UNIVERSITY OF THE PHILIPPINES MINDANAO
College of Science and Mathematics
Department of Mathematics, Physics, and Computer Science

Growth Curves and Descriptive Statistics

Wendy Shane Balboa | Aretha Rgeel Castigon | Saintjoy Mandalinao | Ivy Ringcunada

This dataset contains historical daily stock prices for Apple (since 1980) and Microsoft (since 1986), adjusted for stock splits and dividends. The columns represent Opening, High, Low, and Closing prices for each trading day. The dataset follows a daily periodicity, excluding weekends and market holidays. The adjustments for stock splits and dividends ensure that past stock prices remain comparable to present-day values.

Sheet 1: **Combined Data of Apple and Microsoft Historical Annual Stock Price Data**

AJ23

	A	B	C	D	E	F	G	H	I
1	Date	Apple_Open	App_High	App_Low	App_Close	Mic_Open	Mic_High	Mic_Low	Mic_Close
2	12/12/1980	0.0991	0.0995	0.0991	0.0991				
3	12/15/1980	0.0944	0.0944	0.0939	0.0939				
4	12/16/1980	0.0874	0.0874	0.087	0.087				
5	12/17/1980	0.0892	0.0896	0.0892	0.0892				
6	12/18/1980	0.0918	0.0922	0.0918	0.0918				
7	12/19/1980	0.0974	0.0978	0.0974	0.0974				
8	12/22/1980	0.1021	0.1025	0.1021	0.1021				
9	12/23/1980	0.1064	0.1068	0.1064	0.1064				
10	12/24/1980	0.112	0.1125	0.112	0.112				
11	12/26/1980	0.1223	0.1228	0.1223	0.1223				
12	12/29/1980	0.1241	0.1245	0.1241	0.1241				
13	12/30/1980	0.1215	0.1215	0.121	0.121				
14	12/31/1980	0.118	0.118	0.1176	0.1176				
15	1/2/1981	0.1189	0.1198	0.1189	0.1189				
16	1/5/1981	0.1167	0.1167	0.1163	0.1163				
17	1/6/1981	0.1116	0.1116	0.1111	0.1111				
18	1/7/1981	0.1068	0.1068	0.1064	0.1064				
19	1/8/1981	0.1047	0.1047	0.1043	0.1043				
20	1/9/1981	0.1099	0.1103	0.1099	0.1099				
21	1/12/1981	0.1099	0.1099	0.109	0.109				
22	1/13/1981	0.1056	0.1056	0.1051	0.1051				
23	1/14/1981	0.1056	0.106	0.1056	0.1056				
24	1/15/1981	0.1077	0.1086	0.1077	0.1077				
25	1/16/1981	0.1073	0.1073	0.1068	0.1068				
26	1/19/1981	0.1133	0.1137	0.1133	0.1133				
27	1/20/1981	0.1103	0.1103	0.1099	0.1099				
28	1/21/1981	0.112	0.1129	0.112	0.112				
29	1/22/1981	0.1133	0.1142	0.1133	0.1133				
30	1/23/1981	0.1133	0.1137	0.1129	0.1129				
31	1/26/1981	0.1116	0.1116	0.1111	0.1111				
32	1/27/1981	0.1111	0.1111	0.1103	0.1103				
33	1/28/1981	0.1073	0.1073	0.1068	0.1068				
34	1/29/1981	0.1034	0.1034	0.1029	0.1029				

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COMBINED DATA | 1986 | 1987 | YEARLY AVG OF HIGH

Sheet 2: Apple and Microsoft Historical Annual Stock Price Data for Year 1986-2025

	A	B	C	D	E	F	G	H	I	J	K	L
1	Date	Apple_Open	App_High	App_Low	App_Close	Mic_Open	Mic_High	Mic_Low	Mic_Close			
2	3/13/1986	0.0853	0.0862	0.084	0.0853	0.0548	0.0628	0.0548	0.0602			
3	3/14/1986	0.0853	0.0905	0.0853	0.09	0.0602	0.0634	0.0602	0.0623			
4	3/17/1986	0.0896	0.0896	0.0874	0.0896	0.0623	0.0639	0.0623	0.0634			
5	3/18/1986	0.0896	0.0939	0.0892	0.0926	0.0634	0.0639	0.0612	0.0618			
6	3/19/1986	0.0926	0.0939	0.0909	0.0913	0.0618	0.0623	0.0602	0.0607			
7	3/20/1986	0.0965	0.1021	0.0965	0.0974	0.0607	0.0607	0.0585	0.0591			
8	3/21/1986	0.0974	0.0991	0.0948	0.0952	0.0591	0.0602	0.0564	0.0575			
9	3/24/1986	0.0952	0.0952	0.0909	0.0922	0.0575	0.0575	0.0553	0.0559			
10	3/25/1986	0.0922	0.0961	0.0922	0.0961	0.0559	0.0569	0.0553	0.0569			
11	3/26/1986	0.0961	0.0991	0.0961	0.0974	0.0569	0.0591	0.0564	0.0585			
12	3/27/1986	0.0974	0.0999	0.0974	0.0974	0.0585	0.0596	0.0585	0.0596			
13	3/31/1986	0.0974	0.0982	0.0965	0.0974	0.0596	0.0596	0.058	0.0591			
14	4/1/1986	0.0974	0.0974	0.0931	0.0939	0.0591	0.0591	0.0585	0.0585			
15	4/2/1986	0.0939	0.0943	0.0905	0.0939	0.0585	0.0602	0.0585	0.0591			
16	4/3/1986	0.0939	0.0952	0.0926	0.0931	0.0596	0.0612	0.0596	0.0596			
17	4/4/1986	0.0931	0.0931	0.0917	0.0922	0.0596	0.0602	0.0596	0.0596			
18	4/7/1986	0.0922	0.0948	0.0905	0.0939	0.0596	0.0602	0.0575	0.0585			

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COMBINED DATA 1986 1987 YEARLY AVG OF HIGH

Sheet 3: Apple and Microsoft Historical Annual Stock Price Data for Year 1987-2025

	A	B	C	D	E	F	G	H	I	J	K
1	Date	Apple_Open	App_High	App_Low	App_Close	Mic_Open	Mic_High	Mic_Low	Mic_Close		
2	1/2/1987	0.1392	0.1417	0.1383	0.1409	0.1037	0.1047	0.1021	0.1026		
3	1/5/1987	0.1422	0.1491	0.1413	0.1482	0.1026	0.1096	0.1021	0.1085		
4	1/6/1987	0.1486	0.1516	0.1469	0.1508	0.1085	0.1107	0.108	0.1101		
5	1/7/1987	0.1512	0.1547	0.1504	0.1542	0.1101	0.116	0.1101	0.116		
6	1/8/1987	0.1542	0.1555	0.1534	0.1542	0.1166	0.1209	0.1166	0.1198		
7	1/9/1987	0.1542	0.1577	0.1529	0.1564	0.1198	0.1252	0.1192	0.1246		
8	1/12/1987	0.1568	0.1577	0.1542	0.1568	0.1246	0.1337	0.1235	0.1327		
9	1/13/1987	0.1555	0.1564	0.1538	0.1538	0.1316	0.1316	0.1268	0.1289		
10	1/14/1987	0.1538	0.1663	0.1534	0.1659	0.1289	0.1295	0.1262	0.1289		
11	1/15/1987	0.1663	0.1771	0.1654	0.1719	0.1289	0.1391	0.1289	0.1359		
12	1/16/1987	0.1723	0.1723	0.1646	0.168	0.1359	0.1359	0.13	0.1327		
13	1/19/1987	0.168	0.1831	0.165	0.1831	0.1327	0.1375	0.13	0.1375		
14	1/20/1987	0.1896	0.1921	0.1775	0.1779	0.1375	0.1429	0.137	0.1397		
15	1/21/1987	0.1754	0.1762	0.1689	0.1689	0.1397	0.1493	0.137	0.1456		
16	1/22/1987	0.1685	0.1814	0.1671	0.1809	0.1456	0.1606	0.1413	0.1601		
17	1/23/1987	0.1809	0.1827	0.1732	0.1732	0.1601	0.1665	0.145	0.145		
18	1/26/1987	0.1723	0.174	0.1706	0.1715	0.1461	0.1493	0.1413	0.1477		
19	1/27/1987	0.1723	0.1831	0.1719	0.1818	0.1477	0.1558	0.1477	0.1536		
20	1/28/1987	0.1827	0.1921	0.1797	0.1909	0.1536	0.1563	0.1493	0.1542		
21	1/29/1987	0.1926	0.1973	0.184	0.1866	0.1542	0.1558	0.1445	0.1477		
22	1/30/1987	0.1861	0.1926	0.1814	0.1913	0.1477	0.1574	0.1456	0.1571		

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COMBINED DATA 1986 1987 YEARLY AVG OF HIGH

Sheet 4: **Computed Yearly Average of Apple and Microsoft Historical Annual Stock Price Data for Year 1987-2025**

Date	App_High	Mic_High
1987	0.274751779	0.216171146
1988	0.292598419	0.242229644
1989	0.296201984	0.273538492
1990	0.270529249	0.543626482
1991	0.382317787	1.010239921
1992	0.401413386	1.573443701
1993	0.304388142	1.636894862
1994	0.256800397	2.005896825
1995	0.308953571	3.256146429
1996	0.191434646	4.716894882
1997	0.138256917	9.475640711
1998	0.235465476	15.45019683
1999	0.445082143	27.49420437
2000	0.711846825	24.10655238
2001	0.312775806	19.6807625
2002	0.294050794	17.17066032
2003	0.283759524	16.41669048
2004	0.542671825	17.33535079
2005	1.424959127	18.26685317
2006	2.167471713	18.81385976
2007	3.919049004	22.12796295
2008	4.371849012	19.80841423
2009	4.473271429	17.39958373
2010	7.903578571	20.82975437
2011	11.06824048	20.5343
2012	17.5697456	24.1147628
2013	14.71404008	27.08275794
2014	20.54252778	36.40954881
2015	27.23344524	41.19555317
2016	24.17119444	49.9946619
2017	35.36933227	66.61744622
2018	45.29915857	95.7896506
2019	50.55474167	124.9398905
2020	94.22270277	188.0003482
2021	139.6829897	269.9959738
2022	154.8247163	266.7279522
2023	172.584828	313.218734
2024	208.4705742	422.0614639
2025	236.3963815	427.8018222

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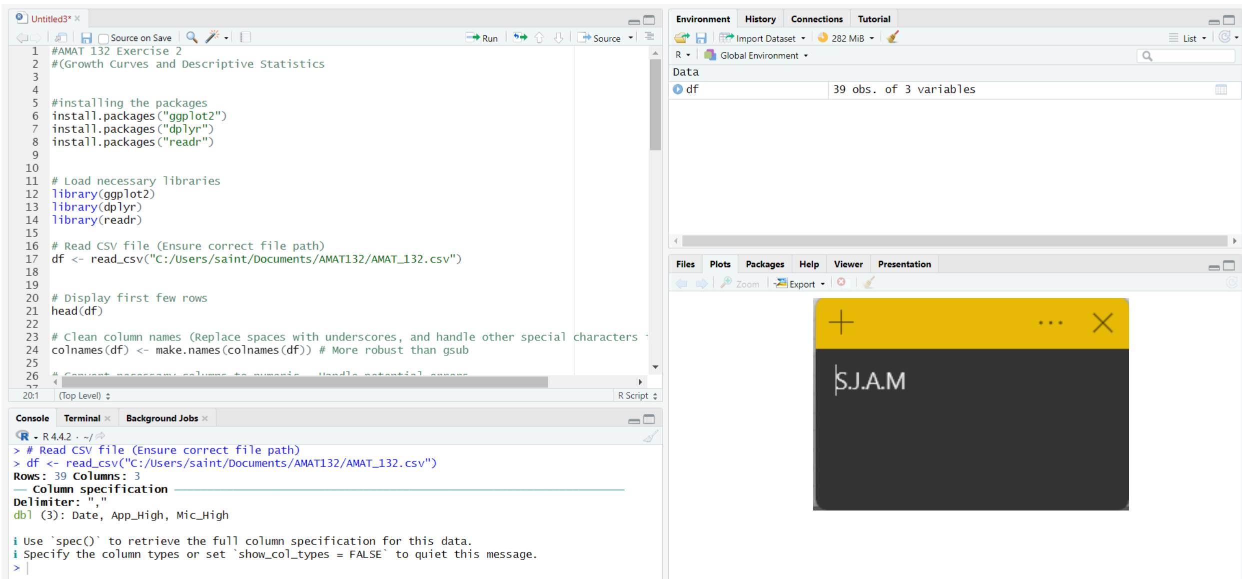
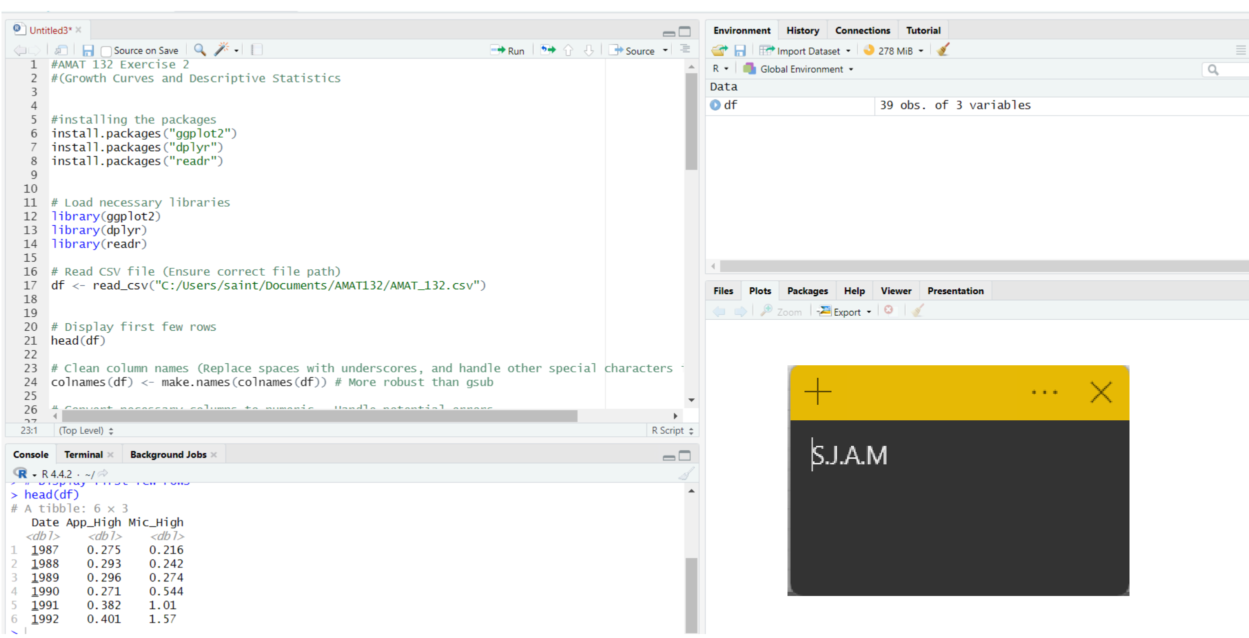
COMBINED DATA 1986 1987 **YEARLY AVG OF HIGH**

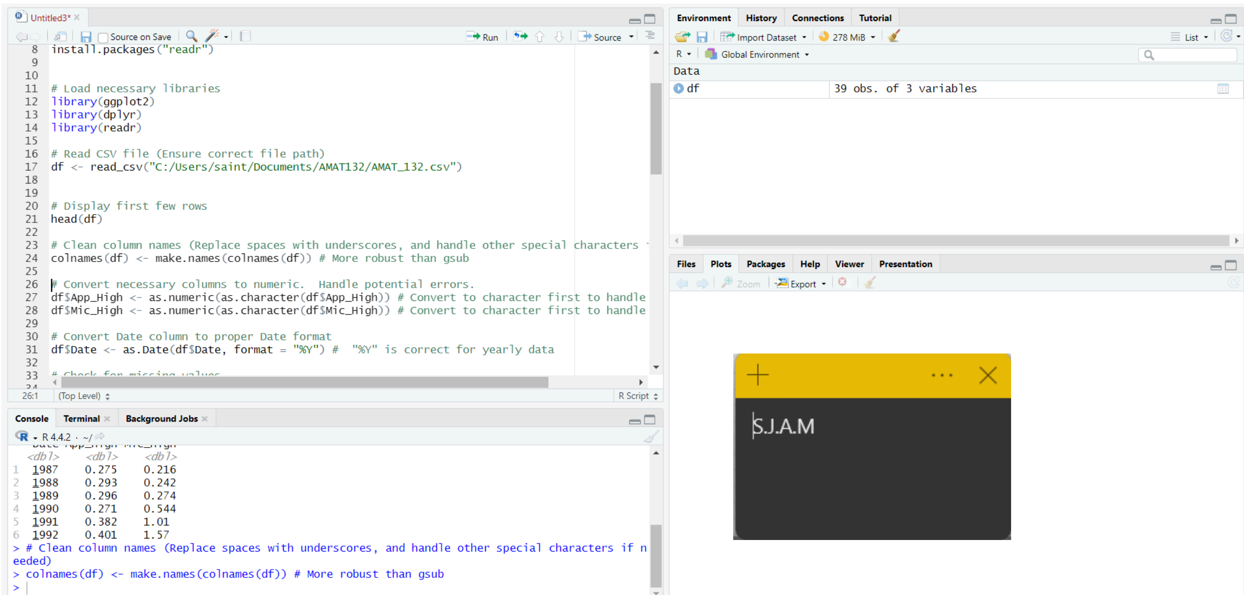
Reading CSV file



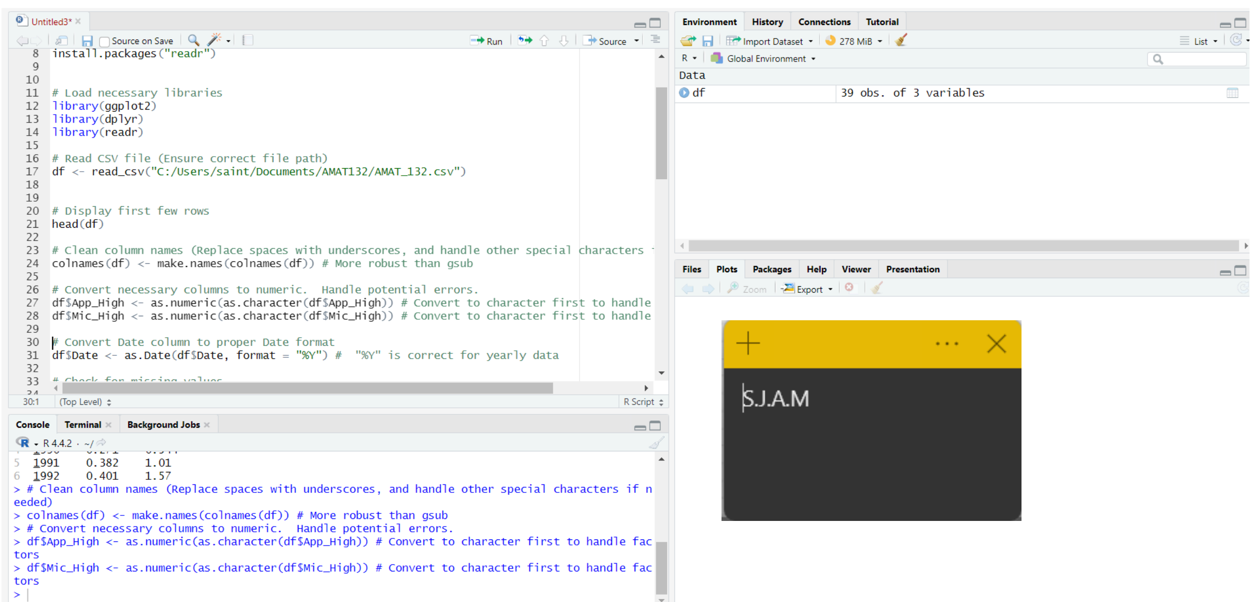
Displaying first few rows



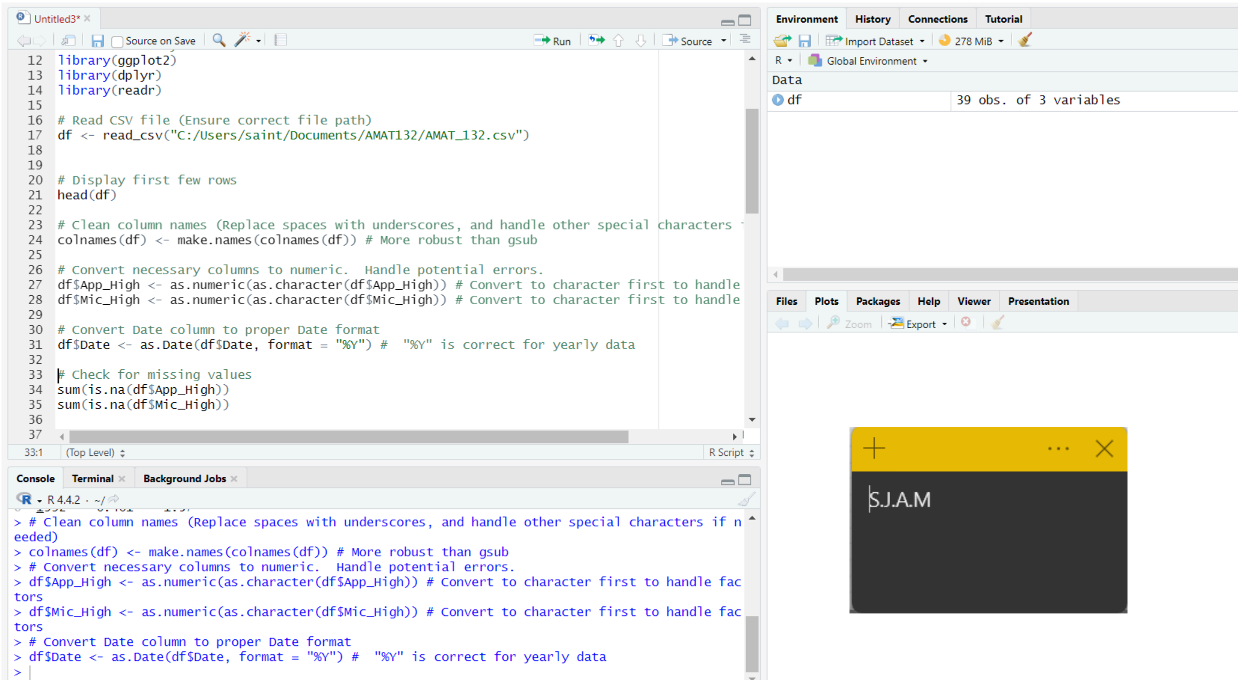
Clean column names (Replace spaces with underscores, and handle other special characters if needed)



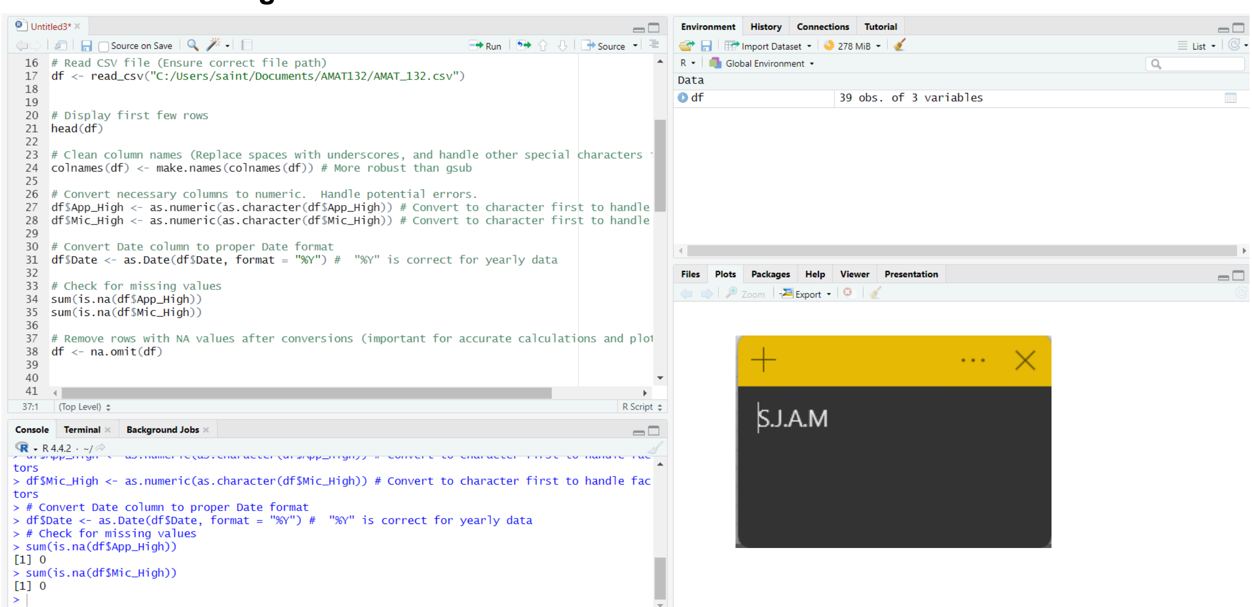
Convert necessary columns to numeric. Handle potential errors.



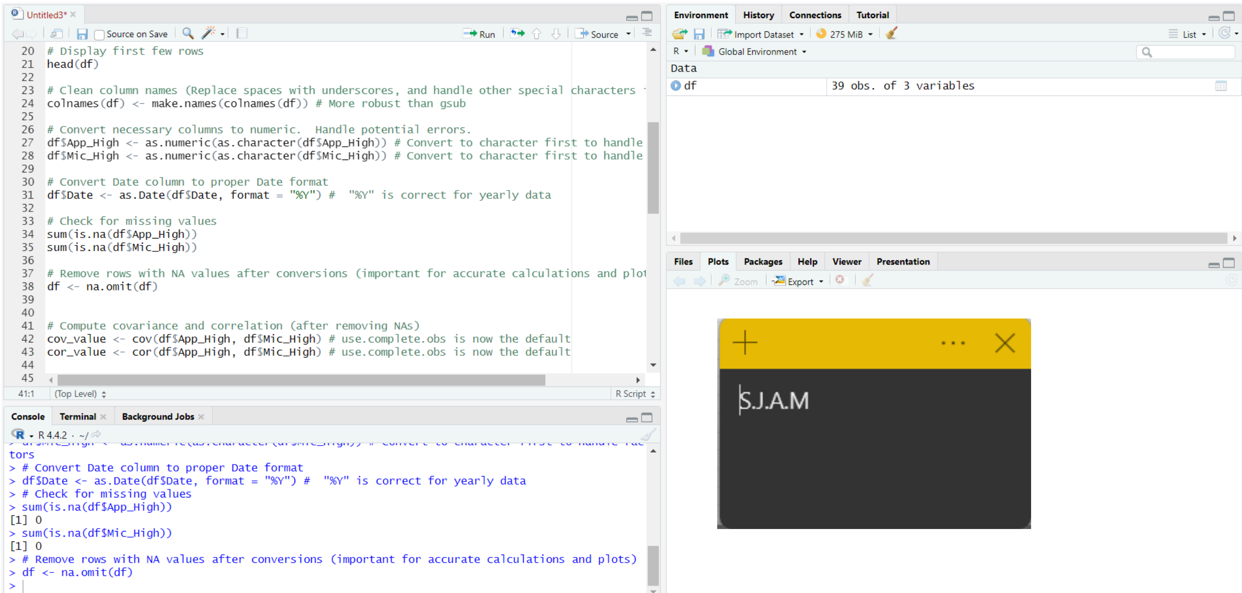
Convert Date column to proper Date format



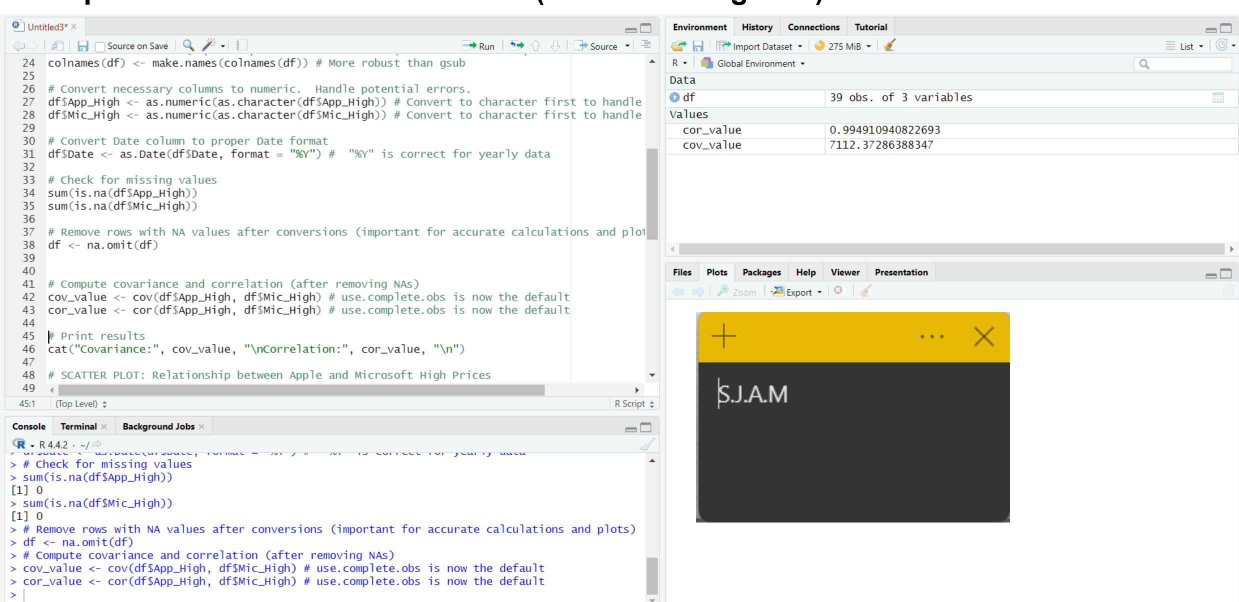
Check for missing values



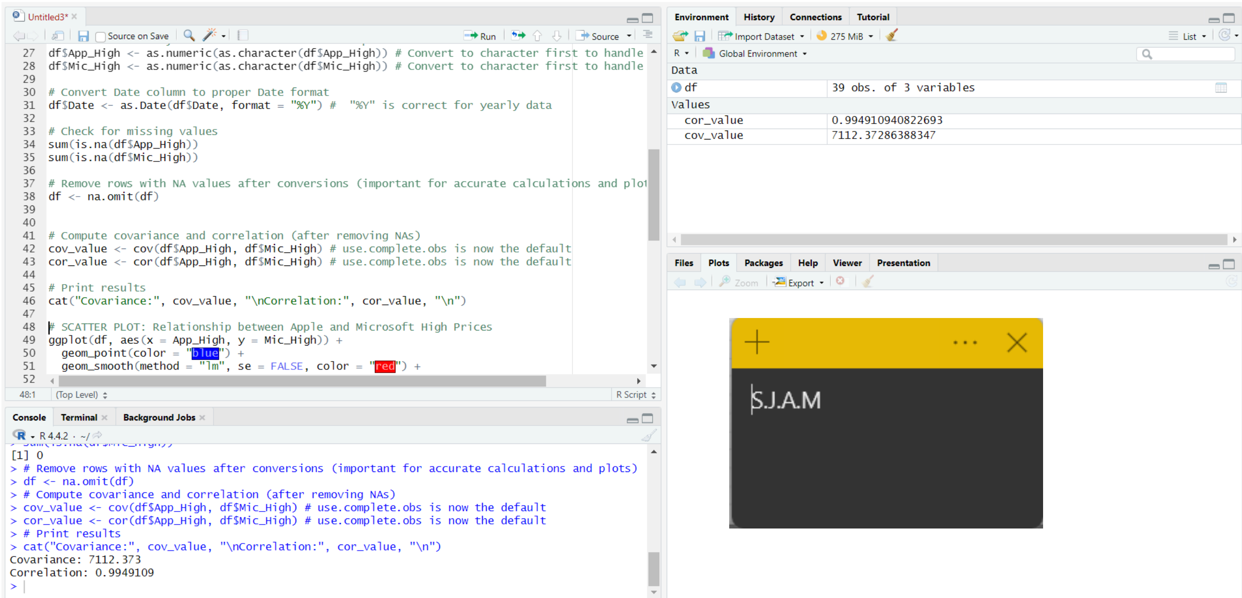
Remove rows with NA values after conversions (important for accurate calculations and plots) df <- na.omit(df)



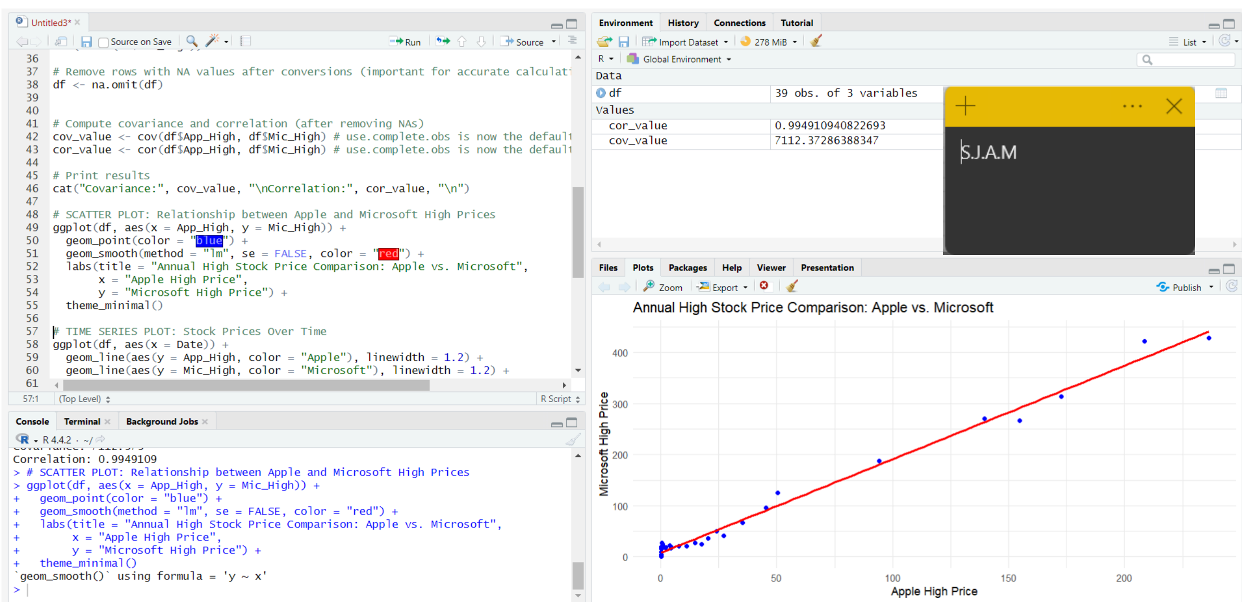
Compute covariance and correlation (after removing NAs)



Printing results for covariance and correlation

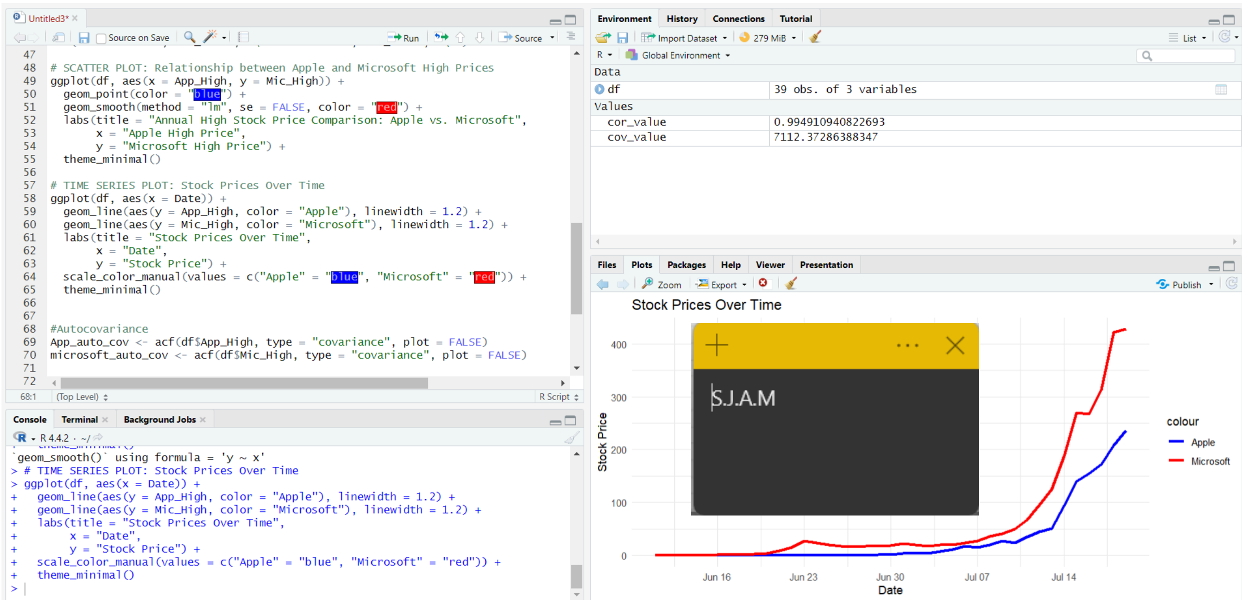


SCATTER PLOT: Relationship between Apple and Microsoft High Prices



The scatter plot shows how the high stock prices of Apple and Microsoft relate to each other, and it reveals a strong positive correlation. This means that when Apple's stock price goes up, Microsoft's tends to rise as well. You can see this trend in the upward slope of the data points, which aligns closely with the red regression line. This line indicates a linear relationship between the two companies' stock prices. There are a few points that stand out as outliers, indicating moments when one company's stock behaved differently—these could be due to specific market factors at play. Overall, the plot suggests that Apple and Microsoft’s stock prices generally move in tandem, likely influenced by larger market trends or conditions in the tech industry.

TIME SERIES PLOT: Stock Prices Over Time

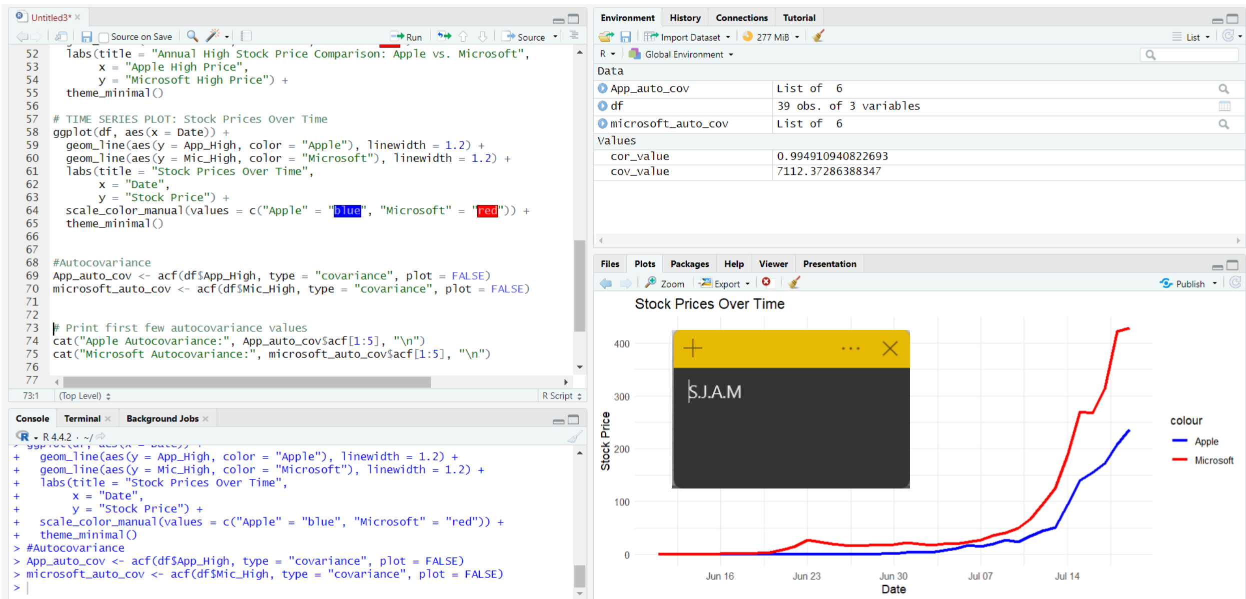


The time series plot offers a snapshot of Apple and Microsoft's stock prices over time. At first, both stocks show a fairly steady trend with just a few ups and downs. However, things take off dramatically in early July. During this spike, Microsoft (shown by the red line) has a more significant surge compared to Apple (shown by the blue line), which suggests that Microsoft is experiencing stronger growth or perhaps more volatility.

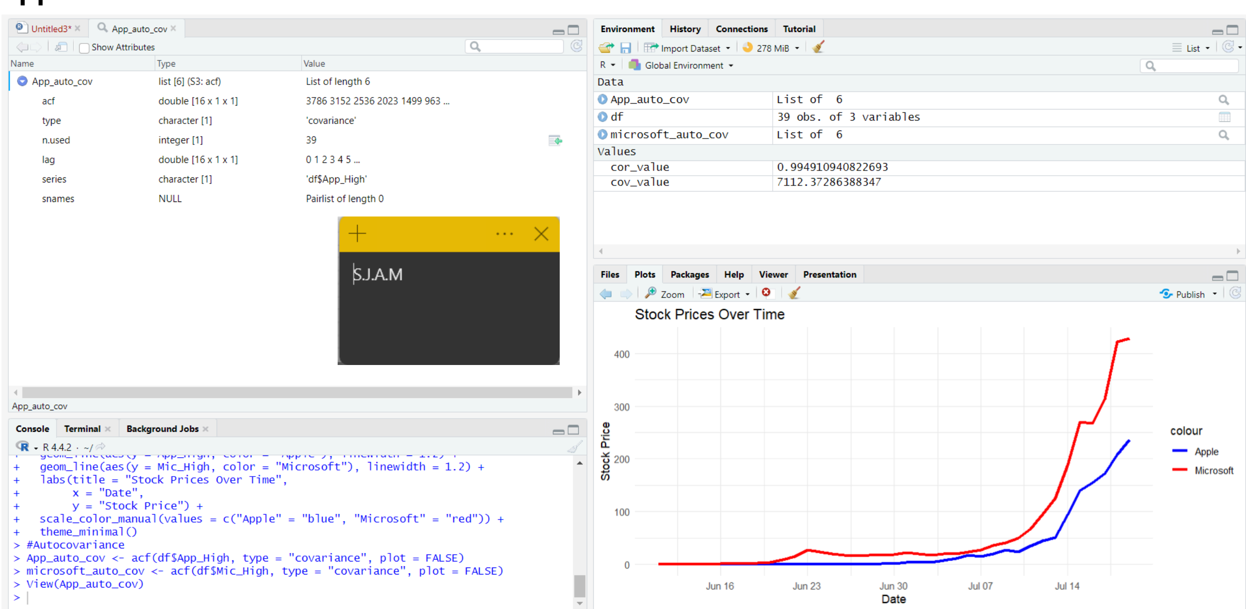
Interestingly, both companies share a similar upward trend, indicating that their stock prices are likely responding to similar market influences. However, it's clear that Microsoft's stock is climbing at a quicker pace. This pattern might be due to various external factors, like earnings reports, developments within their industries, or broader market movements that are impacting both tech giants.

Exercise 2.b Interpret Results

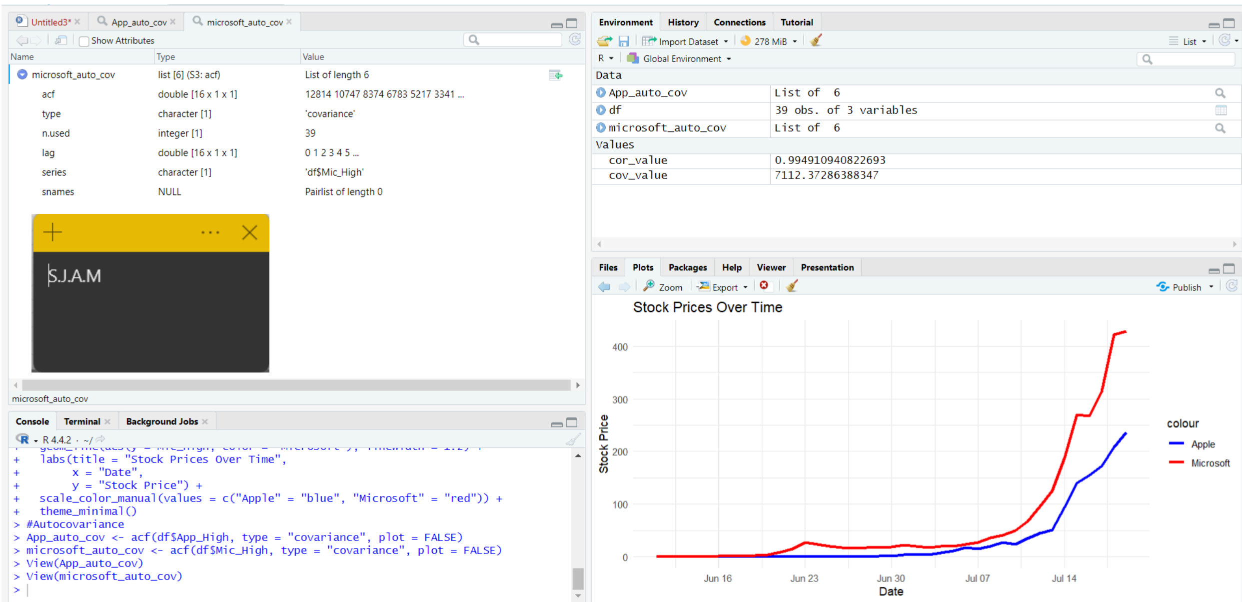
Compute the autocovariance (per lag) for each time series and plot the Autocorrelation Function (ACF) using the code below. Edit the field names when necessary. Interpret results.



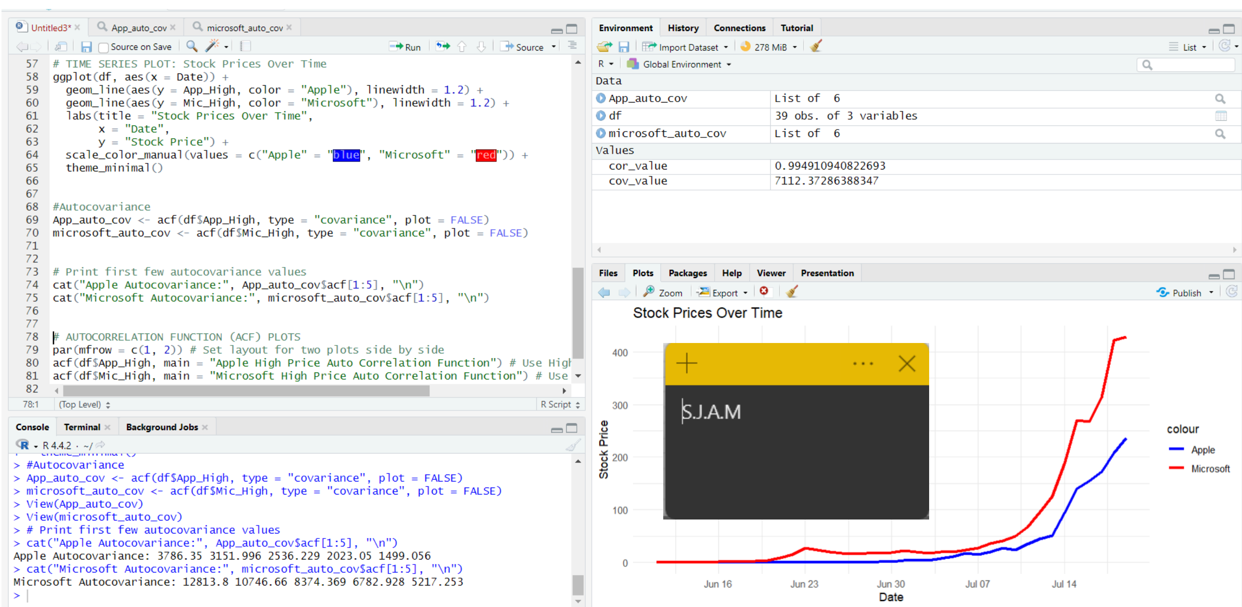
Apple auto covariance



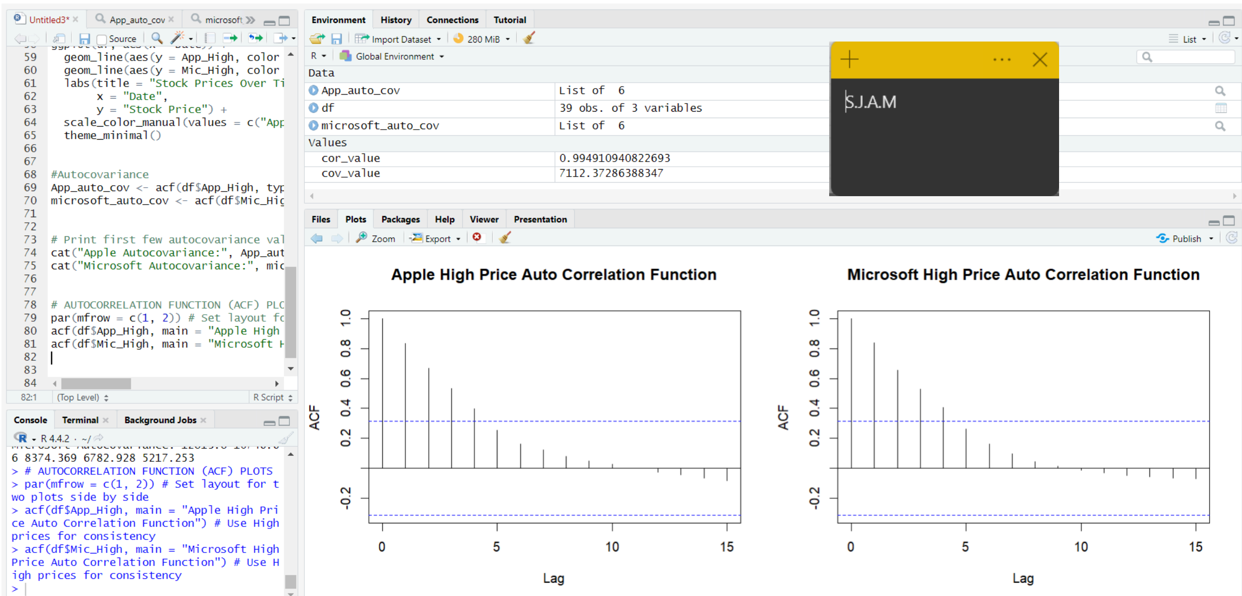
Microsoft auto covariance



Print first few autocovariance values



AUTOCORRELATION FUNCTION (ACF) PLOTS



The **Autocorrelation Function (ACF)** plots for the high stock prices of Apple and Microsoft reveal an interesting connection between past and future prices over time. Starting at a high positive value close to 1 at lag 0, the ACF for both stocks gradually decreases as the lag increases. This means there's a strong relationship between the current stock prices and their recent past values, showing that what happened before significantly affects future prices. However, this influence does weaken over time. The decreasing bar heights suggest that while past prices still play a role in shaping future prices, their impact diminishes as time goes on.

The dashed blue lines you see represent confidence intervals, and any ACF values that fall outside of these lines are statistically significant. For both Apple and Microsoft, the ACF values are significant up to around lag 5, after which they taper off toward zero. This indicates that both stocks have a sort of short-term memory—past prices influence future prices for a few time periods before their effects fade away.

In addition, both stocks have a rising trend, with Microsoft's stock price growing at a more rapid pace than Apple's, especially in the later dates. Both stocks initially stayed relatively consistent at lower price points, but as time went on, the prices of Microsoft rose more rapidly than those of Apple.

With respect to **autocovariance**, the study shows that both Microsoft and Apple stock prices are highly dependent on their immediate past values, as shown by high autocovariance at low lags. Microsoft's autocovariance values are, however, significantly higher than those of Apple, implying higher volatility and price fluctuations. As the lag gets larger, the autocovariance values decrease slowly, showing that past stock prices have decreasing effects on future prices for longer lags. This implies that although both shares exhibit short-term momentum, price movements of Microsoft are stronger and indicate greater general price swings.