Pingouin

- Pingouin is an open-source statistical package written in Python 3 and based mostly on Pandas and NumPy. Some of its main features are listed below.

```
1. ANOVAs: N-ways, repeated measures, mixed, ancova

2. Pairwise post-hocs tests (parametric and non-parametric) and pairwise corr
elations

3. Robust, partial, distance and repeated measures correlations

4. Linear/logistic regression and mediation analysis

5. Bayes Factors

6. Multivariate tests

7. Reliability and consistency

8. Effect sizes and power analysis

9. Parametric/bootstrapped confidence intervals around an effect size or a co
rrelation coefficient

10. Circular statistics

11. Chi-squared tests

12. Plotting: Bland-Altman plot, Q-Q plot, paired plot, robust correlation…
```

In [1]:

```
! pip install pingouin
```

```
Collecting pingouin
  Downloading pingouin-0.3.11.tar.gz (204 kB)
Requirement already satisfied: numpy>=1.15 in c:\users\dell\appdata\roaming
\python\python37\site-packages (from pingouin) (1.19.5)
Requirement already satisfied: scipy>=1.3 in c:\users\dell\appdata\roaming\p
ython\python37\site-packages (from pingouin) (1.6.0)
Requirement already satisfied: pandas>=0.24 in c:\users\dell\appdata\roaming
\python\python37\site-packages (from pingouin) (0.24.2)
Requirement already satisfied: matplotlib>=3.0.2 in c:\users\dell\appdata\ro
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Requirement already satisfied: seaborn>=0.9.0 in c:\users\dell\appdata\roami
ng\python\python37\site-packages (from pingouin) (0.11.1)
Requirement already satisfied: statsmodels>=0.10.0 in c:\programdata\anacond
a3\lib\site-packages (from pingouin) (0.11.0)
Requirement already satisfied: scikit-learn in c:\users\dell\appdata\roaming
\python\python37\site-packages (from pingouin) (0.24.0)
Collecting pandas_flavor>=0.1.2
  Downloading pandas_flavor-0.2.0-py2.py3-none-any.whl (6.6 kB)
Collecting outdated
  Downloading outdated-0.2.1-py3-none-any.whl (7.5 kB)
Requirement already satisfied: tabulate in c:\users\dell\appdata\roaming\pyt
hon\python37\site-packages (from pingouin) (0.8.7)
Requirement already satisfied: pytz>=2011k in c:\programdata\anaconda3\lib\s
ite-packages (from pandas>=0.24->pingouin) (2019.3)
Requirement already satisfied: python-dateutil>=2.5.0 in c:\programdata\anac
onda3\lib\site-packages (from pandas>=0.24->pingouin) (2.8.1)
Requirement already satisfied: pillow>=6.2.0 in c:\users\dell\appdata\roamin
g\python\python37\site-packages (from matplotlib>=3.0.2->pingouin) (8.1.0)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.3 in
c:\programdata\anaconda3\lib\site-packages (from matplotlib>=3.0.2->pingoui
n) (2.4.6)
Requirement already satisfied: cycler>=0.10 in c:\programdata\anaconda3\lib
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Requirement already satisfied: kiwisolver>=1.0.1 in c:\programdata\anaconda3
\lib\site-packages (from matplotlib>=3.0.2->pingouin) (1.1.0)
Requirement already satisfied: patsy>=0.5 in c:\programdata\anaconda3\lib\si
te-packages (from statsmodels>=0.10.0->pingouin) (0.5.1)
Requirement already satisfied: joblib>=0.11 in c:\programdata\anaconda3\lib
\site-packages (from scikit-learn->pingouin) (0.14.1)
Requirement already satisfied: threadpoolctl>=2.0.0 in c:\programdata\anacon
da3\lib\site-packages (from scikit-learn->pingouin) (2.1.0)
Collecting xarray
  Downloading xarray-0.17.0-py3-none-any.whl (759 kB)
Collecting littleutils
  Downloading littleutils-0.2.2.tar.gz (6.6 kB)
Requirement already satisfied: requests in c:\users\dell\appdata\roaming\pyt
hon\python37\site-packages (from outdated->pingouin) (2.25.1)
Requirement already satisfied: six>=1.5 in c:\users\dell\appdata\roaming\pyt
hon\python37\site-packages (from python-dateutil>=2.5.0->pandas>=0.24->pingo
uin) (1.12.0)
Requirement already satisfied: setuptools in c:\programdata\anaconda3\lib\si
te-packages (from kiwisolver>=1.0.1->matplotlib>=3.0.2->pingouin) (45.2.0.po
st20200210)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in c:\programdata\anaco
nda3\lib\site-packages (from requests->outdated->pingouin) (1.25.8)
Requirement already satisfied: chardet<5,>=3.0.2 in c:\programdata\anaconda3
\lib\site-packages (from requests->outdated->pingouin) (3.0.4)
```

```
Requirement already satisfied: idna<3,>=2.5 in c:\programdata\anaconda3\lib
\site-packages (from requests->outdated->pingouin) (2.8)
Requirement already satisfied: certifi>=2017.4.17 in c:\programdata\anaconda
3\lib\site-packages (from requests->outdated->pingouin) (2019.11.28)
Building wheels for collected packages: pingouin, littleutils
  Building wheel for pingouin (setup.py): started
  Building wheel for pingouin (setup.py): finished with status 'done'
  Created wheel for pingouin: filename=pingouin-0.3.11-py3-none-any.whl size
=203323 sha256=b6698734317a92e88d5f566854199b53848531ef8cd52340a86429468c3db
0ca
  Stored in directory: c:\users\dell\appdata\local\pip\cache\wheels\74\6d\d2
\9320ff7695f6983f4394c10630792f4bd4c8351facfd39b649
  Building wheel for littleutils (setup.py): started
  Building wheel for littleutils (setup.py): finished with status 'done'
  Created wheel for littleutils: filename=littleutils-0.2.2-py3-none-any.whl
size=7048 sha256=19adffaa8ab2ff858f0c32766300a90779b8904d0ff49e4af178858ab38
8aa05
  Stored in directory: c:\users\dell\appdata\local\pip\cache\wheels\d6\64\cd
\32819b511a488e4993f2fab909a95330289c3f4e0f6ef4676d
Successfully built pingouin littleutils
Installing collected packages: xarray, pandas-flavor, littleutils, outdated,
pingouin
Successfully installed littleutils-0.2.2 outdated-0.2.1 pandas-flavor-0.2.0
pingouin-0.3.11 xarray-0.17.0

ERROR: xarray 0.17.0 has requirement pandas>=0.25, but you'll have pandas 0.
24.2 which is incompatible.
```

1. T-test

In [2]:

```
import numpy as np
import pingouin as pg

np.random.seed(123)
mean, cov, n = [4, 5], [(1, .6), (.6, 1)], 30

x, y = np.random.multivariate_normal(mean, cov, n).T

# T-test
pg.ttest(x, y)
```

Out[2]:

	T	dof	tail	p-val	CI95%	cohen-d	BF10	power
T-test	-3.400706	58	two-sided	0.001222	[-1.68, -0.43]	0.878059	26.155	0.916807

2. Pearson’s correlation

In [3]:

```
pg.corr(x, y)
```

Out[3]:

	n	r	CI95%	r2	adj_r2	p-val	BF10	power
pearson	30	0.594785	[0.3, 0.79]	0.353769	0.3059	0.000527	69.723	0.950373

3. Test the normality of the data

In [4]:

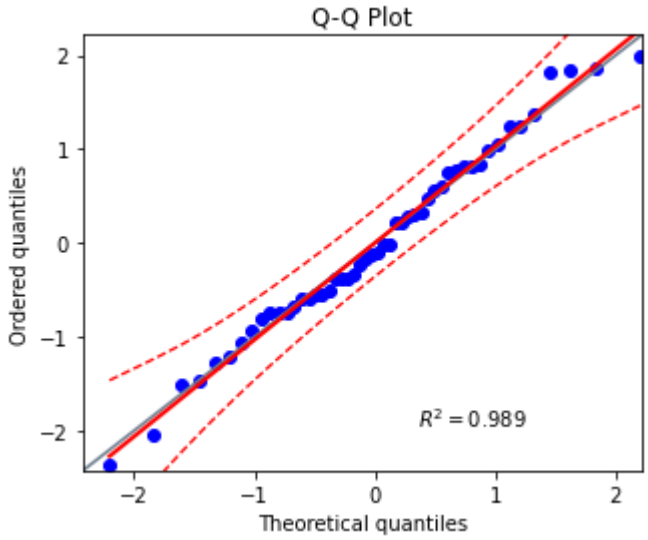
```
print(pg.normality(x))                                          # Univariate normality
print(pg.multivariate_normality(np.column_stack((x, y)))) # Multivariate normality
```

```
          W      pval  normal
0  0.985831  0.950477    True
HZResults(hz=0.32439653736062, pval=0.7523511059223205, normal=True)
```

4. Q-Q plot

In [5]:

```
np.random.seed(123)
x = np.random.normal(size=50)
ax = pg.qqplot(x, dist='norm')
```



Anova

One-way ANOVA

In [6]:

```
# Read an example dataset
df = pg.read_dataset('mixed_anova')

# Run the ANOVA
aov = pg.anova(data=df, dv='Scores', between='Group', detailed=True)
print(aov)
```

```
   Source          SS   DF        MS         F   p-unc       np2
0   Group    5.459963    1  5.459963  5.243656  0.0232  0.028616
1  Within  185.342729  178  1.041251       NaN     NaN       NaN
```

Repeated measures ANOVA

In [7]:

```
pg.rm_anova(data=df, dv='Scores', within='Time', subject='Subject', detailed=True)
```

Out[7]:

	Source	SS	DF	MS	F	p-unc	np2	eps
0	Time	7.628428	2	3.814214	3.912796	0.022629	0.062194	0.998751
1	Error	115.027023	118	0.974805	NaN	NaN	NaN	NaN

Two-way mixed ANOVA

In [8]:

```
# Compute the two-way mixed ANOVA and export to a .csv file
aov = pg.mixed_anova(data=df, dv='Scores', between='Group', within='Time',
                     subject='Subject', correction=False, effsize="np2")
pg.print_table(aov)
```

```
=============
ANOVA SUMMARY
=============

Source          SS    DF1    DF2     MS      F    p-unc    np2      eps
-----------  -----  -----  -----  -----  -----  -------  -----  -------
Group        5.460      1     58  5.460  5.052    0.028  0.080  nan
Time         7.628      2    116  3.814  4.027    0.020  0.065    0.999
Interaction  5.167      2    116  2.584  2.728    0.070  0.045  nan
```

Multiple linear regression

Boston housing dataset

In [9]:

```
from sklearn.datasets import load_boston

X, y = load_boston(return_X_y=True)
```

In [10]:

```
pg.linear_regression(X, y)
```

Out[10]:

	names	coef	se	T	pval	r2	adj_r2	CI[2.5%]	CI[97
0	Intercept	36.459488	5.103459	7.144074	3.283439e-12	0.740643	0.73379	26.432226	46.48
1	x1	-0.108011	0.032865	-3.286517	1.086810e-03	0.740643	0.73379	-0.172584	-0.04
2	x2	0.046420	0.013727	3.381576	7.781097e-04	0.740643	0.73379	0.019449	0.07
3	x3	0.020559	0.061496	0.334310	7.382881e-01	0.740643	0.73379	-0.100268	0.14
4	x4	2.686734	0.861580	3.118381	1.925030e-03	0.740643	0.73379	0.993904	4.37
5	x5	-17.766611	3.819744	-4.651257	4.245644e-06	0.740643	0.73379	-25.271634	-10.26
6	x6	3.809865	0.417925	9.116140	1.979441e-18	0.740643	0.73379	2.988727	4.63
7	x7	0.000692	0.013210	0.052402	9.582293e-01	0.740643	0.73379	-0.025262	0.02
8	x8	-1.475567	0.199455	-7.398004	6.013491e-13	0.740643	0.73379	-1.867455	-1.08
9	x9	0.306049	0.066346	4.612900	5.070529e-06	0.740643	0.73379	0.175692	0.43
10	x10	-0.012335	0.003761	-3.280009	1.111637e-03	0.740643	0.73379	-0.019723	-0.00
11	x11	-0.952747	0.130827	-7.282511	1.308835e-12	0.740643	0.73379	-1.209795	-0.69
12	x12	0.009312	0.002686	3.466793	5.728592e-04	0.740643	0.73379	0.004034	0.01
13	x13	-0.524758	0.050715	-10.347146	7.776912e-23	0.740643	0.73379	-0.624404	-0.42

These Are Some Exmple Of pingouin https://pingouin-stats.org/ (https://pingouin-stats.org/)