Case Study - Marketing Analytics

http://archive.ics.uci.edu/ml/datasets/Bank+Marketing (http://archive.ics.uci.edu/ml/datasets/Bank+Marketing)

In [1]:
```
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np

pd.options.display.max_rows = 10
```

In [2]:
```
%matplotlib inline
```

Conversion Rate

In [3]:
```
url = 'http://people.bu.edu/kalathur/datasets/bank-additional-full.csv'
df = pd.read_csv(url, sep=';')
```

In [4]:
```
df.shape
```

Out[4]:
```
(41188, 21)
```

In [5]:
```
df.columns
```

Out[5]:
```
Index(['age', 'job', 'marital', 'education', 'default', 'housing', 'loan',
       'contact', 'month', 'day_of_week', 'duration', 'campaign', 'pdays',
       'previous', 'poutcome', 'emp.var.rate', 'cons.price.idx',
       'cons.conf.idx', 'euribor3m', 'nr.employed', 'y'],
      dtype='object')
```

In [6]:
```
df[['age','job','education','contact','duration','campaign','y']]
```

Out[6]:

	age	job	education	contact	duration	campaign	y
0	56	housemaid	basic.4y	telephone	261	1	no
1	57	services	high.school	telephone	149	1	no
2	37	services	high.school	telephone	226	1	no
3	40	admin.	basic.6y	telephone	151	1	no
4	56	services	high.school	telephone	307	1	no
...	...	...	...	...	...	...	...
41183	73	retired	professional.course	cellular	334	1	yes
41184	46	blue-collar	professional.course	cellular	383	1	no
41185	56	retired	university.degree	cellular	189	2	no
41186	44	technician	professional.course	cellular	442	1	yes
41187	74	retired	professional.course	cellular	239	3	no

41188 rows × 7 columns

In [7]:
```
df['conversion'] = df['y'].apply(lambda x: 1 if x == 'yes' else 0)
```

In [8]:
```
df[['age','job','education','contact','duration','campaign','y','conversion']]
```

Out[8]:

	age	job	education	contact	duration	campaign	y	conversion
0	56	housemaid	basic.4y	telephone	261	1	no	0
1	57	services	high.school	telephone	149	1	no	0
2	37	services	high.school	telephone	226	1	no	0
3	40	admin.	basic.6y	telephone	151	1	no	0
4	56	services	high.school	telephone	307	1	no	0
...	...	...	...	...	...	...	...	...
41183	73	retired	professional.course	cellular	334	1	yes	1
41184	46	blue-collar	professional.course	cellular	383	1	no	0
41185	56	retired	university.degree	cellular	189	2	no	0
41186	44	technician	professional.course	cellular	442	1	yes	1
41187	74	retired	professional.course	cellular	239	3	no	0

41188 rows × 8 columns

In [9]:
```
df['campaign'].value_counts()
```

Out[9]:
```
1     17642
2     10570
3      5341
4      2651
5      1599
      ...
43        2
37        1
39        1
41        1
56        1
Name: campaign, Length: 42, dtype: int64
```

1. Aggregate Conversion Rate

In [10]:
```
print('Total conversions: {} out of {}'.format(
    df.conversion.sum(), len(df)))
```

```
Total conversions: 4640 out of 41188
```

In [11]:
```
print('Conversion rate: {:.2f}%'.format(
    df.conversion.sum() / len(df) * 100.0))
```

```
Conversion rate: 11.27%
```

2. Conversion Rates by Number of Contacts

In [12]:
```
df.groupby('campaign')['conversion'].sum()
```

Out[12]:
```
campaign
1     2300
2     1211
3      574
4      249
5      120
      ...
40       0
41       0
42       0
43       0
56       0
Name: conversion, Length: 42, dtype: int64
```

In [13]:
```
df.groupby('campaign')['conversion'].count()
```

Out[13]:
```
campaign
1     17642
2     10570
3      5341
4      2651
5      1599
      ...
40        2
41        1
42        2
43        2
56        1
Name: conversion, Length: 42, dtype: int64
```

In [14]:
```
conversions_by_contacts = df.groupby('campaign')['conversion'].agg(
    [np.sum, len])
conversions_by_contacts
```

Out[14]:

campaign	sum	len
1	2300	17642
2	1211	10570
3	574	5341
4	249	2651
5	120	1599
...	...	...
40	0	2
41	0	1
42	0	2
43	0	2
56	0	1

42 rows × 2 columns

In [15]:
```
pd.crosstab(df['campaign'], df['conversion'], margins=all).drop(0, axis=1)
```

Out[15]:

conversion	1	All
campaign		
1	2300	17642
2	1211	10570
3	574	5341
4	249	2651
5	120	1599
...	...	...
41	0	1
42	0	2
43	0	2
56	0	1
All	4640	41188

43 rows × 2 columns

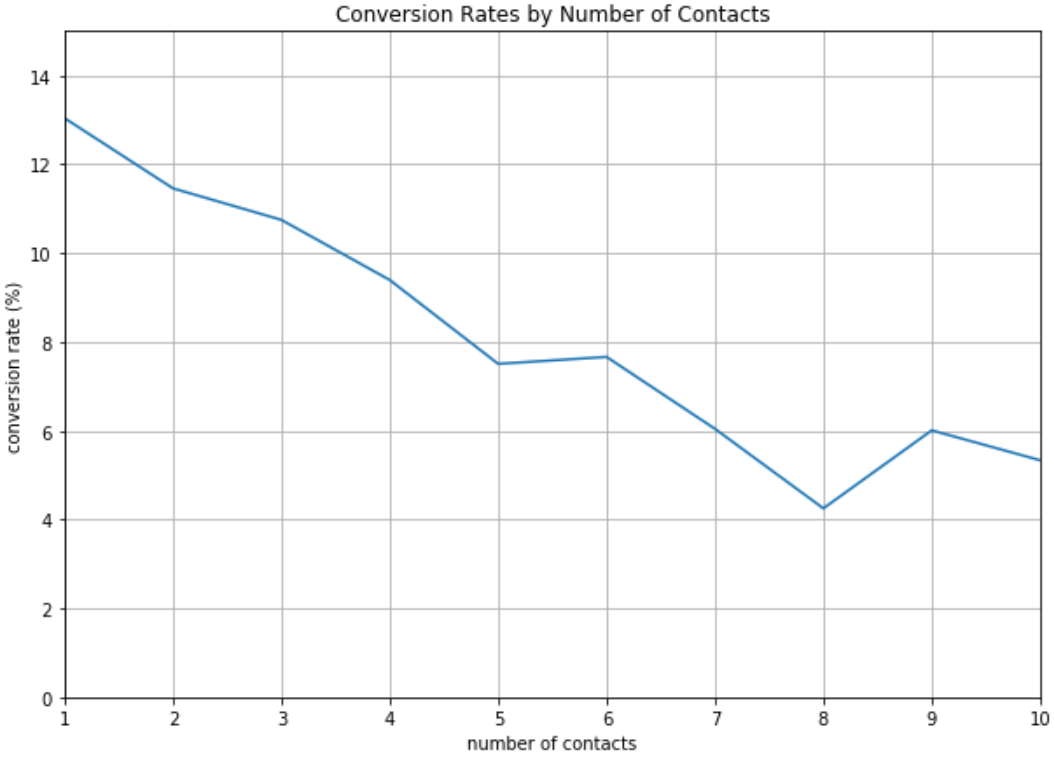
In [16]:
```
conversions_by_contacts['rate'] = conversions_by_contacts[
    'sum'] / conversions_by_contacts['len'] * 100.0
conversions_by_contacts
```

Out[16]:

campaign	sum	len	rate
1	2300	17642	13.037071
2	1211	10570	11.456954
3	574	5341	10.747051
4	249	2651	9.392682
5	120	1599	7.504690
...	...	...	...
40	0	2	0.000000
41	0	1	0.000000
42	0	2	0.000000
43	0	2	0.000000
56	0	1	0.000000

42 rows × 3 columns

In [17]:
```
ax = conversions_by_contacts['rate'][:10].plot(
    grid=True,
    figsize=(10, 7),
    xticks=conversions_by_contacts.index[:10],
    title='Conversion Rates by Number of Contacts'
)

ax.set_ylim([0, 15])
ax.set_xlabel('number of contacts')
ax.set_ylabel('conversion rate (%)')

plt.show()
```



3. Conversion Rates by Age

In [18]:
```
conversions_by_age = df.groupby('age')['conversion'].agg(
    [np.sum, len])

conversions_by_age
```

Out[18]:

age	sum	len
17	2	5
18	12	28
19	20	42
20	23	65
21	29	102
...	...	...
91	0	2
92	3	4
94	0	1
95	0	1

In [19]:
```
# same as

pd.crosstab(df['age'], df['conversion'], margins=all).drop(0, axis=1)
```

Out[19]:

conversion	1	All
age		
17	2	5
18	12	28
19	20	42
20	23	65
21	29	102
...	...	...
92	3	4
94	0	1
95	0	1
98	2	2
All	4640	41188

79 rows × 2 columns

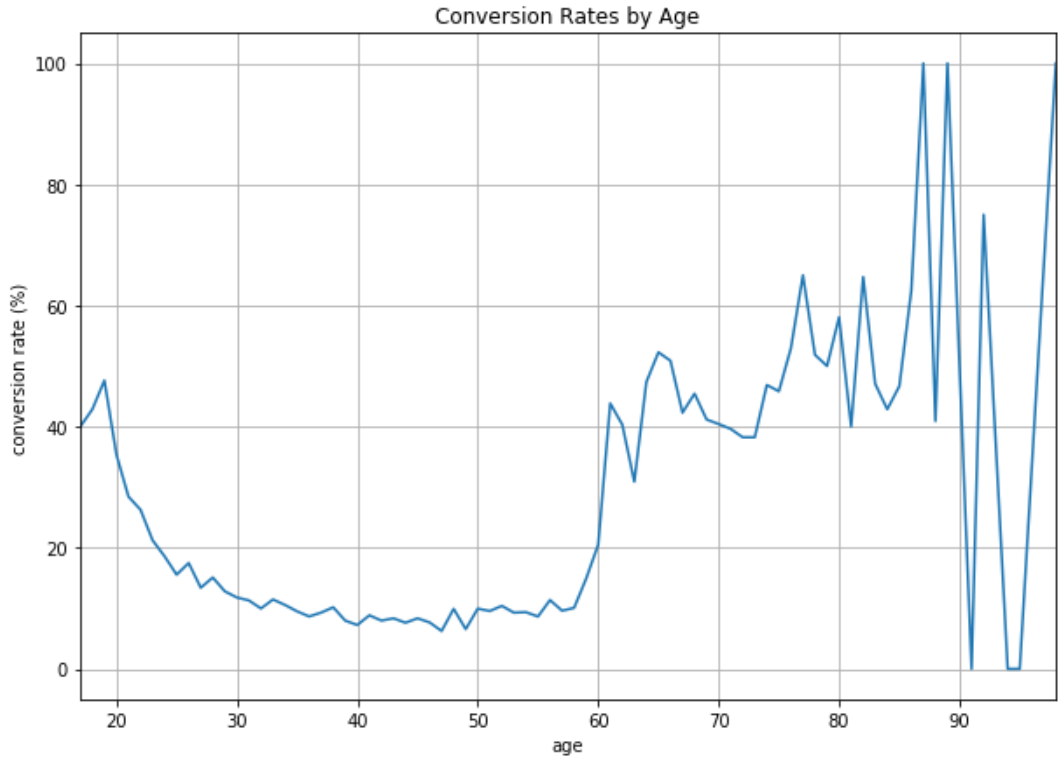
In [20]:
```
conversions_by_age['rate'] = \
    conversions_by_age['sum']/conversions_by_age['len'] * 100.0

conversions_by_age.sort_values(by='rate', ascending=False)
```

Out[20]:

age	sum	len	rate
98	2	2	100.000000
89	2	2	100.000000
87	1	1	100.000000
92	3	4	75.000000
77	13	20	65.000000
...	...	...	...
49	55	839	6.555423
47	58	928	6.250000
91	0	2	0.000000
94	0	1	0.000000
95	0	1	0.000000

78 rows × 3 columns

In [21]:
```
ax = conversions_by_age['rate'].plot(
    grid=True,
    figsize=(10, 7),
    title='Conversion Rates by Age'
)

ax.set_xlabel('age')
ax.set_ylabel('conversion rate (%)')

plt.show()
```



Analyze by Age Groups

In [22]:
```
df['age'].min(), df['age'].max()
```

Out[22]:
```
(17, 98)
```

In [23]:
```
df['age_group'] = df['age'].apply(
    lambda x: '[17, 30)' if x < 30 else '[30, 40)' if x < 40 \
        else '[40, 50)' if x < 50 else '[50, 60)' if x < 60 \
        else '[60, 70)' if x < 70 else '70+'
)
```

In [24]:
```
df[['age','age_group','job','education','contact','duration','campaign','y','conversion']]
```

Out[24]:

	age	age_group	job	education	contact	duration	campaign	y	conversion
0	56	[50, 60)	housemaid	basic.4y	telephone	261	1	no	0
1	57	[50, 60)	services	high.school	telephone	149	1	no	0
2	37	[30, 40)	services	high.school	telephone	226	1	no	0
3	40	[40, 50)	admin.	basic.6y	telephone	151	1	no	0
4	56	[50, 60)	services	high.school	telephone	307	1	no	0
...	...	...	...	...	...	...	...	...	...
41183	73	70+	retired	professional.course	cellular	334	1	yes	1
41184	46	[40, 50)	blue-collar	professional.course	cellular	383	1	no	0
41185	56	[50, 60)	retired	university.degree	cellular	189	2	no	0
41186	44	[40, 50)	technician	professional.course	cellular	442	1	yes	1
41187	74	70+	retired	professional.course	cellular	239	3	no	0

41188 rows × 9 columns

In [25]:
```
df['age_group'] = pd.cut(df['age'],
                         [17,30,40,50,60,70,100], right=False)

df[['age','age_group','job','education','contact','duration','campaign','y','conversion']]
```

Out[25]:

	age	age_group	job	education	contact	duration	campaign	y	conversion
0	56	[50, 60)	housemaid	basic.4y	telephone	261	1	no	0
1	57	[50, 60)	services	high.school	telephone	149	1	no	0
2	37	[30, 40)	services	high.school	telephone	226	1	no	0
3	40	[40, 50)	admin.	basic.6y	telephone	151	1	no	0
4	56	[50, 60)	services	high.school	telephone	307	1	no	0
...	...	...	...	...	...	...	...	...	...
41183	73	[70, 100)	retired	professional.course	cellular	334	1	yes	1
41184	46	[40, 50)	blue-collar	professional.course	cellular	383	1	no	0
41185	56	[50, 60)	retired	university.degree	cellular	189	2	no	0
41186	44	[40, 50)	technician	professional.course	cellular	442	1	yes	1
41187	74	[70, 100)	retired	professional.course	cellular	239	3	no	0

41188 rows × 9 columns

In [ ]:

In [26]:
```
conversions_by_age_group = df.groupby('age_group')['conversion'].agg(
    [np.sum, len])
conversions_by_age_group
```

Out[26]:

age_group	sum	len
[17, 30)	922	5669
[30, 40)	1715	16938
[40, 50)	834	10526
[50, 60)	697	6862
[60, 70)	251	724
[70, 100)	221	469

In [27]:
```
# same as

pd.crosstab(df['age_group'], df['conversion'], margins=True).drop(0, axis=1)
```

Out[27]:

age_group	conversion 1	All
[17, 30)	922	5669
[30, 40)	1715	16938
[40, 50)	834	10526
[50, 60)	697	6862
[60, 70)	251	724
[70, 100)	221	469
All	4640	41188

In [28]:
```
conversions_by_age_group['rate'] = \
    conversions_by_age_group['sum']/conversions_by_age_group['len']*100

conversions_by_age_group
```

Out[28]:

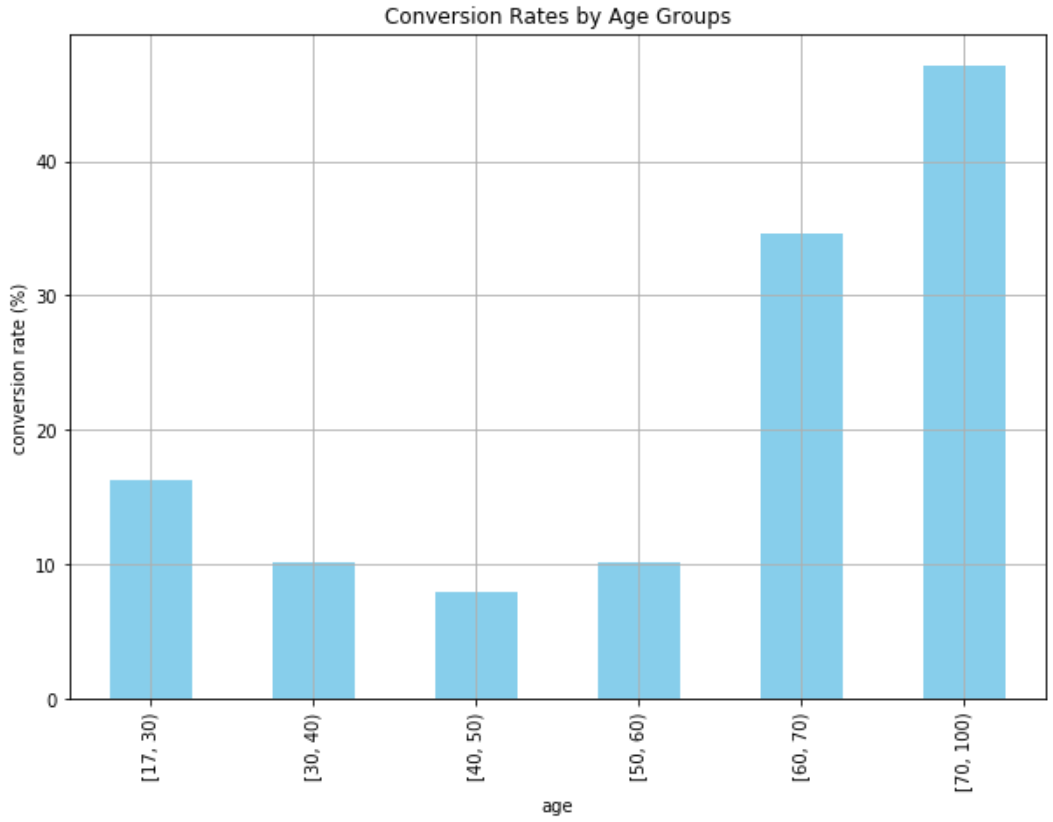
age_group	sum	len	rate
[17, 30)	922	5669	16.263891
[30, 40)	1715	16938	10.125162
[40, 50)	834	10526	7.923238
[50, 60)	697	6862	10.157389
[60, 70)	251	724	34.668508
[70, 100)	221	469	47.121535

In [29]:
```
conversions_by_age_group.sort_values(by='rate', ascending=False)
```

Out[29]:

age_group	sum	len	rate
[70, 100)	221	469	47.121535
[60, 70)	251	724	34.668508
[17, 30)	922	5669	16.263891
[50, 60)	697	6862	10.157389
[30, 40)	1715	16938	10.125162
[40, 50)	834	10526	7.923238

In [30]:
```
ax = conversions_by_age_group['rate'].plot(
    kind='bar',
    color='skyblue',
    grid=True,
    figsize=(10, 7),
    title='Conversion Rates by Age Groups'
)

ax.set_xlabel('age')
ax.set_ylabel('conversion rate (%)')

plt.show()
```



4. Conversions vs. Non-Conversions

4.1. Marital Status

In [31]:
```
conversions_by_marital_status = \
    df.pivot_table(index='marital', columns='conversion',
                   values='y', aggfunc=len)

conversions_by_marital_status
```

Out[31]:

conversion	0	1
marital		
divorced	4136	476
married	22396	2532
single	9948	1620
unknown	68	12

In [32]:
```
pd.crosstab(df['marital'], df['conversion'])
```

Out[32]:

conversion	0	1
marital		
divorced	4136	476
married	22396	2532
single	9948	1620
unknown	68	12

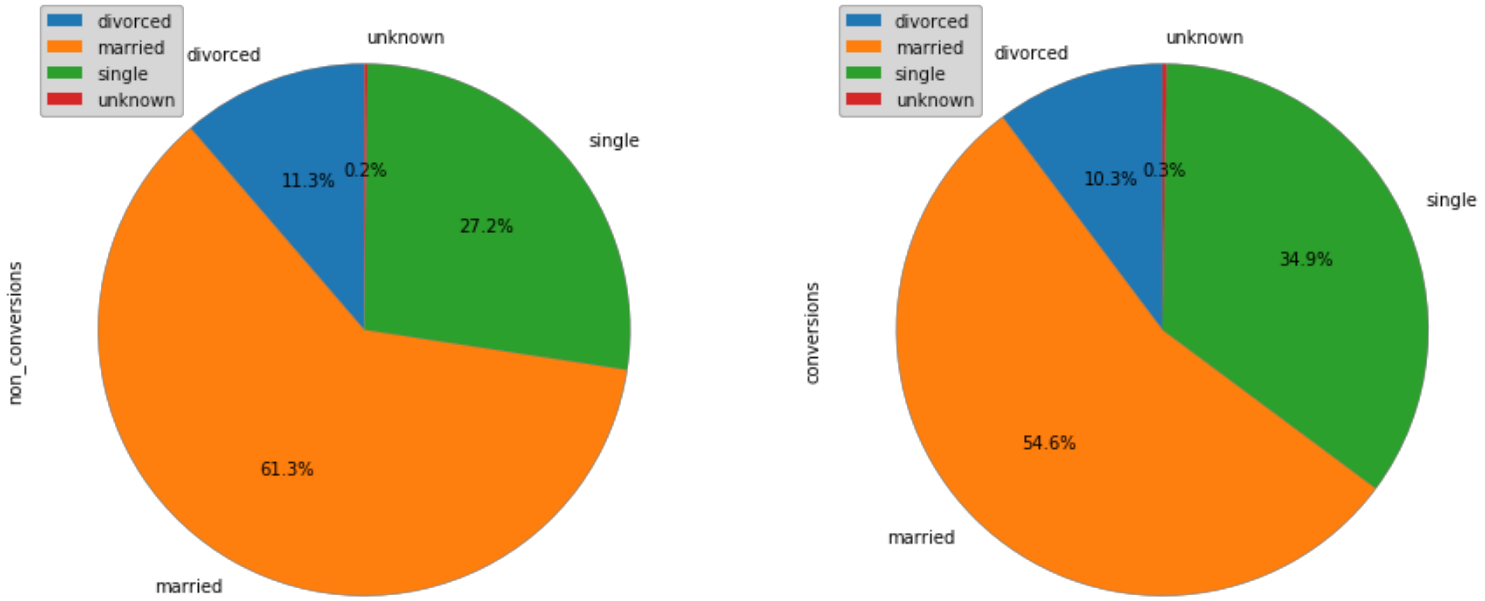
In [33]:
```
conversions_by_marital_status.columns = ['non_conversions', 'conversions']
conversions_by_marital_status
```

Out[33]:

marital	non_conversions	conversions
divorced	4136	476
married	22396	2532
single	9948	1620
unknown	68	12

In [ ]:

In [34]:
```
conversions_by_marital_status.plot(
    kind='pie',
    figsize=(15, 7),
    startangle=90,
    subplots=True,
    autopct=lambda x: '%0.1f%%' % x
)

plt.show()
```



4.2. Education

In [35]:
```
conversions_by_education = df.pivot_table(
    index='education', columns='conversion',
    values='y',  aggfunc=len)

conversions_by_education
```

Out[35]:

education	conversion 0	1
basic.4y	3748	428
basic.6y	2104	188
basic.9y	5572	473
high.school	8484	1031
illiterate	14	4
professional.course	4648	595
university.degree	10498	1670
unknown	1480	251

In [36]:
```
# same as

pd.crosstab(df['education'], df['conversion'])
```

Out[36]:

education	conversion 0	1
basic.4y	3748	428
basic.6y	2104	188
basic.9y	5572	473
high.school	8484	1031
illiterate	14	4
professional.course	4648	595
university.degree	10498	1670
unknown	1480	251

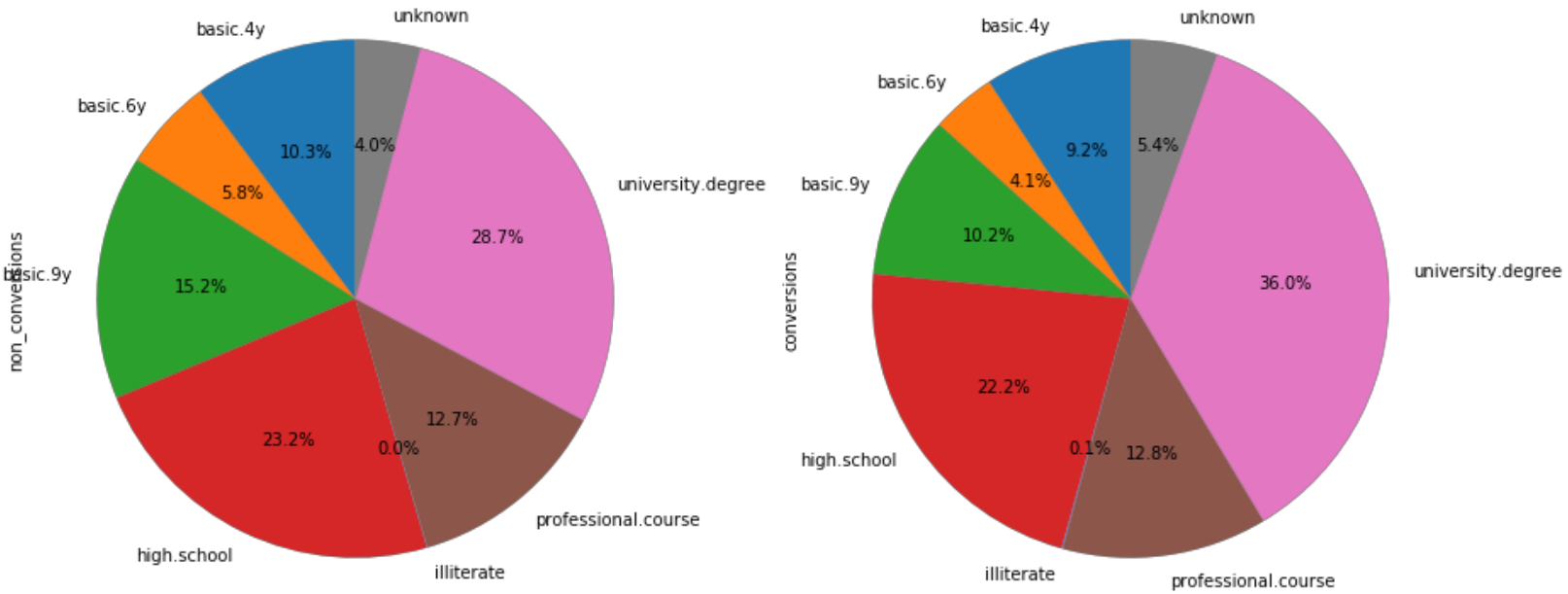
In [37]:
```
conversions_by_education.columns = ['non_conversions', 'conversions']
conversions_by_education
```

Out[37]:

education	non_conversions	conversions
basic.4y	3748	428
basic.6y	2104	188
basic.9y	5572	473
high.school	8484	1031
illiterate	14	4
professional.course	4648	595
university.degree	10498	1670
unknown	1480	251

In [ ]:

In [38]:
```
conversions_by_education.plot(
    kind='pie',
    figsize=(15, 7),
    startangle=90,
    subplots=True,
    autopct=lambda x: '%0.1f%%' % x,
    legend=False
)

plt.show()
```



4.3. Last Contact Duration

In [39]:
```
df.groupby('conversion')['duration'].describe()
```

Out[39]:

conversion	count	mean	std	min	25%	50%	75%	max
0	36548.0	220.844807	207.096293	0.0	95.0	163.5	279.00	4918.0
1	4640.0	553.191164	401.171871	37.0	253.0	449.0	741.25	4199.0

In [40]:
```
duration_conversions = \
    df.loc[df['conversion'] == 1, 'duration'].reset_index(drop=True)

duration_conversions
```

Out[40]:
```
0        1575
1        1042
2        1467
3         579
4         461
        ...
4635      208
4636      483
4637      281
4638      334
4639      442
Name: duration, Length: 4640, dtype: int64
```

In [41]:
```
duration_nonconversions = \
    df.loc[df['conversion'] == 0, 'duration'].reset_index(drop=True)

duration_nonconversions
```

Out[41]:
```
0         261
1         149
2         226
3         151
4         307
         ...
36543     254
36544     112
36545     383
36546     189
36547     239
Name: duration, Length: 36548, dtype: int64
```

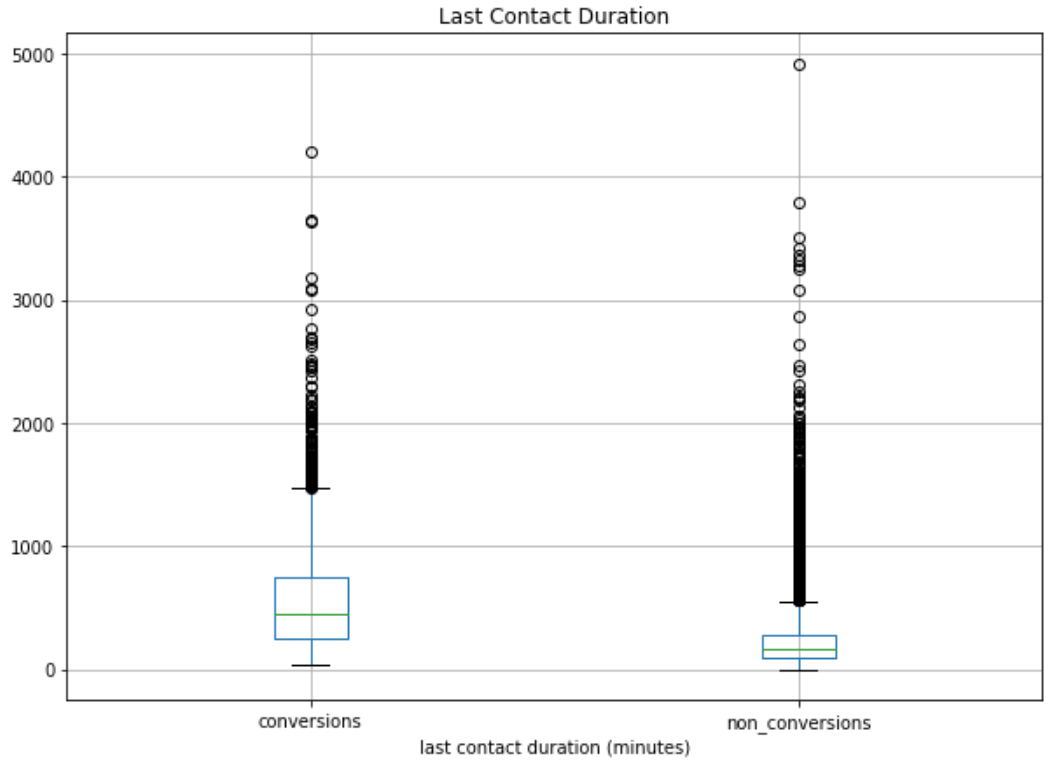
In [42]:
```
durations_df = pd.DataFrame(
    {'conversions': duration_conversions,
     'non_conversions': duration_nonconversions})

durations_df
```

Out[42]:

	conversions	non_conversions
0	1575.0	261
1	1042.0	149
2	1467.0	226
3	579.0	151
4	461.0	307
...	...	...
36543	NaN	254
36544	NaN	112
36545	NaN	383
36546	NaN	189
36547	NaN	239

36548 rows × 2 columns

In [43]:
```
ax = durations_df.plot(
    kind='box',
    grid=True,
    figsize=(10,7)
)

ax.set_title('Last Contact Duration')
ax.set_xlabel('last contact duration (minutes)')

plt.show()
```



5. Conversions by Age Groups & Marital Status

In [44]:
```
df.groupby(['age_group', 'marital'])['conversion'].sum().unstack()
```

Out[44]:

age_group	divorced	married	single	unknown
[17, 30)	12.0	158.0	751.0	1.0
[30, 40)	128.0	897.0	684.0	6.0
[40, 50)	126.0	575.0	130.0	3.0
[50, 60)	119.0	533.0	44.0	1.0
[60, 70)	27.0	218.0	5.0	1.0
[70, 100)	64.0	151.0	6.0	NaN

In [45]:
```
# same as

df.pivot_table(
    index='age_group', columns='marital',
    values='conversion',  aggfunc=np.sum)
```

Out[45]:

age_group	divorced	married	single	unknown
[17, 30)	12.0	158.0	751.0	1.0
[30, 40)	128.0	897.0	684.0	6.0
[40, 50)	126.0	575.0	130.0	3.0
[50, 60)	119.0	533.0	44.0	1.0
[60, 70)	27.0	218.0	5.0	1.0
[70, 100)	64.0	151.0	6.0	NaN

In [46]:
```
# same as

pd.crosstab([df['conversion'], df['age_group']], df['marital']).xs(1)
```

Out[46]:

age_group	marital	divorced	married	single	unknown
[17, 30)		12	158	751	1
[30, 40)		128	897	684	6
[40, 50)		126	575	130	3
[50, 60)		119	533	44	1
[60, 70)		27	218	5	1
[70, 100)		64	151	6	0

In [47]:
```
age_marital_df = df.pivot_table(
    index='age_group', columns='marital',
    values='conversion',  aggfunc=np.sum).fillna(0)

age_marital_df
```

Out[47]:

age_group	marital	divorced	married	single	unknown
[17, 30)		12.0	158.0	751.0	1.0
[30, 40)		128.0	897.0	684.0	6.0
[40, 50)		126.0	575.0	130.0	3.0
[50, 60)		119.0	533.0	44.0	1.0
[60, 70)		27.0	218.0	5.0	1.0
[70, 100)		64.0	151.0	6.0	0.0

In [48]:
```
group_counts = df.groupby('age_group')['conversion'].count()
group_counts
```

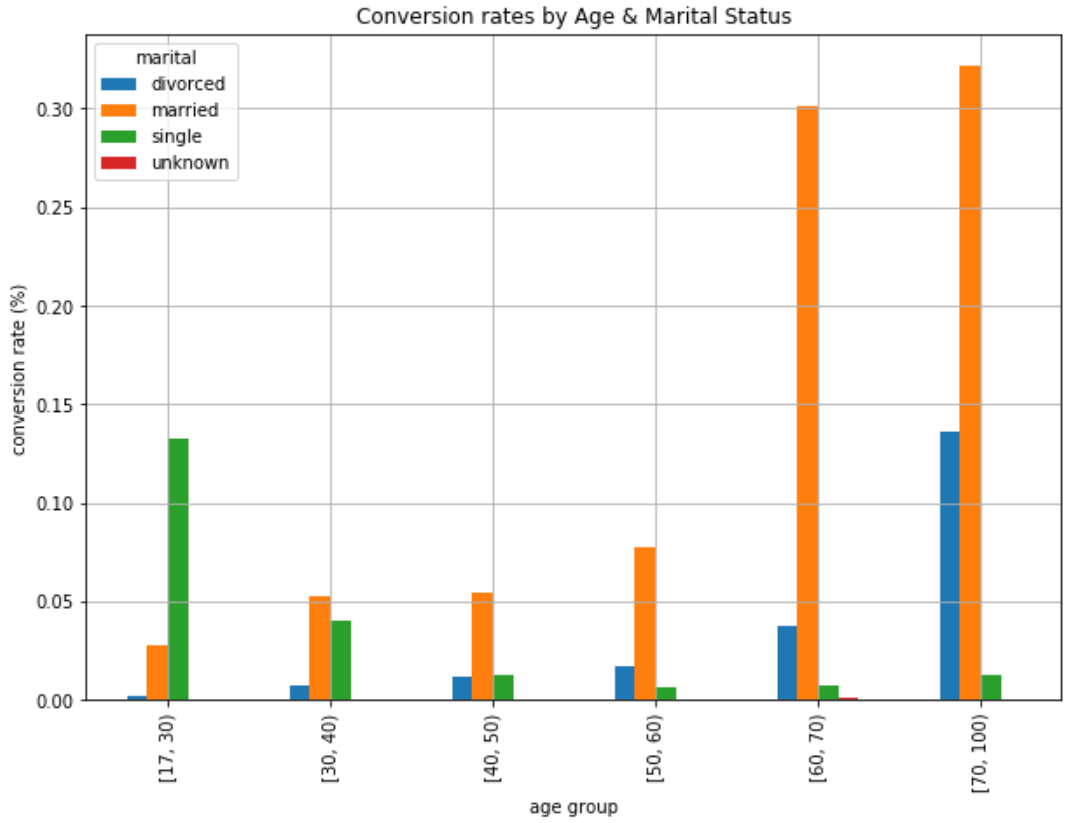
Out[48]:
```
age_group
[17, 30)       5669
[30, 40)      16938
[40, 50)      10526
[50, 60)       6862
[60, 70)        724
[70, 100)       469
Name: conversion, dtype: int64
```

In [49]:
```
age_marital_df = age_marital_df.divide(group_counts,axis=0)

age_marital_df
```

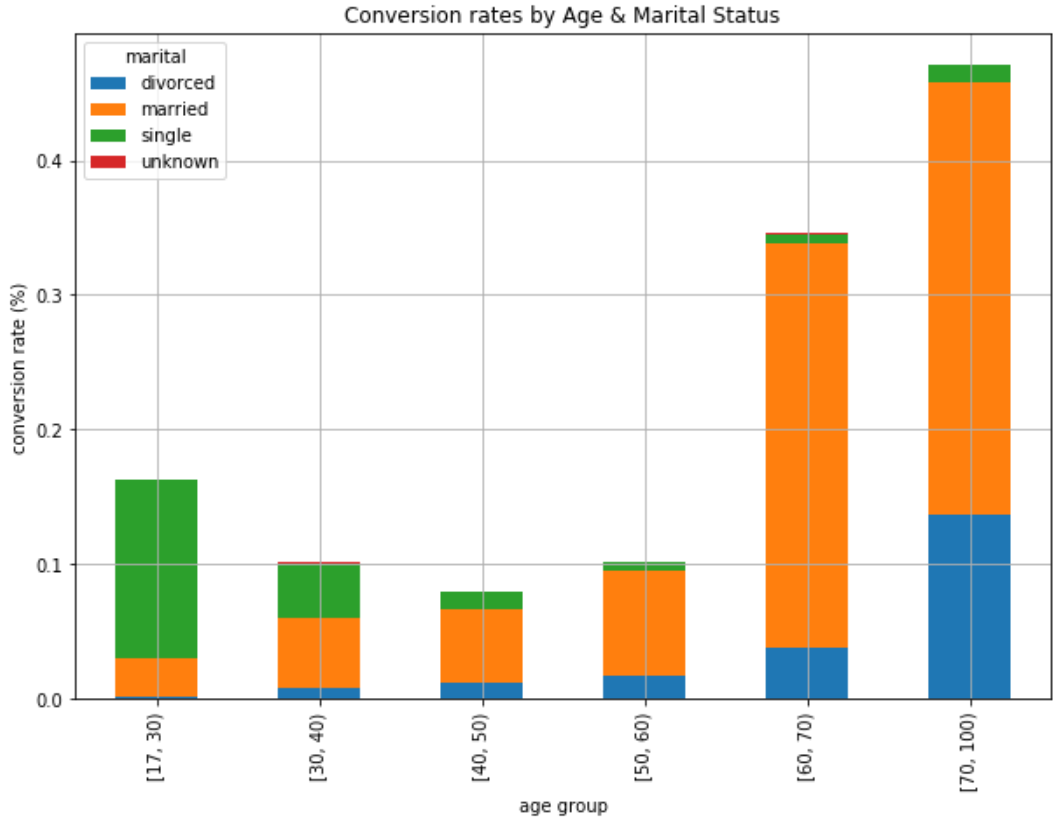
Out[49]:

marital	divorced	married	single	unknown
age_group				
[17, 30)	0.002117	0.027871	0.132475	0.000176
[30, 40)	0.007557	0.052958	0.040383	0.000354
[40, 50)	0.011970	0.054627	0.012350	0.000285
[50, 60)	0.017342	0.077674	0.006412	0.000146
[60, 70)	0.037293	0.301105	0.006906	0.001381
[70, 100)	0.136461	0.321962	0.012793	0.000000

In [50]:
```
ax = age_marital_df.plot(
    kind='bar',
    grid=True,
    figsize=(10,7)
)

ax.set_title('Conversion rates by Age & Marital Status')
ax.set_xlabel('age group')
ax.set_ylabel('conversion rate (%)')

plt.show()
```



In [51]:
```
ax = age_marital_df.plot(
    kind='bar',
    stacked=True,
    grid=True,
    figsize=(10,7)
)

ax.set_title('Conversion rates by Age & Marital Status')
ax.set_xlabel('age group')
ax.set_ylabel('conversion rate (%)')

plt.show()
```



In [ ]: