**Researches about theory (R)**

9\_R.  History and derivation of the normal distribution. Touch, at least, the following three important perspectives, putting them into an historical context to understand how the idea developed:  
  
1) as approximation of binomial (De Moivre)  
2) as error curve (Gauss)  
3) as limit of sum of independent r.v.'s (Laplace)

In probability theory, a normal (or Gaussian or Gauss or Laplace-Gauss) distribution is a type of continuous probability distribution for a real-valued random variable. Normal distributions are important in statistics and are often used in the natural and social sciences to represent real-valued random variables whose distributions are not known. Their importance is partly due to the central limit theorem. It states that, under some conditions, the average of many samples (observations) of a random variable with finite mean and variance is itself a random variable, whose distribution converges to a normal distribution as the number of samples increases. Therefore, physical quantities that are expected to be the sum of many independent processes, such as measurement errors, often have distributions that are nearly normal. A normal distribution is sometimes informally called a bell curve. However, many other distributions are bell-shaped.

Chart, histogram

Description automatically generated

The simplest case of a normal distribution is known as the standard normal distributions or unit normal distribution. This is a special case when the mean is equal to 0 and the standard deviation equal to 1.

TO DO

**Applications / Practice (A)     [work on this at least 30' a day, all days]**

9\_A\_1. Create a simulation with graphics to convince yourself of the uniform convergence of the empirical CDF to the theoretical distribution (Glivenko-Cantelli theorem). You may use a simple random variable of your choice for such a demonstration.

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9\_A\_2.  Generate sample paths of jump processes which at each time considered t = 1, ..., n perform jumps computed as:  
  
-   σ sqrt(1/n) R(t)  
where R(t)  is a [-1,1] Rademacher random variable (<https://en.wikipedia.org/wiki/Rademacher_distribution>).  
  
-  σ sqrt(1/n) \* Z(t), where  Z(t) is a N(0,1) random variable (<https://en.wikipedia.org/wiki/Normal_distribution>)

and see what happens as n (simulation parameter) becomes larger.

[As before, at time n (last time) and one other chosen inner time 1<j<n (j is a program parameter) create and represent with histogram the distribution of the process ]

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**Researches about applications (RA)**

7\_RA Do a research about the random walk process and its properties. Compare your finding with your applications drawing your personal conclusions. Explain based on your exercise the beaviour of the distribution of the stochastic process (check out "Donsker's invariance principle"). What are, in particular, its mean and variance at time n ?

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