02-segmentation

January 16, 2026

IMPORT LIBRARIES

```
[3]: import numpy as np
     import pandas as pd
     import matplotlib.pyplot as plt
     import seaborn as sns

     from sklearn.preprocessing import StandardScaler
     from sklearn.cluster import KMeans
```

LOAD CLEAN DATA

```
[9]: df = pd.read_csv(
         r"D:\decision-intelligence-project\Data\Processed_Data\clean_transactions.
      ↪csv",
         dtype={"InvoiceNo": "str"},
         low_memory=False
     )

     df["InvoiceDate"] = pd.to_datetime(df["InvoiceDate"])
     df.head()
```

```
[9]:   InvoiceNo StockCode                          Description  Quantity  \
     0    536365    85123A   WHITE HANGING HEART T-LIGHT HOLDER         6
     1    536365     71053                  WHITE METAL LANTERN         6
     2    536365    84406B       CREAM CUPID HEARTS COAT HANGER         8
     3    536365    84029G  KNITTED UNION FLAG HOT WATER BOTTLE         6
     4    536365    84029E       RED WOOLLY HOTTIE WHITE HEART.         6

               InvoiceDate  UnitPrice  CustomerID         Country  Year  Month  \
     0 2010-12-01 08:26:00       2.55     17850.0  United Kingdom  2010     12
     1 2010-12-01 08:26:00       3.39     17850.0  United Kingdom  2010     12
     2 2010-12-01 08:26:00       2.75     17850.0  United Kingdom  2010     12
     3 2010-12-01 08:26:00       3.39     17850.0  United Kingdom  2010     12
     4 2010-12-01 08:26:00       3.39     17850.0  United Kingdom  2010     12

       Quarter  Revenue  Channel  Promotion_Flag  Profit_Margin    Profit
     0  2010Q4    15.30   Online               0       0.235824  3.608111
```

```
1  2010Q4    20.34  Offline               0       0.355912  7.239256
2  2010Q4    22.00  Offline               0       0.166214  3.656700
3  2010Q4    20.34   Online               0       0.218856  4.451527
4  2010Q4    20.34   Online               0       0.310762  6.320903
```

BUILD RFM FEATURES

[10]:

```
snapshot_date = df["InvoiceDate"].max() + pd.Timedelta(days=1)
```

Create RFM Table

[12]:

```
rfm = (
    df.groupby("CustomerID")
    .agg(
        Recency=("InvoiceDate", lambda x: (snapshot_date - x.max()).days),
        Frequency=("InvoiceNo", "nunique"),
        Monetary=("Revenue", "sum")
    )
    .reset_index()
)

rfm.head()
```

[12]:

```
   CustomerID  Recency  Frequency  Monetary
0     12346.0      326          1  77183.60
1     12347.0        2          7   4310.00
2     12348.0       75          4   1797.24
3     12349.0       19          1   1757.55
4     12350.0      310          1    334.40
```

SCALE FEATURES

REQUIRED FOR KMEANS

[13]:

```
scaler = StandardScaler()
rfm_scaled = scaler.fit_transform(rfm[["Recency", "Frequency", "Monetary"]])
```

FIND OPTIMAL CLUSTERS

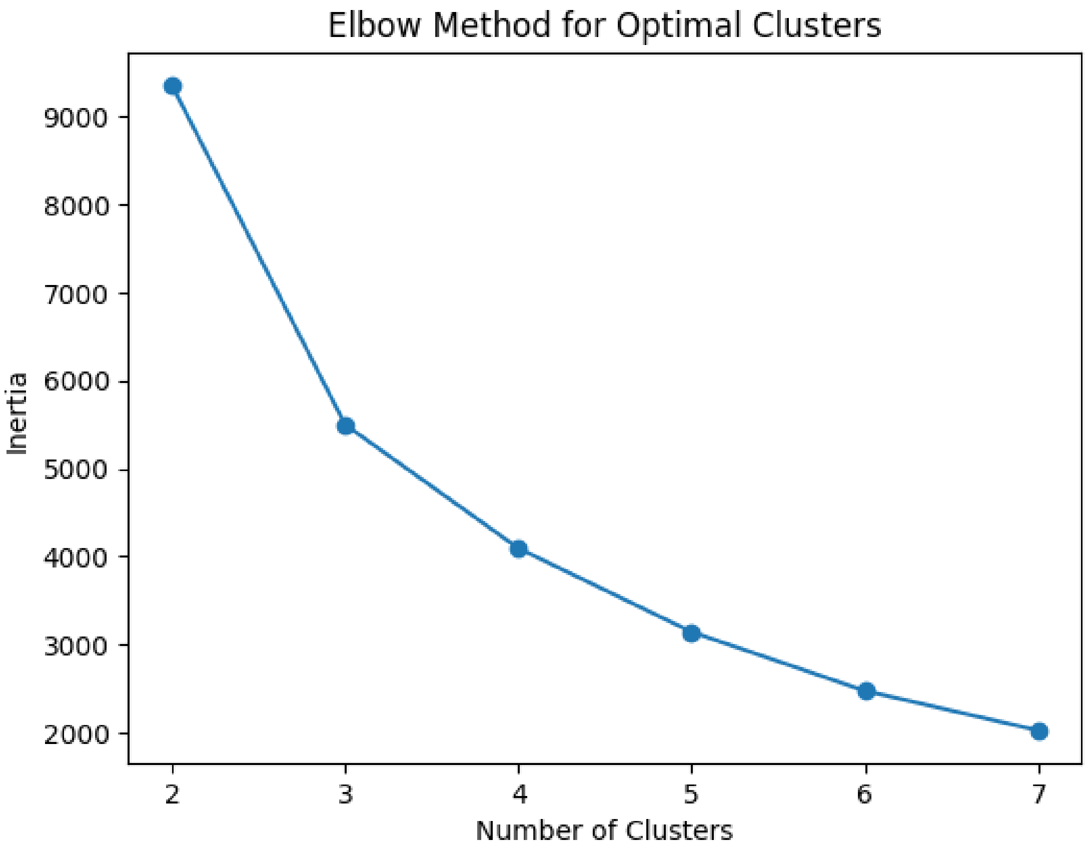
ELBOW METHOD

[14]:

```
inertia = []

for k in range(2, 8):
    kmeans = KMeans(n_clusters=k, random_state=42)
    kmeans.fit(rfm_scaled)
    inertia.append(kmeans.inertia_)

plt.plot(range(2, 8), inertia, marker="o")
plt.xlabel("Number of Clusters")
plt.ylabel("Inertia")
plt.title("Elbow Method for Optimal Clusters")
plt.show()
```



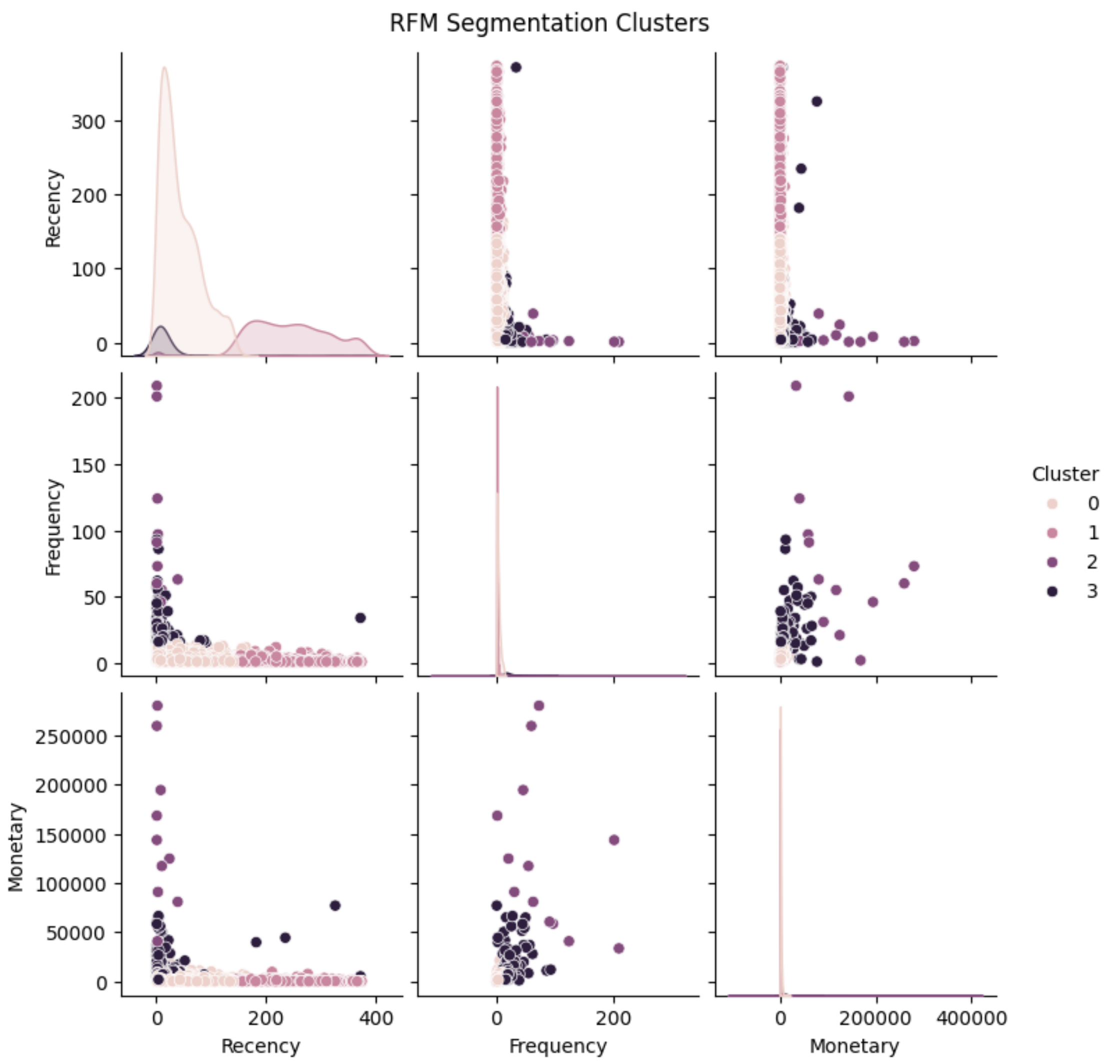
APPLY KMEANS

FINAL MODEL

[15]:
```
kmeans = KMeans(n_clusters=4, random_state=42)
rfm["Cluster"] = kmeans.fit_predict(rfm_scaled)

rfm.head()
sns.pairplot(rfm, hue="Cluster", vars=["Recency", "Frequency", "Monetary"])
plt.suptitle("RFM Segmentation Clusters", y=1.02)
```

[15]:
```
Text(0.5, 1.02, 'RFM Segmentation Clusters')
```



INTERPRET CLUSTERS

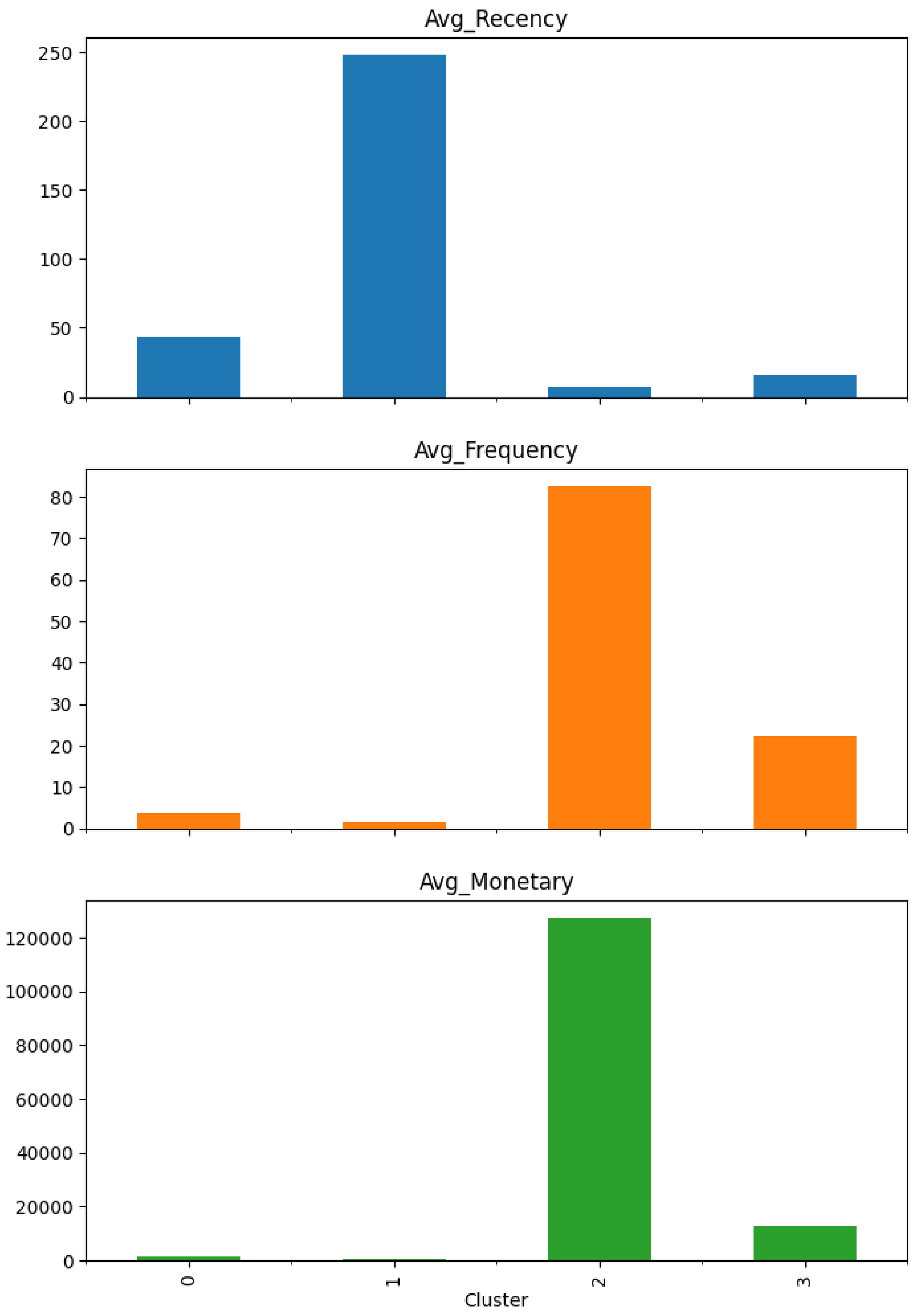
THIS IS CRITICAL

[16]:

```
cluster_summary = (
    rfm.groupby("Cluster")
    .agg(
        Avg_Recency=("Recency", "mean"),
        Avg_Frequency=("Frequency", "mean"),
        Avg_Monetary=("Monetary", "mean"),
        Customer_Count=("CustomerID", "count")
    )
    .reset_index()
)
```

```
cluster_summary
cluster_summary.plot(
    kind="bar",
    x="Cluster",
    y=["Avg_Recency", "Avg_Frequency", "Avg_Monetary"],
    subplots=True,
    layout=(3, 1),
    figsize=(8, 12),
    legend=False
)
```

```
[16]: array([[<Axes: title={'center': 'Avg_Recency'}, xlabel='Cluster'>],
              [<Axes: title={'center': 'Avg_Frequency'}, xlabel='Cluster'>],
              [<Axes: title={'center': 'Avg_Monetary'}, xlabel='Cluster'>]],
             dtype=object)
```


Avg_Recency
250
200
150
100
50
0
Avg_Frequency
80
70
60
50
40
30
20
10
0
Avg_Monetary
120000
100000
80000
60000
40000
20000
0
0
1
2
3
Cluster

MAP CLUSTERS > EXECUTIVE DECISIONS

THE MAGIC

[17]:

```
def map_decision(row):
    if row["Avg_Monetary"] > 3000 and row["Avg_Frequency"] > 10:
        return "Defend (High Value Loyal)"
    elif row["Avg_Monetary"] > 1500:
        return "Invest (High Potential)"
    elif row["Avg_Frequency"] > 5:
        return "Grow Selectively"
    else:
        return "Exit / Deprioritize"

cluster_summary["Decision_Action"] = cluster_summary.apply(map_decision, axis=1)

cluster_summary
```

[17]:

```
   Cluster  Avg_Recency  Avg_Frequency   Avg_Monetary  Customer_Count  \
0        0    43.702685       3.682711    1359.049284            3054
1        1   248.075914       1.552015     480.617480            1067
2        2     7.384615      82.538462  127338.313846              13
3        3    15.500000      22.333333   12709.090490             204

             Decision_Action
0        Exit / Deprioritize
1        Exit / Deprioritize
2  Defend (High Value Loyal)
3  Defend (High Value Loyal)
```

MERGE DECISIONS BACK TO CUSTOMERS

[19]:

```
rfm = rfm.merge(
    cluster_summary[["Cluster", "Decision_Action"]],
    on="Cluster",
    how="left"
)

rfm.head()
```

[19]:

```
   CustomerID  Recency  Frequency  Monetary  Cluster  \
0     12346.0      326          1  77183.60        3
1     12347.0        2          7   4310.00        0
2     12348.0       75          4   1797.24        0
3     12349.0       19          1   1757.55        0
4     12350.0      310          1    334.40        1

           Decision_Action_x          Decision_Action_y
0  Defend (High Value Loyal)  Defend (High Value Loyal)
```

```
1        Exit / Deprioritize        Exit / Deprioritize
2        Exit / Deprioritize        Exit / Deprioritize
3        Exit / Deprioritize        Exit / Deprioritize
4        Exit / Deprioritize        Exit / Deprioritize
```

SAVE SEGMENTATION OUTPUT

[26]:
```
import os

output_dir = r"D:\decision-intelligence-project\Data\processed"
os.makedirs(output_dir, exist_ok=True)
rfm.to_csv(f"{output_dir}/customer_segmentation.csv", index=False)
cluster_summary.to_csv(f"{output_dir}/segment_decision_summary.csv",␣
  ↪index=False)
```