1 HW: Machine Learning in Finance

1.1 due 2023-02-12

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In [1]:

```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
import warnings
warnings.filterwarnings("ignore")
```

executed in 2.52s, finished 15:41:51 2023-02-08

In [2]:

```
ds = pd.read_csv(
    "/Users/yu-chingliao/Library/CloudStorage/GoogleDrive-josephliao0127@gmail.com/My Drive/Note/UIUC/Spring_2023/IE5
)
ds
```

executed in 75ms, finished 15:41:51 2023-02-08

Out[2]:

	CUSIP	Ticker	Issue Date	Maturity	1st Call Date	Moodys	S_and_P	Fitch	Bloomberg Composite Rating	Coupon	...	percent_intra_dealer	percent_uncapped	bond
0	000324AA1	FLECIN	7/1/2014	7/1/2019	10/23/2017	Nan	Nan	Nan	Nan	12.00	...	0.006645	0.292359	
1	00080QAB1	RBS	3/15/2004	6/4/2018	Nan	Ba1	BB+	BBB	BB+	4.65	...	0.425018	0.974071	
2	00081TAD0	ACCO	5/14/2010	3/15/2015	Nan	WR	NR	BB+	NR	10.63	...	0.115207	0.594470	
3	00081TAH1	ACCO	6/17/2013	4/30/2020	Nan	WR	NR	WD	NR	6.75	...	0.426332	0.892462	
4	00081TAJ7	ACCO	12/22/2016	12/15/2024	12/15/2019	B1	BB-	BB	BB-	5.25	...	0.157216	0.690722	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	
2716	629377CC4	NRG	4/18/2017	1/15/2027	7/15/2021	B1	BB-	Nan	B+	6.63	...	0.376000	0.708571	
2717	62940QAA3	NSGHLD	3/14/2007	12/15/2025	Nan	Ba1	BB+	Nan	BB+	7.75	...	0.024540	0.699387	
2718	62941FAH1	VMED	7/25/2006	8/15/2016	Nan	WR	NR	BB+	NR	9.13	...	0.193798	0.527132	
2719	62943WAA7	NYLD	8/5/2014	8/15/2024	Nan	Ba2	BB	Nan	BB	5.38	...	0.063197	0.605948	
2720	62943WAB5	NYLD	7/21/2015	8/15/2024	8/15/2019	Ba2	BB	Nan	BB	5.38	...	0.241427	0.766118	

2721 rows × 37 columns

2 Print the shape out.

In [3]:

```
labels = list(ds.columns)
n_column = len(labels)
n_row = len(ds)

print("The number of Columns is", n_column, ".")
print("The number of Rows is", n_row, ".")
```

executed in 4ms, finished 15:41:51 2023-02-08

```
The number of Columns is 37 .
The number of Rows is 2721 .
```

3 Print the nature out

In [4]:

```
nl = []
sl = []
ol = []

for label in labels:
    Number = 0
    String = 0
    Other = 0

    for i in ds[label]:
        if type(i) == str:
            String += 1
        elif (type(i) == int) or (type(i) == float):
            Number += 1
        else:
            Other += 1
    nl.append(Number)
    sl.append(String)
    ol.append(Other)

Output = {
    "Label": labels,
    "Number": nl,
    "String": sl,
    "Other": ol
}
Output = pd.DataFrame(Output)
Output
```

executed in 61ms, finished 15:41:53 2023-02-08

Out[4]:

	Label	Number	String	Other
0	CUSIP	0	2721	0
1	Ticker	0	2721	0
2	Issue Date	0	2721	0
3	Maturity	0	2721	0
4	1st Call Date	0	2721	0
5	Moodys	0	2721	0
6	S_and_P	0	2721	0
7	Fitch	0	2721	0
8	Bloomberg Composite Rating	0	2721	0
9	Coupon	2721	0	0
10	Issued Amount	2721	0	0
11	Maturity Type	0	2721	0
12	Coupon Type	0	2721	0
13	Maturity At Issue months	2721	0	0
14	Industry	0	2721	0
15	LiquidityScore	2721	0	0
16	Months in JNK	0	2721	0
17	Months in HYG	0	2721	0
18	Months in Both	0	2721	0
19	IN_ETF	0	2721	0
20	LIQ SCORE	2721	0	0
21	n_trades	2721	0	0
22	volume_trades	2721	0	0
23	total_median_size	2721	0	0
24	total_mean_size	2721	0	0
25	n_days_trade	2721	0	0
26	days_diff_max	2721	0	0
27	percent_intra_dealer	2721	0	0
28	percent_uncapped	2721	0	0
29	bond_type	2721	0	0
30	Client_Trade_Percentage	2721	0	0
31	weekly_mean_volume	2721	0	0
32	weekly_median_volume	2721	0	0
33	weekly_max_volume	2721	0	0
34	weekly_min_volume	2721	0	0
35	weekly_mean_ntrades	2721	0	0
36	weekly_median_ntrades	2721	0	0

4 Summary of Statistics

I pick column #9: Coupon as the example numerical data , and #12: Coupon Type as catagorical data.

In [5]:

```
numer = np.array(ds['Coupon'])

#Mean, Var and Std
print('μ =', numer.mean(), 'Var =', numer.var(), "σ =", numer.std(),'\n')

#quantiles
def q(ds, n_q):
    result = []
    for i in range(n_q+1):
        result.append(np.percentile(ds, i*(100)/n_q))
    return result
print("Boundaries for 4 Equal Percentiles\n",q(numer, 4), "\n")

#10 equal percenetiles
print("Boundaries for 10 Equal Percentiles\n",q(numer, 10), "\n")

#catagorical analysis
cat = list(ds['Coupon Type'])
neat_cat = list(set(cat))
print("Unique Label Values \n", neat_cat)

#count catagorics
counts = []
for i in neat_cat:
    counts.append(sum(ds['Coupon Type'] == i))
Output = {
    "Types" : neat_cat,
    "Counts" : counts
}
Output = pd.DataFrame(Output)
Output = Output.set_index("Types")
Output
```

executed in 26ms, finished 15:41:54 2023-02-08

```
μ = 10.30787210584344 Var = 3974.0157451596806 σ = 63.0397949327223

Boundaries for 4 Equal Percentiles
 [0.0, 5.0, 6.25, 7.75, 999.0]

Boundaries for 10 Equal Percentiles
 [0.0, 2.95, 4.63, 5.25, 5.75, 6.25, 6.83, 7.5, 8.13, 9.38, 999.0]

Unique Label Values
 ['DEFAULTED', 'FIXED', 'EXCHANGED', 'FLOATING', 'ZERO COUPON', 'FUNGED', 'PAY-IN-KIND', 'VARIABLE', 'STEP CPN', 'FLA
T TRADING']
```

Out[5]:

	Counts
Types	
DEFAULTED	184
FIXED	2139
EXCHANGED	102
FLOATING	124
ZERO COUPON	7
FUNGED	2
PAY-IN-KIND	41
VARIABLE	111
STEP CPN	4
FLAT TRADING	7

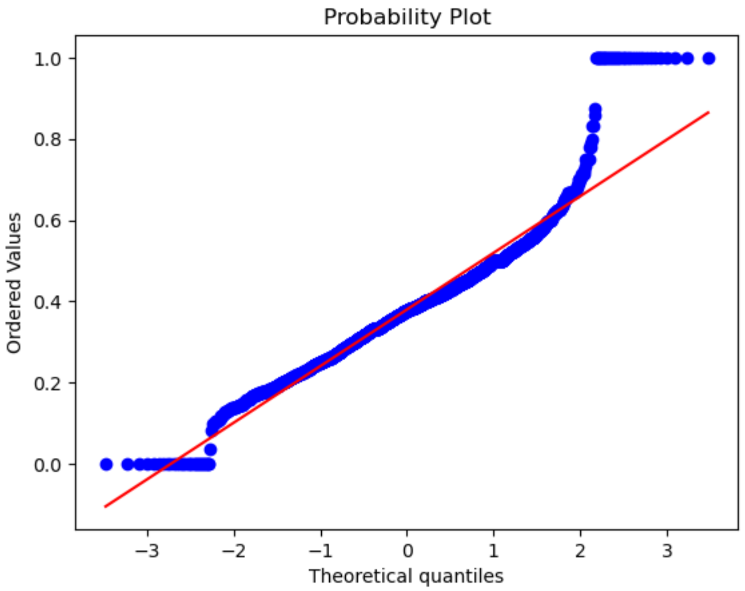
5 QQ Plot

In [6]:

```
import pylab
import scipy.stats as stats
```

executed in 2.30s, finished 15:41:58 2023-02-08

In [32]:
```
stats.probplot(ds['Client_Trade_Percentage'], dist="norm", plot=pylab)
pylab.show()
print("P-Value:", stats.normaltest(ds['Client_Trade_Percentage'])[1])
print("Reject H0: Client_Trade_Percentage is Normally distributed.")
```
executed in 161ms, finished 15:50:09 2023-02-08



```
P-Value: 1.5092726895984126e-133
Reject H0: Client_Trade_Percentage is Normally distributed.
```

There are some extremely value though rest are quite "normal".

6 Print Summary of data

In [124]:
```
summary = ds.describe()
print(summary)
```
executed in 55ms, finished 14:52:25 2023-02-06

```
count      2.721000e+03          2.721000e+03         2.721000e+03
mean       7.588325e+06          5.672609e+06         4.915523e+07
std        8.979311e+06          7.340321e+06         6.703860e+07
min        7.000000e+03          7.000000e+03         7.000000e+03
25%        2.295273e+06          1.750000e+06         9.020000e+06
50%        4.926339e+06          3.527000e+06         2.410000e+07
75%        9.649299e+06          7.011000e+06         6.370500e+07
max        1.179500e+08          1.179500e+08         8.728140e+08

       weekly_min_volume  weekly_mean_ntrades  weekly_median_ntrades
count       2.721000e+03          2721.000000            2721.000000
mean        6.690499e+05            21.598988               2.471885
std         3.094537e+06            32.901129               5.581749
min         1.400000e+01             1.000000               1.000000
25%         2.100000e+04             4.046154               1.000000
50%         1.060000e+05            10.821429               1.000000
75%         4.300000e+05            24.526316               2.000000
max         1.002500e+08           513.769231             160.000000

[8 rows x 21 columns]
```

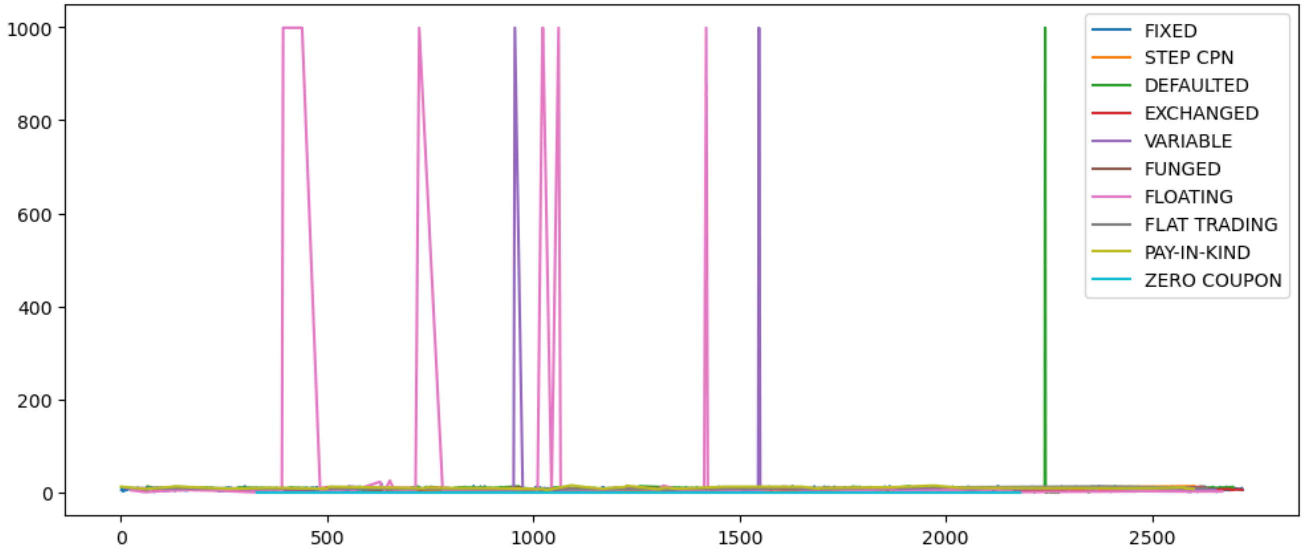
7 Plot out data

In [147]:
```
def legend(pos="bottom",ncol=3):
    if pos=="bottom":
        plt.legend(bbox_to_anchor=(0.5,-0.2), loc='upper center',facecolor="lightgray",ncol=ncol)
    elif pos=="side":
        plt.legend(bbox_to_anchor=(1.1,0.5), loc='center left',facecolor="lightgray",ncol=1)
```
executed in 5ms, finished 15:06:13 2023-02-06

In [155]:

```
plt.figure(figsize=[12,5])
for i in neat_cat:
    plt.plot(ds['Coupon'].loc[ds['Coupon Type']==i], label = i)
plt.legend()
plt.show()
```

executed in 229ms, finished 15:15:33 2023-02-06



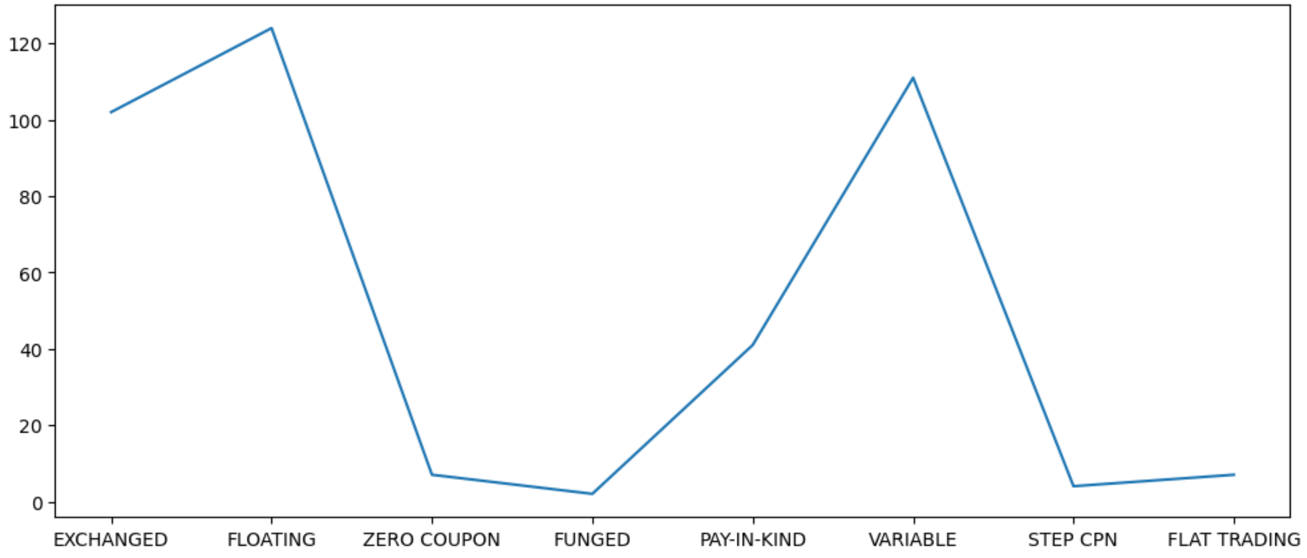
Since this plot is extremely useless, instead I plot below so that we can see the coupon we can get on different coupon types.

In [36]:

```
plt.figure(figsize=[12, 5])
plt.plot(Output[2:])
plt.show()

#fixed out and plot again
```

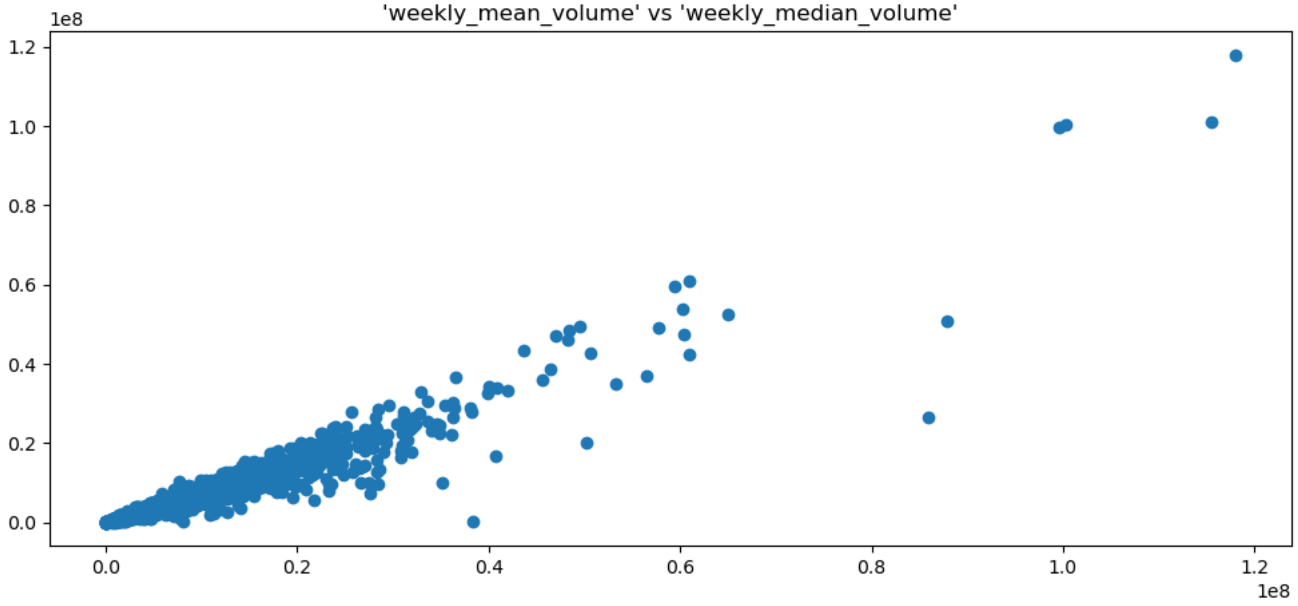
executed in 149ms, finished 15:50:41 2023-02-08



8 Cross Plotting Pairs of Attributes (Scatter Plot)

I use 'weekly_mean_volume' to cross plot with 'weekly_median_volume'.

In [170]:
```
plt.figure(figsize=[12,5])
plt.scatter(ds['weekly_mean_volume'], ds['weekly_median_volume'])
plt.title("'weekly_mean_volume' vs 'weekly_median_volume'")
plt.show()
```
executed in 171ms, finished 15:23:21 2023-02-06



It is somewhat positively correlated, but not strict enough.

9 Target vs Real Attributes

I plot coupon against coupon types

In [43]:
```
ds.columns
```
executed in 5ms, finished 15:54:27 2023-02-08

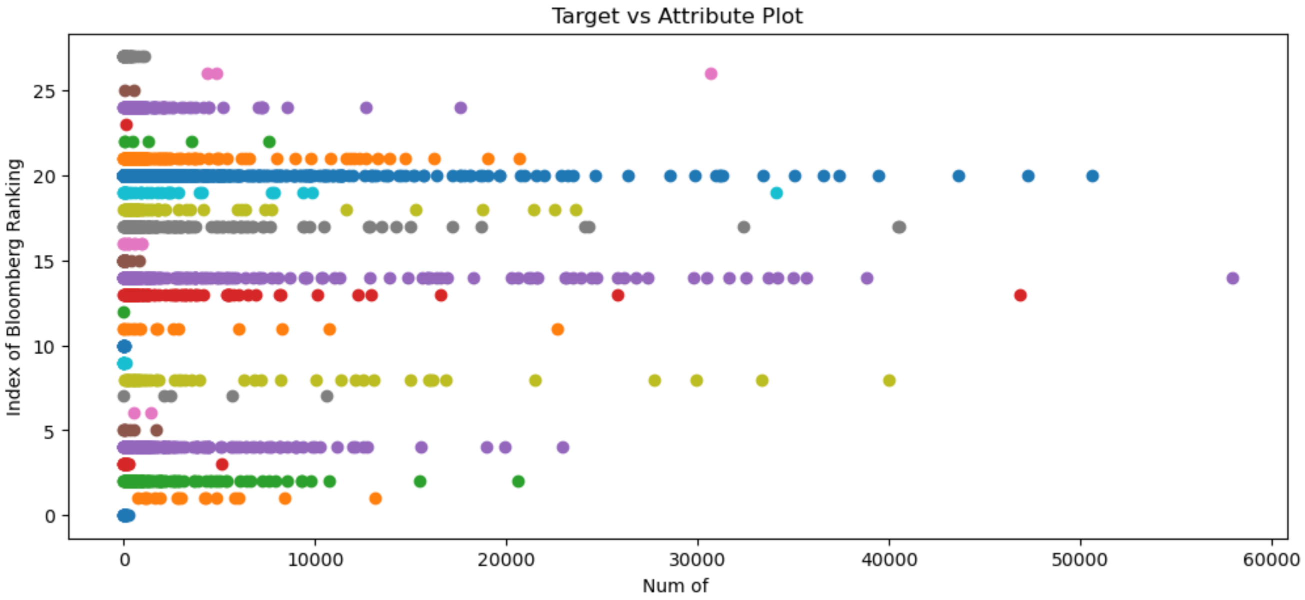
Out[43]:
```
Index(['CUSIP', 'Ticker', 'Issue Date', 'Maturity', '1st Call Date', 'Moodys',
       'S_and_P', 'Fitch', 'Bloomberg Composite Rating', 'Coupon',
       'Issued Amount', 'Maturity Type', 'Coupon Type',
       'Maturity At Issue months', 'Industry', 'LiquidityScore',
       'Months in JNK', 'Months in HYG', 'Months in Both', 'IN_ETF',
       'LIQ SCORE', 'n_trades', 'volume_trades', 'total_median_size',
       'total_mean_size', 'n_days_trade', 'days_diff_max',
       'percent_intra_dealer', 'percent_uncapped', 'bond_type',
       'Client_Trade_Percentage', 'weekly_mean_volume', 'weekly_median_volume',
       'weekly_max_volume', 'weekly_min_volume', 'weekly_mean_ntrades',
       'weekly_median_ntrades'],
      dtype='object')
```

In [40]:
```
credit_rating = list(set(ds['Bloomberg Composite Rating']))
```
executed in 3ms, finished 15:53:28 2023-02-08

In [46]:

```
plt.figure(figsize=[12,5])
for i in range(len(credit_rating)):
    plt.scatter(ds['n_trades'].loc[ds['Bloomberg Composite Rating'] == credit_rating[i]],
                i* np.ones_like(ds['n_trades'].loc[ds['Bloomberg Composite Rating'] == credit_rating[i]]))
plt.ylabel("Index of Bloomberg Ranking")
plt.xlabel("Num of ")
plt.title("Target vs Attribute Plot")
plt.show()
```

executed in 615ms, finished 15:58:24 2023-02-08



10 Correlations

In [192]:

```
ds.corr()
```

executed in 38ms, finished 15:42:29 2023-02-06

Out[192]:

	Coupon	Issued Amount	Maturity At Issue months	LiquidityScore	LIQ SCORE	n_trades	volume_trades	total_median_size	total_mean_size	n_days_trade	.
Coupon	1.000000	-0.014238	0.098844	-0.042302	-0.042302	-0.023330	-0.026717	0.044601	0.026891	-0.028336	.
Issued Amount	-0.014238	1.000000	0.008601	0.134930	0.134930	0.156948	0.326310	0.062343	0.078362	0.068113	.
Maturity At Issue months	0.098844	0.008601	1.000000	0.072507	0.072507	0.038839	-0.015227	-0.115086	-0.138581	0.029530	.
LiquidityScore	-0.042302	0.134930	0.072507	1.000000	1.000000	0.803139	0.786718	-0.627008	-0.656980	0.873040	.
LIQ SCORE	-0.042302	0.134930	0.072507	1.000000	1.000000	0.803139	0.786718	-0.627008	-0.656980	0.873040	.
n_trades	-0.023330	0.156948	0.038839	0.803139	0.803139	1.000000	0.769322	-0.425801	-0.468673	0.704310	.
volume_trades	-0.026717	0.326310	-0.015227	0.786718	0.786718	0.769322	1.000000	-0.276204	-0.278564	0.772564	.
total_median_size	0.044601	0.062343	-0.115086	-0.627008	-0.627008	-0.425801	-0.276204	1.000000	0.930213	-0.490428	.
total_mean_size	0.026891	0.078362	-0.138581	-0.656980	-0.656980	-0.468673	-0.278564	0.930213	1.000000	-0.494483	.
n_days_trade	-0.028336	0.068113	0.029530	0.873040	0.873040	0.704310	0.772564	-0.490428	-0.494483	1.000000	.
days_diff_max	-0.025089	-0.008097	0.103178	0.717280	0.717280	0.497633	0.540932	-0.425033	-0.430947	0.796236	.
percent_intra_dealer	-0.014316	0.052617	0.104127	0.671903	0.671903	0.415695	0.387555	-0.650101	-0.679317	0.500944	.
percent_uncapped	-0.045897	-0.112369	0.100168	0.666321	0.666321	0.396880	0.241814	-0.826443	-0.862401	0.433119	.
bond_type	0.051856	-0.070714	0.102990	-0.368492	-0.368492	-0.208283	-0.452584	0.081332	0.086759	-0.444068	.
Client_Trade_Percentage	0.029125	-0.049513	-0.040186	-0.496127	-0.496127	-0.348408	-0.327922	0.486900	0.502385	-0.406258	.
weekly_mean_volume	-0.027724	0.382050	-0.023002	0.385978	0.385978	0.309053	0.503159	0.060608	0.052018	0.168114	.
weekly_median_volume	-0.028584	0.396947	-0.032868	0.371213	0.371213	0.285998	0.479018	0.053381	0.054723	0.169430	.
weekly_max_volume	-0.026362	0.261469	-0.017137	0.481142	0.481142	0.432955	0.616802	-0.066253	-0.087748	0.323094	.
weekly_min_volume	-0.014438	0.105208	-0.020392	0.025707	0.025707	-0.041335	-0.037198	0.138658	0.177104	-0.118874	.
weekly_mean_ntrades	-0.028045	0.274420	0.036729	0.673569	0.673569	0.804753	0.602055	-0.378970	-0.428501	0.416313	.
weekly_median_ntrades	-0.018326	0.188765	0.006573	0.239951	0.239951	0.234165	0.144272	-0.096283	-0.100327	0.026527	.

21 rows × 21 columns

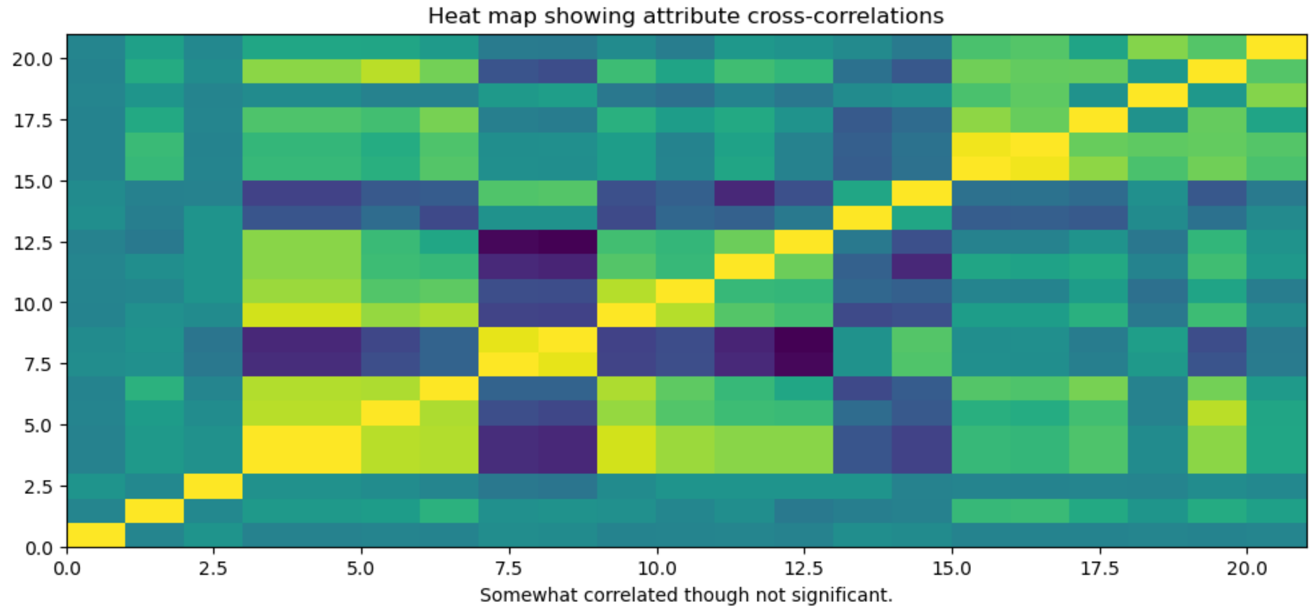
n_trade and liquidity seemed to be positively correlated, and LIQ and liquidity is duplicating so redundant.

11 Correlation Visualization

In [188]:

```
#calculate correlations between real-valued attributes
corMat = pd.DataFrame(ds.corr())
#visualize correlations using heatmap
plt.figure(figsize=[12,5])
plt.title("Heat map showing attribute cross-correlations")
plt.pcolor(corMat)
plt.xlabel('Somewhat correlated though not significant.')
plt.show()
```

executed in 179ms, finished 15:40:00 2023-02-06



12 Signing

In [1]:

```
print("My name is Yu-Ching Liao")
print("My NetID is: 656724372")
print("I hereby certify that I have read the University policy on Academic Integrity and that I am not in violation.")
```

executed in 4ms, finished 15:57:22 2023-02-06

```
My name is Yu-Ching Liao
My NetID is: 656724372
I hereby certify that I have read the University policy on Academic Integrity and that I am not in violation.
```

In [ ]: