P5.2 Statistics for Medicine

Massimo Borelli

Master of Advanced Studies in Medical Physics

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

The Abdus Salam
International Centre
for Theoretical Physics

Finite random variables

The `otitis` dataset
(number of episodes of otitis media in the first two years of life)

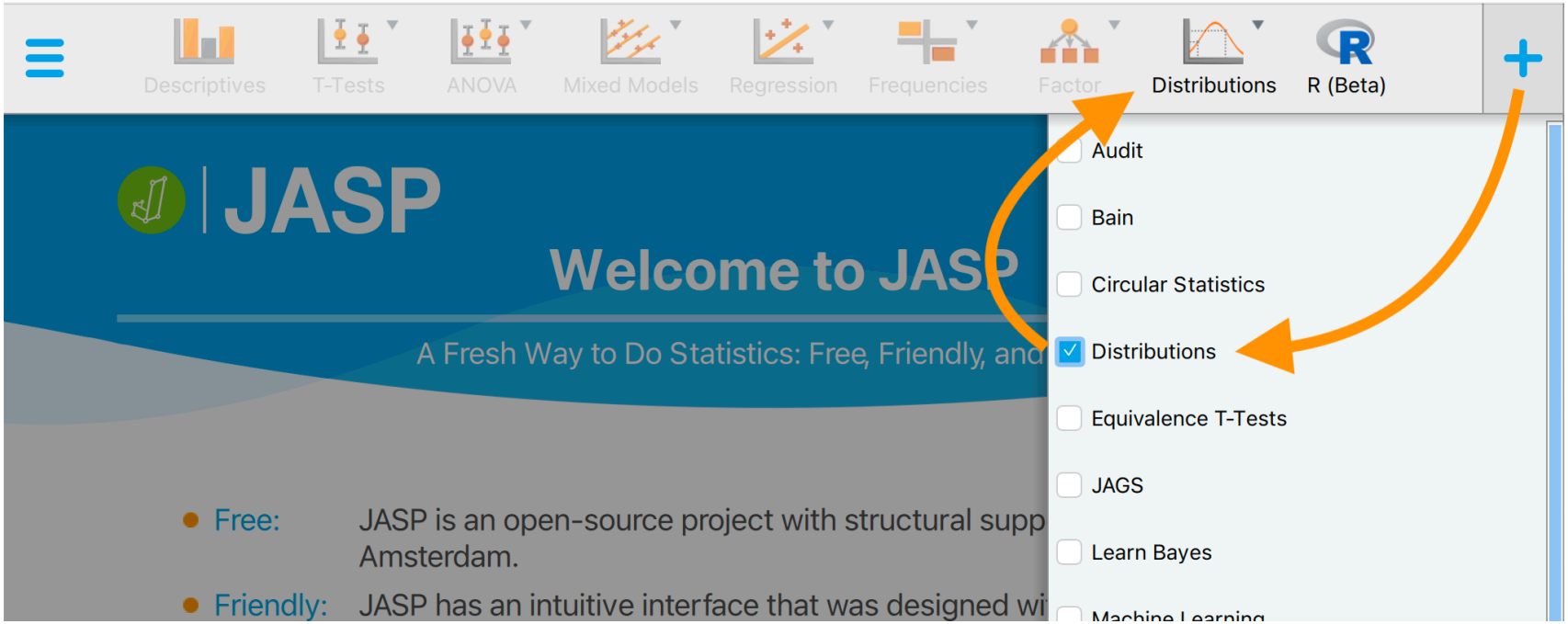
$$\begin{pmatrix} 0 & 1 & 2 & 3 & 4 & 5 & 6 \\ 0.129 & 0.264 & 0.271 & 0.185 & 0.095 & 0.039 & 0.017 \end{pmatrix}$$

- **probability mass / discrete density** function

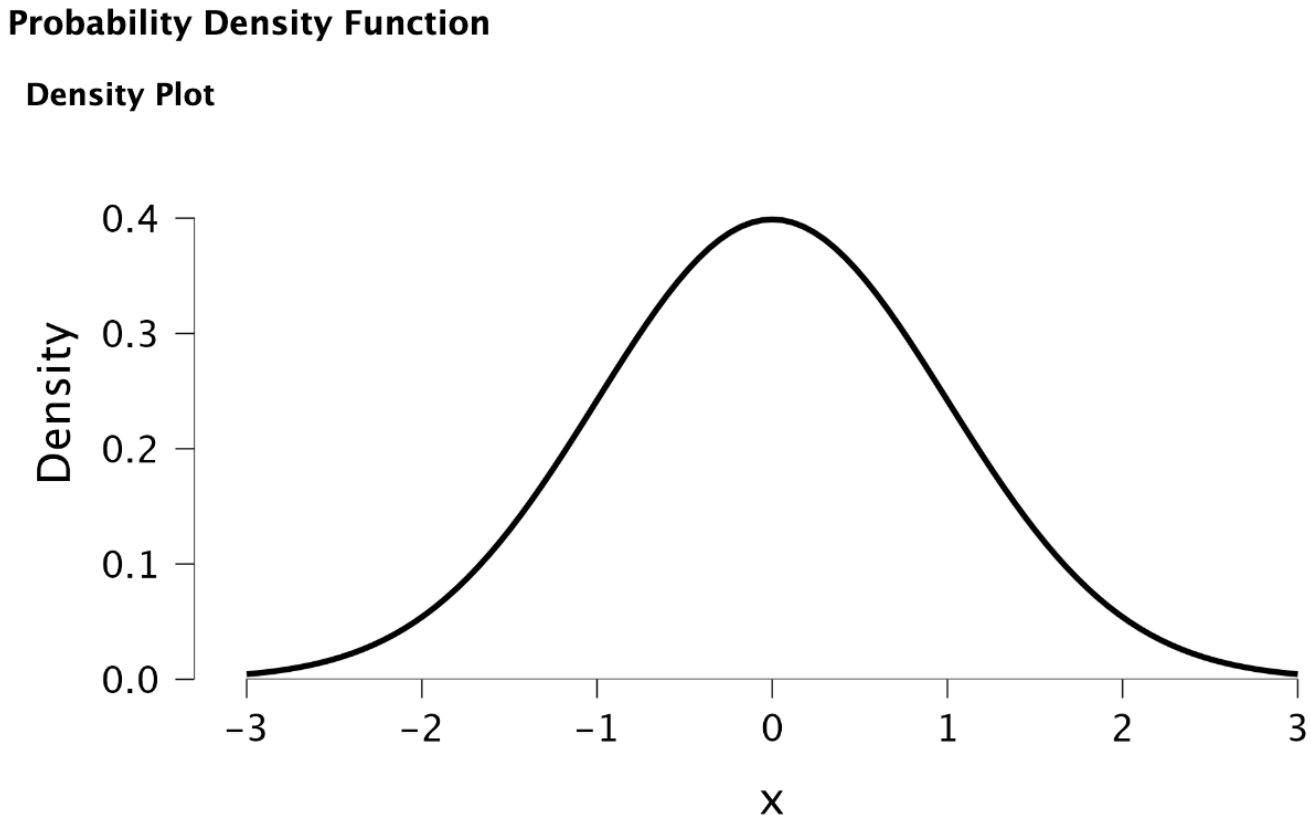
Example (graph)

Draw the barplot with JASP

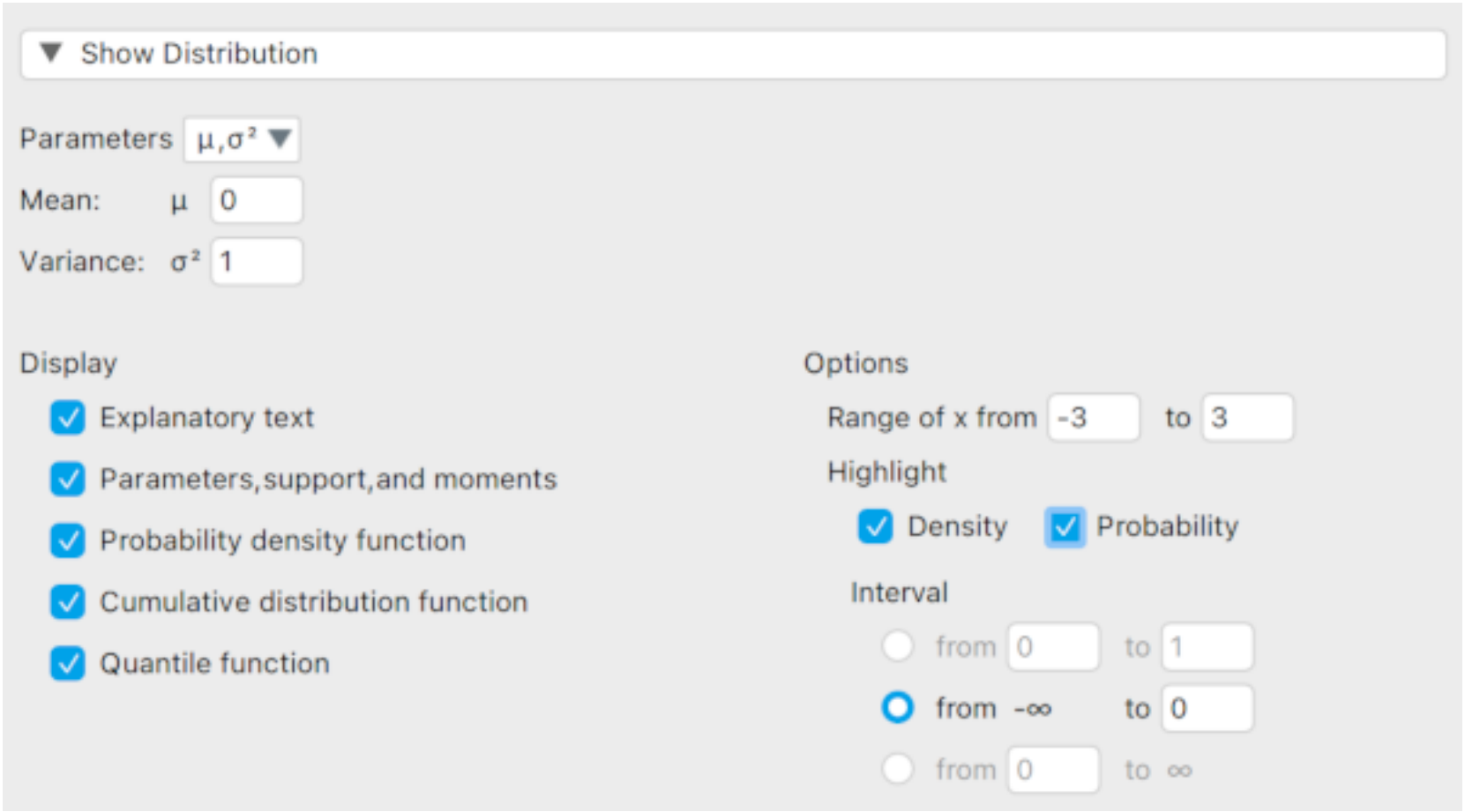
Commonly used random variables



the Normal distribution



the Normal distribution



the Normal distribution

Example (B. Rosner, example 5.22)

The cerebral blood flow (CBF) in the general population is, approximately, normally distributed with mean $\mu = 75$ and standard deviation $\sigma = 17$. Which could be the percentage of persons having a CBF < 40?

the Normal distribution

Example (B. Rosner, example 5.23)

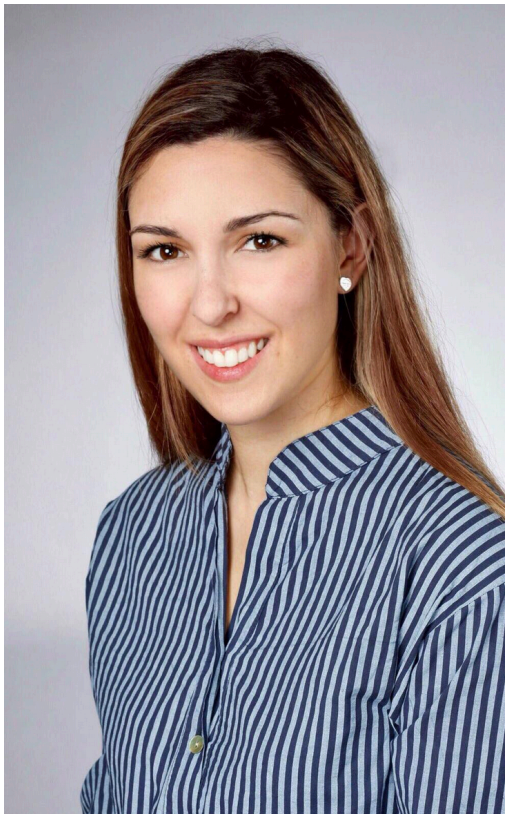
Glaucoma is characterized by intraocular pressure greater than 20 mmHg, while in normal population intraocular pressure X has mean $\mu = 16$ and standard deviation $\sigma = 9$. How much it could be $P(12 \leq X \leq 20)$?

the Normal distribution

Example (B. Rosner, example 5.24)

In adult male, the diastolic pressure is normally distributed with mean $\mu = 80$ and variance $\sigma^2 = 144$. Find the upper and the lower fifth percentile.

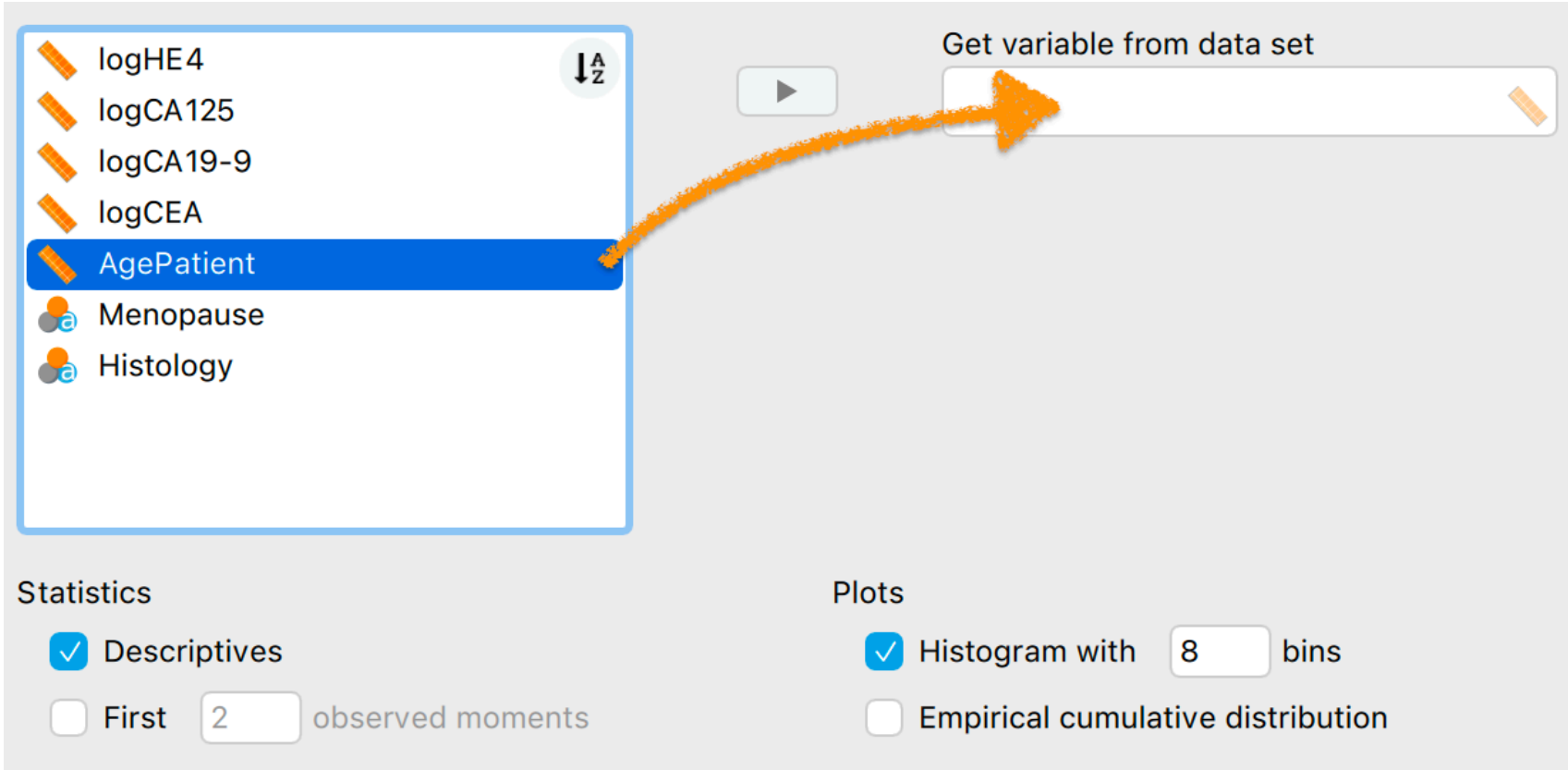
the Normal distribution: the QQ plot



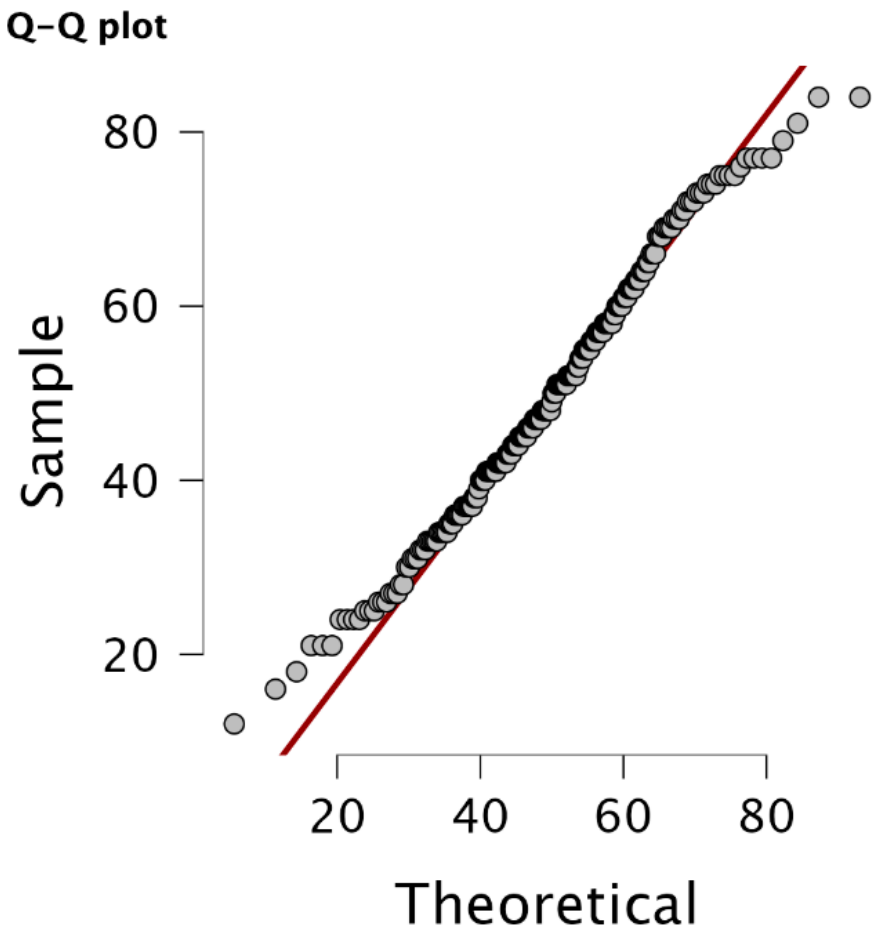
S. Najaf
the `roma` dataset

- `Histology`
- `AgePatient`
- `Menopause status`
- four biomarkers (log transformed):
  - `logHE4`,
  - `logCA125`
  - `logCA19.9`
  - `logCEA`

the Normal distribution



the Normal distribution



caveat: the Normal distribution

Do two dromedaries make a camel? Bernard Rosner

> *.. linear combination of normal random variables are often of specific concern. It can be shown that any linear combination of normal random variables is itself normally distributed.*

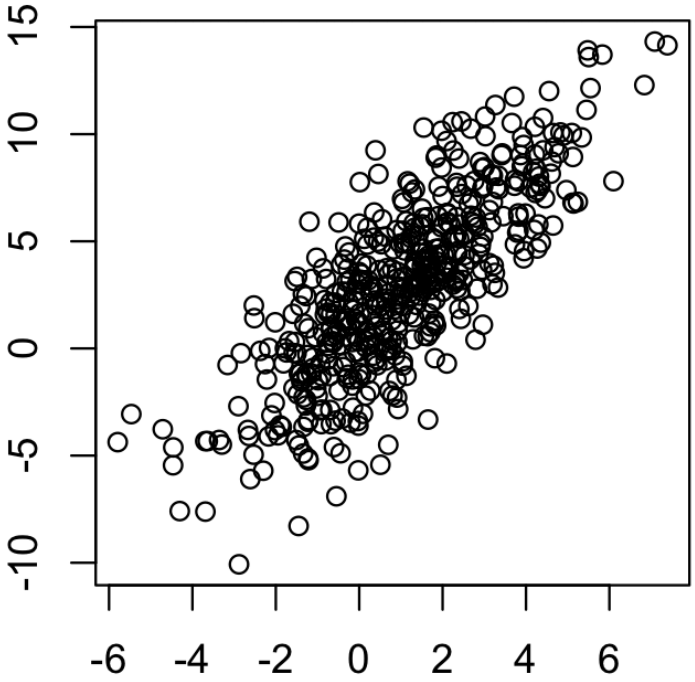
Martin Bland:

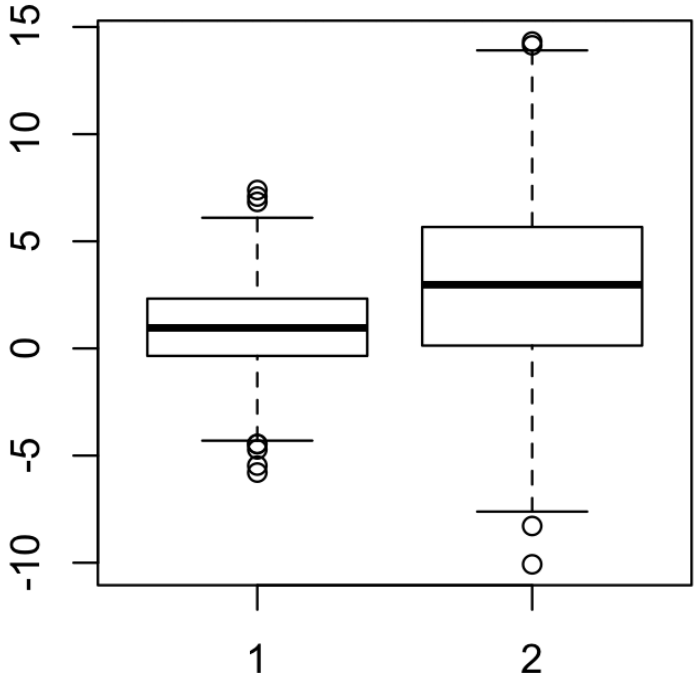
> *... If we add two variables from Normal distributions together, even with different means and variances, the sum follows a Normal distribution.*

caveat: the Normal distribution

Do two dromedaries make a camel?

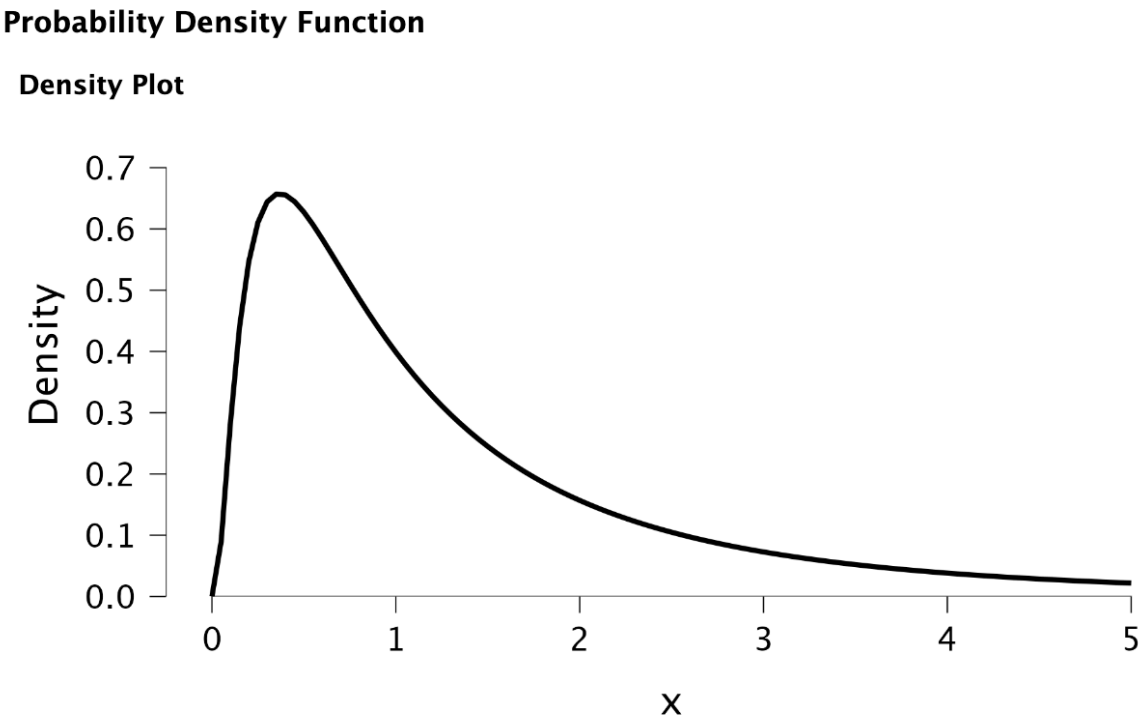
caveat: the Normal distribution





C. Kowalski. 1973
Non-Normal Bivariate Distributions with Normal Marginals
https://www.tandfonline.com/doi/abs10.1080/00031305.1973.10479002

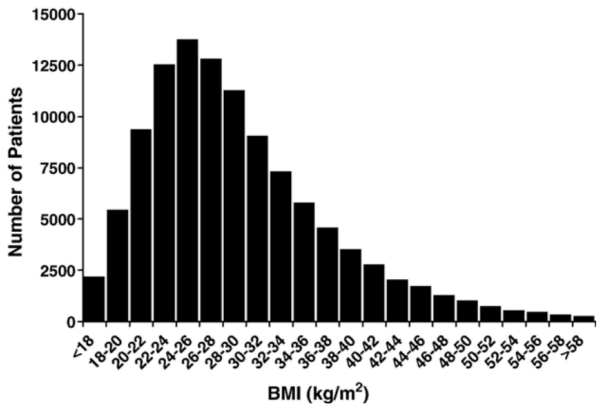
the log-Normal distribution



Eckhard Limpert, et al.
Log-normal Distributions across the Sciences: Keys and Clues
`https://academic.oup.com/bioscience/article/51/5/341/243981`

the logNormal distribution

Figure 1

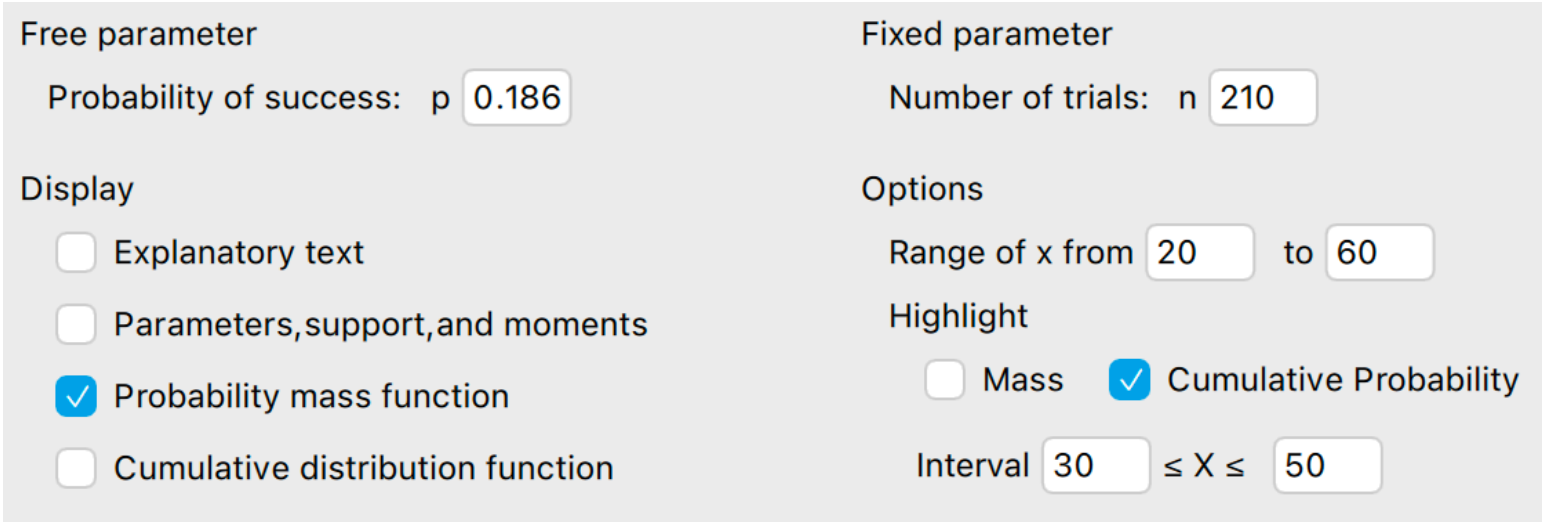


Distribution of BMI values. A histogram of the BMI values (expressed in kilograms per square meter) among the 108 927 hospitalization

Example (Gregg Fonarow et al. - summarizing body mass index)

Suppose that you are required to lead a pilot study concerning radiation dosimetry in 25 obese patients. How do you think you are going to describe the data? Using the mean and the standard deviation, or the median and the quartiles? What are here the difficulties?

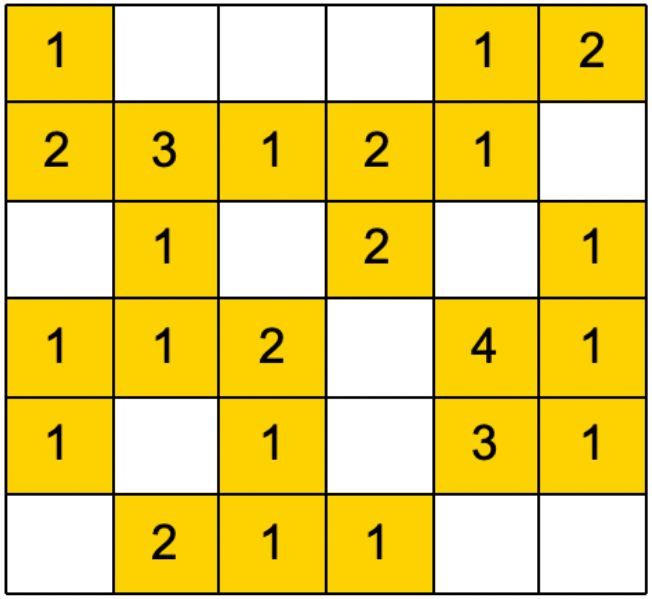
the binomial distribution



Example (probability)

Suppose that you collect a new sample of 210 women with the same symptoms of those enrolled in `roma`. Obviously, only by chance you will observe exactly '39' malignancies. Can you compute the probability to observe a number of malignancy between 30 and 50?

the Poisson distribution



Example (probability)

Use JASP to discover in a $\lambda = 0.37$ Poisson distribution how many, in probability, cells could have a value greater or equal than 2.

the Poisson distribution