Probability vs Odds

What's the difference? Learn it and never forget it with an easy example!

z_ai Aug 18, 2020 · 5 min read ★

Image from Unsplash

But do they really? It is very easy to confuse these two terms.

In this post, we will quickly clarify what each of them is, their differences, and their relationship.

Let's go!

What is a probability?

We use probability in our every day language all the time when we say things like '*I don't think so*' or '*That is very unlikely*'. **Probability**, in a non-rigorous description, **can be defined as a measurement of how strongly we believe things about the world**.

We can calculate probabilities by counting the outcomes of events. For example, if we consider a coin tossing game where we choose heads, and therefore want to calculate the probability of a favourable outcome, as the number of times that a desired outcome can occur divided by the total number of possible outcomes.

For our example, this can be described in the following terms.

$$P(heads) = \frac{\{heads\}}{\{heads, tails\}} = \frac{1}{2} = 0.5$$

Probability of getting heads. Image by author.

Counting the outcomes of events is useful and simple in certain occasions, like the previous example. However, it is easy to see that when there are many multiple combinations and possible outcomes, **this technique becomes unfeasible, as it does not hold for a wide range of real life problems**.

For example, could you viably answer the following questions using the previous approach?

- *How likely is it that it will rain tomorrow?*

Do you think we will have time to stop and buy an ice cream?

As you can see, if go past binary options (yes or no, or 0 and 1), and try to pick something in between (a probability), **precisely answering these questions is not so easy**. We can do it, however, by using odds and expressing probabilities as a ratio of beliefs.

Let's see how!

Using odds to calculate probabilities

As we just saw, **we need an effective way to calculate probabilities in more general situations**. To show how we can do this with odds, consider the following example:

Imagine you, and a friend are discussing which one is a better runner. You've been training a lot lately, you've always beaten him in the past, and lets be honest, he is not in a very good shape since he started going out so much.

How do you quantify your belief that you will surely beat him in a race? Many times we do this through bets: '*I'll bet you 5 bucks that I will beat you in a race in a week. If you win, I'll give you 10.*' you say.

What does this mean, probabilistically speaking? As this is a race with only two possible outcomes, you can either win it or lose it, and the probabilities of winning plus loosing must always sum up to 1, like shown in the following figure:

$$P(win) + P(loose) = 1$$

The sum of all the probabilities must always be 1. Image by author.

Also, your statement saying that you will get 5 dollars if you win and give 10 if you loose expresses odds of the bet.

Odds are a way to express a belief about an event as a ratio of how much you would be willing to pay if you were wrong, versus how much you'd get if you were right. They can be quantified in the following manner:

$$\frac{}{P(loose)} = \frac{}{5} = 2$$

Odds of the bet.

Now, how do we translate this into a probability? Easy. As all probabilities must sum 1, we use the equation in the figure just above the previous one and get:

$$P(loose) = 1 - P(win)$$

Lastly, if we substitute in the odds we get:

$$P(win) = 2P(loose)$$
$$P(win) = 2(1 - P(win))$$
$$P(win) = 2 - 2P(win)$$
$$3P(win) = 2$$
$$P(win) = 2/3 = 0.66$$

Calculation of what we think our probability of winning is.

As we can see, our belief that we will win is of 0.66 or 66%. Seemed like more when we decided to bet the double of what we would get right?

that hypothesis (the ratio of the bet of winning vs losing):

$$P(H) = \frac{O(H)}{1 + O(H)}$$

General relationship between probabilities an odds.

Conclusion and further resources

That is it! Probability is awesome. As always, I hope you **enjoyed the post, and that you have learned what the differences between probabilities and odds are with this easy, everyday example.**

If you did then take a look at my other posts on Probability, Data Science and Machine Learning here. Have a good read!

If you want to dig deeper into the topic, check out the following video by StatQuest:

- Probability Learning: **Bayes' Theorem**
- Probability Learning: **How Bayes' Theorem is applied in Machine Learning**
- Probability Learning: **Maximum Likelihood**
- Probability Learning: **The Math Behind Bayes**
- Probability Learning: **Naive Bayes**
- Probability Learning: **Hidden Markov Models**
- Probability Learning: **Monte Carlo Methods**

I deeply encourage you to read them, as they are fun and full of useful information about probabilistic Machine Learning.

*If you want to learn more about Machine Learning and Artificial Intelligence **follow me on Medium**, and stay tuned for my next posts! Also, you can check out **this repository** for more resources on Machine Learning and AI!*

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