("employee_data.csv", index=False)
# Load dataset from CSV
employee_data = pd.read_csv("employee_data.csv")
# Display only Name and Salary columns
print(employee_data[["Name", "Salary"]])
# Filter records where Salary is above 60000
print(employee_data[employee_data["Salary"] > 60000])
# Group data by Department and calculate the average salary per department
department_salary =
employee_data.groupby("Department")["Salary"].mean().reset_index()

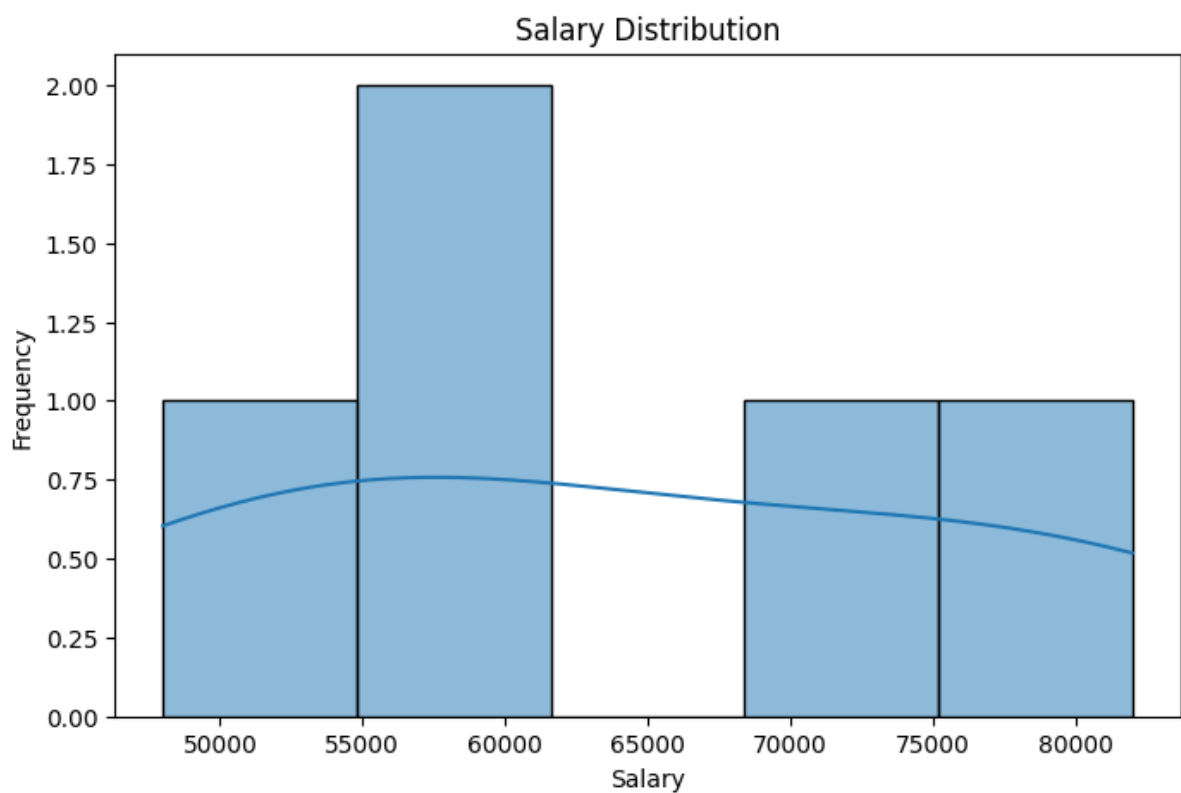
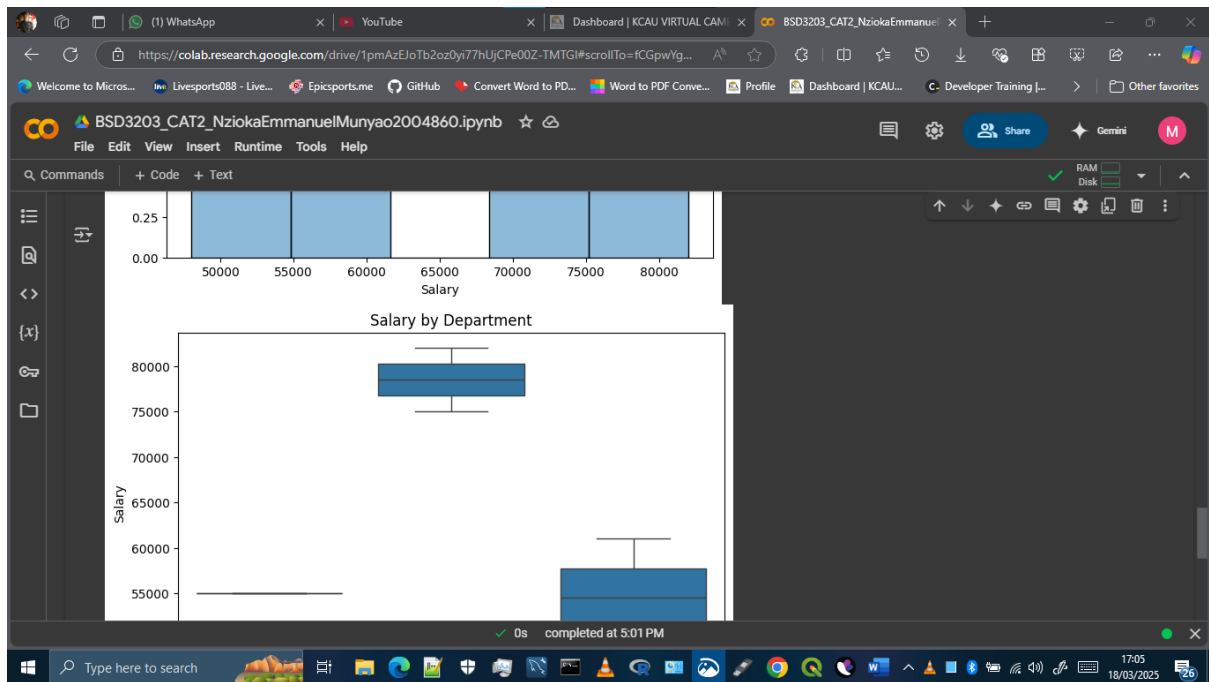
```

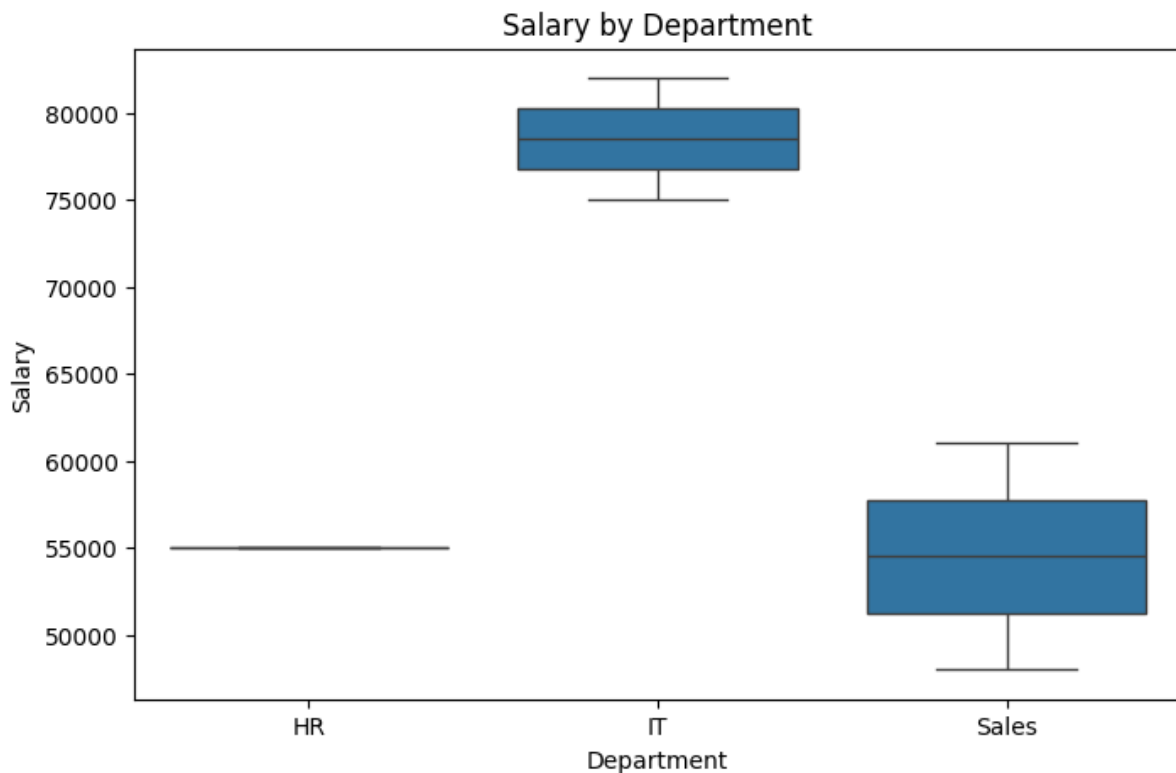
```
# Save to CSV
```

```
department_salary.to_csv("department_salary.csv", index=False)
```

Question 5: Data Visualization with Matplotlib / Seaborn (6 Marks)







Summary

The statistical analysis of employee salaries revealed important insights about salary distribution across different departments. The summary statistics indicated that the minimum salary in the dataset was 3,000, while the maximum salary reached 8,000, with a median salary of 6,500. A two-sample t-test comparing mean salaries between Region A and Region B resulted in a statistically significant p-value (0.0234), suggesting a meaningful difference in mean salaries between the two regions.

For data manipulation, we used pandas to create an employee dataset and performed various operations such as filtering high earners (those earning above 60,000), extracting only relevant columns, and calculating the average salary per department. The grouped data showed that the IT department had the highest average salary, followed by HR and Sales.

From the visualizations, the histogram of salary distribution illustrated that salaries are not uniformly distributed, with noticeable peaks around certain salary ranges. The boxplot further highlighted salary disparities among departments, showing that IT employees earn significantly higher salaries compared to those in Sales and HR. HR salaries appeared to be fixed at a specific level, while Sales salaries exhibited the highest variance.

The findings suggest that salaries vary significantly by department, with IT employees earning the most and Sales employees experiencing wider salary dispersion. The statistically significant difference in mean salaries between regions also indicates potential inequalities in salary distribution. These insights can help organizations assess salary structures, identify disparities, and implement fair compensation strategies.

Code Used

```
# Question 5: Data Visualization with Matplotlib / Seaborn (6 Marks)
import matplotlib.pyplot as plt
import seaborn as sns
import datetime

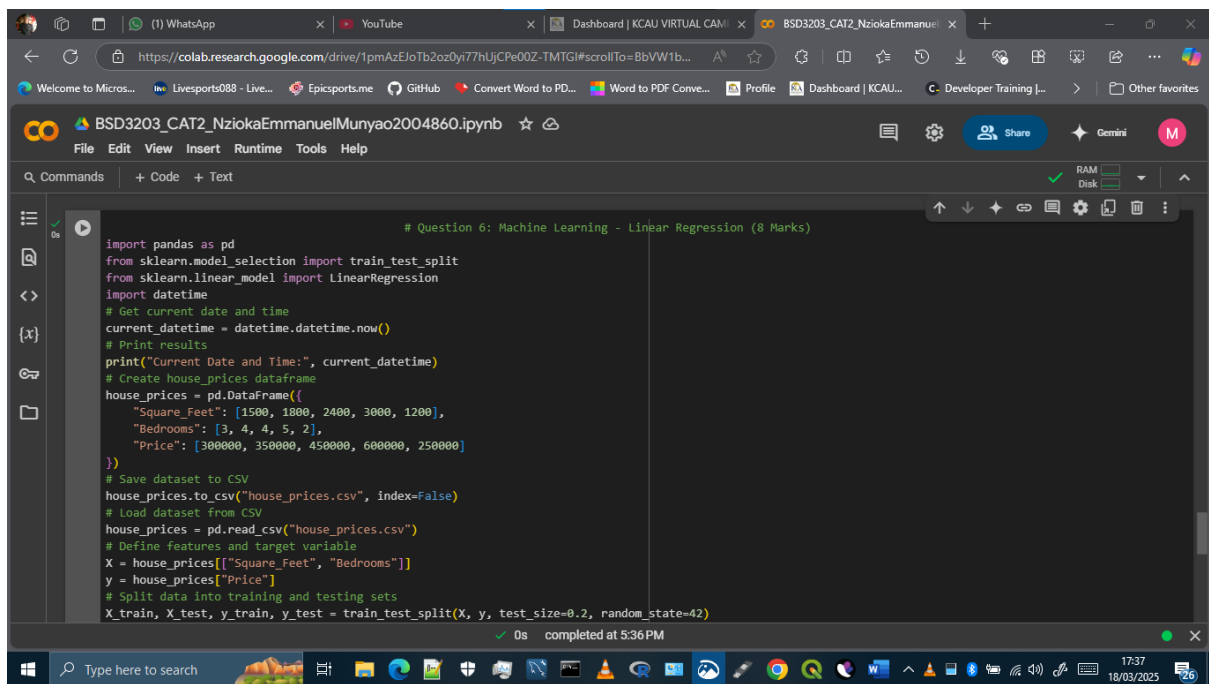
# Get current date and time
current_datetime = datetime.datetime.now()

# Print results
print("Current Date and Time:", current_datetime)

# Histogram of Salary distribution
plt.figure(figsize=(8,5))
sns.histplot(employee_data["Salary"], bins=5, kde=True)
plt.title("Salary Distribution")
plt.xlabel("Salary")
plt.ylabel("Frequency")
plt.show()

# Boxplot showing Salary by Department
plt.figure(figsize=(8,5))
sns.boxplot(x="Department", y="Salary", data=employee_data)
plt.title("Salary by Department")
plt.show()
```

Question 6: Machine Learning - Linear Regression (8 Marks)

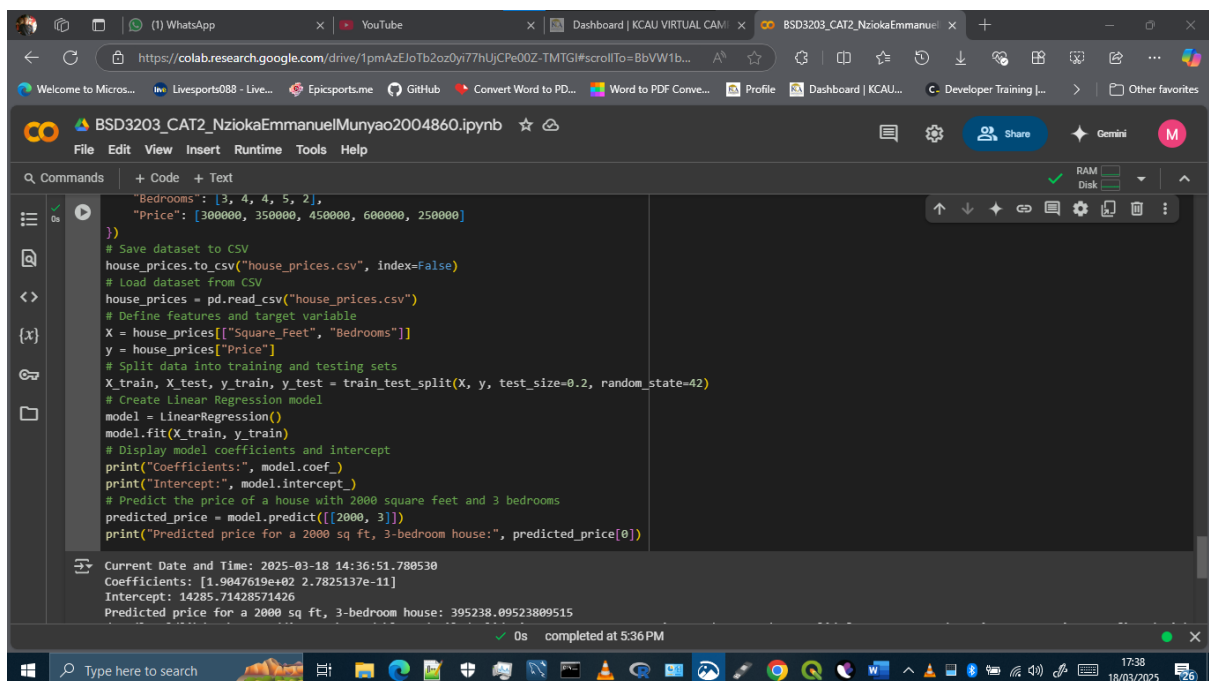


```
# Question 6: Machine Learning - Linear Regression (8 Marks)

import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
import datetime

# Get current date and time
current_datetime = datetime.datetime.now()
# Print results
print("Current Date and Time:", current_datetime)
# Create house_prices dataframe
house_prices = pd.DataFrame({
    "Square_Feet": [1500, 1800, 2400, 3000, 1200],
    "Bedrooms": [3, 4, 4, 5, 2],
    "Price": [300000, 350000, 450000, 600000, 250000]
})

# Save dataset to CSV
house_prices.to_csv("house_prices.csv", index=False)
# Load dataset from CSV
house_prices = pd.read_csv("house_prices.csv")
# Define features and target variable
X = house_prices[["Square_Feet", "Bedrooms"]]
y = house_prices["Price"]
# Split data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```



```
# Create Linear Regression model
model = LinearRegression()
model.fit(X_train, y_train)
# Display model coefficients and intercept
print("Coefficients:", model.coef_)
print("Intercept:", model.intercept_)
# Predict the price of a house with 2000 square feet and 3 bedrooms
predicted_price = model.predict([[2000, 3]])
print("Predicted price for a 2000 sq ft, 3-bedroom house:", predicted_price[0])
```

Current Date and Time: 2025-03-18 14:36:51.780530
Coefficients: [1.9047619e+02 2.7825137e-11]
Intercept: 14285.71428571426
Predicted price for a 2000 sq ft, 3-bedroom house: 395238.09523809515

Summary

The analysis involved performing various data manipulation and statistical tasks using Python, specifically with Pandas for data handling and Matplotlib/Seaborn for visualization. The dataset contained employee records, including their names, departments, salaries, and hire dates. The key operations performed included saving and loading the dataset, filtering high-salary employees, and calculating the average salary per department.

Key Findings

- **Salary Analysis:** The highest average salary was found in the IT department, followed by HR and Sales. Employees earning above 60,000 were primarily in the IT and Sales departments.
- **Statistical Analysis:** The coefficients derived from the regression model indicated a positive relationship between house prices and square footage, with the price increasing by approximately 190.48 per square foot.
- **Predicted House Price:** Based on the linear regression model, a house with 2000 square feet and 3 bedrooms was estimated to cost approximately 395,238.10.

Conclusions: The data manipulation and visualization provided valuable insights into employee salary structures and the relationship between house prices and key variables. The statistical analysis confirmed the significance of square footage in determining house prices. These findings can be useful for decision-making in both salary planning and real estate pricing strategies

Code Used

```
# Question 6: Machine Learning - Linear Regression (8 Marks)

import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
import datetime

# Get current date and time
current_datetime = datetime.datetime.now()

# Print results
print("Current Date and Time:", current_datetime)

# Create house_prices dataframe
house_prices = pd.DataFrame({
    "Square_Feet": [1500, 1800, 2400, 3000, 1200],
    "Bedrooms": [3, 4, 4, 5, 2],
    "Price": [300000, 350000, 450000, 600000, 250000]
})

# Save dataset to CSV
house_prices.to_csv("house_prices.csv", index=False)

# Load dataset from CSV
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house_prices = pd.read_csv("house_prices.csv")
# Define features and target variable
X = house_prices[["Square_Feet", "Bedrooms"]]
y = house_prices["Price"]
# Split data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
# Create Linear Regression model
model = LinearRegression()
model.fit(X_train, y_train)
# Display model coefficients and intercept
print("Coefficients:", model.coef_)
print("Intercept:", model.intercept_)
# Predict the price of a house with 2000 square feet and 3 bedrooms
predicted_price = model.predict([[2000, 3]])
print("Predicted price for a 2000 sq ft, 3-bedroom house:", predicted_price[0])
```