TP4 - Statistiques sous Python

Analyse de Données Massives - Master 1ère année

Nous allons utiliser dans ce TP le module `pandas` permettant l'analyse de données avec Python. La première instruction est d'installer le module, à faire dans un terminale de commande. Nous devons aussi installer les modules `matplotlib` et `scipy`.

```
{bash}
pip3 install pandas
pip3 install matplotlib
pip3 install scipy
pip3 install numpy
```

Une fois ces modules installée, nous pouvons lancer un `notebook` pour commencer notre programme.

Il faut tout d'abord importer ces modules. La dernière ligne permettra de voir le résultat des graphiques dans le document.

In [160]:
```
import matplotlib.pyplot
import pandas
import scipy.stats
import numpy

%matplotlib inline
```

Données

Nous allons travailler sur les données tips (donnees/tips.csv). Vous pouvez trouver des informations (ici (https://www.rdocumentation.org/packages/reshape2/versions/1.4.2/topics/tips)). Voici comment lire ces données dans `python` avec `read_csv()` de `pandas`.

In [161]:
```
# Lecture d'un fichier texte
tips = pandas.read_csv("donnees/tips.csv",
                       header = 0, sep = ",")
```

Sur ces données, il est bien évidemment possible de voir quelques informations classiques.

In [162]:
```
type(tips)
```

Out[162]:
```
pandas.core.frame.DataFrame
```

In [163]:
```
# informations diverses
tips.shape
```

Out[163]:
```
(244, 7)
```

In [164]:
```
tips.count()
```

Out[164]:
```
total_bill    244
tip           244
sex           244
smoker        244
day           244
time          244
size          244
dtype: int64
```

In [165]:
```
tips.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 244 entries, 0 to 243
Data columns (total 7 columns):
total_bill    244 non-null float64
tip           244 non-null float64
sex           244 non-null object
smoker        244 non-null object
day           244 non-null object
time          244 non-null object
size          244 non-null int64
dtypes: float64(2), int64(1), object(4)
memory usage: 13.4+ KB
```

In [166]:
```
list(tips.columns)
```

Out[166]:
```
['total_bill', 'tip', 'sex', 'smoker', 'day', 'time', 'size']
```

In [167]:
```
list(tips)
```

Out[167]:
```
['total_bill', 'tip', 'sex', 'smoker', 'day', 'time', 'size']
```

Statistiques descriptives univariés

La fonction `describe()` permet de décrire toutes les variables quantitatives d'un jeu de données directement.

In [168]:
```
# résumé basique
tips.describe()
```

Out[168]:

	total_bill	tip	size
count	244.000000	244.000000	244.000000
mean	19.785943	2.998279	2.569672
std	8.902412	1.383638	0.951100
min	3.070000	1.000000	1.000000
25%	13.347500	2.000000	2.000000
50%	17.795000	2.900000	2.000000
75%	24.127500	3.562500	3.000000
max	50.810000	10.000000	6.000000

In [169]:
```
tips.describe().round(2)
```

Out[169]:

	total_bill	tip	size
count	244.00	244.00	244.00
mean	19.79	3.00	2.57
std	8.90	1.38	0.95
min	3.07	1.00	1.00
25%	13.35	2.00	2.00
50%	17.80	2.90	2.00
75%	24.13	3.56	3.00
max	50.81	10.00	6.00

Quantitative

Il est possible de sélectionner les variables soit via les crochets `[]`, soit par un point `.`.

Les fonctions ci-dessous permettent de décrire une variable quantitative (ici `"total_bill"`).

In [170]:
```
tips.total_bill.describe()
```

Out[170]:
```
count    244.000000
mean      19.785943
std        8.902412
min        3.070000
25%       13.347500
50%       17.795000
75%       24.127500
max       50.810000
Name: total_bill, dtype: float64
```

In [171]:
```
tips["total_bill"].describe()
```

Out[171]:
```
count    244.000000
mean      19.785943
std        8.902412
min        3.070000
25%       13.347500
50%       17.795000
75%       24.127500
max       50.810000
Name: total_bill, dtype: float64
```

In [172]:
```
tips.total_bill.mean()
```

Out[172]:
```
19.78594262295082
```

In [173]:
```
tips.total_bill.std()
```

Out[173]:
```
8.9024119548568557
```

In [174]:
```
tips.total_bill.var()
```

Out[174]:
```
79.252938613978273
```

In [175]:
```
tips.total_bill.min()
```

Out[175]:
```
3.0699999999999998
```

In [176]:
```
tips.total_bill.max()
```

Out[176]:
```
50.810000000000002
```

In [177]:
```
tips.total_bill.median()
```

Out[177]:
```
17.795
```

```
In [178]: tips.total_bill.quantile([.01, .1, .9, .99])
```

```
Out[178]: 0.01     7.250
          0.10    10.340
          0.90    32.235
          0.99    48.227
          Name: total_bill, dtype: float64
```

```
In [179]: scipy.stats.normaltest(tips.total_bill)
```

```
Out[179]: NormaltestResult(statistic=45.117819123473318, pvalue=1.5951078766352608e-1
          0)
```

```
In [180]: scipy.stats.shapiro(tips.total_bill)
```

```
Out[180]: (0.9197188019752502, 3.3245434183371003e-10)
```

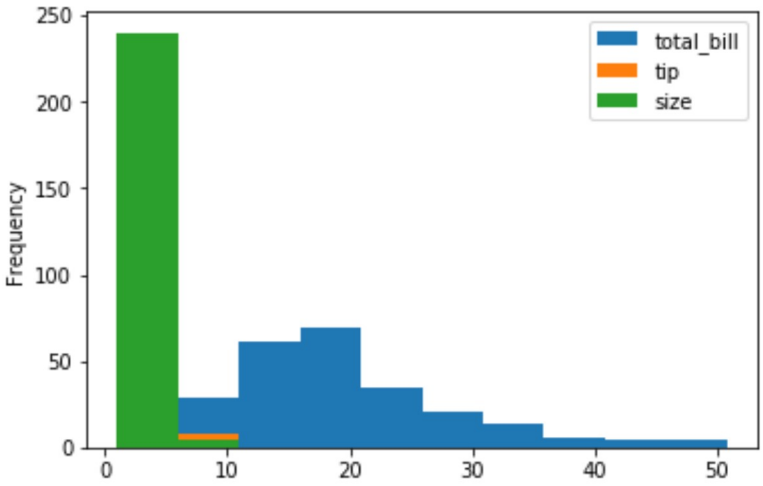
Histogramme

Pour représenter graphiquement cette variable, `pandas` met à disposition (via le module `matplotlib` utilisé par `pandas`) des fonctions graphiques.

Pour réaliser un **histogramme**, nous utilisons la fonction `hist()`. Celle-ci peut prendre des options. La fonction `plot()` avec le paramètre `kind` avec la valeur `"hist"` revient au même résultat.

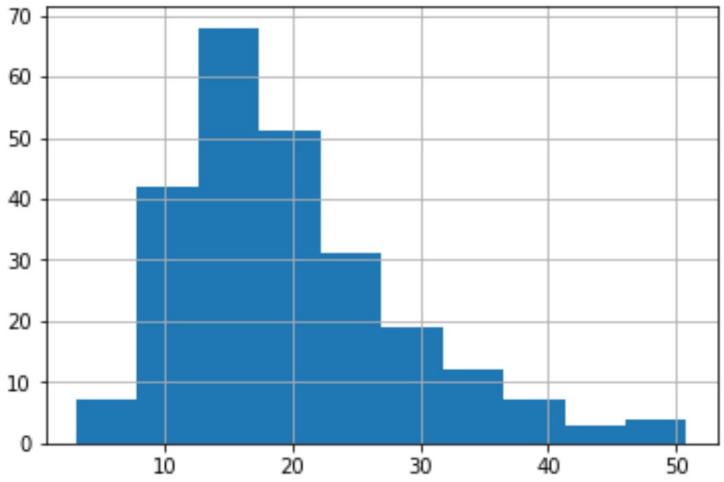
```
In [181]: tips.plot.hist()
```

```
Out[181]: <matplotlib.axes._subplots.AxesSubplot at 0x10d4c4e48>
```



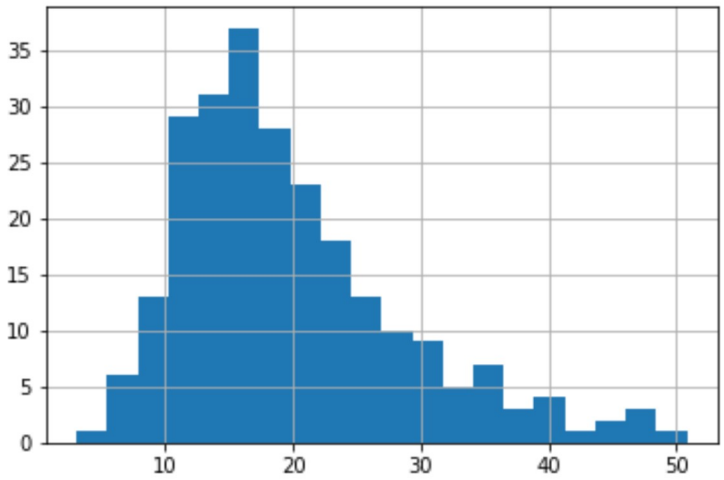
In [182]:
```
tips.total_bill.hist()
```

Out[182]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x10d4c40b8>
```



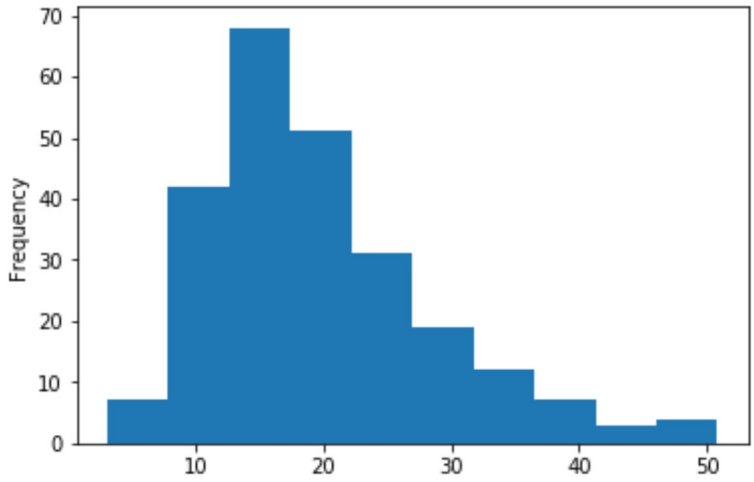
In [183]:
```
tips.total_bill.hist(bins = 20)
```

Out[183]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x10d687470>
```



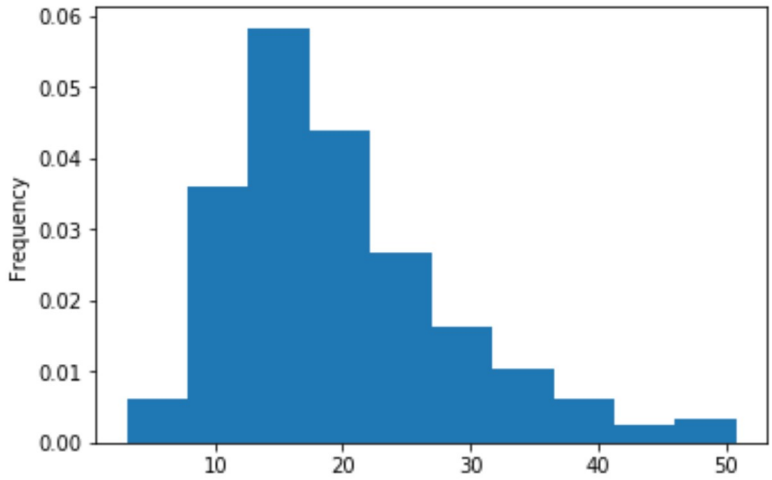
In [184]:
```
tips.total_bill.plot(kind = "hist")
```

Out[184]: <matplotlib.axes._subplots.AxesSubplot at 0x10d80a860>



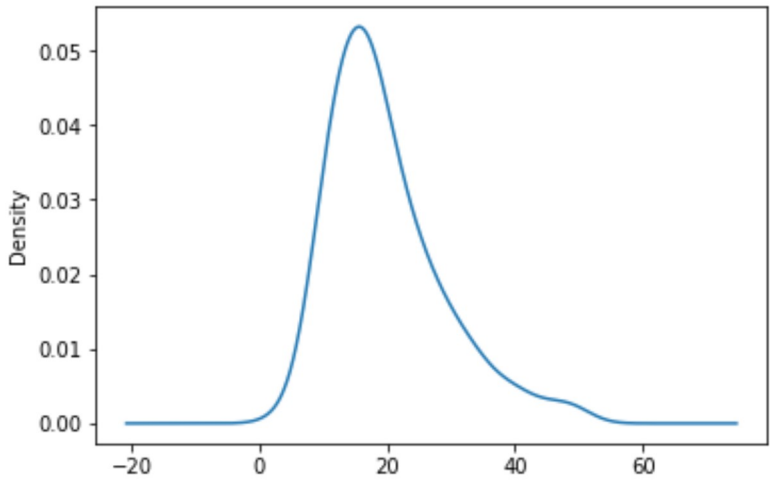
In [185]:
```
tips.total_bill.plot(kind = "hist", normed = True)
```

Out[185]: <matplotlib.axes._subplots.AxesSubplot at 0x10d90d518>



In [186]:
```
tips.total_bill.plot(kind = "kde")
```

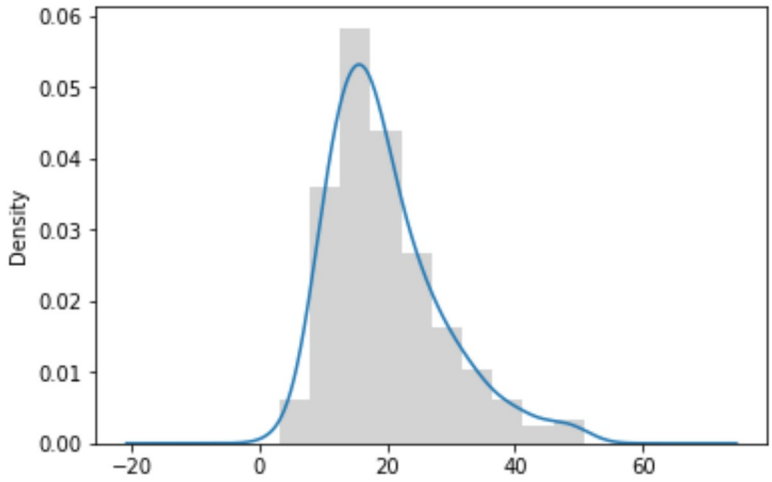
Out[186]: <matplotlib.axes._subplots.AxesSubplot at 0x10d9e08d0>



Pour avoir la densité et l'histogramme sur le même graphique, il est nécessaire de compiler les deux lignes suivantes **ensemble**.

In [187]:
```
tips.total_bill.plot(kind = "hist", normed = True, color = "lightgrey")
tips.total_bill.plot(kind = "kde")
```

Out[187]: <matplotlib.axes._subplots.AxesSubplot at 0x10dafb4e0>

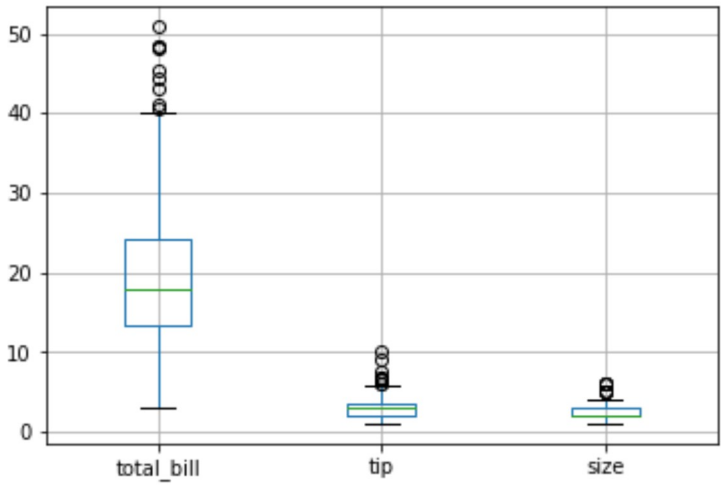


Boîtes à moustaches

Enfin, pour les **boîtes à moustaches**, il faut passer par le `DataFrame` pour l'afficher, et choisir une variable spécifiquement éventuellement.

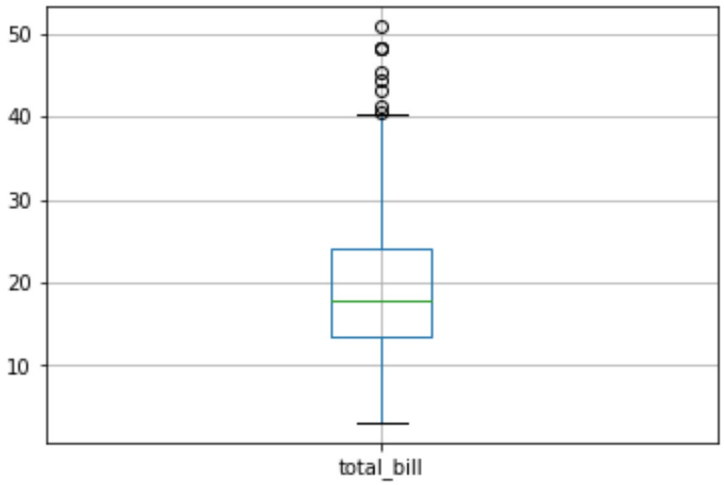
In [188]:
```
tips.boxplot()
```

Out[188]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x10dc566a0>
```



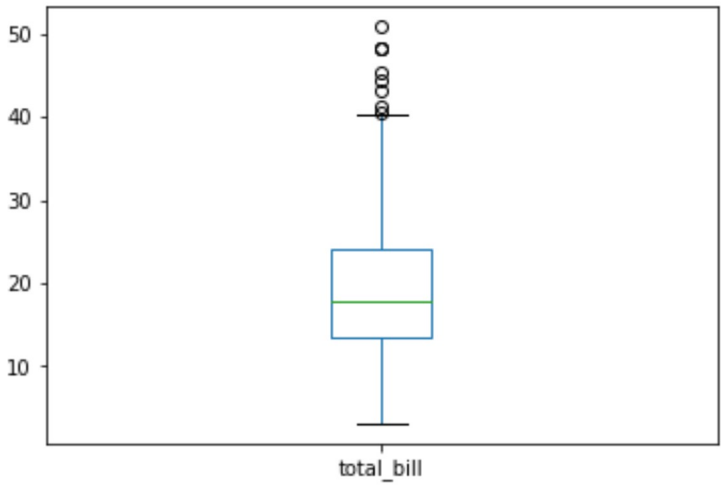
In [189]:
```
tips.boxplot(column = "total_bill")
```

Out[189]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x10e8c0550>
```



In [190]:
```
tips.boxplot(column = "total_bill", grid = False)
```

Out[190]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x10e8f1588>
```



Qualitative

Pour les variables qualitatives, il y a plusieurs façons de faire pour obtenir la table d'occurences (ou des effectifs), ainsi que la table des proportions des modalités.

In [191]:
```
tips.sex.describe()
```

Out[191]:
```
count      244
unique       2
top       Male
freq       157
Name: sex, dtype: object
```

In [192]:
```
tips.sex.unique()
```

Out[192]:
```
array(['Female', 'Male'], dtype=object)
```

In [193]:
```
tips.sex.value_counts()
```

Out[193]:
```
Male      157
Female     87
Name: sex, dtype: int64
```

In [194]:
```
pandas.crosstab(tips.sex, "freq")
```

Out[194]:

col_0	freq
sex	
Female	87
Male	157

In [195]:
```
pandas.crosstab(tips.sex, "freq", normalize=True)
```

Out[195]:

col_0	freq
sex	
Female	0.356557
Male	0.643443

In [196]:
```
scipy.stats.chisquare(t)
```

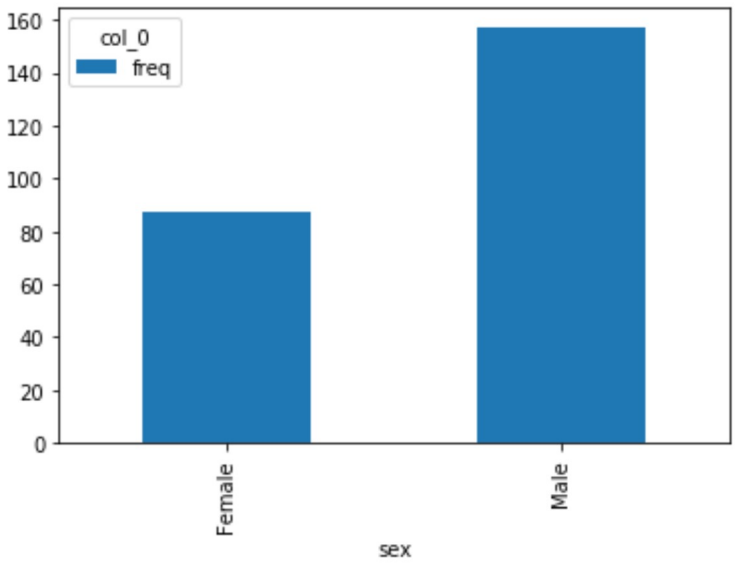
Out[196]:
```
Power_divergenceResult(statistic=array([ 20.08196721]), pvalue=array([  7.4
1929371e-06]))
```

Diagramme en barres

Ensuite, pour réaliser un **diagramme en barres**, nous utilisons le type `"bar"` pour `plot()`. Les calculs de proportions précédents nous permettent d'afficher une représentation des proportions plutôt que des effectifs.

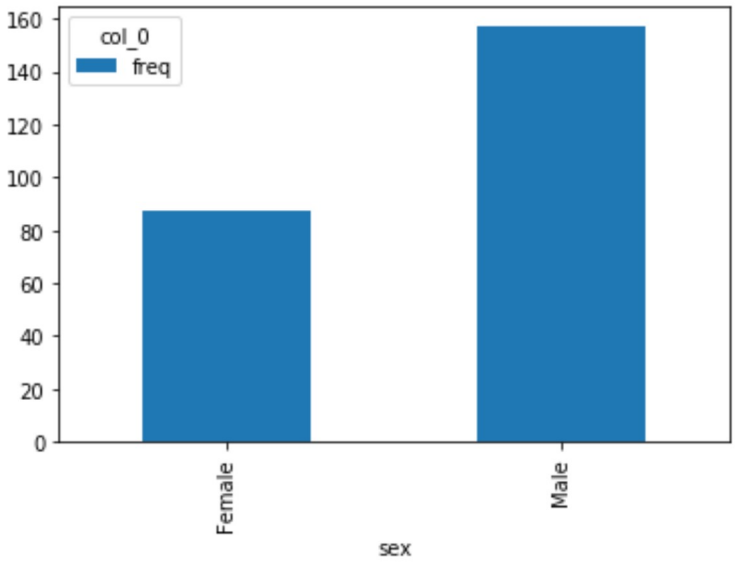
In [197]:
```
t = pandas.crosstab(tips.sex, "freq")
t.plot.bar()
```

Out[197]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x10e9cd780>
```



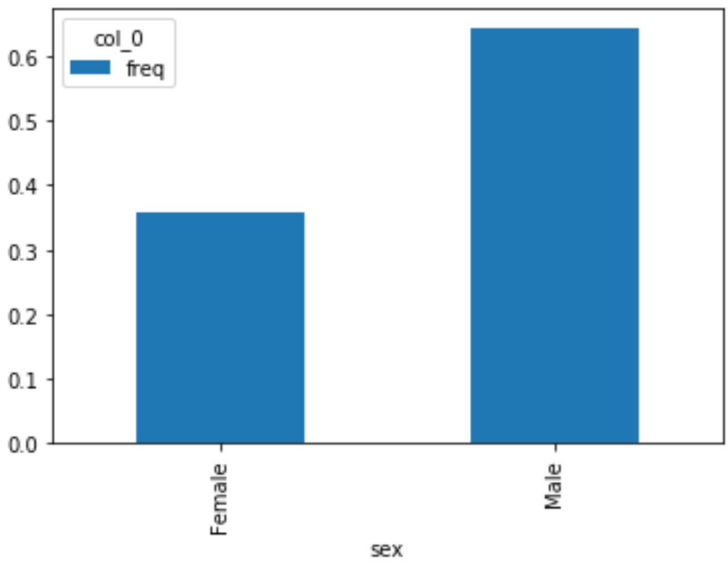
In [198]:
```
t.plot(kind = "bar")
```

Out[198]: <matplotlib.axes._subplots.AxesSubplot at 0x10ed11908>



In [199]:
```
t = pandas.crosstab(tips.sex, "freq", normalize=True)
t.plot(kind = "bar")
```

Out[199]: <matplotlib.axes._subplots.AxesSubplot at 0x10ed555f8>



In [200]:
```
(t * 100).plot(kind = "bar")
```

Out[200]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x10e97db00>
```

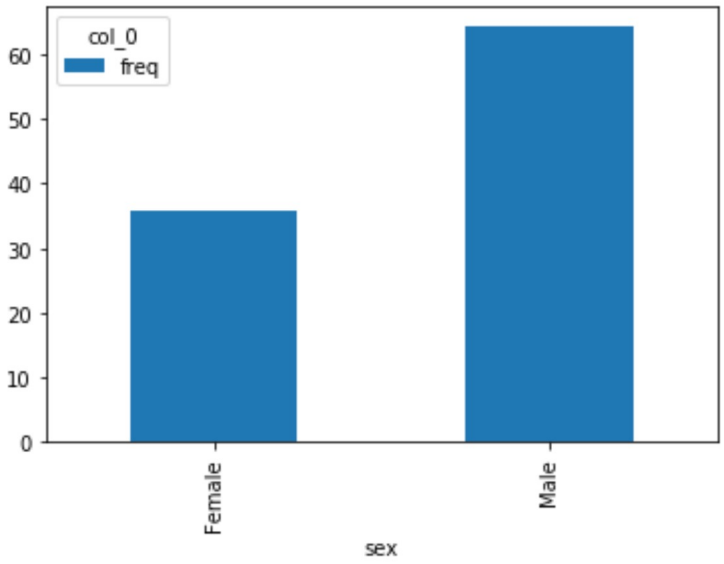
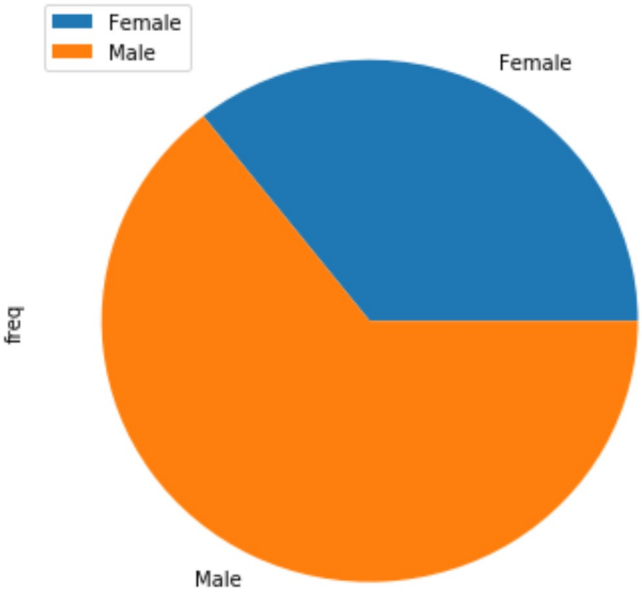


Diagramme circulaire

Et pour un **diagramme circulaire**, seul le tableau des effectifs produit par `value_counts()` nous permet de le réaliser.

In [201]:
```
t = pandas.crosstab(tips.sex, "freq")
t.plot.pie(subplots=True, figsize = (6, 6))
```

Out[201]:
```
array([<matplotlib.axes._subplots.AxesSubplot object at 0x10efc3470>], dtyp
e=object)
```



Statistiques descriptives bivariées

Quantitative - quantitative

In [202]:
```
tips.corr()
```

Out[202]:

	total_bill	tip	size
total_bill	1.000000	0.675734	0.598315
tip	0.675734	1.000000	0.489299
size	0.598315	0.489299	1.000000

In [203]:
```
tips.total_bill.corr(tips.tip)
```

Out[203]:
```
0.67573410921136445
```

In [204]:
```
tips.total_bill.cov(tips.tip)
```

Out[204]:
```
8.3235016292248538
```

In [205]:
```
scipy.stats.pearsonr(tips.total_bill, tips.tip)
```

Out[205]:
```
(0.67573410921136434, 6.6924706468640407e-34)
```

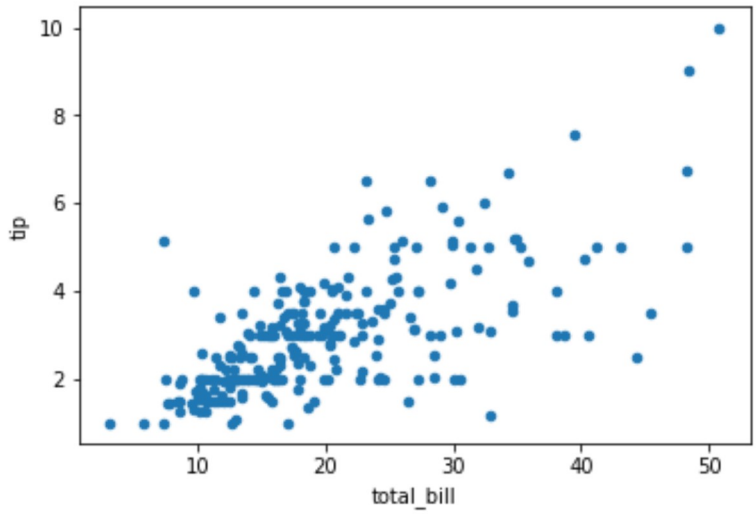
In [206]:
```
scipy.stats.kendalltau(tips.total_bill, tips.tip)
```

Out[206]:
```
KendalltauResult(correlation=0.51718097214238101, pvalue=2.4455728480214792
e-32)
```

Nuage de points

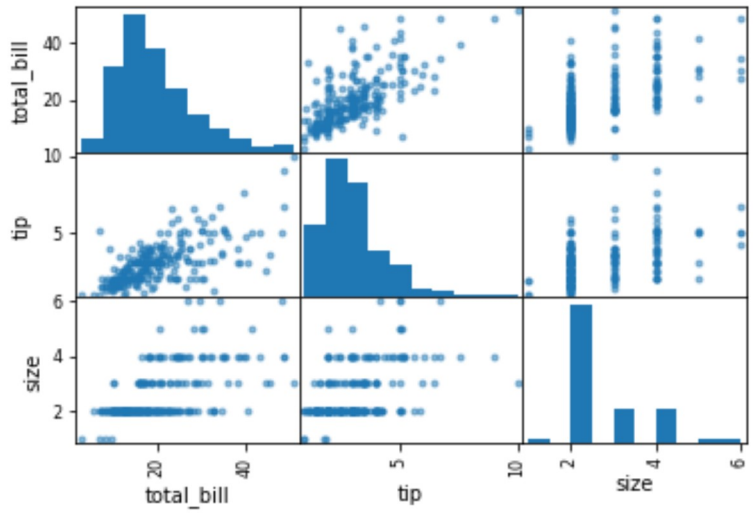
In [207]:
```
tips.plot.scatter("total_bill", "tip")
```

Out[207]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x10f100e10>
```



In [208]:
```
pandas.scatter_matrix(tips)
```

Out[208]:
```
array([[<matplotlib.axes._subplots.AxesSubplot object at 0x10f23c358>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x10f388d68>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x10f4990b8>],
       [<matplotlib.axes._subplots.AxesSubplot object at 0x10f4e99b0>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x10f54fcc0>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x10f54fcf8>],
       [<matplotlib.axes._subplots.AxesSubplot object at 0x10f611860>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x10f65ebe0>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x10f6ce128>]], dt
ype=object)
```



Qualitative - qualitative

In [209]:
```
pandas.crosstab(tips.sex, tips.smoker)
```

Out[209]:

smoker	No	Yes
sex		
Female	54	33
Male	97	60

In [210]:
```
pandas.crosstab(tips.sex, tips.smoker, margins=True)
```

Out[210]:

smoker	No	Yes	All
sex			
Female	54	33	87
Male	97	60	157
All	151	93	244

In [211]:
```
pandas.crosstab(tips.sex, tips.smoker, normalize = True)
```

Out[211]:

smoker	No	Yes
sex		
Female	0.221311	0.135246
Male	0.397541	0.245902

In [212]:
```
pandas.crosstab(tips.sex, tips.smoker, normalize = "index")
```

Out[212]:

smoker	No	Yes
sex		
Female	0.620690	0.379310
Male	0.617834	0.382166

In [213]:
```
pandas.crosstab(tips.sex, tips.smoker, normalize = "index", margins=True)
```

Out[213]:

smoker	No	Yes
sex		
Female	0.620690	0.379310
Male	0.617834	0.382166
All	0.618852	0.381148

In [214]:
```
pandas.crosstab(tips.sex, tips.smoker, normalize = "columns")
```

Out[214]:

smoker	No	Yes
sex		
Female	0.357616	0.354839
Male	0.642384	0.645161

In [215]:
```
pandas.crosstab(tips.sex, tips.smoker, normalize = "columns", margins=True)
```

Out[215]:

smoker	No	Yes	All
sex			
Female	0.357616	0.354839	0.356557
Male	0.642384	0.645161	0.643443

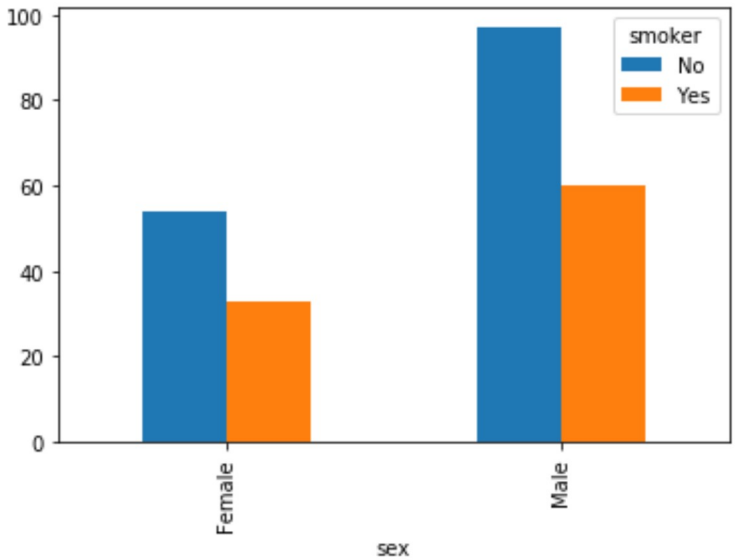
In [216]:
```
t = pandas.crosstab(tips.sex, tips.smoker)
scipy.stats.chi2_contingency(t)
```

Out[216]:
```
(0.0087632905317735939,
 0.92541702049442298,
 1,
 array([[ 53.84016393,  33.15983607],
        [ 97.15983607,  59.84016393]]))
```

Diagramme en barres

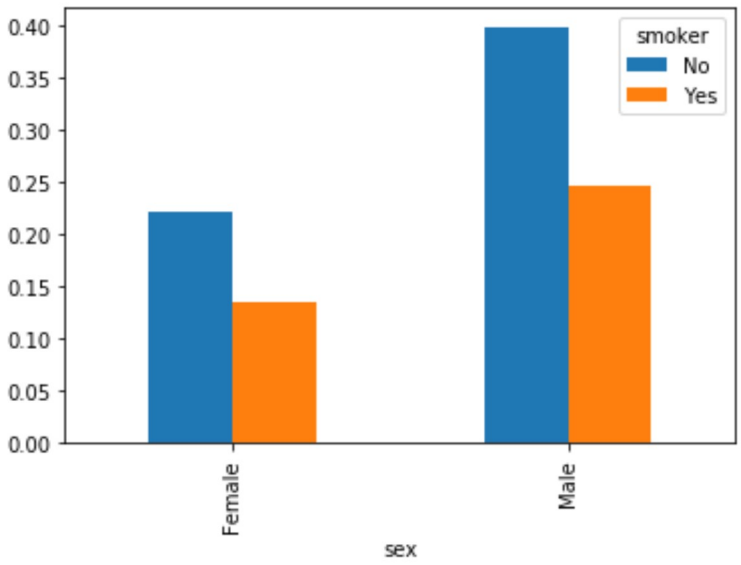
In [217]:
```
t = pandas.crosstab(tips.sex, tips.smoker)
t.plot.bar()
```

Out[217]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x10f8045f8>
```



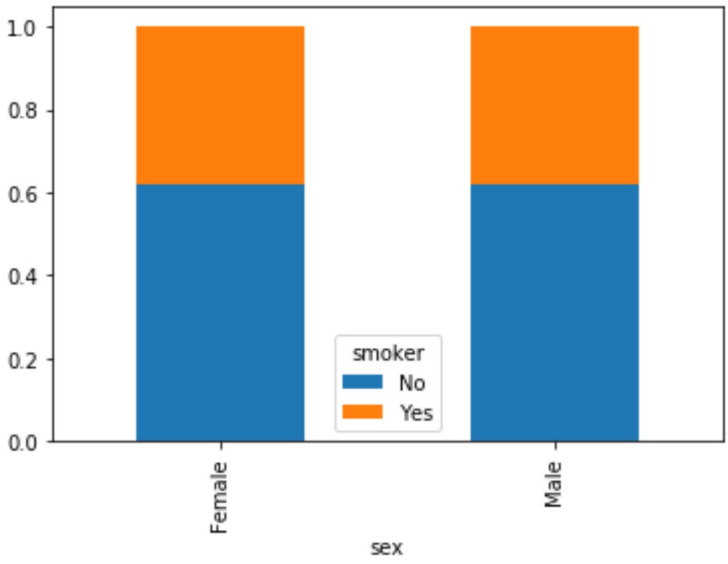
In [218]:
```
t = pandas.crosstab(tips.sex, tips.smoker, normalize=True)
t.plot.bar()
```

Out[218]: <matplotlib.axes._subplots.AxesSubplot at 0x10f814d68>



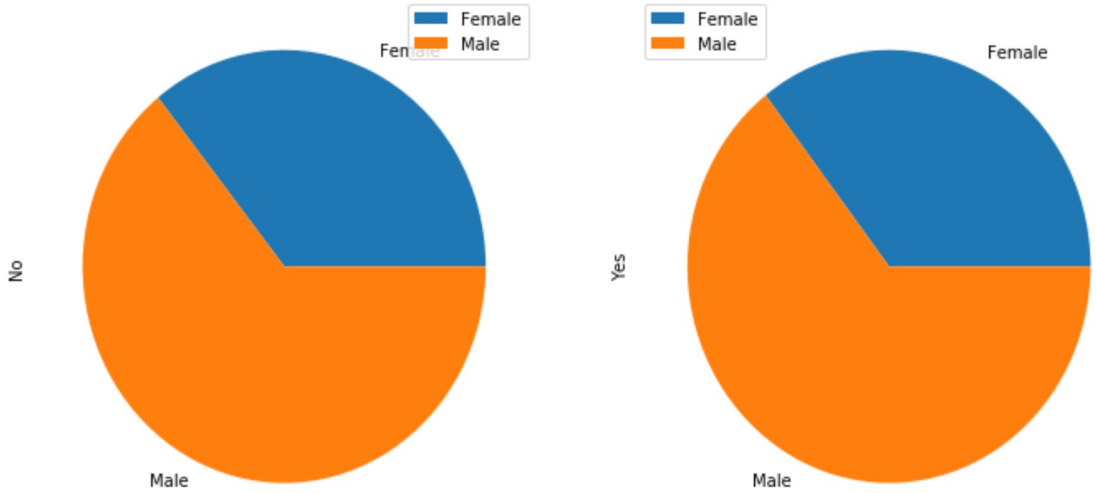
In [219]:
```
t = pandas.crosstab(tips.sex, tips.smoker, normalize="index")
t.plot.bar(stacked=True)
```

Out[219]: <matplotlib.axes._subplots.AxesSubplot at 0x10faa5a58>



In [220]:
```
t = pandas.crosstab(tips.sex, tips.smoker)
t.plot.pie(subplots=True, figsize = (12, 6))
```

Out[220]:
```
array([<matplotlib.axes._subplots.AxesSubplot object at 0x10faf84a8>,
       <matplotlib.axes._subplots.AxesSubplot object at 0x10fc82d68>], dtype=object)
```



Qualitative - quantitative

In [221]:
```
tips.groupby("sex").mean()
```

Out[221]:

	total_bill	tip	size
sex			
Female	18.056897	2.833448	2.459770
Male	20.744076	3.089618	2.630573

In [222]:
```
tips.groupby("sex")["total_bill"].agg([numpy.mean, numpy.std, numpy.median, numpy.min, numpy.max])
```

Out[222]:

	mean	std	median	amin	amax
sex					
Female	18.056897	8.009209	16.40	3.07	44.30
Male	20.744076	9.246469	18.35	7.25	50.81

In [223]:
```
billFemale = tips.total_bill[tips.sex == "Female"]
billMale = tips.total_bill[tips.sex == "Male"]
scipy.stats.ttest_ind(billFemale, billMale)
```

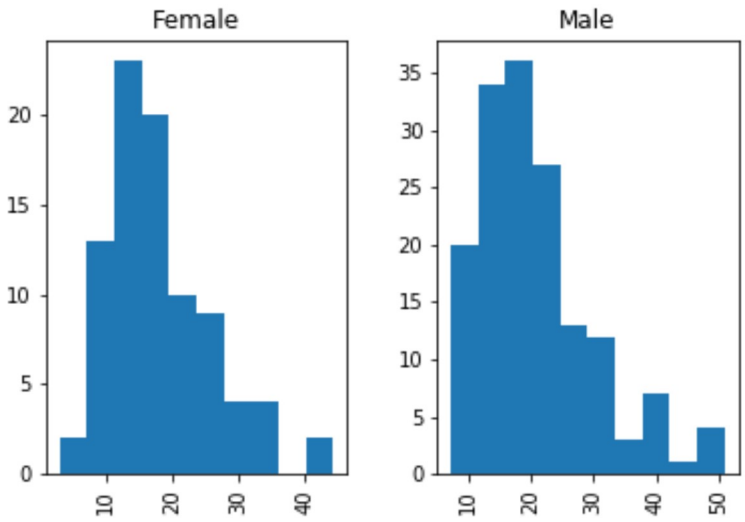
Out[223]:
```
Ttest_indResult(statistic=-2.2777940289803134, pvalue=0.023611666846859398)
```

In [224]:
```
billGrouped = [tips.total_bill[tips.sex == s] for s in list(tips.sex.unique
())]
scipy.stats.f_oneway(*billGrouped)
```

Out[224]:
```
F_onewayResult(statistic=5.1883456384583608, pvalue=0.023611666846859697)
```

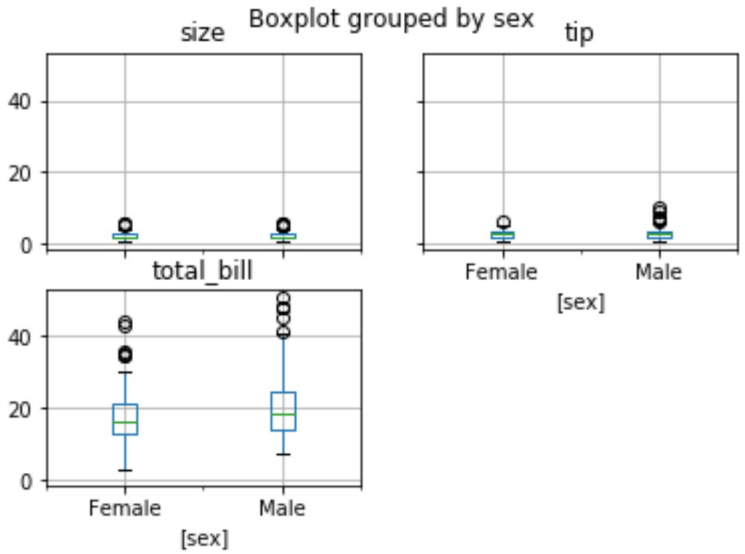
In [225]:
```
tips.hist(column = "total_bill", by = "sex")
```

Out[225]:
```
array([<matplotlib.axes._subplots.AxesSubplot object at 0x10fdb3cc0>,
       <matplotlib.axes._subplots.AxesSubplot object at 0x10ff23048>], dtyp
e=object)
```



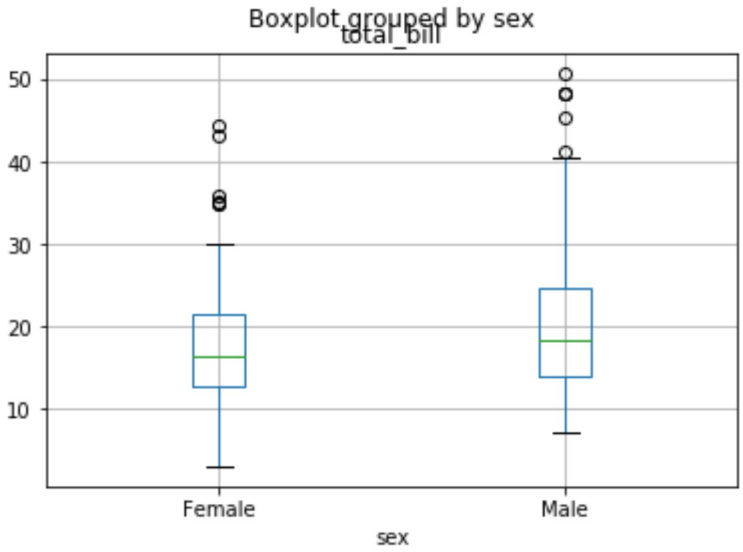
In [226]:
```
tips.boxplot(by = "sex")
```

Out[226]:
```
array([[<matplotlib.axes._subplots.AxesSubplot object at 0x10ffe20b8>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x10fffa908>],
       [<matplotlib.axes._subplots.AxesSubplot object at 0x11017cb70>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x1101d7208>]], dt
ype=object)
```



In [227]:
```
tips.boxplot(column = "total_bill", by = "sex")
```

Out[227]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1101542b0>
```



Exercices

A partir du fichier `diamonds.csv` (donnees/diamonds.csv) (voir l'aide ici (http://docs.ggplot2.org/0.9.3.1/diamonds.html)), analyser les données suivant le déroulement classique

1. Description de chaque variable
2. Recherche des liens entre le prix (`price`) et les autres variables

In [ ]:
```

```