In [48]:
```
import numpy as np
import pandas as pd
import scipy.stats as sps
import statsmodels as sm
from statsmodels.sandbox.stats.multicomp import multipletests

import matplotlib.pyplot as plt
import seaborn as sns
sns.set(font_scale=1.3)

%matplotlib inline
```

Данные о внебрачных отношениях

Данные используются для объяснения распределения времени между работой, временем, проведенным с супругом/супругой, и временем, проведенным с любовником/любовницей.

http://www.statsmodels.org/stable/datasets/generated/fair.html
(http://www.statsmodels.org/stable/datasets/generated/fair.html)

Исследуем, как каждый фактор влияет на долю времени, проведенного во внебрачных отношениях.

```
Number of observations: 6366
Number of variables: 9
Variable name definitions:

    rate_marriage   : How rate marriage, 1 = very poor, 2 = poor, 3 = fair,
                      4 = good, 5 = very good
    age             : Age
    yrs_married     : No. years married. Interval approximations. See
                      original paper for detailed explanation.
    children        : No. children
    religious       : How relgious, 1 = not, 2 = mildly, 3 = fairly,
                      4 = strongly
    educ            : Level of education, 9 = grade school, 12 = high
                      school, 14 = some college, 16 = college graduate,
                      17 = some graduate school, 20 = advanced degree
    occupation      : 1 = student, 2 = farming, agriculture; semi-skilled,
                      or unskilled worker; 3 = white-colloar; 4 = teacher
                      counselor social worker, nurse; artist, writers;
                      technician, skilled worker, 5 = managerial,
                      administrative, business, 6 = professional with
                      advanced degree
    occupation_husb : Husband's occupation. Same as occupation.
    affairs         : measure of time spent in extramarital affairs

See the original paper for more details.
```

Посмотрим на данные. Все переменные, кроме `affairs` являются категориальными, а переменная `affairs` --- вещественной.

In [3]:
```
data = pd.DataFrame(sm.datasets.fair.load().data)
data.head()
```

Out[3]:

	rate_marriage	age	yrs_married	children	religious	educ	occupation	occupation_husb	affairs
0	3.0	32.0	9.0	3.0	3.0	17.0	2.0	5.0	0.111111
1	3.0	27.0	13.0	3.0	1.0	14.0	3.0	4.0	3.230769
2	4.0	22.0	2.5	0.0	1.0	16.0	3.0	5.0	1.400000
3	4.0	37.0	16.5	4.0	3.0	16.0	5.0	5.0	0.727273
4	5.0	27.0	9.0	1.0	1.0	14.0	3.0	4.0	4.666666

В данных у 2/3 людей вообще не было внебрачных отношений

In [4]:
```
(data['affairs'] == 0).mean()
```

Out[4]:
```
0.6775054979579014
```

У таких людей все хорошо, и мы их не рассматриваем, так что просто удалим их.

In [5]:
```
data = data[data['affairs'] > 0]
len(data)
```

Out[5]:
```
2053
```

Описательные статистики по времени во внебрачных отношениях по всем людям

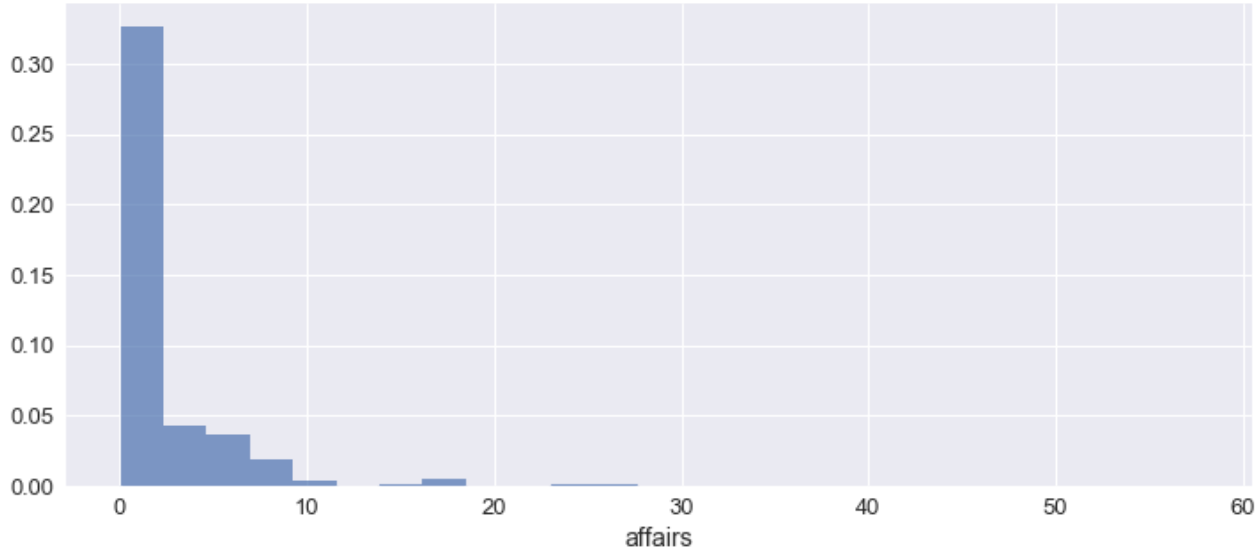
In [6]:
```
data['affairs'].describe()
```

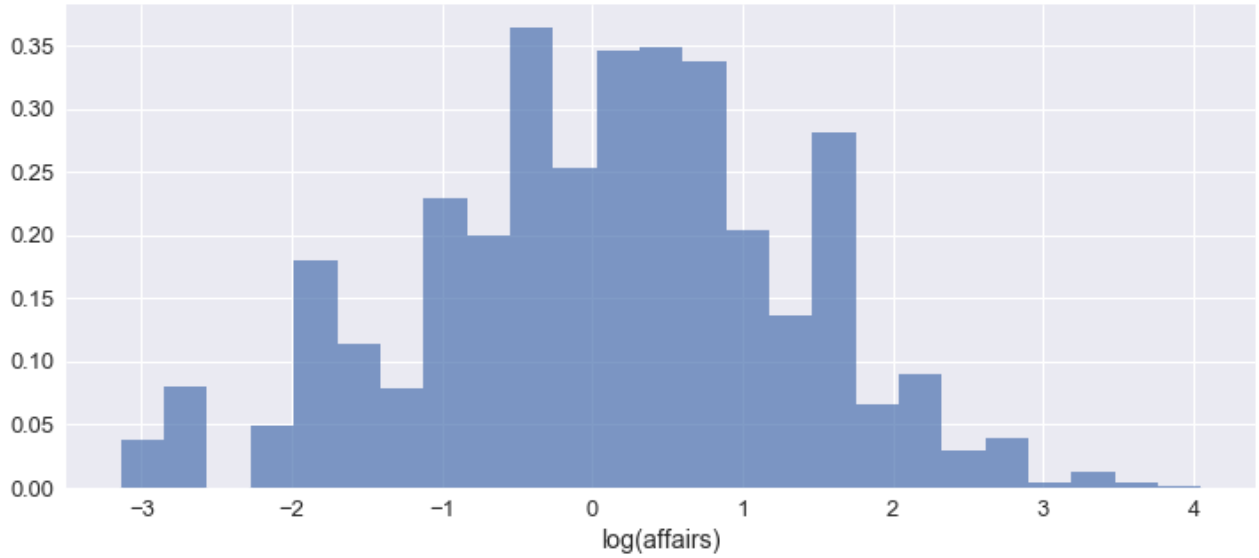
Out[6]:
```
count    2053.000000
mean        2.187243
std         3.437478
min         0.043478
25%         0.521739
50%         1.217391
75%         2.177776
max        57.599991
Name: affairs, dtype: float64
```

Посмотрим на гистограмму времени во внебрачных отношениях и на гистограмму логарифма этой величины

In [9]:

```
plt.figure(figsize=(12, 5))
plt.hist(data['affairs'], bins=25, alpha=0.7, normed=True)
plt.xlabel('affairs');

data['log(affairs)'] = np.log(data['affairs'])

plt.figure(figsize=(12, 5))
plt.hist(data['log(affairs)'], bins=25, alpha=0.7, normed=True)
plt.xlabel('log(affairs)');
```





Логарифм времени попахивает нормальностью судя по гистограмме, но критерий Шапиро-Уилка отвергает ее

In [10]:

```
sps.shapiro(data['log(affairs)'])
```

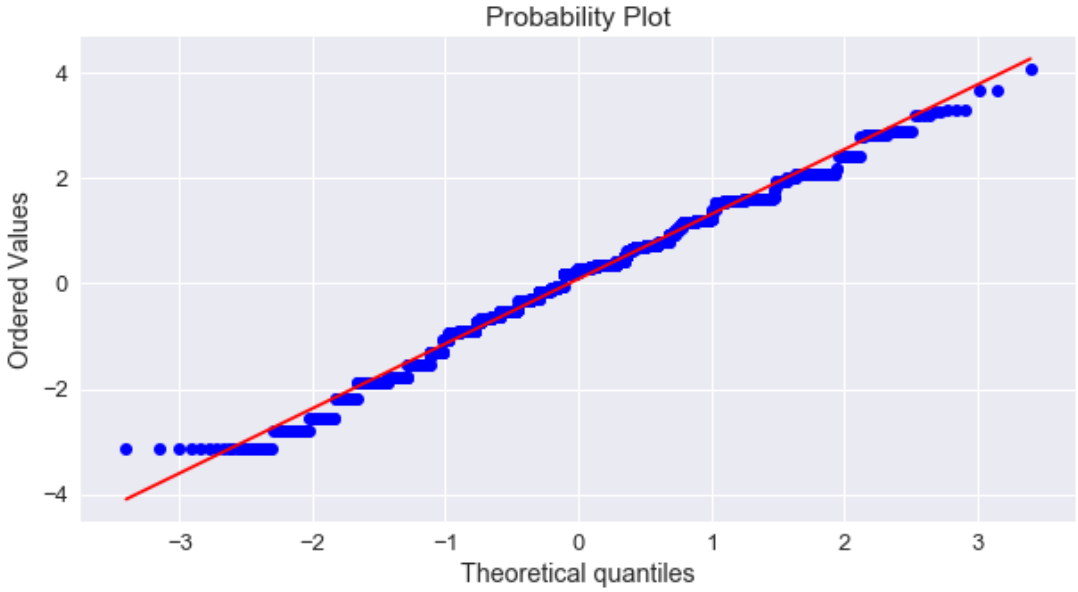
Out[10]:

```
(0.9899781942367554, 9.874644157914503e-11)
```

На QQ plot точки отдаленно расположены вдоль одной прямой

In [12]:

```
plt.figure(figsize=(10, 5))
ax = plt.subplot(111)
sps.probplot(data['log(affairs)'], plot=ax);
```



Анализ влияния факторов

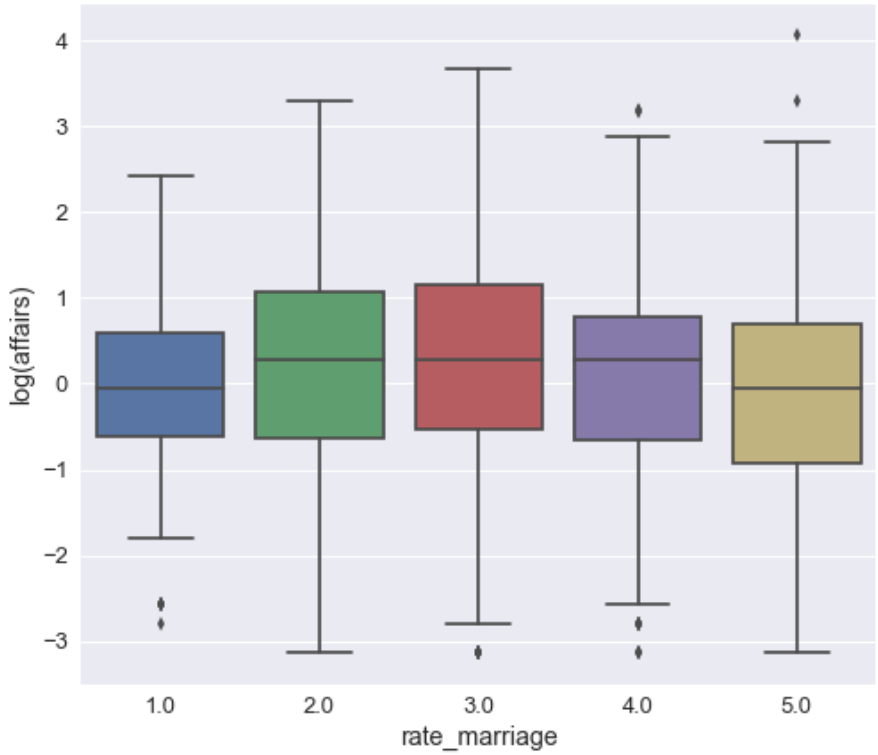
In [45]:

```
def analyse_factor(factor_name):
    print('Factor ' + factor_name)

    gb = data['affairs'].groupby(by=data[factor_name])
    samples = [np.array(group[1]) for group in gb]
    kruskal_result = sps.kruskal(*samples)
    print(kruskal_result)

    plt.figure(figsize=(8, 7))
    sns.boxplot(x=data[factor_name], y=data['log(affairs)'])
    plt.show()

    return kruskal_result.pvalue
```

In [46]:

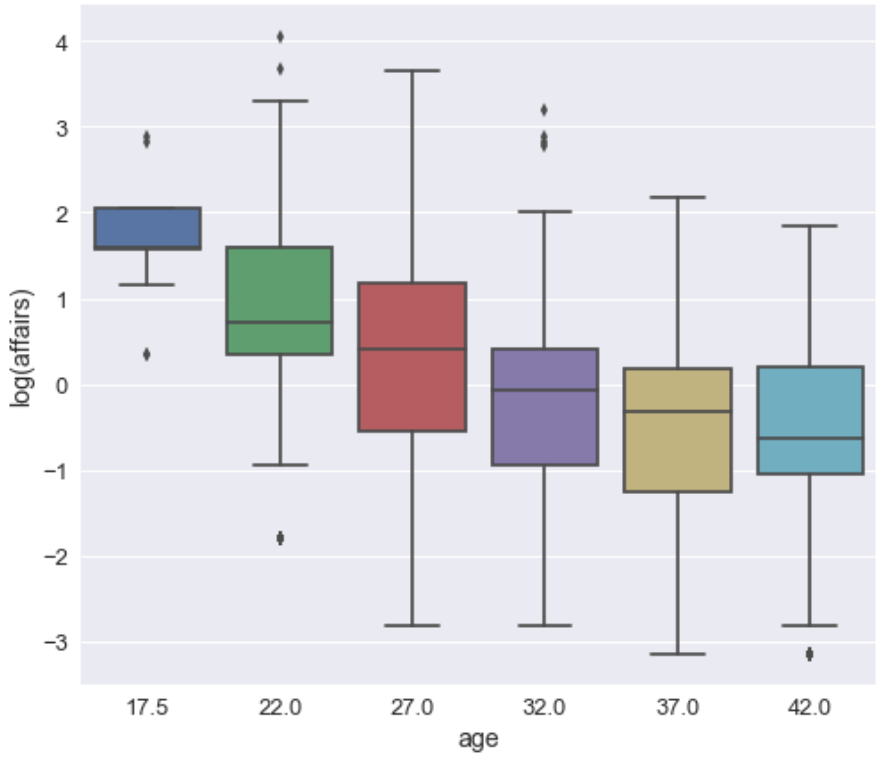
```
result = pd.DataFrame(columns=['factor', 'pvalue'])

for factor_name in ['rate_marriage', 'age', 'yrs_married',
                    'children', 'religious', 'educ', 'occupation']:
    pvalue = analyse_factor(factor_name)
    result = result.append({'factor': factor_name, 'pvalue': pvalue}, ignore_inde
    print('\n==================================================================\n')
```

```
Factor rate_marriage
KruskalResult(statistic=18.79797401228851, pvalue=0.0008611183487432226)
```



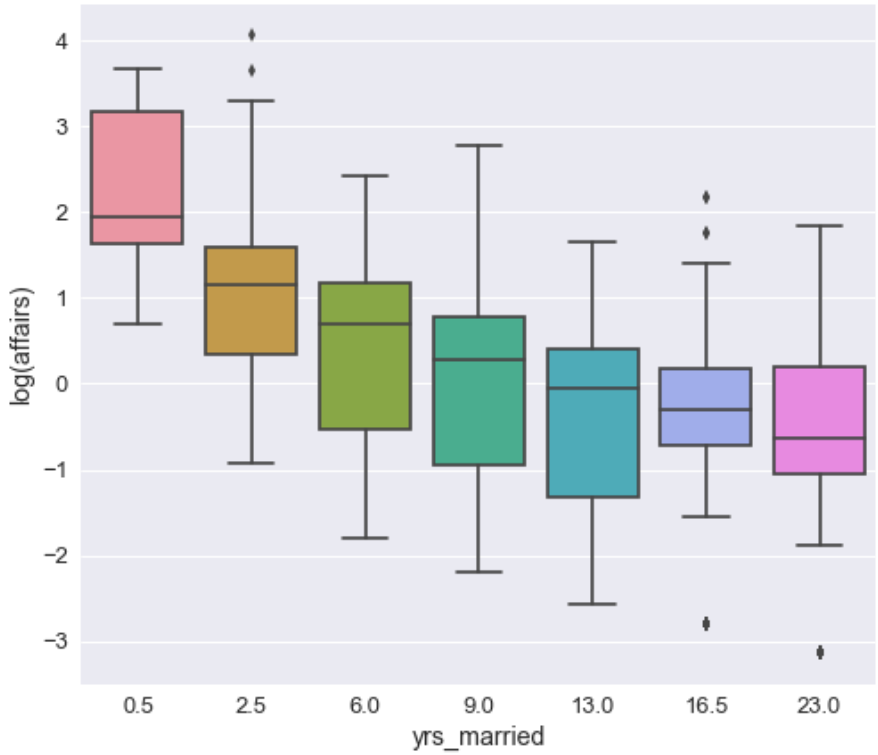

```
==================================================================
```

```
Factor age
KruskalResult(statistic=366.92107249211216, pvalue=3.974891144400868e-77)
```



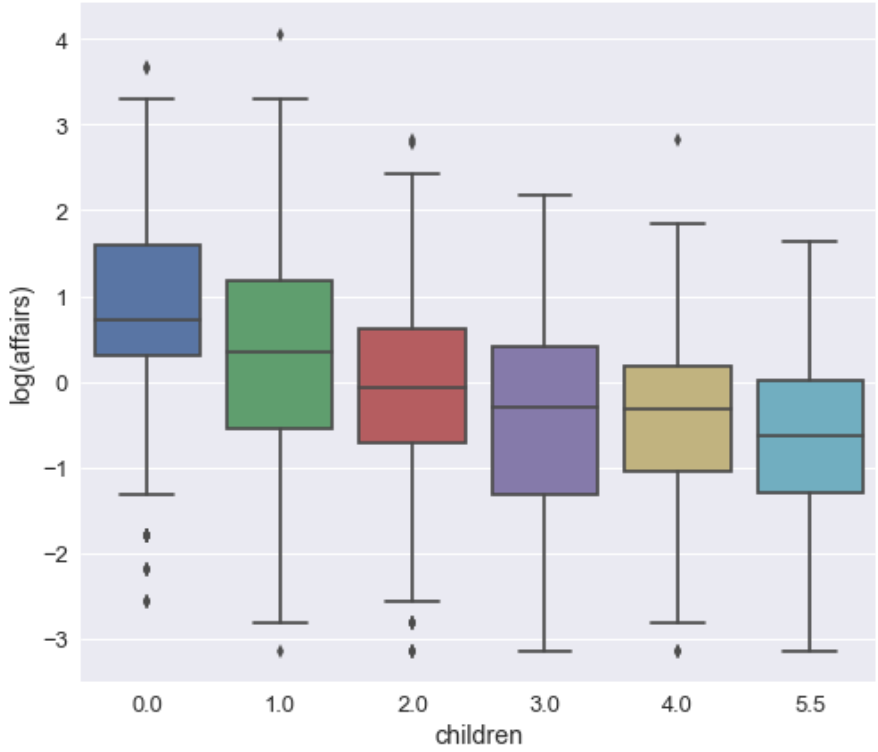

```
==================================================================
```

```
Factor yrs_married
KruskalResult(statistic=465.6566234684575, pvalue=2.0927681559863934e-97)
```



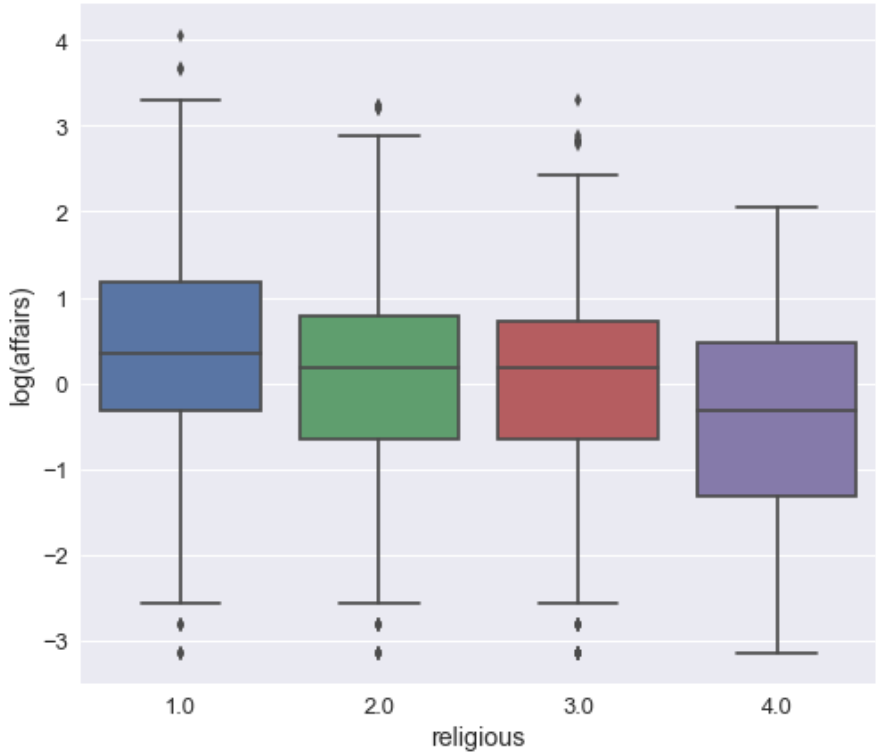

```
================================================================
```

```
Factor children
KruskalResult(statistic=313.2218528260669, pvalue=1.437105588563059e-65)
```



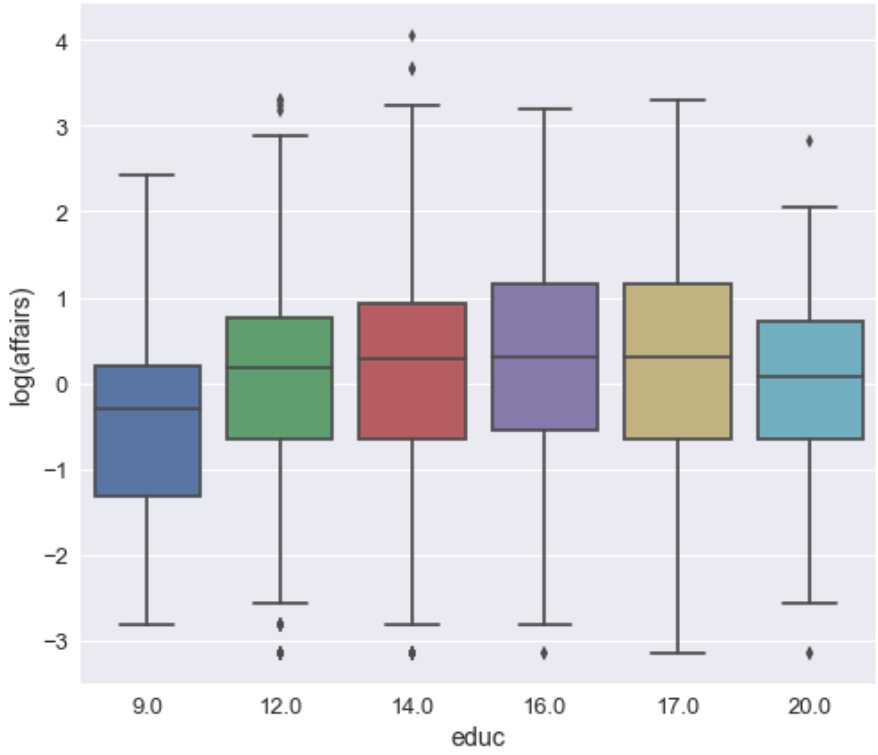

```
================================================================
```

```
Factor religious
KruskalResult(statistic=44.566982906003965, pvalue=1.1436297209005018e-09)
```



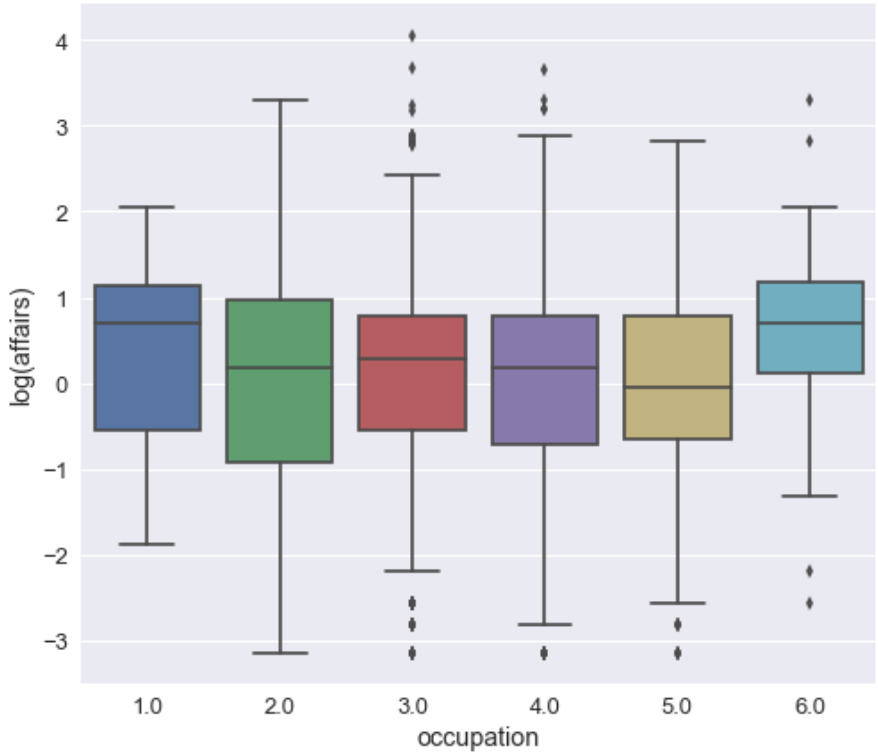
==========

Factor educ
KruskalResult(statistic=12.061049042219755, pvalue=0.03396077556581535)



==========

Factor occupation
KruskalResult(statistic=10.43824253852124, pvalue=0.06372848246987972)



==========

In [50]:
```
result['pvalue corrected'] = multipletests(result['pvalue'], method='holm')[1]
result['reject'] = result['pvalue corrected'] < 0.05

result
```

Out[50]:

	factor	pvalue	pvalue corrected	reject
0	rate_marriage	8.611183e-04	2.583355e-03	True
1	age	3.974891e-77	2.384935e-76	True
2	yrs_married	2.092768e-97	1.464938e-96	True
3	children	1.437106e-65	7.185528e-65	True
4	religious	1.143630e-09	4.574519e-09	True
5	educ	3.396078e-02	6.792155e-02	False
6	occupation	6.372848e-02	6.792155e-02	False

Прикладная статистика и анализ данных, 2019

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https://mipt-stats.gitlab.io/ (https://mipt-stats.gitlab.io/)