Example: Virus or Not? 

Zhang Wei says he is itchy. There is a test for Virus to Cats, but this test is not always right:

For people that **really do** have the Virus, the test says "Yes" **80%** of the time
For people that **do not** have the Virus, the test says "Yes" **10%** of the time ("false positive")

If 1% of the population has the Virus, and **Zhang Wei's test says "Yes"**, what are the chances that Zhang Wei really has the Virus?

We want to know the chance of having the Virus when test says "Yes",
written **P(Virus|Yes)**

Let's get our formula:

$$\text{P(Virus|Yes)} = \frac{\boldsymbol{P}(Virus)\,\boldsymbol{P}(\boldsymbol{Yes}|Virus)}{\boldsymbol{P}(\boldsymbol{Yes})}$$

- P(Virus) is Probability of Virus = 1%
- P(Yes|Virus) is Probability of test saying "Yes" for people with Virus = 80%
- P(Yes) is Probability of test saying "Yes" (to anyone) =??%

Oh no! We **don't know** what the **general** chance of the test saying "Yes" is...

... But we can calculate it by adding up those **with**, and those **without** the Virus:

- 1% have the Virus, and the test says "Yes" to 80% of them
- 99% do **not** have the Virus and the test says "Yes" to 10% of them

Let's add that up:

$$\text{P(Yes)} = 1\% \times 80\% + 99\% \times 10\% = 10.7\%$$

Which means that about 10.7% of the population will get a "Yes" result?

So now we can complete our formula:

$$\text{P(Virus|Yes)} = \frac{\mathbf{1}\% \times \mathbf{80}\%}{\mathbf{10}.7\%} = 7.48\%$$

P(Virus|Yes) = about **7%**