Importing Libraries

In [9]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
# sns.set()
import warnings
warnings.filterwarnings('ignore')
```

https://archive-beta.ics.uci.edu/dataset/352/online+retail

In [10]:
```
retail = pd.read_excel('Online Retail.xlsx')
```

In [11]:
```
retail.head()
```

Out[11]:

	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID	Cou
0	536365	85123A	WHITE HANGING HEART T-LIGHT HOLDER	6	2010-12-01 08:26:00	2.55	17850.0	Un Kingc
1	536365	71053	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850.0	Un Kingc
2	536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850.0	Un Kingc
3	536365	84029G	KNITTED UNION FLAG HOT WATER BOTTLE	6	2010-12-01 08:26:00	3.39	17850.0	Un Kingc
4	536365	84029E	RED WOOLLY HOTTIE WHITE HEART.	6	2010-12-01 08:26:00	3.39	17850.0	Un Kingc

In [12]:
```
retail_df = retail.copy()
```

In [13]:
```
retail_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 541909 entries, 0 to 541908
Data columns (total 8 columns):
 #   Column       Non-Null Count   Dtype         
---  ------       --------------   -----         
 0   InvoiceNo    541909 non-null  object        
 1   StockCode    541909 non-null  object        
 2   Description  540455 non-null  object        
 3   Quantity     541909 non-null  int64         
 4   InvoiceDate  541909 non-null  datetime64[ns]
 5   UnitPrice    541909 non-null  float64       
 6   CustomerID   406829 non-null  float64       
 7   Country      541909 non-null  object        
dtypes: datetime64[ns](1), float64(2), int64(1), object(4)
memory usage: 33.1+ MB
```

In [14]:
```
retail_df.describe().round(2)
```

Out[14]:

	Quantity	InvoiceDate	UnitPrice	CustomerID
count	541909.00	541909	541909.00	406829.00
mean	9.55	2011-07-04 13:34:57.156386048	4.61	15287.69
min	-80995.00	2010-12-01 08:26:00	-11062.06	12346.00
25%	1.00	2011-03-28 11:34:00	1.25	13953.00
50%	3.00	2011-07-19 17:17:00	2.08	15152.00
75%	10.00	2011-10-19 11:27:00	4.13	16791.00
max	80995.00	2011-12-09 12:50:00	38970.00	18287.00
std	218.08	NaN	96.76	1713.60

In [ ]:
```

```

Data Preparation & Exploration

In [15]:
```
retail_df.isna().sum()
```

Out[15]:
```
InvoiceNo          0
StockCode          0
Description     1454
Quantity           0
InvoiceDate        0
UnitPrice          0
CustomerID     135080
Country            0
dtype: int64
```

In [16]:
```
retail_df.dropna(inplace= True)
```

In [17]:
```
retail_df.shape
```

Out[17]:
```
(406829, 8)
```

In [18]:
```
retail_df['Description']
```

Out[18]:
```
0          WHITE HANGING HEART T-LIGHT HOLDER
1                         WHITE METAL LANTERN
2              CREAM CUPID HEARTS COAT HANGER
3         KNITTED UNION FLAG HOT WATER BOTTLE
4              RED WOOLLY HOTTIE WHITE HEART.
                         ...
541904            PACK OF 20 SPACEBOY NAPKINS
541905          CHILDREN'S APRON DOLLY GIRL
541906          CHILDRENS CUTLERY DOLLY GIRL
541907        CHILDRENS CUTLERY CIRCUS PARADE
541908          BAKING SET 9 PIECE RETROSPOT
Name: Description, Length: 406829, dtype: object
```

In [19]:
```
retail_df.groupby('Description').agg({'Quantity':'sum'}).sort_values('Quantity', as
```

Out[19]:

Description	Quantity
WORLD WAR 2 GLIDERS ASSTD DESIGNS	53215
JUMBO BAG RED RETROSPOT	45066
ASSORTED COLOUR BIRD ORNAMENT	35314
WHITE HANGING HEART T-LIGHT HOLDER	34147
PACK OF 72 RETROSPOT CAKE CASES	33409

In [20]:
```
retail_df['InvoiceNo'].str.contains('C').count()
```

Out[20]:
```
np.int64(8905)
```

In [21]:
```
retail_df[~retail_df['InvoiceNo'].str.contains('C', na=False)]
```

Out[21]:

	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID
0	536365	85123A	WHITE HANGING HEART T-LIGHT HOLDER	6	2010-12-01 08:26:00	2.55	17850.0
1	536365	71053	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850.0
2	536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850.0
3	536365	84029G	KNITTED UNION FLAG HOT WATER BOTTLE	6	2010-12-01 08:26:00	3.39	17850.0
4	536365	84029E	RED WOOLLY HOTTIE WHITE HEART.	6	2010-12-01 08:26:00	3.39	17850.0
...	...	...	...	...	...	...	...
541904	581587	22613	PACK OF 20 SPACEBOY NAPKINS	12	2011-12-09 12:50:00	0.85	12680.0
541905	581587	22899	CHILDREN'S APRON DOLLY GIRL	6	2011-12-09 12:50:00	2.10	12680.0
541906	581587	23254	CHILDRENS CUTLERY DOLLY GIRL	4	2011-12-09 12:50:00	4.15	12680.0
541907	581587	23255	CHILDRENS CUTLERY CIRCUS PARADE	4	2011-12-09 12:50:00	4.15	12680.0
541908	581587	22138	BAKING SET 9 PIECE RETROSPOT	3	2011-12-09 12:50:00	4.95	12680.0

397924 rows × 8 columns

In [22]:
```
retail_df['TotalPrice'] = retail_df['Quantity'] * retail_df['UnitPrice']
```

In [23]:
```
retail_df
```

Out[23]:

	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID
0	536365	85123A	WHITE HANGING HEART T-LIGHT HOLDER	6	2010-12-01 08:26:00	2.55	17850.0
1	536365	71053	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850.0
2	536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850.0
3	536365	84029G	KNITTED UNION FLAG HOT WATER BOTTLE	6	2010-12-01 08:26:00	3.39	17850.0
4	536365	84029E	RED WOOLLY HOTTIE WHITE HEART.	6	2010-12-01 08:26:00	3.39	17850.0
...	...	...	...	...	...	...	...
541904	581587	22613	PACK OF 20 SPACEBOY NAPKINS	12	2011-12-09 12:50:00	0.85	12680.0
541905	581587	22899	CHILDREN'S APRON DOLLY GIRL	6	2011-12-09 12:50:00	2.10	12680.0
541906	581587	23254	CHILDRENS CUTLERY DOLLY GIRL	4	2011-12-09 12:50:00	4.15	12680.0
541907	581587	23255	CHILDRENS CUTLERY CIRCUS PARADE	4	2011-12-09 12:50:00	4.15	12680.0
541908	581587	22138	BAKING SET 9 PIECE RETROSPOT	3	2011-12-09 12:50:00	4.95	12680.0

406829 rows × 9 columns

In [ ]:

RFM Analysis

In [24]:
```
import datetime as dt
```

In [25]:
```
retail_df['InvoiceDate'].max()
```

Out[25]:
```
Timestamp('2011-12-09 12:50:00')
```

In [26]:
```
today_date = dt.datetime(2011, 12, 11)
```

In [30]:
```
rfm = retail_df.groupby('CustomerID').agg({'InvoiceDate': lambda date: (today_date
                                        'InvoiceNo' : lambda num: num.nunique(),
                                         'TotalPrice': lambda TotalPrice: TotalPr
                                        })
rfm
```

Out[30]:

CustomerID	InvoiceDate	InvoiceNo	TotalPrice
12346.0	326	2	0.00
12347.0	3	7	4310.00
12348.0	76	4	1797.24
12349.0	19	1	1757.55
12350.0	311	1	334.40
...	...	...	...
18280.0	278	1	180.60
18281.0	181	1	80.82
18282.0	8	3	176.60
18283.0	4	16	2094.88
18287.0	43	3	1837.28

4372 rows × 3 columns

In [31]:
```
rfm.columns = ['Recency' , 'Frequency' , 'Monetary']
rfm
```

Out[31]:

CustomerID	Recency	Frequency	Monetary
12346.0	326	2	0.00
12347.0	3	7	4310.00
12348.0	76	4	1797.24
12349.0	19	1	1757.55
12350.0	311	1	334.40
...	...	...	...
18280.0	278	1	180.60
18281.0	181	1	80.82
18282.0	8	3	176.60
18283.0	4	16	2094.88
18287.0	43	3	1837.28

4372 rows × 3 columns

In [32]:
```
rfm = rfm[rfm['Monetary'] > 0]
rfm
```

Out[32]:

CustomerID	Recency	Frequency	Monetary
12347.0	3	7	4310.00
12348.0	76	4	1797.24
12349.0	19	1	1757.55
12350.0	311	1	334.40
12352.0	37	11	1545.41
...	...	...	...
18280.0	278	1	180.60
18281.0	181	1	80.82
18282.0	8	3	176.60
18283.0	4	16	2094.88
18287.0	43	3	1837.28

4320 rows × 3 columns

In [33]:
```
rfm.describe().T
```

Out[33]:

	count	mean	std	min	25%	50%	75%	
Recency	4320.0	90.892130	99.142113	1.000000e+00	17.000	50.00	139.00	37
Frequency	4320.0	5.117130	9.386392	1.000000e+00	1.000	3.00	6.00	24
Monetary	4320.0	1924.373832	8264.936833	7.105427e-15	302.435	657.85	1626.26	27948

In [36]:
```
rfm['recency_score'] = pd.qcut(rfm['Recency'], 5, labels = [5, 4, 3, 2, 1])
```

In [37]:
```
rfm['frequency_score'] = pd.qcut(rfm['Frequency'].rank(method = 'first'), 5, labels
```

In [40]:
```
rfm['monetary_score'] = pd.qcut(rfm['Monetary'], 5, labels=[1, 2, 3, 4, 5])
```

In [41]:
```
rfm.head()
```

Out[41]:

CustomerID	Recency	Frequency	Monetary	recency_score	frequency_score	monetary_sco
12347.0	3	7	4310.00	5	4	
12348.0	76	4	1797.24	2	3	
12349.0	19	1	1757.55	4	1	
12350.0	311	1	334.40	1	1	
12352.0	37	11	1545.41	3	5	

In [42]:
```
rfm['RFM_SCORE'] = (rfm['recency_score'].astype(str) + rfm['frequency_score'].astyp
```

In [44]:
```
rfm.head(10)
```

Out[44]:

CustomerID	Recency	Frequency	Monetary	recency_score	frequency_score	monetary_sco
12347.0	3	7	4310.00	5	4	
12348.0	76	4	1797.24	2	3	
12349.0	19	1	1757.55	4	1	
12350.0	311	1	334.40	1	1	
12352.0	37	11	1545.41	3	5	
12353.0	205	1	89.00	1	1	
12354.0	233	1	1079.40	1	1	
12355.0	215	1	459.40	1	1	
12356.0	23	3	2811.43	4	3	
12357.0	34	1	6207.67	3	1	

In [45]:

```
# Segmenting Customers Using RFM Score

seg_map = {
    r'[1-2][1-2]' : 'hibernating',
    r'[1-2][3-4]' : 'at_Risk',
    r'[1-2]5' : 'cant_loose',
    r'3[1-2]' : 'about_to_sleep',
    r'33' : 'need_attention',
    r'[3-4][4-5]' : 'loyal_customers',
    r'41' : 'promising',
    r'51' : 'new_customers',
    r'5[4-5]' : 'champions',
}

rfm['segment'] = rfm['RFM_SCORE'].replace(seg_map, regex=True)
rfm.head()
```

Out[45]:

CustomerID	Recency	Frequency	Monetary	recency_score	frequency_score	monetary_sco
12347.0	3	7	4310.00	5	4	
12348.0	76	4	1797.24	2	3	
12349.0	19	1	1757.55	4	1	
12350.0	311	1	334.40	1	1	
12352.0	37	11	1545.41	3	5	

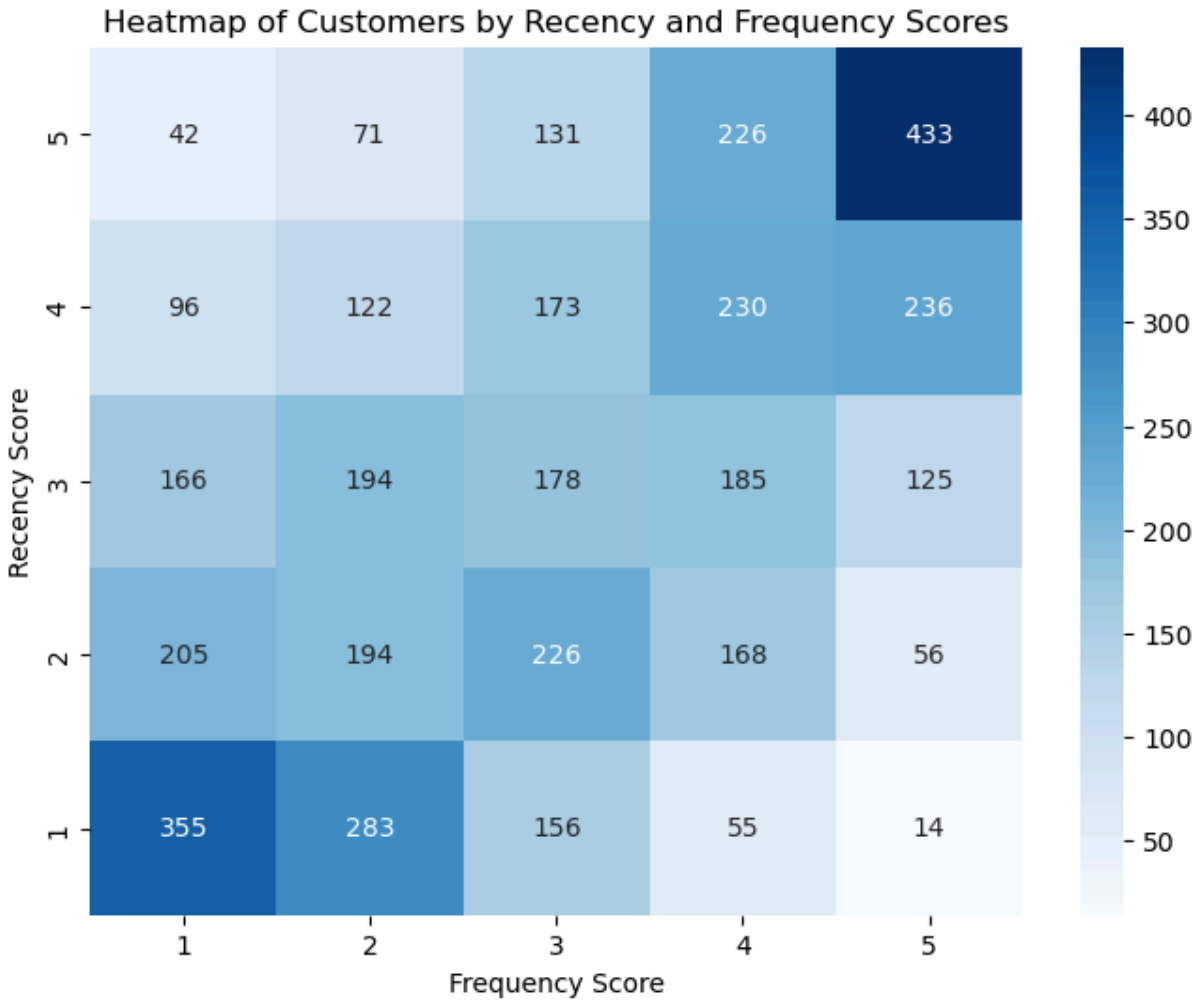
In [46]:
```
rfm[['segment', 'Recency', 'Frequency', 'Monetary']].groupby('segment').agg(['mean'
```

Out[46]:

	Recency			Frequency			Monetary	
	mean	count	max	mean	count	max	mean	count	max
segment									
42	24.0	122	32	2.0	122	2	429.0	122	2907.0
43	23.0	173	32	3.0	173	4	841.0	173	6749.0
52	7.0	71	12	2.0	71	2	615.0	71	3193.0
53	6.0	131	12	3.0	131	4	878.0	131	12394.0
about_to_sleep	52.0	360	71	1.0	360	2	440.0	360	6208.0
at_Risk	156.0	605	373	3.0	605	7	970.0	605	21536.0
cant_loose	132.0	70	313	10.0	70	35	2383.0	70	10217.0
champions	6.0	659	12	15.0	659	248	6552.0	659	279489.0
hibernating	214.0	1037	374	1.0	1037	2	400.0	1037	7830.0
loyal_customers	33.0	776	71	8.0	776	76	2733.0	776	123725.0
need_attention	49.0	178	71	3.0	178	4	821.0	178	3546.0
new_customers	7.0	42	12	1.0	42	1	377.0	42	3861.0
promising	23.0	96	32	1.0	96	1	306.0	96	1758.0

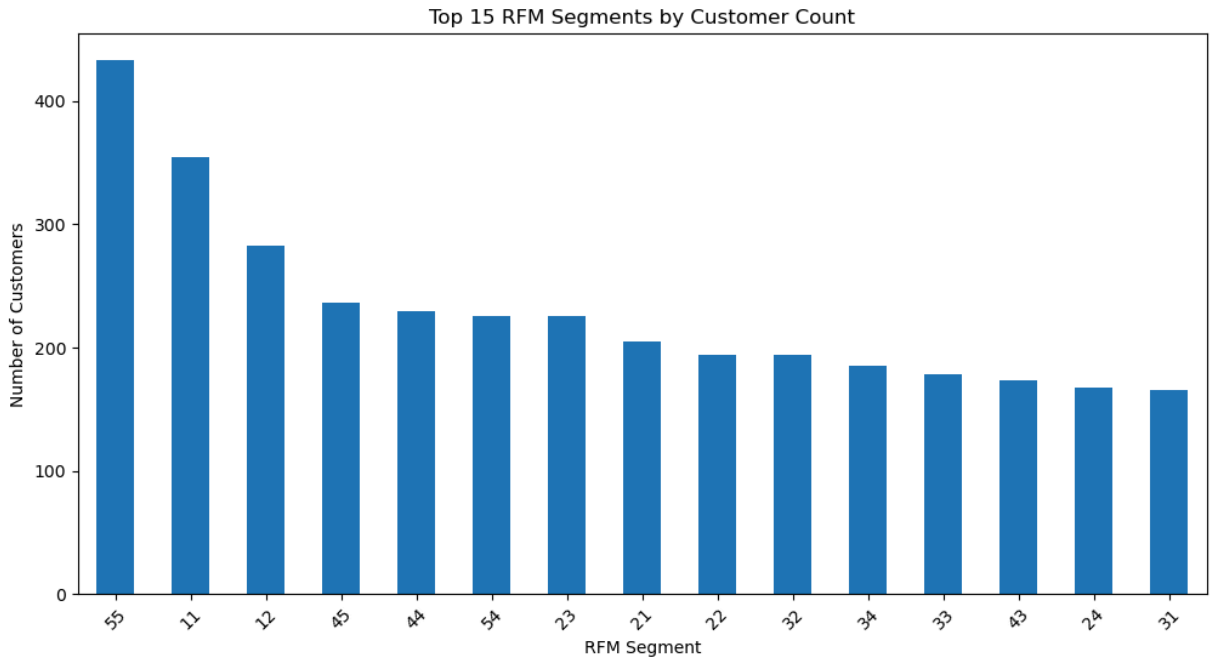
In [52]:
```
rfm_segment_count = rfm.groupby(['recency_score','frequency_score'])['segment'].cou

plt.figure(figsize=(8,6))
sns.heatmap(rfm_segment_count, cmap="Blues", annot=True, fmt=".0f")
plt.title("Heatmap of Customers by Recency and Frequency Scores")
plt.xlabel("Frequency Score")
plt.ylabel("Recency Score")
plt.show()
```



In [53]:
```
segment_counts = rfm['RFM_SCORE'].value_counts()

plt.figure(figsize=(12,6))
segment_counts.head(15).plot(kind='bar')
plt.title("Top 15 RFM Segments by Customer Count")
plt.xlabel("RFM Segment")
plt.ylabel("Number of Customers")
plt.xticks(rotation=45)
plt.show()
```

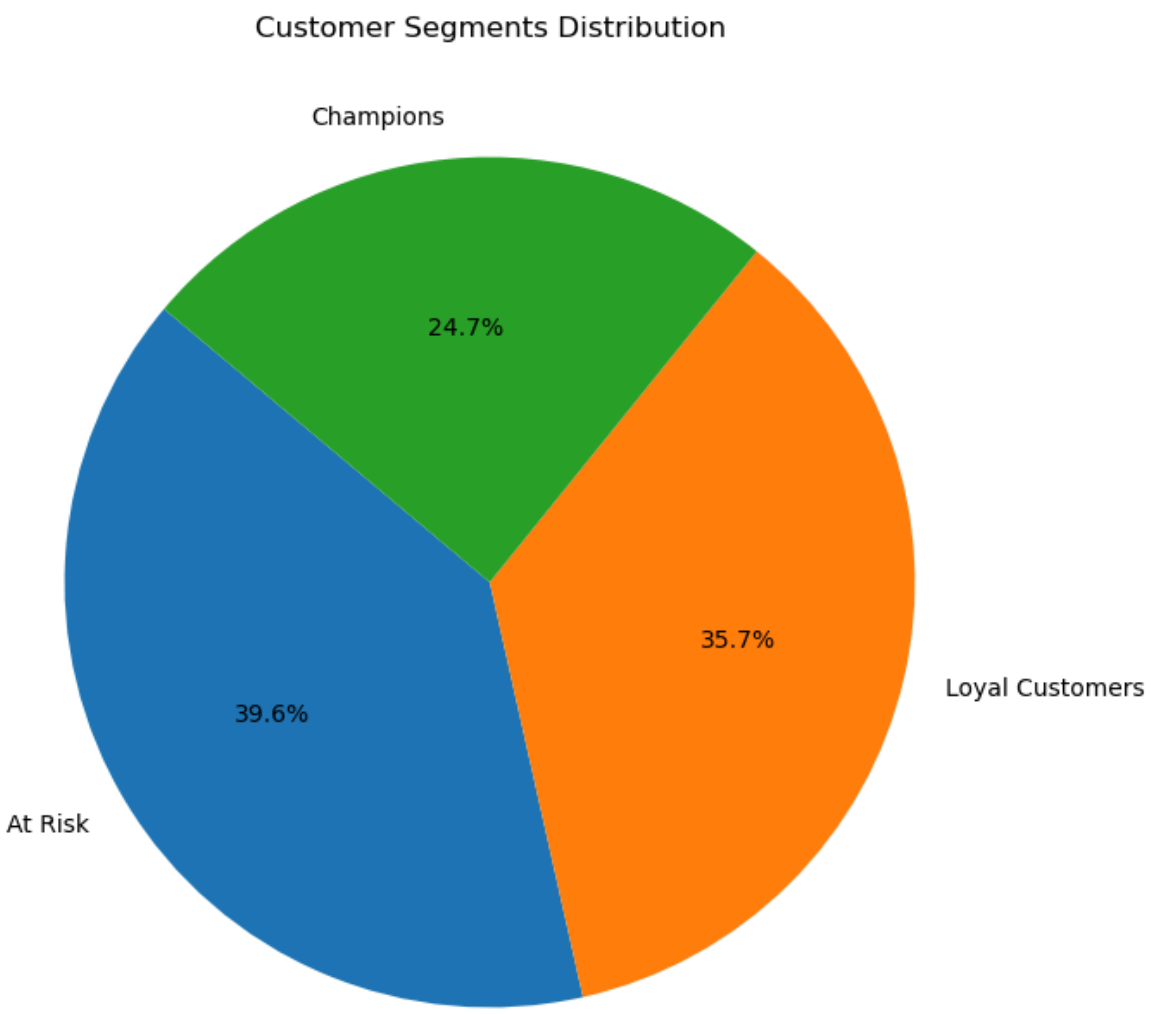


In [55]:
```
def rfm_level(row):
    if row['recency_score'] >= 4 and row['recency_score'] >= 4 and row['monetary_sc
        return 'Champions'
    elif row['recency_score'] >= 3:
        return 'Loyal Customers'
    else:
        return 'At Risk'

rfm['Segment'] = rfm.apply(rfm_level, axis=1)
```

In [56]:
```
segment_pie = rfm['Segment'].value_counts()

plt.figure(figsize=(8,8))
plt.pie(segment_pie, labels=segment_pie.index, autopct='%1.1f%%', startangle=140)
plt.title("Customer Segments Distribution")
plt.show()
```


Customer Segments Distribution
Champions
24.7%
35.7%
Loyal Customers
39.6%
At Risk

In [ ]: