

The powerLaw package: Comparing distributions

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The `powerLaw` package provides an easy to use interface for fitting and visualising heavy tailed distributions, including power-laws. This vignette provides examples of comparing competing distributions.

1 Comparing distributions

This short vignette aims to provide some guidance when comparing distributions using Vuong's test statistic. The hypothesis being tested is

H_0 : Both distributions are equally far from the true distribution

and

H_1 : One of the test distributions is closer to the true distribution.

To perform this test we use the `compare_distributions` function¹ and examine the `p_two_sided` value.

2 Example: Simulated data 1

First let's generate some data from a power-law distribution

```
library("powerLaw")
set.seed(1)
x = rpldis(10000, xmin=2, alpha=2.1)
```

and fit a discrete power-law distribution

```
m1 = displ$new(x)
m1$setPars(estimate_pars(m1))
```

The estimated values of x_{\min} and α are 2 and 2.09, respectively. As an alternative distribution, we will fit a discrete log-normal distribution²

¹The `compare_distributions` function also returns a one sided p -value. Essentially, the one side p -value is testing whether the first model is better than the second, i.e. a **one** sided test.

²When comparing distributions, each model must have the same x_{\min} value. In this example, both models have $x_{\min} = 2$.

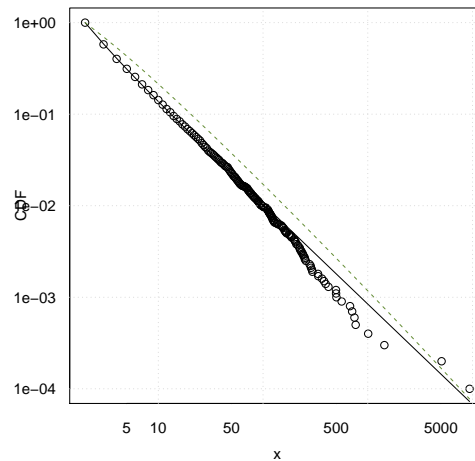


Figure 1: Plot of the simulated data CDF, with power law and log normal lines of best fit.

```
m2 = dislnorm$new(x)
m2$setPars(estimate_pars(m2))
```

Plotting both models

```
plot(m2, ylab="CDF")
lines(m1)
lines(m2, col=2, lty=2)
```

suggests that the power-law model gives a better fit (figure 1). Investigating this formally

```
comp = compare_distributions(m1, m2)
comp$p_two_sided

## [1] 0.005119439
```

means we can reject H_0 since $p = 0.005119$ and conclude that one model is closer to the true distribution.

One or two-sided p -value

The two-sided p -value does not depend on the order of the model comparison

```
## [1] 0.005119439
## [1] 0.005119439
```

However, the one-sided p -value is order dependent

```
## [1] 0.002559719
## [1] 0.9974403
```

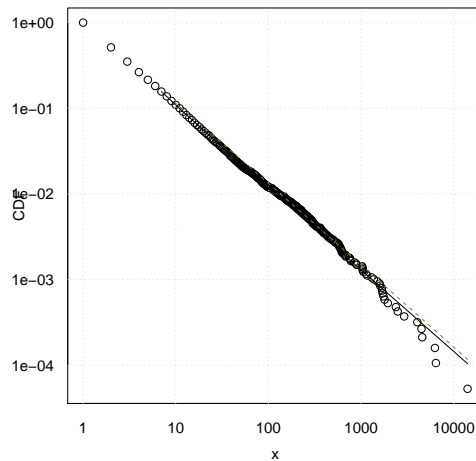


Figure 2: The Moby Dick data set with power law and log normal lines of best fit.

3 Example: Moby Dick data set

This time we will look at the Moby Dick data set

```
data("moby")
```

Again we fit a power law

```
m1 = displ$new(moby)
m1$setXmin(estimate_xmin(m1))
```

and a log-normal model³

```
m2 = dislnorm$new(moby)
m2$setXmin(m1$getXmin())
m2$setPars(estimate_pars(m2))
```

Plotting the CDFs

```
plot(m2, ylab="CDF")
lines(m1)
lines(m2, col=2, lty=2)
```

suggests that both models perform equally well (figure 2). The formal hypothesis test

```
comp = compare_distributions(m1, m2)
```

gives a p -value and test statistic of

```
comp$p_two_sided
## [1] 0.6823925
comp$test_statistic
## [1] 0.4092005
```

³In order to compare distributions, x_{\min} must be equal for both distributions.

which means we can not reject H_0 . The p -value and test statistic are similar to the values found in table 6.3 of [Clauset et al. \(2009\)](#).

References

A. Clauset, C.R. Shalizi, and M.E.J. Newman. Power-law distributions in empirical data. *SIAM Review*, 51(4):661–703, 2009.