Calculating Probabilities Using Excel

BIO210 Biostatistics

Extra Reading Material for Lecture 13

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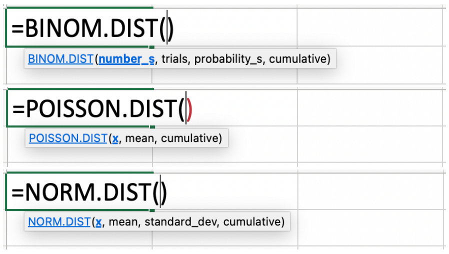
Spring 2025

1 Calculating Probability

Look up pre-computed tables is one way to find out probabilities of certain distribution. It is good enough, but it is not convenient. In reality, you always want to use some statistical software for this purpose. If you are familiar with certain programming languages, such as **Python** or **R**, you probably don't really need me to show you how to calculate probabilities. Here, we just use **Excel** to calculate probabilities, which is straightforward. You don't need to have any programming skills to use it.

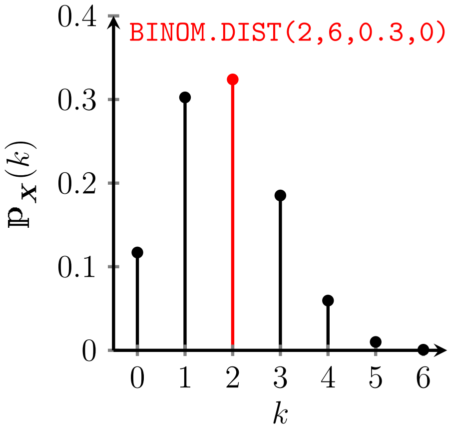
You can use the functions `BINOM.DIST`, `POISSON.DIST` and `NORM.S.DIST` to calculate probabilities of the Binomial, Poisson and the standard normal (Gaussian) distributions, respectively.



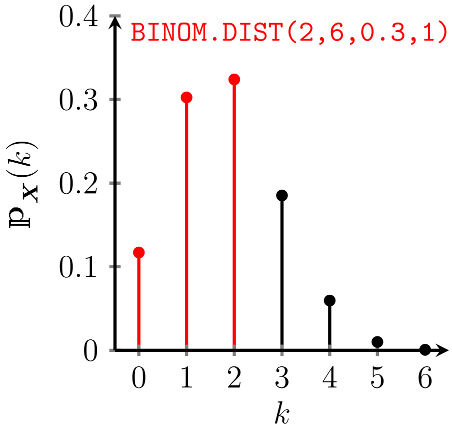
Like shown in the picture on the right-handside. If you put an "=" sign followed by the name of the function in a cell in **Excel**, you will get some pointers to help you fill in the content. The first argument is always the value of your *random variables*, that is x. Then, you need to put the *parameters* of the distribution. In the Binomial case, those are "trials (n)" and "probability_s (p)". In the Poisson case, you only need "mean (λ)". Finally, in the standard normal case, we have the parameters. The mean is 0 and the standard deviation is 1, so we do not really need to put the parameters in this case. The last argument is the same for all three cases, which is whether you want cumulative probability or not. 1 or `TRUE` means "yes, give me the cumulative probability", and 0 or `FALSE` means "no, give me the exact probability or density".

Some examples are shown in the next page with three different distributions: $\boldsymbol{B(6, 0.3)}$, $\boldsymbol{Pois(2)}$ and $\boldsymbol{\mathcal{N}(0, 1^2)}$. The corresponding values in terms of **Excel** functions are also shown in the picture. You should be able to easily see how to calculate any probability using that information.

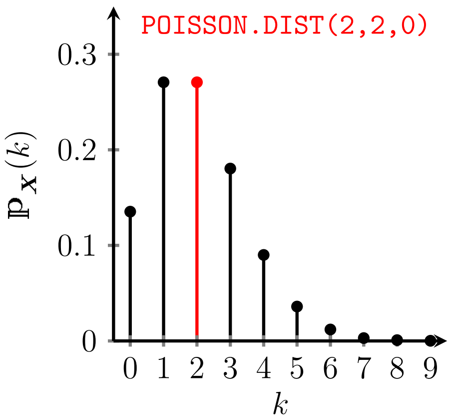
$\boldsymbol{B(6, 0.3)}$



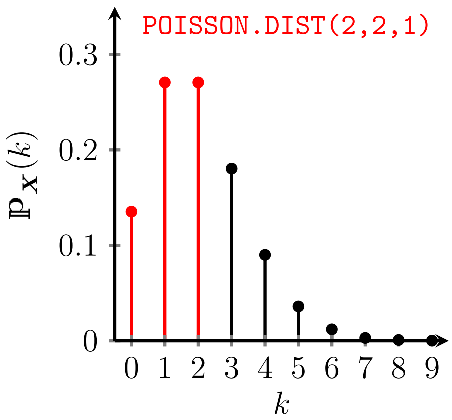
$\boldsymbol{B(6, 0.3)}$



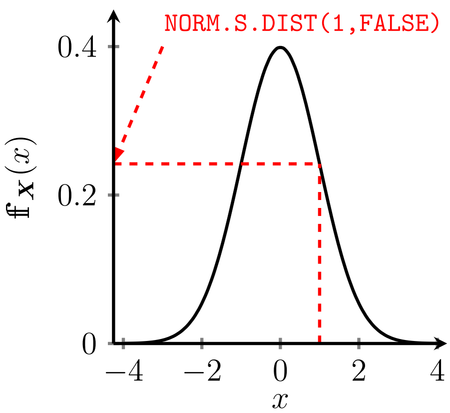
$\boldsymbol{Pois(2)}$



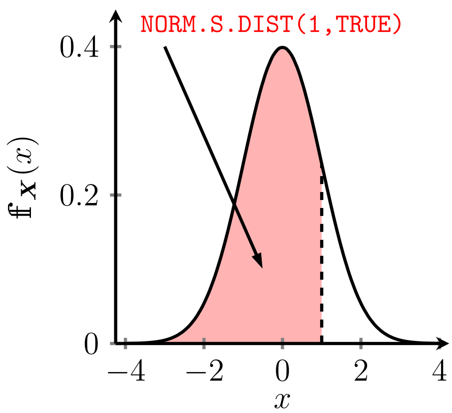
$\boldsymbol{Pois(2)}$



$\boldsymbol{\mathcal{N}(0, 1^2)}$



$\boldsymbol{\mathcal{N}(0, 1^2)}$



2 Find x with certain probability in a normal distribution

In reality, we sometimes need to do the opposite when we are dealing with a normal distribution. For example, in a standard normal distribution $\boldsymbol{\mathcal{N}(1, 2^2)}$, we want to find a specific value x, such that $\mathbb{P}\left(\boldsymbol{X} \leqslant x\right) = 0.1$.

What we can do is to use the inverse function of the standard normal distribution, which is `NORM.S.INV`. This function only takes one value, which is the left-tail probability.

Using this method, we find out that `NORM.INV(0.1) = -1.28`. It means that $\mathbb{P}\left(Z \leqslant -1.28\right) = 0.1$. Therefore, in the original distribution $\boldsymbol{\mathcal{N}(1, 2^2)}$ we know that the distance between x and the mean is -1.28 standard deviations. That is:

$$\frac{x-\mu}{\sigma} = -1.28 \quad \Rightarrow \quad \frac{x-1}{2} = -1.28 \quad \Rightarrow \quad x = -1.56$$

meaning that in a normal distribution $\boldsymbol{\mathcal{N}(1, 2^2)}$, the probability of a value that is less than -1.56 is 0.1: $\mathbb{P}\left(\boldsymbol{X} \leqslant -1.56\right) = 0.1$.

The following plots showcase what happens visually:

The standard normal $\boldsymbol{\mathcal{N}(0, 1^2)}$ Original distribution $\boldsymbol{\mathcal{N}(1, 2^2)}$