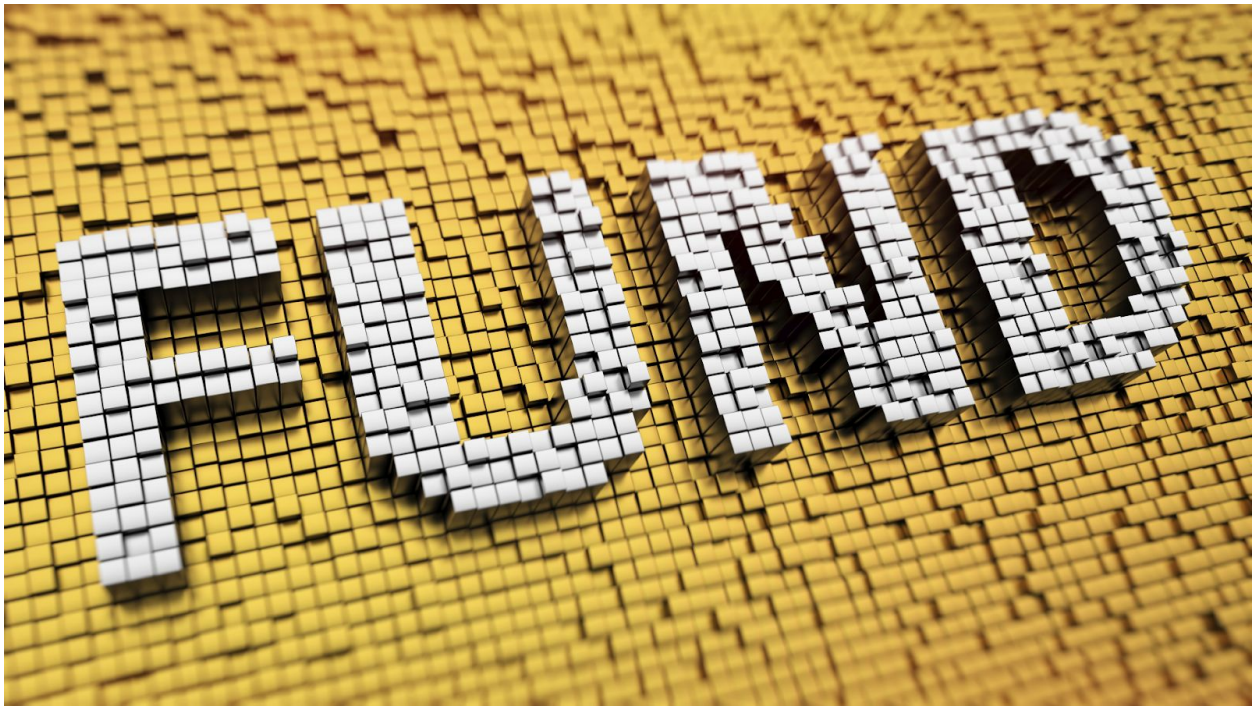


Startup funding pattern analysis

Prepared by Mid Eum Lee

Summary

Objective
The objective of this analysis is to investigate the history of investment in different categories of startups and get an insight on the significant factors for funding.

Goal
The goal is to overview the patterns of startup investment and provide the useful advice for new entrepreneurs to launch a startup.

Solution

Exploratory data analysis

Project outline

The analysis is performed in three steps:

- Dataset was explored and analyzed.
- Dataset was cleaned and modified.
- Data visualization was applied on the dataset.

Importing of packages

```
import pandas as pd
import numpy as np
from scipy import stats
import statistics
import matplotlib
import matplotlib.pyplot as plt
from matplotlib.pyplot import figure
import scipy.stats as st


from IPython import display
import seaborn as sns
import csv
from statistics import mean
```

In [4]:
```
df = pd.read_csv('startup.csv')
```

In [5]:
```
df.head()
```

Out[5]:

	name	category_list	funding_total_usd	status	country_code	state_code	city	funding_r
0	H2O.ai	Software	33.600000	operating	USA	CA	Mountain View	
1	One Inc.	Mobile	1.150050	operating	USA	CA	San Francisco	
2	1000 Corks	Software	0.040000	operating	USA	OR	Lake Oswego	
3	1000museums.com	Software	6.795451	operating	USA	MA	Lenox	
4	Redox	Health	4.000000	operating	USA	WI	Madison	

In [6]:
```
df_dropped = df.dropna()
```

In [7]:
```
df_dropped.tail()
```

Out[7]:

	name	category_list	funding_total_usd	status	country_code	state_code	city	funding_rou
13708	Zyngenia	Technology	25.000000	operating	USA	MD	Gaithersburg	
13709	ZYOMYX	Technology	34.275015	operating	USA	MO	Fremont	
13710	Zype	Software	3.300000	operating	USA	NY	New York	
13711	Whisk (formerly Zypsee)	Sports	2.150000	operating	USA	NY	New York	
13712	Ôasys	Hardware	0.018192	operating	USA	CA	San Francisco	

In [8]:
```
df_dropped['founded_at'].unique()
```

Out[8]:
```
array(['2011', '2008', '2014', '2000', '2013', '2012', '2007', '2010',
       '1990', '2002', '2001', '2009', '2006', '1999', '1998', '2004',
       '2015', '2005', '1986', '2003', '1971', '1989', '1997', '1979',
       '1993', '1987', '1961', '1996', '1947', '1994', '1992', '1984',
       '1995', '1949', '1985', '1974', '1969', '1975', '1918', '1980',
       '1944', '1972', '1983', '1982', '1976', '1988', '1991', '1977',
       '26-Feb', '1973', '1981', '1917', 'Feb-31', '1-Jan', '1970',
       '1906', '1978', '19-Jul', '1958', '1966', '1953', '1952', '1956',
       '1908', '1962', '1945', '1967', '1909', '1954', '1968', '1965',
       '1928', '1963', '18-Sep', '24-Aug', '1920', '1925', '1930', '1926',
       '1919', '1924', '1951', '29-Apr', '1923', '1914', '1929', '1902',
       '1939', '1912', '1911', '1933', '1950'], dtype=object)
```

Question1: what is the funding_total_usd for 2011? USD in K

In [9]:
```
df_dropped[df_dropped['founded_at']=='2011']['funding_total_usd']
```

Out[9]:
```
0         33.600000
1          1.150050
9          0.794000
13         3.400000
20         0.500000
             ...
13661     35.600000
13665     45.500000
13681      4.220018
13690      0.080000
13711      2.150000
Name: funding_total_usd, Length: 1532, dtype: float64
```

In [10]:
```
# total funding for 2011
df_dropped[df_dropped['founded_at']=='2011']['funding_total_usd'].sum()
```

Out[10]:
```
24591.242369436
```

In [11]:
```
df_dropped['founded_at'].sort_values()
```

Out[11]:
```
8528       1-Jan
12530      1-Jan
12534      1-Jan
12536      1-Jan
12529      1-Jan
             ...
8318      24-Aug
916       26-Feb
10168     29-Apr
1330      Feb-31
2129      Feb-31
Name: founded_at, Length: 13712, dtype: object
```

In [13]:
```
df_dropped['founded_at'].value_counts()
```

Out[13]:
```
2012       1657
2011       1532
2013       1511
2010       1157
2014        943
           ...
19-Jul        1
29-Apr        1
26-Feb        1
1945          1
1911          1
Name: founded_at, Length: 92, dtype: int64
```

In [14]:
```
df_dropped[df_dropped['founded_at'] == '2011']['funding_total_usd'].sum()
```

Out[14]:
```
24591.242369436
```

Question2: what is the funding_total_usd for all available years?

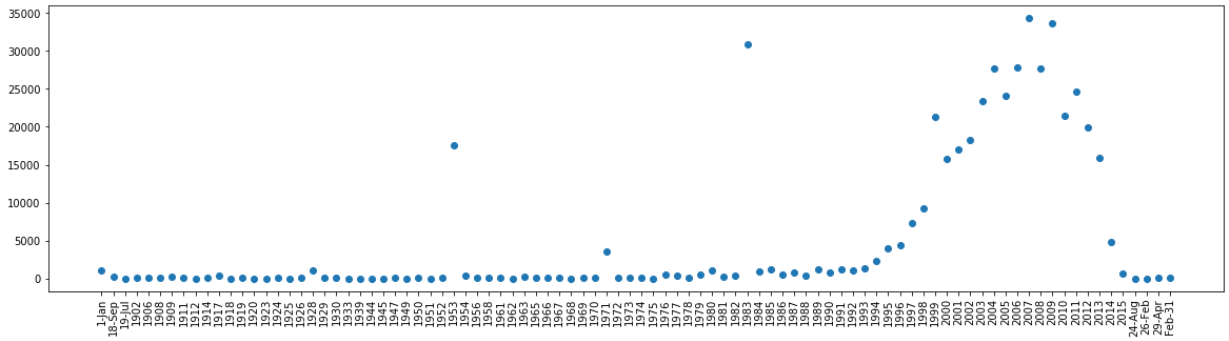
In [15]:
```
ls = []
for i in list(df_dropped['founded_at'].sort_values().unique()):
    ls.append(df_dropped[df_dropped['founded_at'] == i]['funding_total_usd'].sum
())

print(ls)
```

```
[987.853094, 250.0, 9.0, 20.0, 16.0, 16.5, 245.0, 19.33, 2.0, 18.0, 300.0, 0.157,
120.0, 2.5, 1.75, 81.35, 0.15432, 16.600216, 1000.0, 59.929933, 25.65, 0.150768,
7.5, 5.0, 7.4, 10.0, 2.0, 28.5, 6.0, 96.30000000000001, 17600.0, 331.0, 60.0, 19.
6, 23.5, 6.0, 207.259114, 25.0, 10.0, 90.8, 4.67321, 38.65, 13.378196, 3591.0, 2
1.36, 57.0726, 52.0, 0.75, 506.2, 334.096, 97.41040000000001, 489.73600000000005,
1109.7, 203.2, 402.561365, 30826.27123, 969.485851, 1235.964973, 430.713798, 716.
3299959999999, 296.064354, 1181.0722830000002, 792.1911379999999, 1247.632421, 10
73.55674, 1374.605991, 2250.795642, 3907.8827180000003, 4378.504615, 7232.2465834
2, 9221.717702399, 21293.925880151, 15731.084839000001, 16978.641015884, 18256.38
3254, 23352.259765249997, 27726.36569675, 24054.835289000002, 27880.752675999996,
34298.53740258, 27645.401071570002, 33681.691192, 21523.016813984003, 24591.24236
9436, 19868.646866529, 15863.696440848998, 4790.459357878, 672.336355021, 5.5, 1.
0, 26.72, 18.5]
```

In [16]:
```
plt.figure(figsize = (20,5), frameon = False)
plt.xticks(rotation=90)
plt.plot(list(df_dropped['founded_at'].sort_values().unique()), ls,'o')
```

Out[16]:
```
[<matplotlib.lines.Line2D at 0x1241952d0>]
```



For data format (Month-Date) in the founding date, these data may belongs to recent years based on its low funding total in overall trend.

In [17]:
```
print(df_dropped[df_dropped['founded_at'] == '2009']['funding_total_usd'].sum())
```

```
33681.691192
```

In [18]:
```
print(df_dropped[df_dropped['founded_at'] == '2007']['funding_total_usd'].sum())
```

```
34298.53740258
```

In [19]:
```
print(df_dropped[(df_dropped['founded_at'] == '1953')]['funding_total_usd'].sum())
```

```
17600.0
```

In [20]:
```
print(df_dropped[df_dropped['founded_at'] == '1953']['category_list'])
```

```
4584    Hardware
Name: category_list, dtype: object
```

Question 3: Answer Question 2 for Software Category

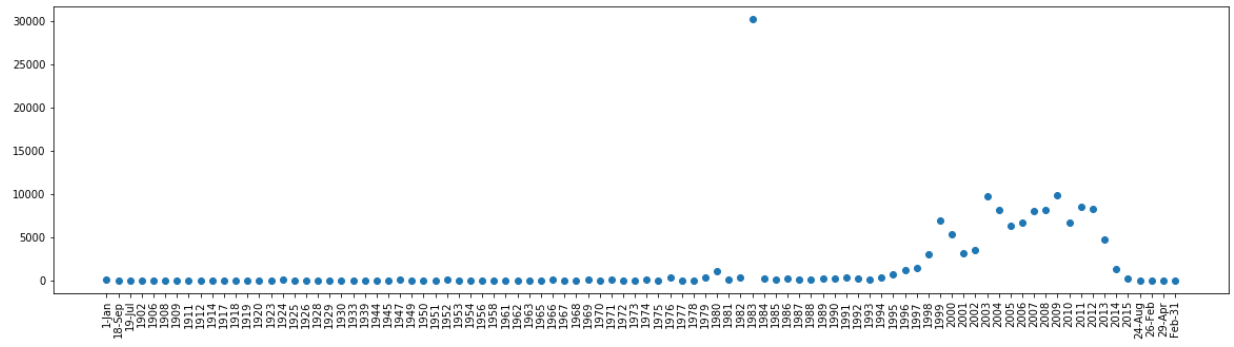
In [21]:
```
ls_software = []
for i in list(df_dropped['founded_at'].sort_values().unique()):
    ls_software.append(df_dropped[(df_dropped['founded_at'] == i) & (df_dropped['c
ategory_list'] == 'Software')]['funding_total_usd'].sum())

print(ls_software)
```

```
[68.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 35.
0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 5.0, 0.0, 10.0, 0.0, 0.0, 0.0, 11.4, 0.0,
0.0, 0.0, 0.0, 0.0, 0.5, 6.0, 0.0, 0.0, 10.0, 0.0, 4.5, 25.0, 0.0, 13.0, 0.0, 2.5726,
12.0, 0.75, 330.2, 0.0, 0.0, 288.3, 1030.5, 104.0, 346.0, 30127.201999999997, 20
0.26204800000002, 101.729971, 236.38709300000002, 66.680511, 114.068238, 246.6496
74, 190.7, 344.546725, 157.02749999999997, 123.93339999999999, 284.2, 722.272222,
1218.3065430000001, 1403.4045914199999, 2995.954001399, 6851.748235581001, 5274.3
68905, 3170.162111884, 3520.6371440000003, 9759.921296249999, 8078.887584, 6230.7
30723000001, 6664.218580000001, 8051.633184, 8089.574015, 9883.793102, 6659.12378
9, 8531.500703976, 8183.62137026, 4727.556383104, 1324.721404466, 159.1, 0.0, 0.
0, 0.0, 0.0]
```

In [22]:
```
plt.figure(figsize = (20,5), frameon = False)
plt.xticks(rotation=90)
plt.plot(list(df_dropped['founded_at'].sort_values().unique()), ls_software,'o')
```

Out[22]:
```
[<matplotlib.lines.Line2D at 0x10ae21ed0>]
```



Question 4: Answer Question 3 for Hardware Category

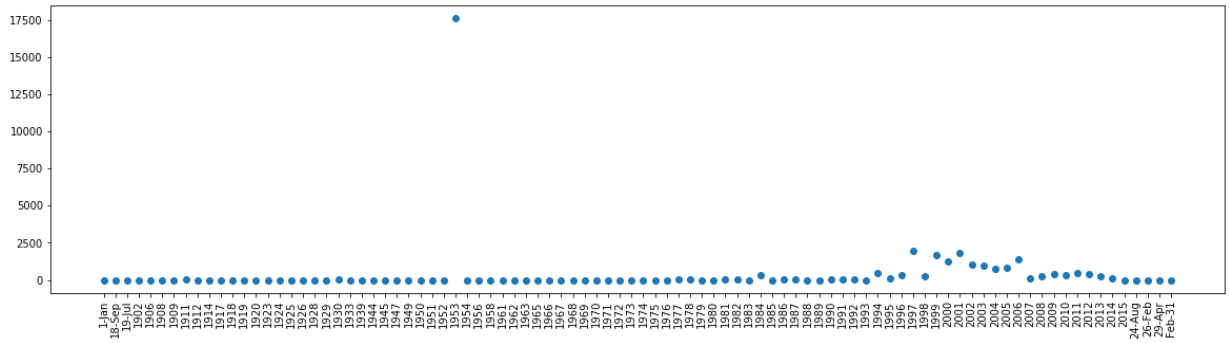
In [23]:
```
ls_Hardware = []
for i in list(df_dropped['founded_at'].sort_values().unique()):
    ls_Hardware.append(df_dropped[(df_dropped['founded_at'] == i) & (df_dropped['c
ategory_list'] == 'Hardware')]['funding_total_usd'].sum())

print(ls_Hardware)
```

```
[0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 19.33, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.
0, 0.0, 0.0, 0.0, 0.0, 25.5, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 17600.
0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.
0, 0.0, 0.0, 21.5, 50.4104, 0.0, 0.0, 5.5, 10.06, 0.0, 350.0, 0.0, 14.92, 48.8114
81, 2.7295, 0.0, 45.78, 17.22, 22.0, 0.0, 437.20918, 81.4, 308.66513399999997, 19
55.67384, 220.60000000000002, 1652.3684250000001, 1248.752311, 1807.473634, 1037.
860842, 934.2154760000001, 726.15455, 799.081749, 1376.7903700000002, 97.20136600
000001, 269.334527, 387.829661, 337.83883000000003, 462.01051700000005, 365.31274
700000006, 263.08059199999997, 105.07751700000001, 0.15369300000000002, 0.0, 0.0,
0.0, 0.0]
```

In [24]:
```
plt.figure(figsize = (20,5), frameon = False)
plt.xticks(rotation=90)
plt.plot(list(df_dropped['founded_at'].sort_values().unique()), ls_Hardware,'o')
```

Out[24]:
```
[<matplotlib.lines.Line2D at 0x125d74a90>]
```



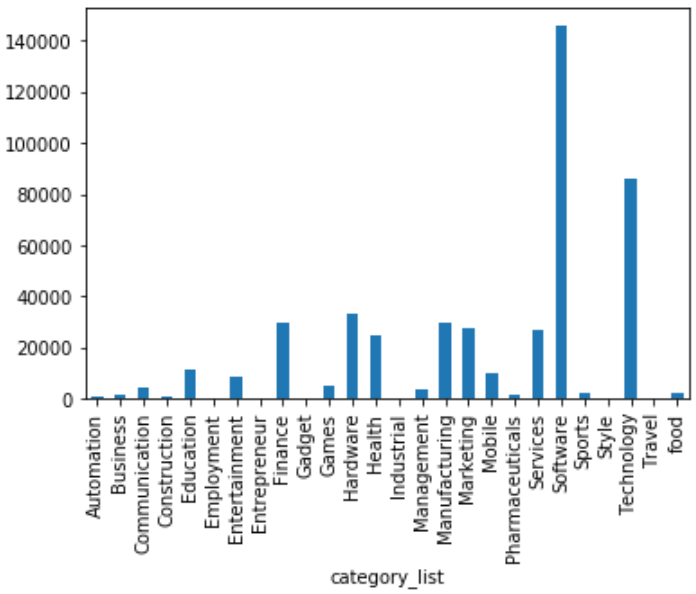
Regardless of the year, how much fund does exist for Automation, Business, ...?

In [25]:
```
df_dropped.groupby('category_list')['funding_total_usd'].sum()
```

Out[25]:
```
category_list
Automation             559.024294
Business              1422.426471
Communication         4052.314321
Construction           416.866774
Education            11273.229054
Employment             120.340000
Entertainment         8277.877143
Entrepreneur             1.545000
Finance              29572.705186
Gadget                   7.500000
Games                 4853.158856
Hardware             33107.846342
Health               24640.058284
Industrial              44.305000
Management            3273.054044
Manufacturing        29928.799992
Marketing            27710.328309
Mobile               10129.438422
Pharmaceuticals       1237.935911
Services             26759.153986
Software            145997.345649
Sports                2070.726740
Style                  244.720695
Technology           86163.164572
Travel                 327.289249
food                  1854.450244
Name: funding_total_usd, dtype: float64
```

In [26]:
```
df_dropped.groupby('category_list')['funding_total_usd'].sum().plot(kind='bar')
```

Out[26]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x10ae16fd0>
```



In [27]:
```
print(sum(ls_software))
```

```
145997.34564934
```

Question 5: What % of startups are software or Technology?

In [28]:
```
sample = df_dropped['category_list'].value_counts()
```

In [29]:
```
total = df_dropped['category_list'].value_counts().sum()
total
```

Out[29]: 13712

In [30]:
```
c = df_dropped['category_list'].value_counts()

d = df_dropped['category_list'].value_counts().sum()
```

In [31]:
```
def percentage (d, c):
    return ((c/d)*100)
for each in c:
    pc = percentage(d, each)
    print (pc)
```

```
34.80892648774796
11.231038506417736
7.934655775962661
7.825262543757293
7.460618436406068
5.870770128354725
4.769544924154025
3.7995915985997666
3.6245624270711785
3.478704784130689
2.72024504084014
1.76487747957993
0.8751458576429404
0.7876312718786465
0.7876312718786465
0.5907234539089848
0.47403733955659283
0.41569428238039674
0.26983663943990666
0.13127187864644108
0.13127187864644108
0.09480746791131855
0.08022170361726955
0.03646441073512252
0.029171528588098013
0.007292882147024503
```

software funding in San Francisco

In [32]:
```
san_francisco = df_dropped.query('city == "San Francisco"')
san_francisco.head()
san_francisco.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1877 entries, 1 to 13712
Data columns (total 20 columns):
name                    1877 non-null object
category_list           1877 non-null object
funding_total_usd       1877 non-null float64
status                  1877 non-null object
country_code            1877 non-null object
state_code              1877 non-null object
city                    1877 non-null object
funding_rounds          1877 non-null float64
Investors               1877 non-null object
Number_of_Investors     1877 non-null float64
Acquirer                1877 non-null object
Acquirer_Category       1877 non-null object
Acquirer_Country        1877 non-null object
Acquirer_State          1877 non-null object
Acquirer_City           1877 non-null object
Acquired_Price          1877 non-null object
Acquired Currency       1877 non-null object
county                  1877 non-null object
founded_at              1877 non-null object
Coordinates             1877 non-null object
dtypes: float64(3), object(17)
memory usage: 307.9+ KB
```

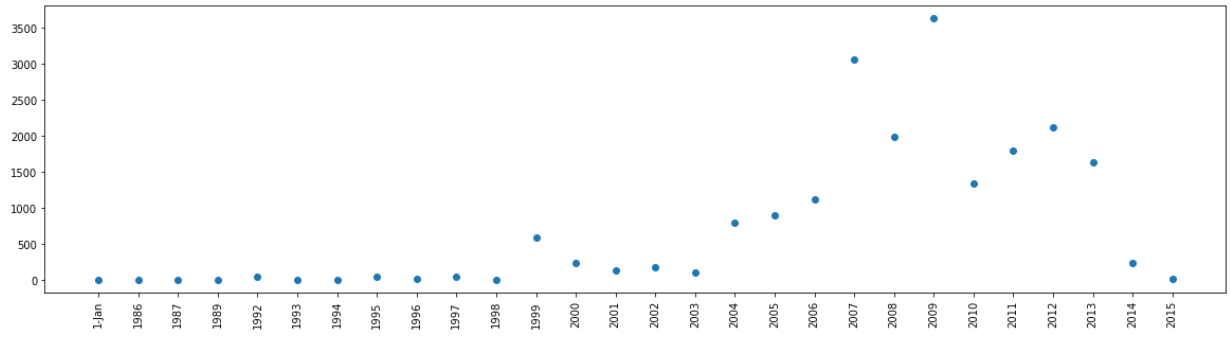
In [33]:
```
sf_software = []
for i in list(san_francisco['founded_at'].sort_values().unique()):
    sf_software.append(san_francisco[(san_francisco['founded_at'] == i) & (san_fra
ncisco['category_list'] == 'Software')]['funding_total_usd'].sum())

print(sf_software)
```

```
[0.0, 0.0, 0.0, 0.0, 44.0, 0.0, 5.0, 37.5, 7.0, 43.0, 3.4361853989999998, 584.620
7999999999, 240.30255899999997, 131.1009, 181.33729399999999, 100.94809322, 796.2
87073, 899.088386, 1117.705074, 3054.856993, 1988.7159819999997, 3636.89242100000
05, 1339.965797, 1793.144333, 2113.9449922599997, 1629.572455, 240.575874466, 18.
400000000000002]
```

In [34]:
```
plt.figure(figsize = (20,5), frameon = False)
plt.xticks(rotation=90)
plt.plot(list(san_francisco['founded_at'].sort_values().unique()), sf_software,'o'
)
```

Out[34]:
```
[<matplotlib.lines.Line2D at 0x126251710>]
```



Pearson correlation between the number of investers and the funding total

Null hypothesis: number of investers are not correlated with funding total.

In [35]:
```
X = df_dropped.Number_of_Investors.values
Y = df_dropped.funding_total_usd.values
```

In [36]:
```
def pearson_r(X, Y):
    corr_mat=np.corrcoef(X,Y)
    return corr_mat[0,1]
r_obs = pearson_r(X,Y)
print('Observed significance value=',r_obs)
```

```
Observed significance value= 0.08024147738834027
```

Statistical analysis of total funding in software category.

In [37]:
```
software_funding = df_dropped.query('category_list == "Software"')
```

In [38]:
```
mean = np.mean(software_funding.funding_total_usd)
print(mean)
```

```
30.588172145262952
```

In [39]:
```
std_dev = np.std(software_funding.funding_total_usd)
print(std_dev)
```

```
448.57335577518586
```

In [40]:
```
mode = stats.mode(software_funding.funding_total_usd)
print(mode)
```

```
ModeResult(mode=array([2.]), count=array([89]))
```

In [41]:
```
median = statistics.median(software_funding.funding_total_usd)
print(median)
```

```
6.052753
```

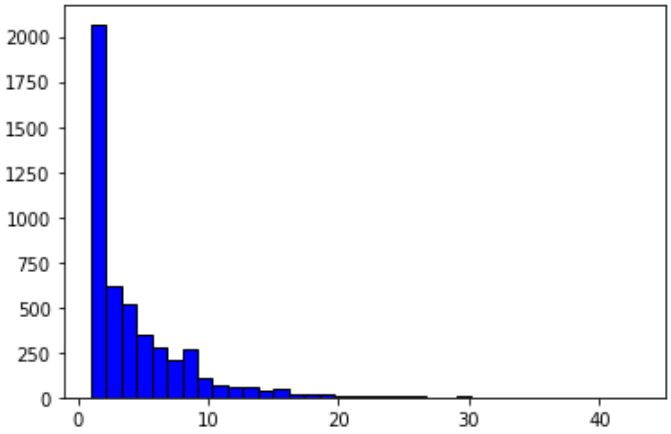
In [42]:
```
software_funding.funding_total_usd.describe()
```

Out[42]:
```
count     4773.000000
mean        30.588172
std        448.620354
min          0.010000
25%          1.450000
50%          6.052753
75%         21.700000
max      30079.503000
Name: funding_total_usd, dtype: float64
```

Analysis of the number of investors in startups

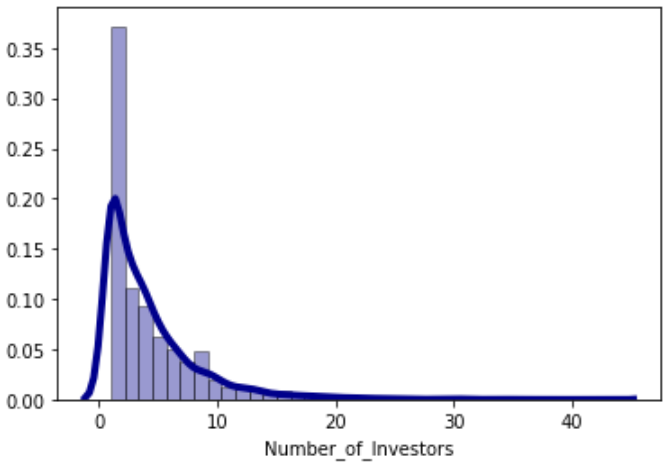
In [43]:
```
# matplotlib histogram
plt.hist(software_funding['Number_of_Investors'], color = 'blue', edgecolor = 'bla
ck',
         bins = int(180/5))
```

Out[43]:
```
(array([2.069e+03, 6.180e+02, 5.150e+02, 3.470e+02, 2.790e+02, 2.110e+02,
        2.690e+02, 1.040e+02, 6.400e+01, 5.400e+01, 5.400e+01, 3.300e+01,
        4.700e+01, 1.900e+01, 1.600e+01, 1.600e+01, 8.000e+00, 1.000e+01,
        1.200e+01, 5.000e+00, 4.000e+00, 3.000e+00, 1.000e+00, 1.000e+00,
        7.000e+00, 2.000e+00, 0.000e+00, 1.000e+00, 2.000e+00, 0.000e+00,
        1.000e+00, 0.000e+00, 0.000e+00, 0.000e+00, 0.000e+00, 1.000e+00]),
 array([ 1.        ,  2.16666667,  3.33333333,  4.5       ,  5.66666667,
         6.83333333,  8.        ,  9.16666667, 10.33333333, 11.5       ,
        12.66666667, 13.83333333, 15.        , 16.16666667, 17.33333333,
        18.5       , 19.66666667, 20.83333333, 22.        , 23.16666667,
        24.33333333, 25.5       , 26.66666667, 27.83333333, 29.        ,
        30.16666667, 31.33333333, 32.5       , 33.66666667, 34.83333333,
        36.        , 37.16666667, 38.33333333, 39.5       , 40.66666667,
        41.83333333, 43.        ]),
 <a list of 36 Patch objects>)
```



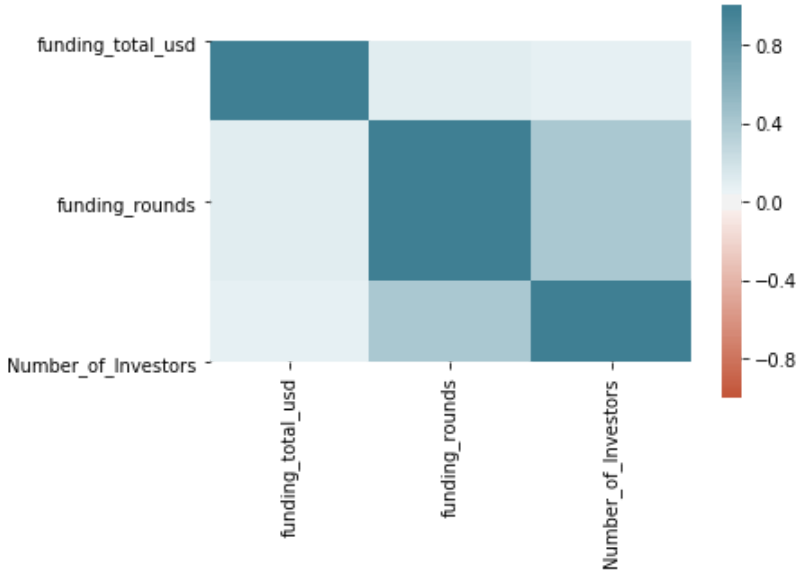
In [44]:
```
# Density Plot and Histogram of all arrival delays
sns.distplot(software_funding['Number_of_Investors'], hist=True, kde=True,
             bins=int(180/5), color = 'darkblue',
             hist_kws={'edgecolor':'black'},
             kde_kws={'linewidth': 4})
```

Out[44]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x126cc21d0>
```



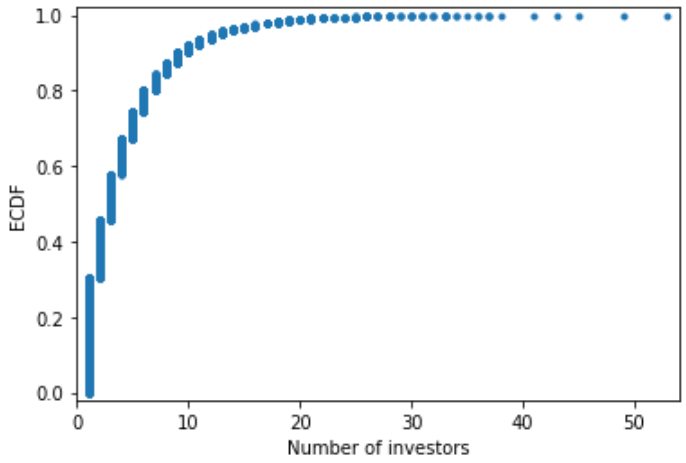
Showing the correlation between number_of_investors and funding_rounds.

In [45]:
```
corr = df_dropped.corr()
ax = sns.heatmap(
    corr,
    vmin=-1, vmax=1, center=0,
    cmap=sns.diverging_palette(20, 220, n=200),
    square=True
)
ax.set_xticklabels(
    ax.get_xticklabels(),
    rotation=90,
)
ax.set_yticklabels(
    ax.get_yticklabels(),
    rotation=0,
    horizontalalignment='right'
);
```



Making an ECDF

In [46]:
```
x = np.sort(df_dropped['Number_of_Investors'])
y = np.arange(1, len(x)+1) /len(x)
_ = plt.plot(x,y, marker='.', linestyle='none')
_ = plt.xlabel('Number of investors')
_ = plt.ylabel('ECDF')
plt.margins(0.02)
plt.show()
```



In [53]:
```
from wordcloud import WordCloud

names = df_dropped["category_list"][~pd.isnull(df_dropped["category_list"])]
#print(names)
wordcloud = WordCloud(max_font_size=50, width=600, height=300).generate(' '.join(n
ames))
plt.figure(figsize=(15,8))
plt.imshow(wordcloud)
plt.title("Wordcloud for category_list", fontsize=35)
plt.axis("off")
plt.show()
```

Conclusion

Patterns of downgrowth

- After years of growth since 2007, investment has continued to underperform.
- From 2010 to 2013, investment declined significantly.

Patterns of upgrowth

- In 1983, massive funding was made in the software industry.
- In the Hardware field, the biggest investment was made only in 1953. This might be due to the fact that IBM effectively created the computer market in 1953 with the IBM 650.

Over 35% startups got 1~2 investors, and the funding round and number of investors showed a mild correlation.