

Simulation

Aim

- Examine how often two random lists of number will appear have a statistically significant relationship in a linear regression

In [16]:

```
# packages to be used  
import numpy as np  
import pandas as pd  
import statsmodels.formula.api as smf
```

In [17]:

```
#enable graphics  
%matplotlib inline
```

In [18]:

```
# create dataframe with two series with 1000 random numbers between 1 and 100  
df=pd.DataFrame()  
df['x'] = np.random.randint(1,100,size=1000)  
df['y'] = np.random.randint(1,100,size=1000)
```

In [19]:

```
# run a regression and see if the coefficient is statistically significant

model='y~x'
results = smf.ols(formula=model, data=df).fit()
results.summary()
```

Out[19]:

OLS Regression Results

Dep. Variable:	y	R-squared:	0.000
Model:	OLS	Adj. R-squared:	-0.001
Method:	Least Squares	F-statistic:	0.4709
Date:	Tue, 13 Nov 2018	Prob (F-statistic):	0.493
Time:	08:08:10	Log-Likelihood:	-4766.7
No. Observations:	1000	AIC:	9537.
Df Residuals:	998	BIC:	9547.
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P> t	[0.025	0.975]
Intercept	50.3397	1.852	27.181	0.000	46.705	53.974
x	-0.0220	0.032	-0.686	0.493	-0.085	0.041

Omnibus:	598.669	Durbin-Watson:	1.986
Prob(Omnibus):	0.000	Jarque-Bera (JB):	57.410
Skew:	0.022	Prob(JB):	3.42e-13
Kurtosis:	1.827	Cond. No.	119.

Warnings:

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

In [20]:

```
# now: do the same 1000 times and record whether the p-value every time

df = pd.DataFrame()
pvalue = list()

for x in range(1000):
    df['x'] = np.random.randint(1,100,size=1000)
    df['y'] = np.random.randint(1,100,size=1000)

    model='y~x'

    results = smf.ols(formula=model, data=df).fit()
    # instead of recording all results, we only want the pvalue for the coefficient
    # so we use: results.pvalues[1] instead of results.summary()
    # each time this value is appended to the list (called pvalue)
    pvalue.append(results.pvalues[1])
```

In [21]:

```
# Look at the results  
pvalue
```

Out[21]:

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```

In [22]:

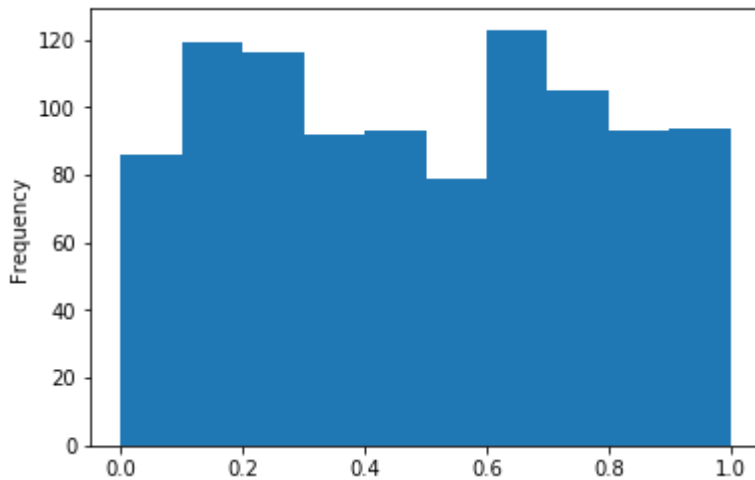
```
# how many time did we get a statistically significant p-value? (Here defined as a p-value below 0.05)  
  
# put the list in a pandas series (makes life easier!)  
df = pd.Series(pvalue)  
df.head()
```

Out[22]:

```
0    0.071382  
1    0.217459  
2    0.143714  
3    0.468210  
4    0.975973  
dtype: float64
```

In [23]:

```
# histogram of p-values  
# (sometimes we will get small p-values at random i.e. it appears that the two series are  
# significantly correlated, but we know this is just random connections since the data  
# was generated randomly)  
df.plot.hist();
```



In [24]:

```
# use the series to answer the question of how often we find a p-value below 0.05 when  
# we have random numbers)  
len(df[df<0.05])
```

Out[24]:

44

more advanced exercise

- Remember: We did 1000 regressions and used two series of length 100 with numbers between 1 and 100
- Do you think the number depends on
 - the number of repeats
 - the range of possible numbers?
 - the length of the list of numbers in each regression

to answer that:

- create a function so we can easily change these values and then see what happens

In [25]:

```
def run_regression(repeats = 1000, min_number=1, max_number=100, list_length=100):  
    """  
    Runs many regressions between two random list of numbers  
    """  
    df = pd.DataFrame()  
    pvalue = list()  
  
    for x in range(repeats):  
        df['x'] = np.random.randint(min_number,max_number,size=list_length)  
        df['y'] = np.random.randint(min_number,max_number,size=list_length)  
  
        model='y~x'  
  
        results = smf.ols(formula=model, data=df).fit()  
        # instead of recording all results, we only want the pvalue for the coefficient  
        # so we use: results.pvalues[1] instead of results.summary()  
        # each time this value is appended to the list (called pvalue)  
        pvalue.append(results.pvalues[1])  
    df = pd.Series(pvalue)  
    return df
```

In [26]:

```
# as before  
pvalues = run_regression(repeats = 1000, min_number=1, max_number=100, list_length=1000  
)
```

In [27]:

```
# but now we can change the values, for instance:  
pvalues = run_regression(repeats = 100, min_number=1, max_number=10, list_length=100)
```

In [28]:

```
len(pvalues[pvalues<0.05])
```

Out[28]:

2

OK, but this was only one run with some different values, what if we want to try a range of different values and see if we find a pattern

In [29]:

```
#solution 1: a loop
# for instance: examine changes in max_number, from 2 to 100

significant_list=list()

for max_num in range(2,100):
    pvalues = run_regression(repeats = 100, min_number=1, max_number=max_num, list_length=100)
    significant = len(pvalues[pvalues<0.05])
    significant_list.append(significant)

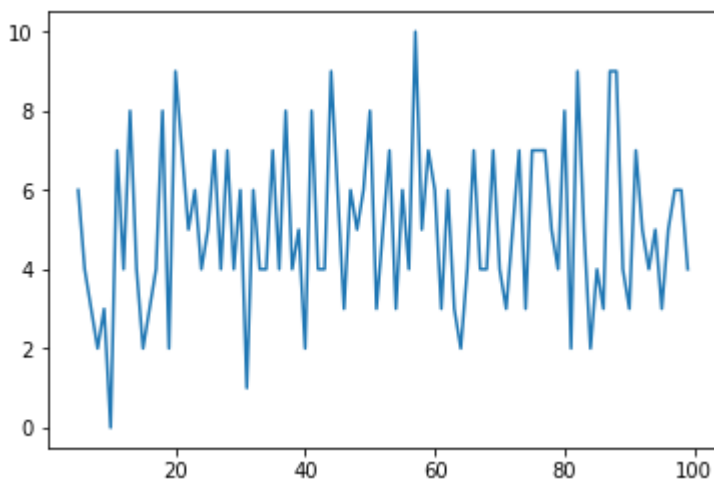
df=pd.Series(significant_list, index=range(2,100))
df.head()
```

Out[29]:

```
2    100
3      3
4      7
5      6
6      4
dtype: int64
```

In [30]:

```
# no (clear) pattern between selecting a small or a large range of numbers
df[3:100].plot.line();
```

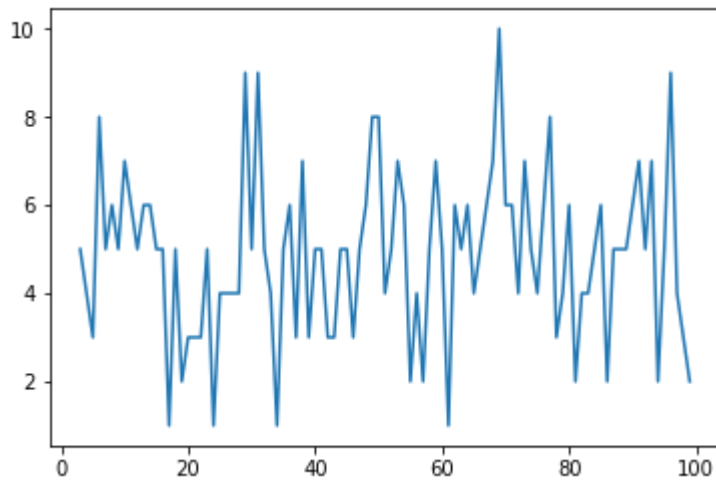


In [14]:

```
df[1:100].plot.line()
```

Out[14]:

<matplotlib.axes._subplots.AxesSubplot at 0x7f302ae55da0>



In []:

In []: