DSC 530 Final Project

Week 12

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Importing Dataset

In [1]:
```
from os.path import basename, exists


def download(url):
    filename = basename(url)
    if not exists(filename):
        from urllib.request import urlretrieve

        local, _ = urlretrieve(url, filename)
        print("Downloaded " + local)


download("https://github.com/AllenDowney/ThinkStats2/raw/master/code/thinkstats2.py")
download("https://github.com/AllenDowney/ThinkStats2/raw/master/code/thinkplot.py")
download("https://github.com/AllenDowney/ThinkStats2/raw/master/code/nsfg.py")
download("https://github.com/AllenDowney/ThinkStats2/raw/master/code/first.py")
```

In [2]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as mtplt
import seaborn as sb
%matplotlib inline
```

In [3]:
```
!pip install kaggle
```

```
Requirement already satisfied: kaggle in c:\users\diggy\anaconda3\lib\site-packages (1.6.6)
Requirement already satisfied: six>=1.10 in c:\users\diggy\anaconda3\lib\site-packages (from kaggle) (1.16.0)
Requirement already satisfied: certifi in c:\users\diggy\anaconda3\lib\site-packages (from kaggle) (2023.11.17)
Requirement already satisfied: python-dateutil in c:\users\diggy\anaconda3\lib\site-packages (from kaggle) (2.8.2)
Requirement already satisfied: requests in c:\users\diggy\anaconda3\lib\site-packages (from kaggle) (2.31.0)
Requirement already satisfied: tqdm in c:\users\diggy\anaconda3\lib\site-packages (from kaggle) (4.65.0)
Requirement already satisfied: python-slugify in c:\users\diggy\anaconda3\lib\site-packages (from kaggle) (5.0.2)
Requirement already satisfied: urllib3 in c:\users\diggy\anaconda3\lib\site-packages (from kaggle) (1.26.16)
Requirement already satisfied: bleach in c:\users\diggy\anaconda3\lib\site-packages (from kaggle) (4.1.0)
Requirement already satisfied: packaging in c:\users\diggy\anaconda3\lib\site-packages (from bleach->kaggle) (23.1)
Requirement already satisfied: webencodings in c:\users\diggy\anaconda3\lib\site-packages (from bleach->kaggle) (0.5.1)
Requirement already satisfied: text-unidecode>=1.3 in c:\users\diggy\anaconda3\lib\site-packages (from python-slugify->kagg
le) (1.3)
Requirement already satisfied: charset-normalizer<4,>=2 in c:\users\diggy\anaconda3\lib\site-packages (from requests->kaggl
e) (2.0.4)
Requirement already satisfied: idna<4,>=2.5 in c:\users\diggy\anaconda3\lib\site-packages (from requests->kaggle) (3.4)
Requirement already satisfied: colorama in c:\users\diggy\anaconda3\lib\site-packages (from tqdm->kaggle) (0.4.6)
```

In [4]:
```
!kaggle datasets download -d kanchana1990/texas-real-estate-trends-2024-500-listings
```

```
texas-real-estate-trends-2024-500-listings.zip: Skipping, found more recently modified local copy (use --force to force dow
nload)
```

In [5]:
```python
data = pd.read_csv('.kaggle/texas-real-estate-trends-2024-500-listings/real_estate_texas_500_2024.csv')
print(data.head())
```

```
                                                 url    status          id  \
0  https://www.realtor.com/realestateandhomes-det...  for_sale  9773941616   
1  https://www.realtor.com/realestateandhomes-det...  for_sale  9224923922   
2  https://www.realtor.com/realestateandhomes-det...  for_sale  9840661824   
3  https://www.realtor.com/realestateandhomes-det...  for_sale  7338317229   
4  https://www.realtor.com/realestateandhomes-det...  for_sale  7285845528   

   listPrice  baths  baths_full  baths_full_calc  beds    sqft  stories  \
0   240000.0      2         2.0              2.0   3.0  1190.0      1.0   
1   379900.0      4         3.0              3.0   4.0  2033.0      1.0   
2   370000.0      2         2.0              2.0   4.0  2062.0      1.0   
3   444000.0      4         3.0              3.0   5.0  3705.0      2.0   
4   569000.0      2         2.0              2.0   3.0  3282.0      2.0   

  sub_type                                               text           type  \
0      NaN  Welcome home to your peaceful retreat nestled ...  single_family   
1      NaN  Beautiful country home on 0.85 fenced acres, m...  single_family   
2      NaN  PRICED TO SELL CORNER LOT HAS A STORM SHELTER ...  single_family   
3      NaN  Come check out country living in the city! Are...  single_family   
4      NaN  Welcome to your dream retreat! Nestled on over...  single_family   

   year_built  
0      2018.0  
1      2002.0  
2      2012.0  
3      1985.0  
4      1981.0  
```

Data Cleaning and Transformation

In [6]:
```python
display(data.head(10))
```

	url	status	id	listPrice	baths	baths_full	baths_full_calc	beds	sqft	stories	sub_type	text
0	https://www.realtor.com/realestateandhomes-det...	for_sale	9773941616	240000.0	2	2.0	2.0	3.0	1190.0	1.0	NaN	Welcome home to your peaceful retreat nestled ...
1	https://www.realtor.com/realestateandhomes-det...	for_sale	9224923922	379900.0	4	3.0	3.0	4.0	2033.0	1.0	NaN	Beautiful country home on 0.85 fenced acres, m...
2	https://www.realtor.com/realestateandhomes-det...	for_sale	9840661824	370000.0	2	2.0	2.0	4.0	2062.0	1.0	NaN	PRICED TO SELL CORNER LOT HAS A STORM SHELTER ...
3	https://www.realtor.com/realestateandhomes-det...	for_sale	7338317229	444000.0	4	3.0	3.0	5.0	3705.0	2.0	NaN	Come check out country living in the city! Are...
4	https://www.realtor.com/realestateandhomes-det...	for_sale	7285845528	569000.0	2	2.0	2.0	3.0	3282.0	2.0	NaN	Welcome to your dream retreat! Nestled on over...
5	https://www.realtor.com/realestateandhomes-det...	for_sale	7550452644	875000.0	5	3.0	3.0	4.0	4873.0	2.0	NaN	Exquisite custom home nestled

In [7]:
```
data.duplicated().sum()
```

Out[7]: 0

In [8]:
```
# fill missing listing price values with the mean
data['listPrice'] = data['listPrice'].fillna(data['listPrice'].mean())

# drop 'baths_full_calc' to reduce redundancy, and increase legibility.
data.drop(columns = ['baths_full_calc'], inplace = True)

# drop 'url' due to irrelevance to analysis
data.drop(columns = ['url'], inplace=True)

# drop 'text' as it is irrelevant to analysis
data.drop(columns = ['text'], inplace=True)

# drop 'sub_type' as it is irrelevant to analysis
data.drop(columns = ['sub_type'], inplace=True)
```

In [9]:
```
data.head(10)
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 501 entries, 0 to 500
Data columns (total 10 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   status      501 non-null    object
 1   id          501 non-null    int64
 2   listPrice   501 non-null    float64
 3   baths       501 non-null    int64
 4   baths_full  436 non-null    float64
 5   beds        440 non-null    float64
 6   sqft        438 non-null    float64
 7   stories     391 non-null    float64
 8   type        501 non-null    object
 9   year_built  289 non-null    float64
dtypes: float64(6), int64(2), object(2)
memory usage: 39.3+ KB
```

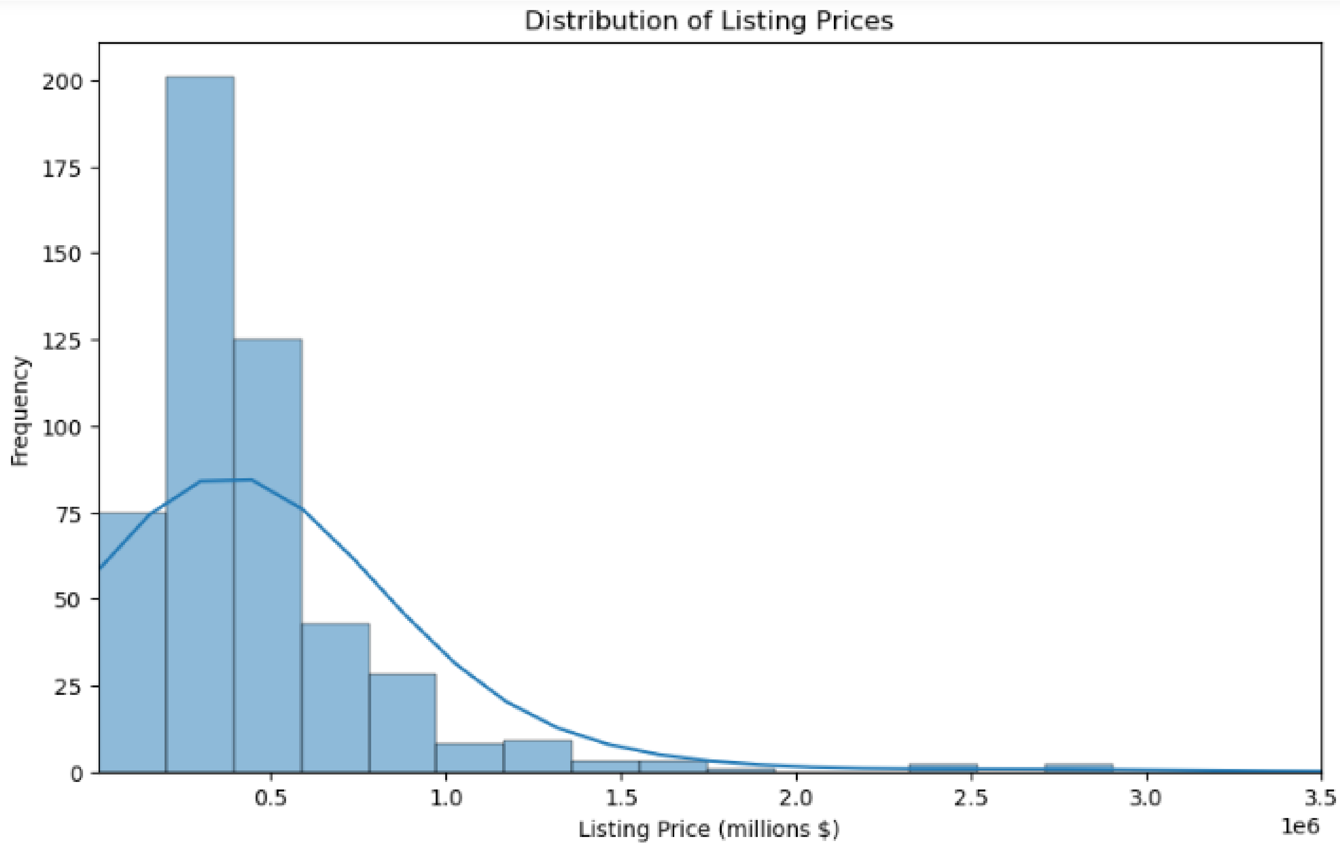
Analysis

Histograms of Variables

In [10]:
```
from scipy.stats import iqr
```

List Price

In [11]:
```
mtplt.figure(figsize = (10,6))
sb.histplot(data['listPrice'], bins = 150, kde = True)
mtplt.title('Distribution of Listing Prices')
mtplt.xlabel('Listing Price (millions $)')
mtplt.ylabel('Frequency')
mtplt.xlim(8000,3500000)
mtplt.show()
```

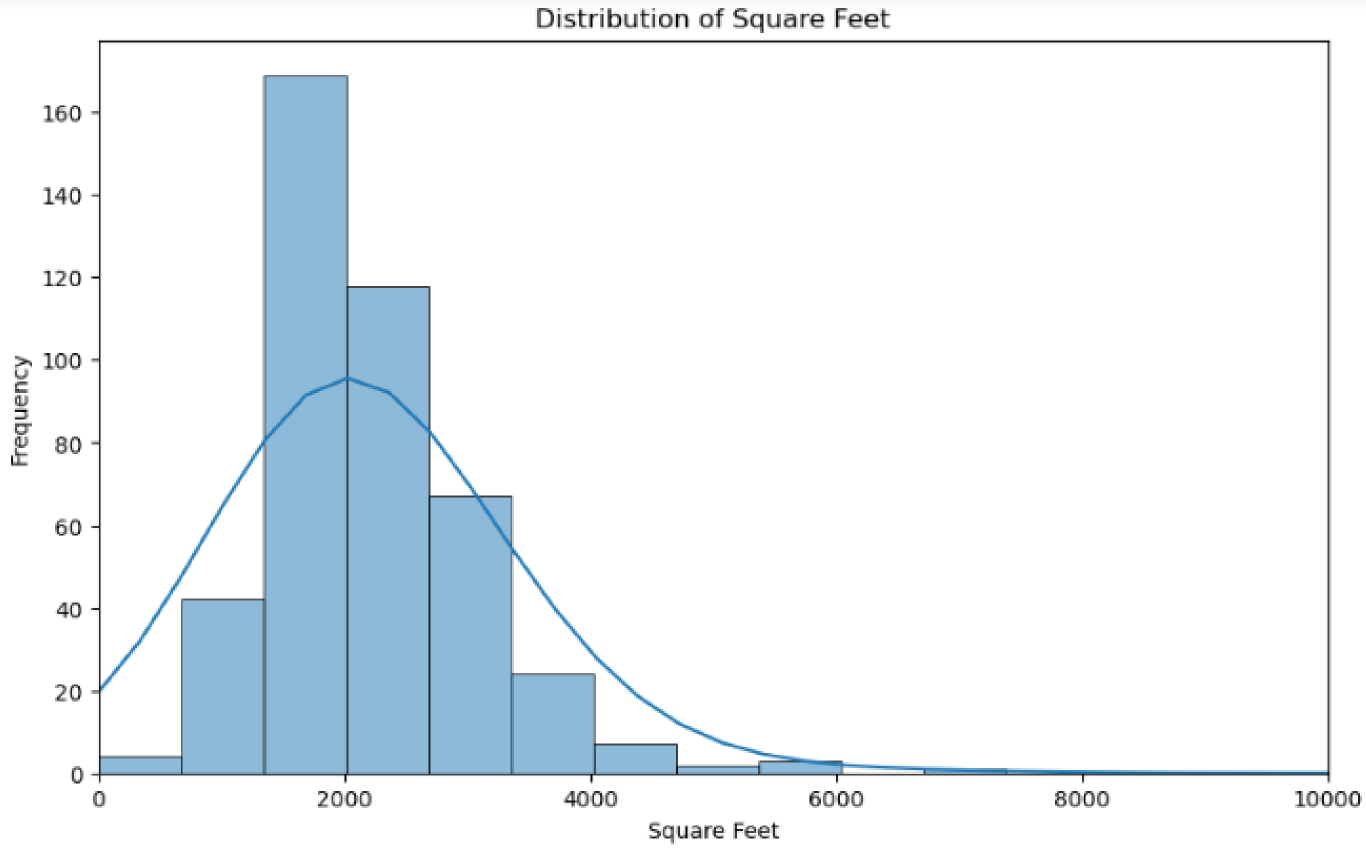


In [81]:
```
listprice = data['listPrice']
lpmean = listprice.mean()
    # $510,668.58
lpmode = listprice.mode()
    # $250,000.00
lpsd = listprice.std()
    # $1,318,409.27
```

Out[81]: 1318409.2650517768

Square Feet

In [13]:
```
mtplt.figure(figsize = (10,6))
sb.histplot(data['sqft'], bins = 100, kde = True)
mtplt.title('Distribution of Square Feet')
mtplt.xlabel('Square Feet')
mtplt.ylabel('Frequency')
mtplt.xlim(0,10000)
mtplt.show()
```

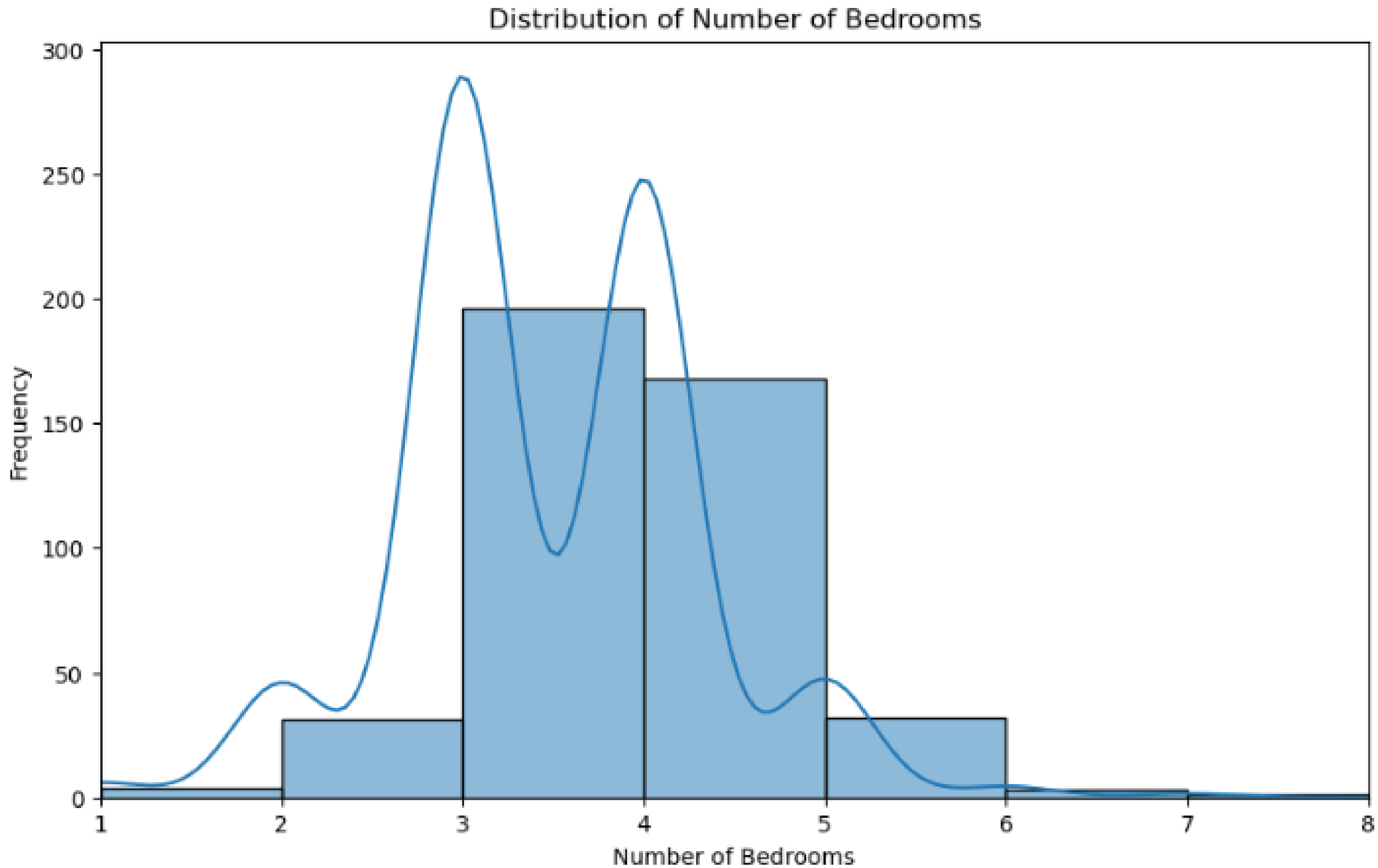


In [83]:
```
sqft = data['sqft']
sqftmean = sqft.mean()
    # 1560 sqft
sqftmode = sqft.mode()
    # 2060 sqft
sqftsd = sqft.std()
    #3220 sqft
```

Out[83]: 3220.2449852955056

Bedrooms

In [15]:
```
mtplt.figure(figsize = (10,6))
sb.histplot(data['beds'], bins = 9, kde = True)
mtplt.title('Distribution of Number of Bedrooms')
mtplt.xlabel('Number of Bedrooms')
mtplt.ylabel('Frequency')
mtplt.xlim(1,8)
mtplt.show()
```

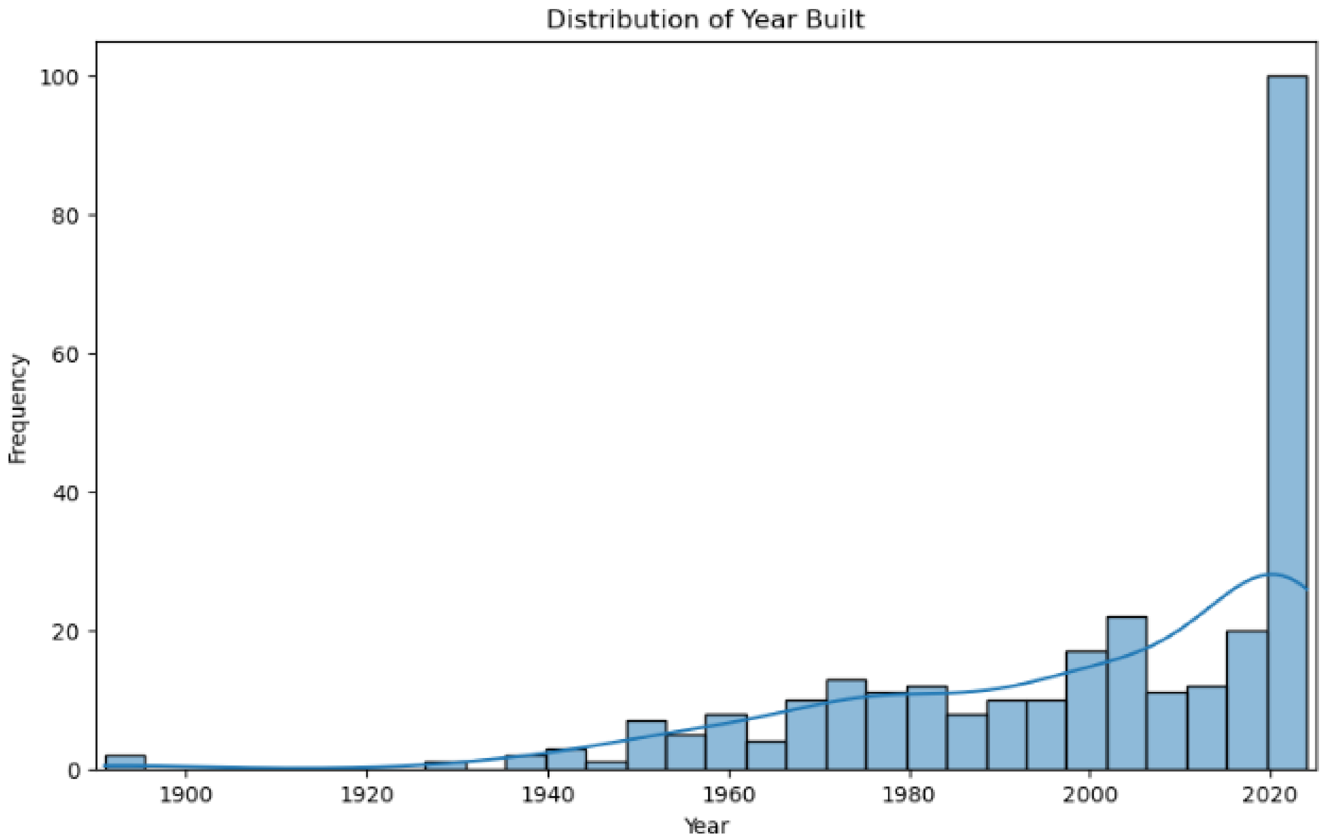


In [86]:

```
beds = data['beds']
bedsmean = beds.mean()
   # 3.5 beds
bedsmode = beds.mode()
    # 3.0 beds
bedssd = beds.std()
    # 0.9 beds
```

Year Built

In [17]:
```
mtplt.figure(figsize = (10, 6))
sb.histplot(data['year_built'], bins = 30, kde = True)
mtplt.title('Distribution of Year Built')
mtplt.xlabel('Year')
mtplt.ylabel('Frequency')
mtplt.xlim(1890, 2025)
mtplt.show()
```

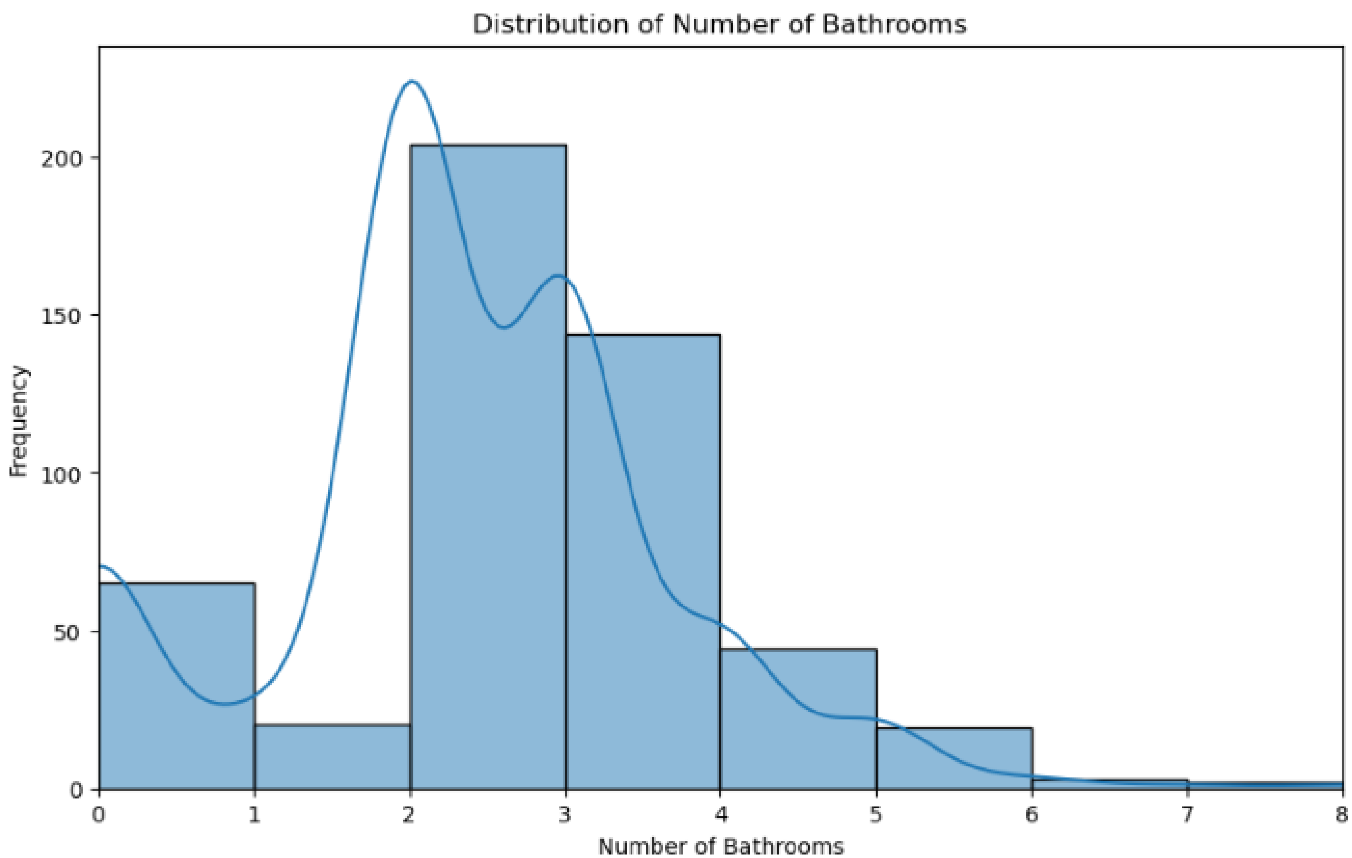


In [88]:
```
yearbuilt = data['year_built']
yb_mean = yearbuilt.mean()
    # 1999
yb_mode = yearbuilt.mode()
    # 2024
yb_sd = yearbuilt.std()
    # 25.4 years
```

Out[88]: 25.400942438778966

Bathrooms

In [19]:
```
mtplt.figure(figsize=(10,6))
sb.histplot(data['baths'], bins = 8, kde = True)
mtplt.title('Distribution of Number of Bathrooms')
mtplt.xlabel('Number of Bathrooms')
mtplt.ylabel('Frequency')
mtplt.xlim(0, 8)
mtplt.show()
```



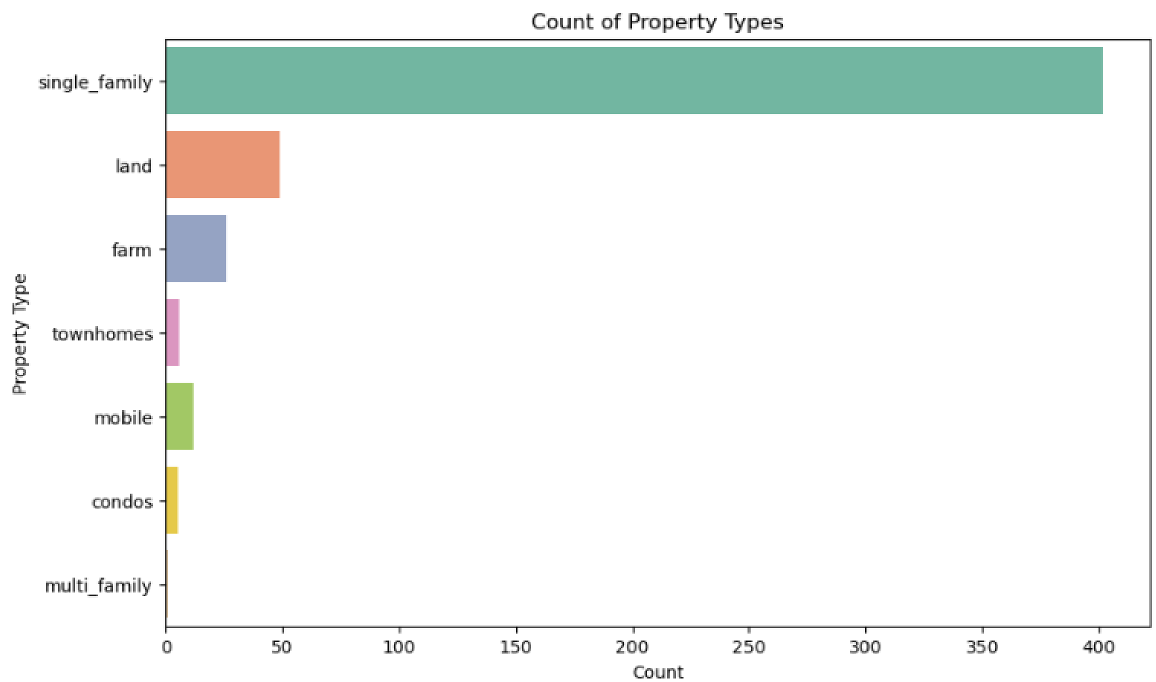
In [91]:
```
baths = data['baths']
baths_mean = baths.mean()
    # 2.3 bathrooms
baths_mode = baths.mode()
    # 2 bathrooms
baths_sd = baths.std()
    # 1.3 bathrooms
```

Property Types

In [21]:
```
mtplt.figure(figsize = (10,6))
sb.countplot(y = 'type', data = data, palette = 'Set2')
mtplt.title('Count of Property Types')
mtplt.xlabel('Count')
mtplt.ylabel('Property Type')
mtplt.show

type_counts = data['type'].value_counts().reset_index()
type_counts.columns = ['Property Type', 'Count']
type_counts
```

Out[21]:

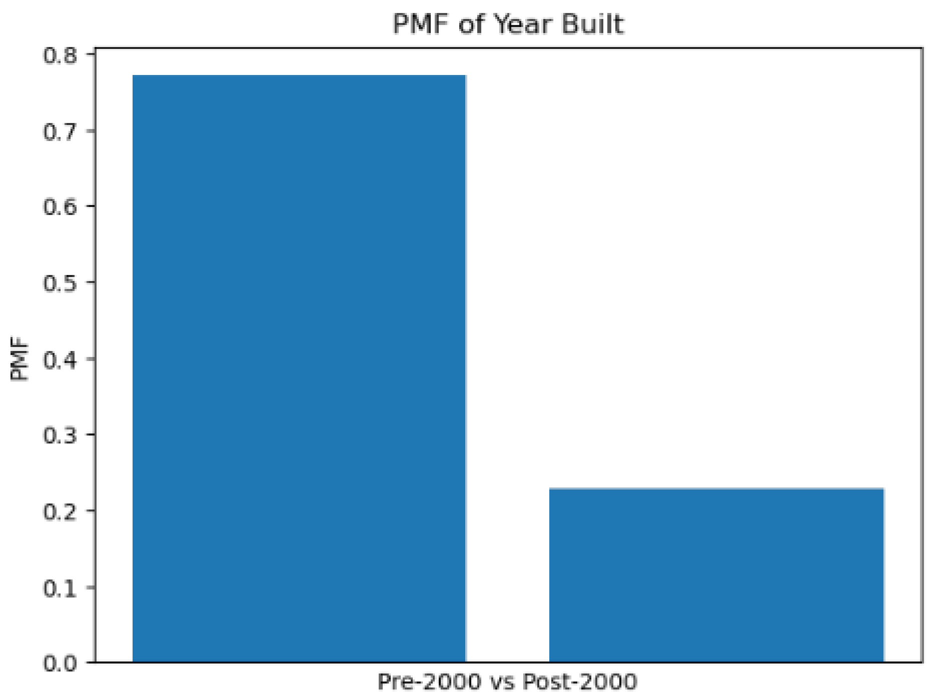
	Property Type	Count
0	single_family	402
1	land	49
2	farm	26
3	mobile	12
4	townhomes	6
5	condos	5
6	multi_family	1



PMF

In [59]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as mtplt
from empiricaldist import Cdf, Pmf
```

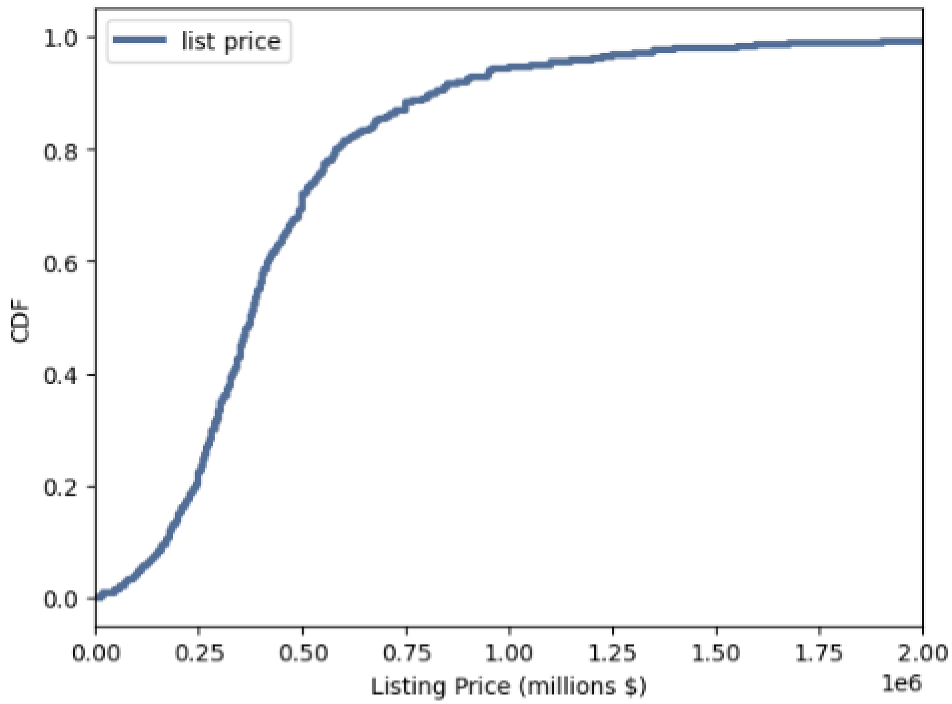
In [65]:
```
fig, ax = mtplt.subplots()

year = data['year_built']
pre2000 = year < 2000

pmf_year = Pmf.from_seq(pre2000)
pmf_year.bar()

ax.set(title='PMF of Year Built',
      xlabel = 'Pre-2000 vs Post-2000',
      ylabel = 'PMF')

mtplt.xticks([])
mtplt.show()
```



CDF

In [66]:
```
def EvalCdf(sample, x):
    count = 0.0
    for value in sample:
        if value <= x:
            count += 1
    prob = count / len(sample)
    return prob
```

In [67]:
```
price = data['listPrice']
cdf = ts2.Cdf(price, label = 'list price')
tp.Cdf(cdf)
tp.Config(xlabel = 'Listing Price (millions $)', ylabel = 'CDF', loc = 'upper left', xlim = [0, 2000000])
```



In [68]:
```
cdf.Prob(1000000)
```

Out[68]: 0.9461077844311377

In [69]:
```
cdf.Value(0.5)
```

Out[69]: 374990.0

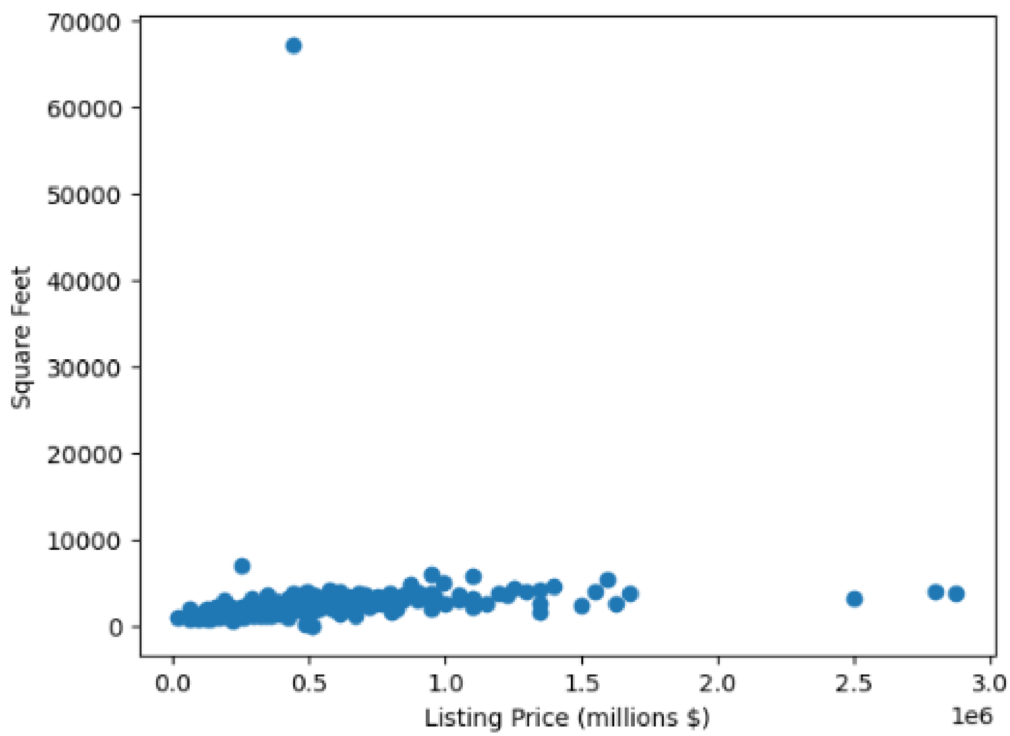
Scatter Plots

Square Feet versus Listing Price

In [70]:
```
%matplotlib inline
import matplotlib.pyplot as mtplt
import numpy as np
```

In [76]:
```
price = data['listPrice']
sqft = data['sqft']

mtplt.scatter(price, sqft)
mtplt.xlabel('Listing Price (millions $)')
mtplt.ylabel('Square Feet')
mtplt.show
```

Out[76]:
```
<function matplotlib.pyplot.show(close=None, block=None)>
```

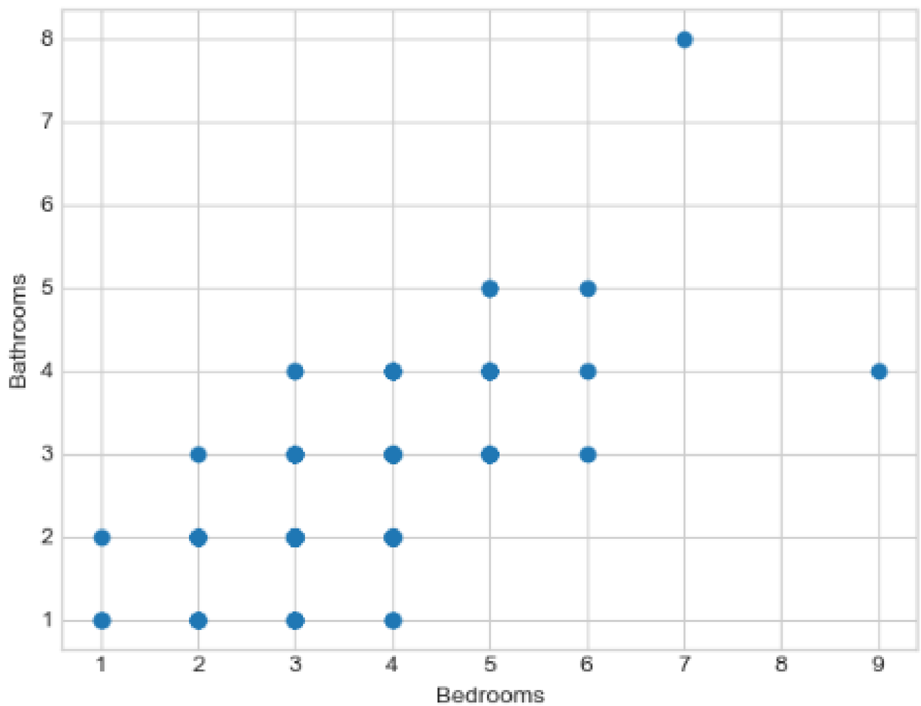


Bedrooms versus Square Footage

In [497]:

```
beds = data['beds']
baths = data['baths_full']
mtplt.scatter(beds, baths)
mtplt.xlabel('Bedrooms')
mtplt.ylabel('Bathrooms')
mtplt.show
```

Out[497]: <function matplotlib.pyplot.show(close=None, block=None)>



Hypothesis Test

H0 = Listing price and square footage are dependent on each other.

H1 = Listing price and square footage are independent of each other.

In [527]:

```
import random
import numpy as np
import thinkstats2 as ts2
import thinkplot as tp
```

In [533]:

```
tempdf = data.groupby(['listPrice', 'sqft']).size().reset_index(name = 'Count')
price_sqft_data = tempdf.drop('Count', axis = 1)
price_sqft_data
```

Out[533]:

	listPrice	sqft
0	19000.0	971.0
1	60000.0	792.0
2	65000.0	2020.0
3	72000.0	1235.0
4	89900.0	1276.0
...	...	...
429	1625000.0	2652.0
430	1675000.0	3702.0
431	2500000.0	3090.0
432	2800000.0	4000.0
433	2875000.0	3766.0

434 rows × 2 columns

In [536]:

```
from scipy.stats import chi2_contingency

obs = price_sqft_data
chi2, p, dof, ex = chi2_contingency(obs, correction = False)

print("Expected Frequencies:", np.round(ex,2))
print("Degrees of Freedom:", dof)
print("Test Stat:%.4f"  % chi2)
print("p value: %.4f" % p)
```

```
 [1.19678211e+06 6.03789000e+03]
 [1.22237101e+06 6.16699000e+03]
 [1.24800867e+06 6.29633000e+03]
 [1.29750794e+06 6.54606000e+03]
 [1.34429290e+06 6.78210000e+03]
 [1.34480532e+06 6.78468000e+03]
 [1.34475358e+06 6.78442000e+03]
 [1.39651046e+06 7.04554000e+03]
 [1.49391305e+06 7.53695000e+03]
 [1.54621817e+06 7.80083000e+03]
 [1.59234744e+06 8.03356000e+03]
 [1.61948155e+06 8.17045000e+03]
 [1.67027529e+06 8.42671000e+03]
 [2.49052504e+06 1.25649600e+04]
 [2.78992454e+06 1.40754600e+04]
 [2.86431523e+06 1.44507700e+04]]
Degrees of Freedom: 433
Test Stat:1833971.9901
p value: 0.0000
```

In [537]:
```python
from scipy.stats import chi2

alpha = 0.01
df = (434-1)*(2-1)
critical_stat = chi2.ppf((1-alpha), df)
print("critical stat:%.4f" % critical_stat)
```

```
critical stat:504.3856
```

Because the p-value is smaller than alpha = 0.01 (and calculated statistic = 1833971.99 is larger than the critical statistic = 504.39), we can reject the null hypothesis. At this significance level, it can be concluded that listing price and square footage are independent of each other.

Regression Analysis

In [564]:
```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as mtplt
import statsmodels.api as sm
```

In [563]:
```python
ps_data = price_sqft_data
x = ps_data['sqft']
y = ps_data['listPrice']
```

In [574]:
```python
x1 = sm.add_constant(x)
results = sm.OLS(y,x1).fit()
```

In [575]:
```python
results.summary()
```

Out[575]:

OLS Regression Results

Dep. Variable:	listPrice	**R-squared:**	0.026
Model:	OLS	**Adj. R-squared:**	0.024
Method:	Least Squares	**F-statistic:**	11.48
Date:	Sat, 02 Mar 2024	**Prob (F-statistic):**	0.000768
Time:	18:30:59	**Log-Likelihood:**	-6119.6
No. Observations:	434	**AIC:**	1.224e+04
Df Residuals:	432	**BIC:**	1.225e+04
Df Model:	1		
Covariance Type:	nonrobust		

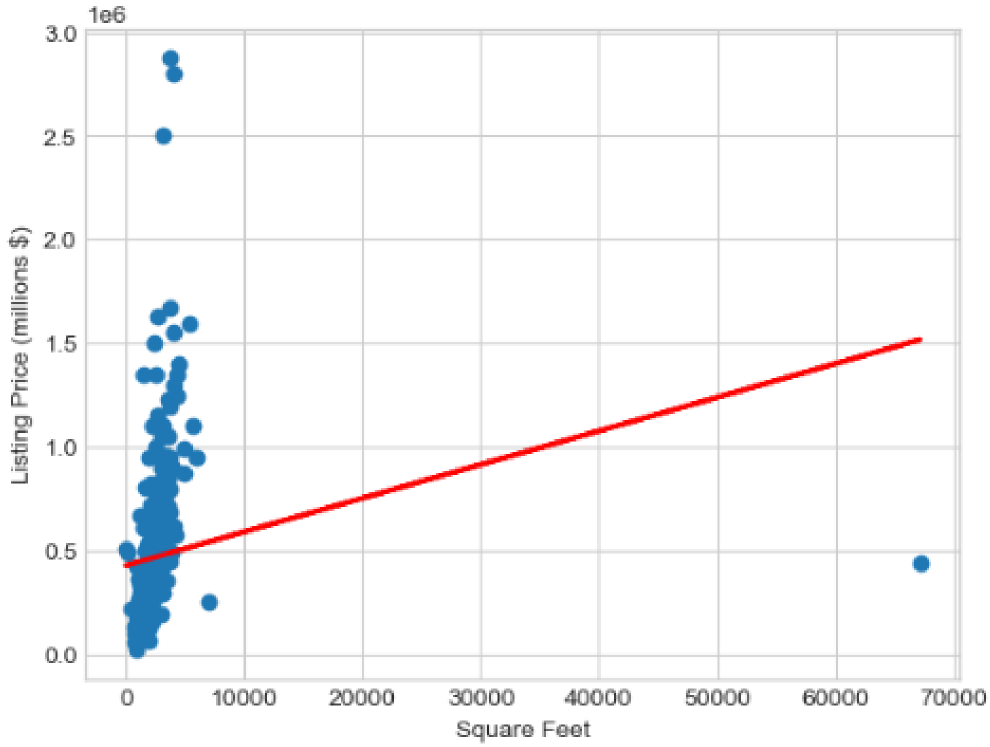
	coef	std err	t	P>|t|	[0.025	0.975]
const	4.262e+05	1.91e+04	22.288	0.000	3.89e+05	4.64e+05
sqft	16.2445	4.794	3.388	0.001	6.822	25.667

Omnibus:	332.646	**Durbin-Watson:**	0.070
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	5887.782
Skew:	3.159	**Prob(JB):**	0.00
Kurtosis:	19.902	**Cond. No.**	4.93e+03

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The condition number is large, 4.93e+03. This might indicate that there are
strong multicollinearity or other numerical problems.

In [577]:

```
plt.scatter(x,y)
yhat = 16.2445*x + 4.262e+05
fig = plt.plot(x,yhat, lw = 2, color = 'red', label = 'regression line')
plt.xlabel('Square Feet')
plt.ylabel('Listing Price (millions $)')
plt.show()
```


1e6
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Listing Price (millions $)
0
10000
20000
30000
40000
50000
60000
70000
Square Feet