Course Code 009959 (Spring 2019)

Probability and Statistics with Programming

Test of Hypothesis Based On Two Sample

(Python Views)

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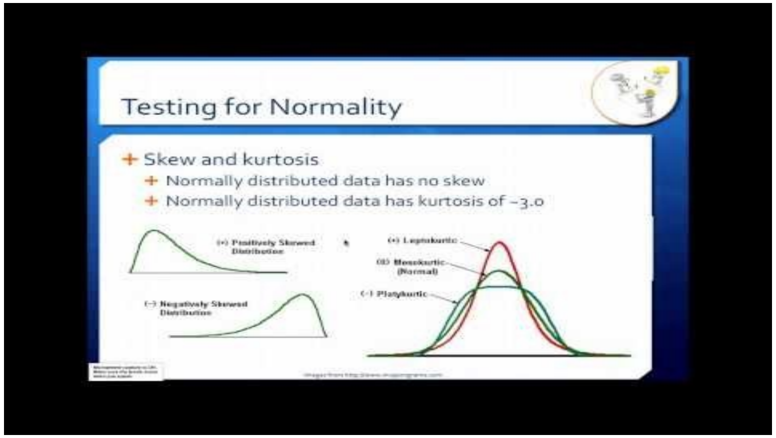
Several methods to test for normality

- Histogram
- Skew and kurtosis
- Probability plots
- Chi-square goodness of fit

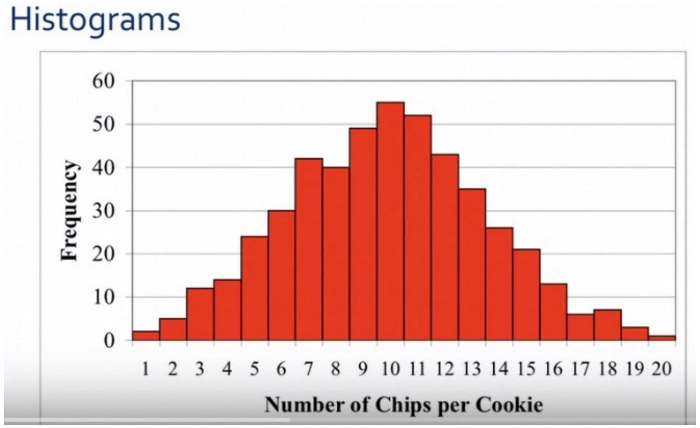
https://youtu.be/72WaWC7Lgjo



Testing for Normality

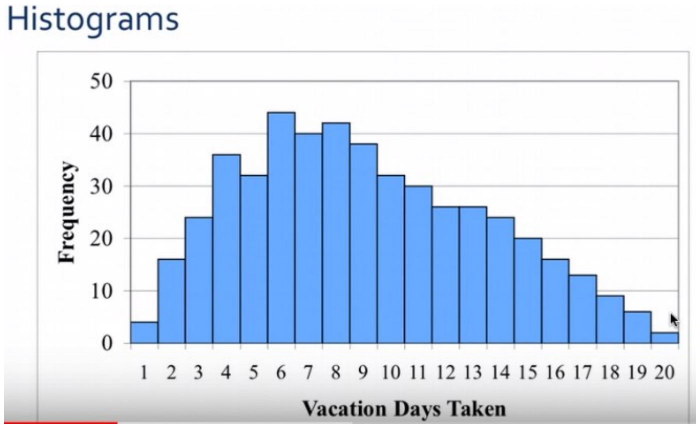
- Skew and kurtosis
  - Normally distributed data has no skew
  - Normally distributed data has kurtosis of –3.0

(+) Positively Skewed Distribution
(–) Negatively Skewed Distribution
(+) Leptokurtic
(0) Mesokurtic (Normal)
(–) Platykurtic

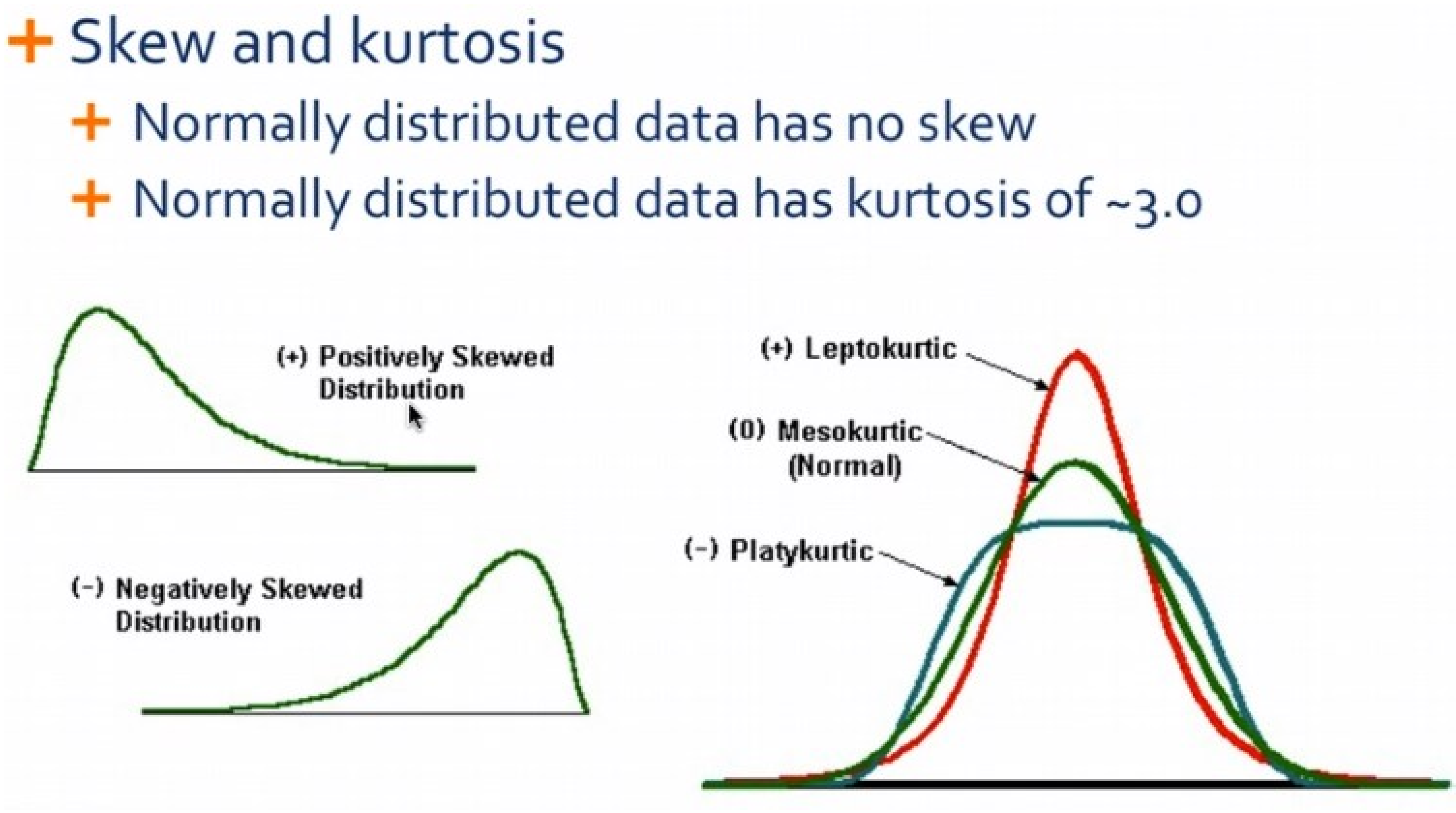


Histograms

data.plot(kind='hist')



Histograms

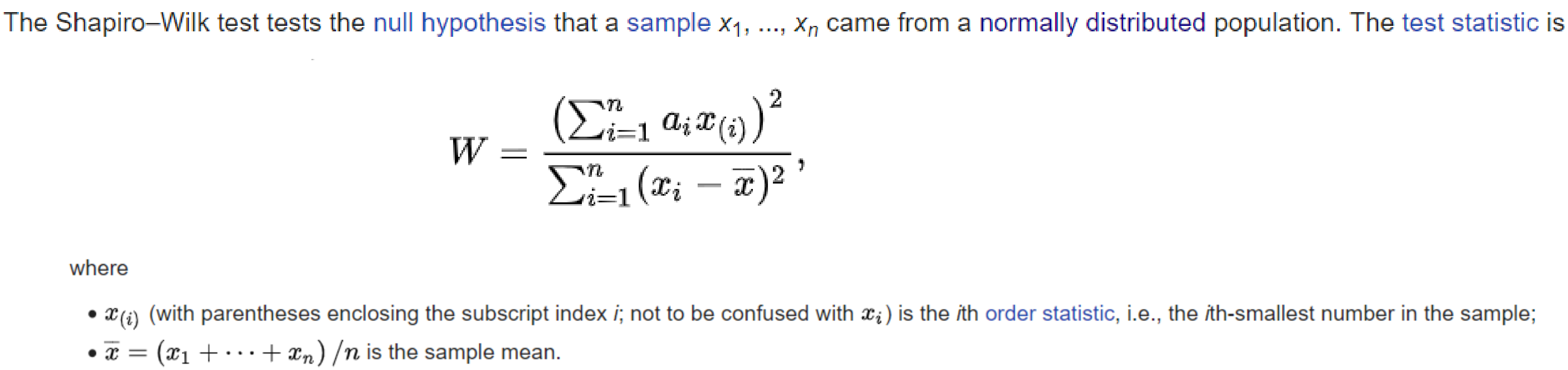


- Skew and kurtosis
  - Normally distributed data has no skew
  - Normally distributed data has kurtosis of ~3.0

(+) Positively Skewed Distribution
(−) Negatively Skewed Distribution
(+) Leptokurtic
(0) Mesokurtic (Normal)
(−) Platykurtic

The *excess kurtosis* is defined as kurtosis minus 3.

Shapiro–Wilk test

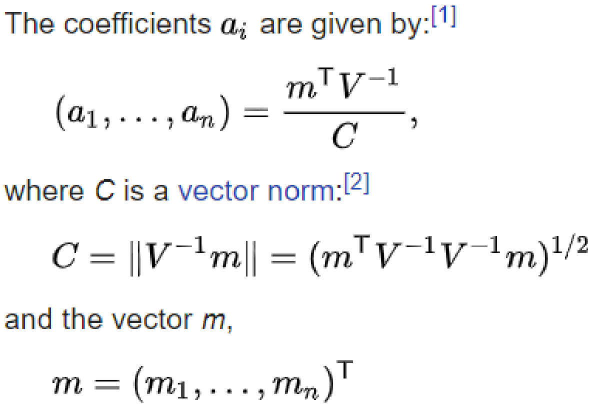


The Shapiro–Wilk test tests the null hypothesis that a sample $x_1, \ldots, x_n$ came from a normally distributed population. The test statistic is

$$W = \frac{\left(\sum_{i=1}^{n} a_i x_{(i)}\right)^2}{\sum_{i=1}^{n} (x_i - \overline{x})^2},$$

where

- $x_{(i)}$ (with parentheses enclosing the subscript index *i*; not to be confused with x_i) is the *i*th order statistic, i.e., the *i*th-smallest number in the sample;
- $\overline{x} = \left(x_1 + \cdots + x_n\right)/n$ is the sample mean.



The coefficients a_i are given by:[1]

$$(a_1, \ldots, a_n) = \frac{m^{\mathsf{T}} V^{-1}}{C},$$

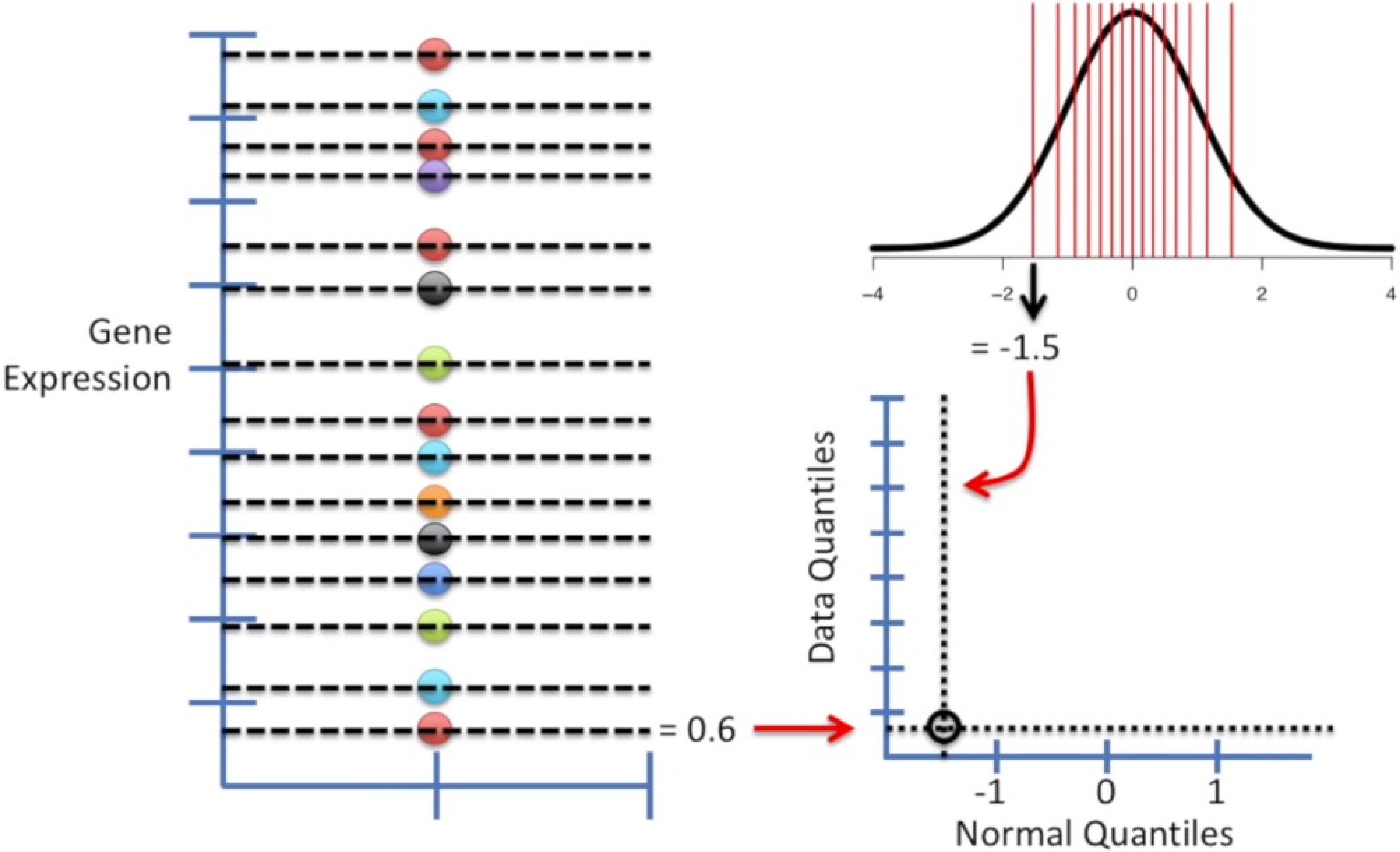
where *C* is a vector norm:[2]

$$C = \|V^{-1} m\| = (m^{\mathsf{T}} V^{-1} V^{-1} m)^{1/2}$$

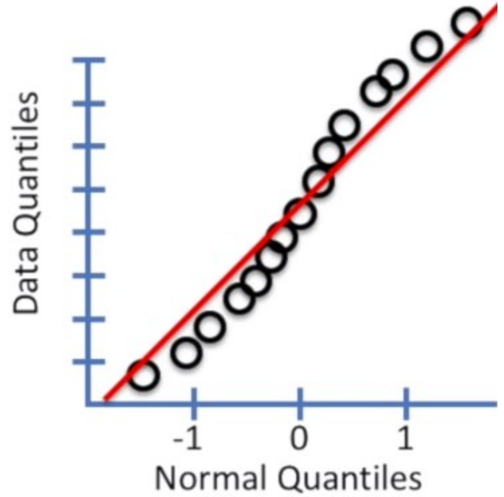
and the vector *m*,

$$m = (m_1, \ldots, m_n)^{\mathsf{T}}$$

stats.shapiro(data)

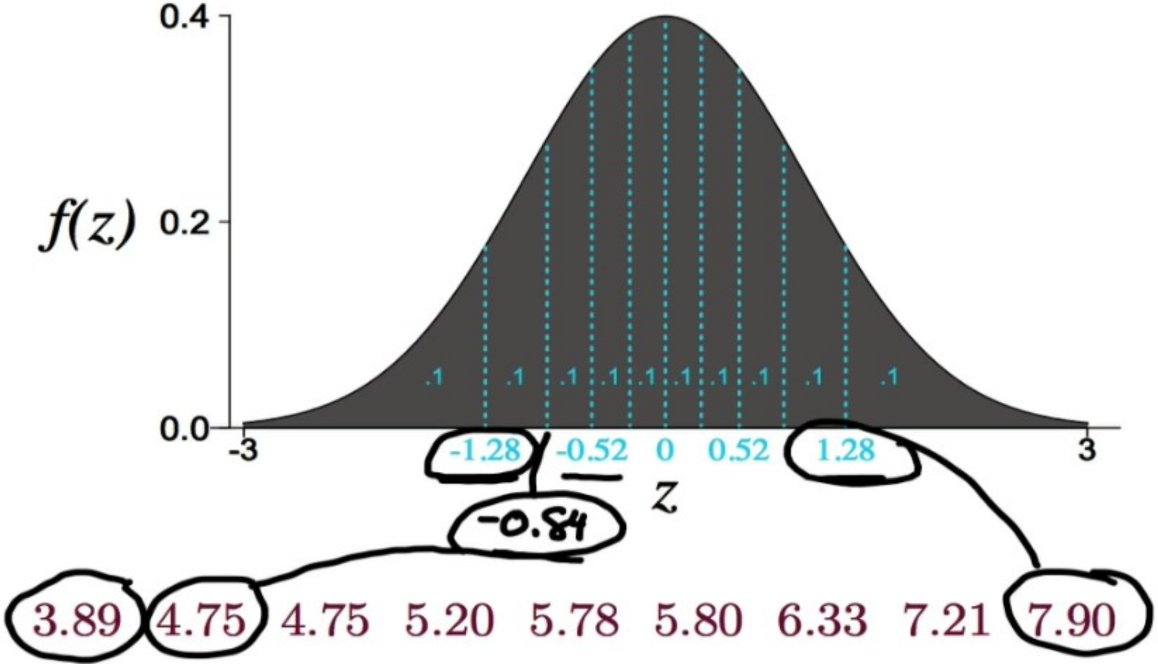


Quantile-Quantile Plots (QQ plots)



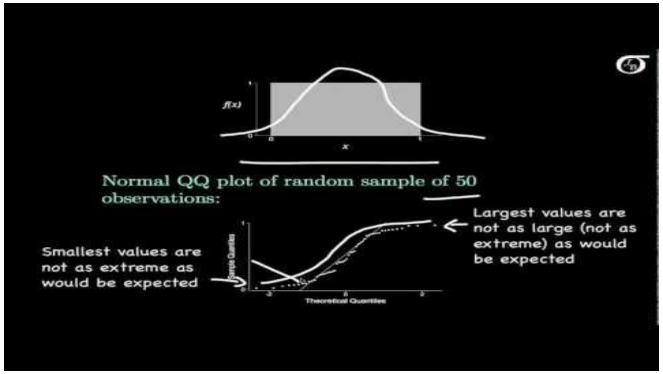
https://youtu.be/okjYjClSjOg

Quantile-Quantile Plots (QQ plots)



```
stats.probplot(data,dist=st.norm,sparams=(0,1),plot=plt);
```

https://youtu.be/X9_ISJ0YpGw


Normal QQ plot of random sample of 50 observations:

Smallest values are not as extreme as would be expected

Largest values are not as large (not as extreme) as would be expected

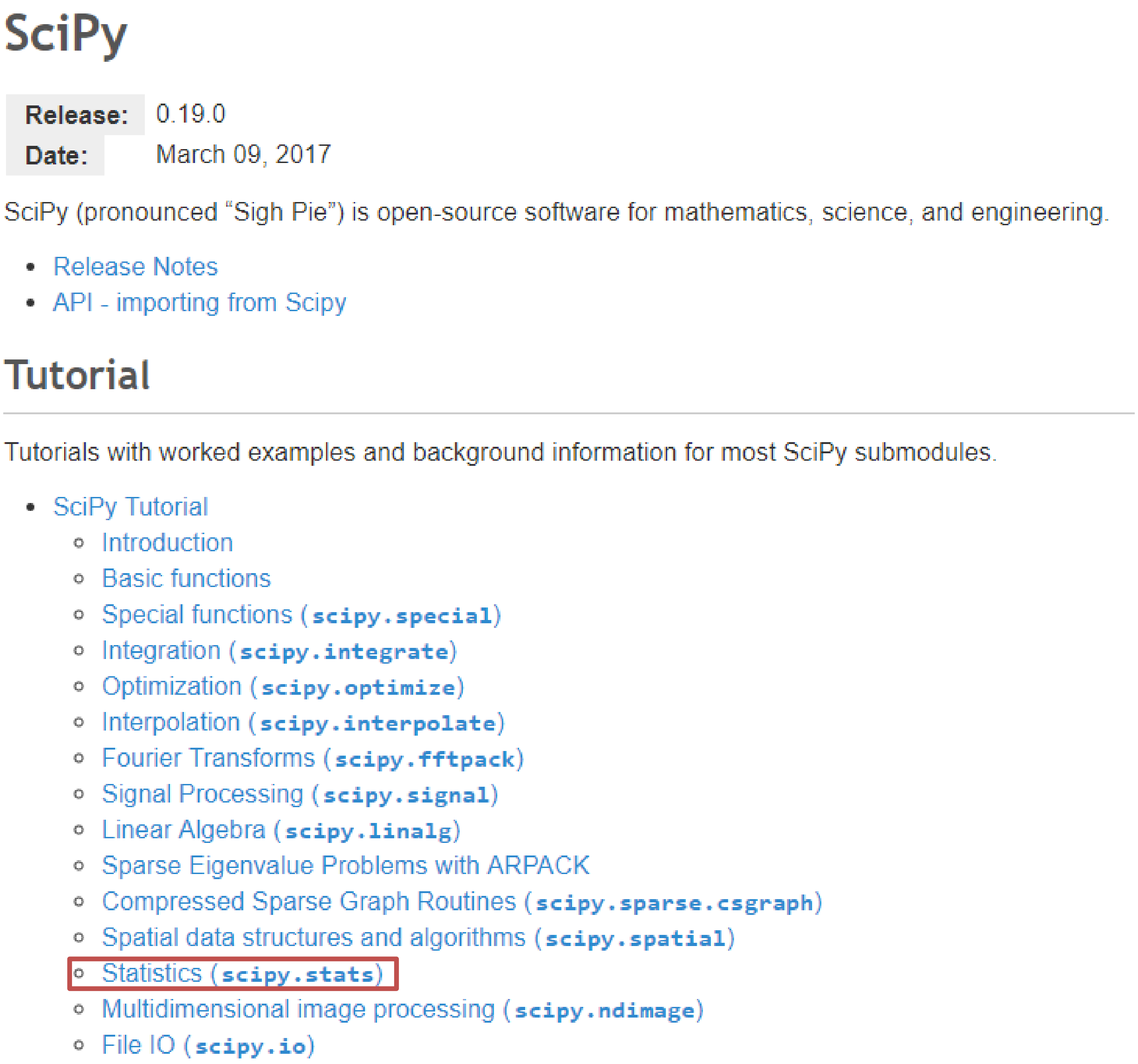
The Unpaired t Test and The Paired t Test requires data to be normally distributed

So, we will perform normality test of the data before we perform t Test

```
stats.ttest_ind(data1, data2)
```

```
stats.ttest_rel(data1, data2)
```

https://pythonfordatascience.org/paired-samples-t-test-python/



SciPy

Release:	0.19.0
Date:	March 09, 2017

SciPy (pronounced “Sigh Pie”) is open-source software for mathematics, science, and engineering.

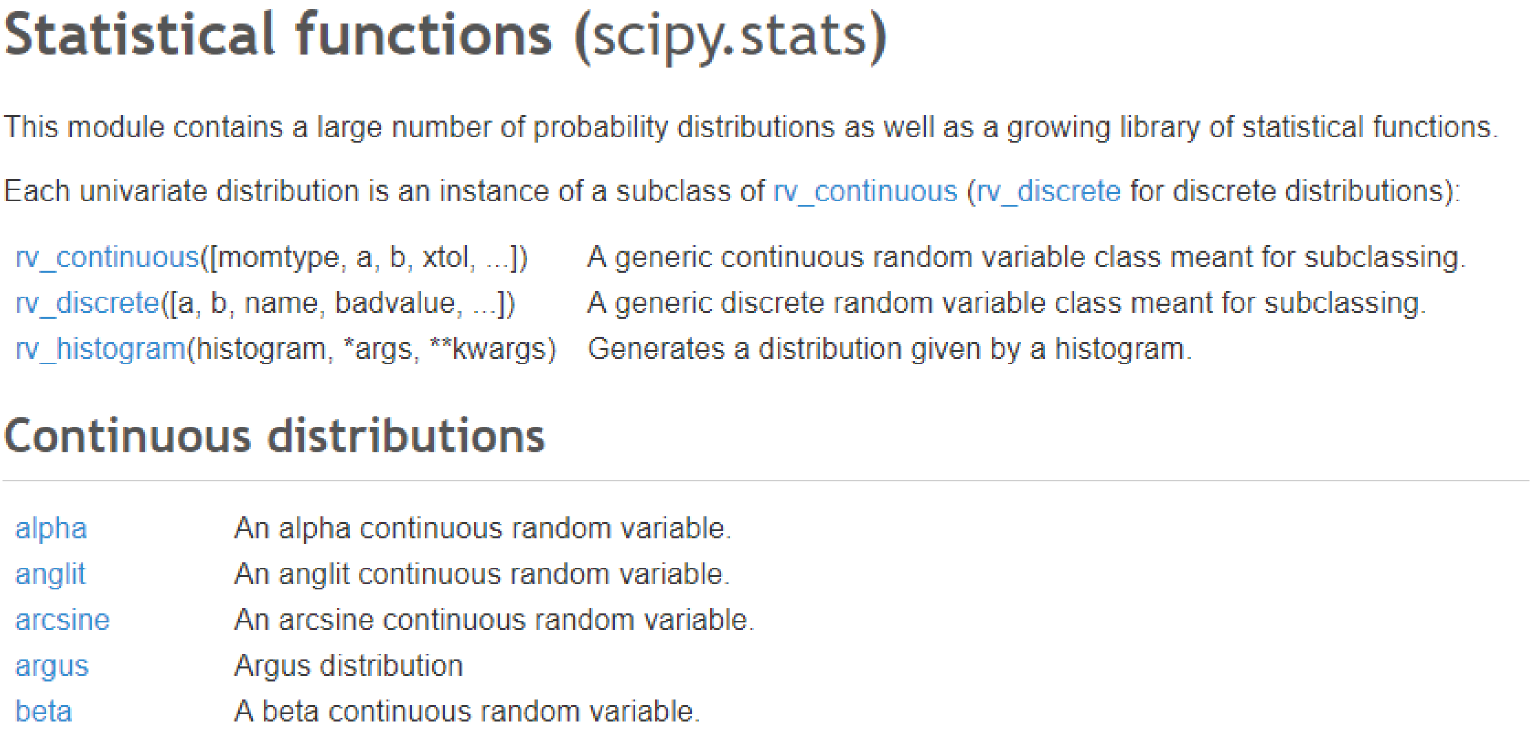
- Release Notes
- API - importing from Scipy

Tutorial

Tutorials with worked examples and background information for most SciPy submodules.

- SciPy Tutorial
  - Introduction
  - Basic functions
  - Special functions (`scipy.special`)
  - Integration (`scipy.integrate`)
  - Optimization (`scipy.optimize`)
  - Interpolation (`scipy.interpolate`)
  - Fourier Transforms (`scipy.fftpack`)
  - Signal Processing (`scipy.signal`)
  - Linear Algebra (`scipy.linalg`)
  - Sparse Eigenvalue Problems with ARPACK
  - Compressed Sparse Graph Routines (`scipy.sparse.csgraph`)
  - Spatial data structures and algorithms (`scipy.spatial`)
  - Statistics (`scipy.stats`)
  - Multidimensional image processing (`scipy.ndimage`)
  - File IO (`scipy.io`)

https://docs.scipy.org/doc/scipy-0.19.0/reference/index.html



Statistical functions (scipy.stats)

This module contains a large number of probability distributions as well as a growing library of statistical functions.

Each univariate distribution is an instance of a subclass of rv_continuous (rv_discrete for discrete distributions):

rv_continuous([momtype, a, b, xtol, ...])	A generic continuous random variable class meant for subclassing.
rv_discrete([a, b, name, badvalue, ...])	A generic discrete random variable class meant for subclassing.
rv_histogram(histogram, *args, **kwargs)	Generates a distribution given by a histogram.

Continuous distributions

alpha	An alpha continuous random variable.
anglit	An anglit continuous random variable.
arcsine	An arcsine continuous random variable.
argus	Argus distribution
beta	A beta continuous random variable.

https://docs.scipy.org/doc/scipy-0.19.0/reference/stats.html#module-scipy.stats

Q&A