

## Network Structure from daily close price

This slide shows the result of implementing Bayesian Network on stock prices. I used numpy and pandas on daily close prices of S&P500 companies and a few daily economic data available from FRB.

1. I omitted 5 stocks that significantly reduced available timepoints of data such as Corteva with ticker symbol CTVA . Corteva was founded in 2019.
2. Data used for creating this output consist mainly of daily close prices from 2011-11-11 to 2019-12-31 .
3. For each row, I ranked the most valuable edge. For example. MS\_child has BAC\_parent in the first column, JPM\_parent in the second column, and GS\_parent in the third column. This means that my model believes Morgan Stanley was the closest stock to Bank of America ,then JP Morgan and then Goldman Sachs .
4. I approximated the score function so it took 1 minute to run the model on my personal laptop

```
In [16]: 1 import pandas as pd
          2 df = pd.read_csv('contribution_rank.csv',index_col=0)
          3 df.loc['MSFT_child':'MS_child']
```

Out[16]:

	0	1	2	3	4	5
<b>MSFT_child</b>	MA_parent	V_parent	GOOGL_parent	GOOG_parent	ADBE_parent	AMZN_parent
<b>MAA_child</b>	UDR_parent	AIV_parent	AVB_parent	EQR_parent	ESS_parent	O_parent
<b>MHK_child</b>	FBHS_parent	MAS_parent	LEG_parent	SWK_parent	WRK_parent	EMN_parent
<b>TAP_child</b>	UNM_parent	MDLZ_parent	KO_parent	GILD_parent	BF-B_parent	PFG_parent
<b>MDLZ_child</b>	PEP_parent	GIS_parent	CL_parent	K_parent	HSY_parent	PG_parent
<b>MNST_child</b>	MTD_parent	PEP_parent	PAYX_parent	MDLZ_parent	MSFT_parent	PKI_parent
<b>MCO_child</b>	SPGI_parent	MA_parent	V_parent	MSCI_parent	ACN_parent	MSFT_parent
<b>MS_child</b>	BAC_parent	JPM_parent	GS_parent	C_parent	LNC_parent	RJF_parent

8 rows × 526 columns

I will present a few other sample outcomes below:

```
In [48]: 1 labels = pd.read_csv('./data/stock_label.csv',index_col=0)
```

### 1. Microsoft, MSFT

```
In [97]: 1 stock = 'MSFT'
2 parents = df.loc[f'{stock}_child',:].str.split('_').apply(lambda x: x[0]
3 print(f'stocks closest to {stock} are: ')
4 labels[labels['Symbol'].isin(parents)]
```

stocks closest to MSFT are:

Out[97]:

	Symbol	Security	SEC filings	GICS Sector	GICS Sub Industry	Headquarters Location	Date first added	CIK	Found
6	ADBE	Adobe Systems Inc	reports	Information Technology	Application Software	San Jose, California	1997-05-05	796343	19
24	GOOGL	Alphabet Inc Class A	reports	Communication Services	Interactive Media & Services	Mountain View, California	2014-04-03	1652044	19
25	GOOG	Alphabet Inc Class C	reports	Communication Services	Interactive Media & Services	Mountain View, California	2006-04-03	1652044	19
310	MA	Mastercard Inc.	reports	Information Technology	Data Processing & Outsourced Services	Harrison, New York	2008-07-18	1141391	N
474	V	Visa Inc.	reports	Information Technology	Data Processing & Outsourced Services	San Francisco, California	2009-12-21	1403161	N

## 2. Exxon Mobil Corporation, xom

```
In [79]: 1 stock = 'XOM'
2 parents = df.loc[f'{stock}_child',:].str.split('_').apply(lambda x: x[0]
3 print(f'stocks closest to {stock} are: ')
4 labels[labels['Symbol'].isin(parents)]
```

stocks closest to XOM are:

Out[79]:

	Symbol	Security	SEC filings	GICS Sector	GICS Sub Industry	Headquarters Location	Date first added	CIK	Founded
103	CVX	Chevron Corp.	reports	Energy	Integrated Oil & Gas	San Ramon, California	NaN	93410	1879
278	KMI	Kinder Morgan	reports	Energy	Oil & Gas Storage & Transportation	Houston, Texas	2012-05-25	1506307	NaN
361	OKE	ONEOK	reports	Energy	Oil & Gas Storage & Transportation	Tulsa, Oklahoma	2010-03-15	1039684	NaN
375	PSX	Phillips 66	reports	Energy	Oil & Gas Refining & Marketing	Houston, Texas	2012-05-01	1534701	NaN
412	SLB	Schlumberger Ltd.	reports	Energy	Oil & Gas Equipment & Services	Curaçao, Kingdom of the Netherlands	1965-03-31	87347	1926

### 3. Lockheed Martin Corporation, LMT

```
In [80]: 1 stock = 'LMT'
2 parents = df.loc[f'{stock}_child',:].str.split('_').apply(lambda x: x[0]
3 print(f'stocks closest to {stock} are: ')
4 labels[labels['Symbol'].isin(parents)]
5
```

stocks closest to LMT are:

Out[80]:

	Symbol	Security	SEC filings	GICS Sector	GICS Sub Industry	Headquarters Location	Date first added	CIK	Founded
211	GD	General Dynamics	reports	Industrials	Aerospace & Defense	Falls Church, Virginia	NaN	40533	1899
284	LHX	L3Harris Technologies	reports	Industrials	Aerospace & Defense	Melbourne, Florida	NaN	202058	NaN
350	NOC	Northrop Grumman	reports	Industrials	Aerospace & Defense	West Falls Church, Virginia	1985- 06-30	1133421	NaN
396	RTN	Raytheon Co.	reports	Industrials	Aerospace & Defense	Waltham, Massachusetts	NaN	1047122	1922
462	UTX	United Technologies	reports	Industrials	Aerospace & Defense	Hartford, Connecticut	NaN	101829	NaN

#### 4. Bank of America, BAC

```
In [82]: 1 stock = 'BAC'
2 parents = df.loc[f'{stock}_child',:].str.split('_').apply(lambda x: x[0]
3 print(f'stocks closest to {stock} are: ')
4 labels[labels['Symbol'].isin(parents)]
```

stocks closest to BAC are:

Out[82]:

	Symbol	Security	SEC filings	GICS Sector	GICS Sub Industry	Headquarters Location	Date first added	CIK	Founded
112	C	Citigroup Inc.	reports	Financials	Diversified Banks	New York, New York	1988-05-31	831001	NaN
219	GS	Goldman Sachs Group	reports	Financials	Investment Banking & Brokerage	New York, New York	2002-07-22	886982	NaN
270	JPM	JPMorgan Chase & Co.	reports	Financials	Diversified Banks	New York, New York	1975-06-30	19617	NaN
329	MS	Morgan Stanley	reports	Financials	Investment Banking & Brokerage	New York, New York	NaN	895421	1935
400	RF	Regions Financial Corp.	reports	Financials	Regional Banks	Birmingham, Alabama	1998-08-28	1281761	NaN

## 5. Walmart, WMT

```
In [86]: 1 stock = 'WMT'
2 parents = df.loc[f'{stock}_child',:].str.split('_').apply(lambda x: x[0]
3 print(f'stocks closest to {stock} are: ')
4 labels[labels['Symbol'].isin(parents)]
```

stocks closest to WMT are:

Out[86]:

	Symbol	Security	SEC filings	GICS Sector	GICS Sub Industry	Headquarters Location	Date first added	CIK	Foun
132	COST	Costco Wholesale Corp.	reports	Consumer Staples	Hypermarkets & Super Centers	Issaquah, Washington	1993-10-01	909832	I
152	DG	Dollar General	reports	Consumer Discretionary	General Merchandise Stores	Goodlettsville, Tennessee	2012-12-03	29534	I
237	HD	Home Depot	reports	Consumer Discretionary	Home Improvement Retail	Atlanta, Georgia	1988-03-31	354950	I
326	MDLZ	Mondelez International	reports	Consumer Staples	Packaged Foods & Meats	Deerfield, Illinois	2012-10-02	1103982	I
370	PEP	PepsiCo Inc.	reports	Consumer Staples	Soft Drinks	Purchase, New York	NaN	77476	1

## 6. Advanced Micro Devices, Inc., AMD

```
In [91]: 1 stock = 'AMD'
2 parents = df.loc[f'{stock}_child',:].str.split('_').apply(lambda x: x[0])
3 print(f'stocks closest to {stock} are: ')
4 labels[labels['Symbol'].isin(parents)]
```

stocks closest to AMD are:

Out[91]:

	Symbol	Security	SEC filings	GICS Sector	GICS Sub Industry	Headquarters Location	Date first added	CIK	Found
49	AMAT	Applied Materials Inc.	reports	Information Technology	Semiconductor Equipment	Santa Clara, California	1995-03-16	6951	1
286	LRCX	Lam Research	reports	Information Technology	Semiconductor Equipment	Fremont, California	2012-06-29	707549	1
320	MCHP	Microchip Technology	reports	Information Technology	Semiconductors	Chandler, Arizona	2007-09-07	827054	1
321	MU	Micron Technology	reports	Information Technology	Semiconductors	Boise, Idaho	1994-09-27	723125	1
355	NVDA	Nvidia Corporation	reports	Information Technology	Semiconductors	Santa Clara, California	2001-11-30	1045810	1

## 7. Alliant Energy Corp, LNT

```
In [92]: 1 stock = 'LNT'
2 parents = df.loc[f'{stock}_child',:].str.split('_').apply(lambda x: x[0])
3 print(f'stocks closest to {stock} are: ')
4 labels[labels['Symbol'].isin(parents)]
```

stocks closest to LNT are:

Out[92]:

	Symbol	Security	SEC filings	GICS Sector	GICS Sub Industry	Headquarters Location	Date first added	CIK	Founded
29	AEE	Ameren Corp	reports	Utilities	Multi-Utilities	St. Louis, Missouri	1991-09-19	1002910	1902
31	AEP	American Electric Power	reports	Utilities	Electric Utilities	Columbus, Ohio	NaN	4904	1906
117	CMS	CMS Energy	reports	Utilities	Multi-Utilities	Jackson, Michigan	1999-05-03	811156	NaN
484	WEC	Wec Energy Group Inc	reports	Utilities	Electric Utilities	Milwaukee, Wisconsin	2008-10-31	783325	NaN
496	XEL	Xcel Energy Inc	reports	Utilities	Multi-Utilities	Minneapolis, Minnesota	NaN	72903	1909

8. Cigna Corp, CI

```
In [93]: 1 stock = 'CI'
2 parents = df.loc[f'{stock}_child',:].str.split('_').apply(lambda x: x[0])
3 print(f'stocks closest to {stock} are: ')
4 labels[labels['Symbol'].isin(parents)]
```

stocks closest to CI are:

Out[93]:

	Symbol	Security	SEC filings	GICS Sector	GICS Sub Industry	Headquarters Location	Date first added	CIK	Founded
43	ANTM	Anthem	reports	Health Care	Managed Health Care	Indianapolis, Indiana	2002-07-25	1156039	2014 (1940s)
96	CNC	Centene Corporation	reports	Health Care	Managed Health Care	St Louis, Missouri	2016-03-30	1071739	NaN
242	HUM	Humana Inc.	reports	Health Care	Managed Health Care	Louisville, Kentucky	NaN	49071	1961
459	UNH	United Health Group Inc.	reports	Health Care	Managed Health Care	Minnetonka, Minnesota	1994-07-01	731766	NaN
485	WCG	WellCare	reports	Health Care	Managed Health Care	Tampa, Florida	1985	1279363	NaN

```
In [ ]: 1
```

```
In [ ]: 1
```