Probability on the Pitch

A short book about chance, for people who love football

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Kick-off: what probability is

You already think in probabilities. You just don't call it that.

When your team is 2–0 up in the 85th minute, you relax. When they're 1–0 up in the 85th minute, you don't. Nobody taught you a formula for that. You just know that one situation is *more likely* to end well than the other.

Probability is a way to put a number on "how likely".

- A probability of **0** means it never happens.
- A probability of **1** means it always happens.
- Everything else sits in between.

We often write it as a percentage instead. A probability of 0.75 is the same as 75%.

The basic formula

When every outcome is equally likely, probability is just counting:

$$P(\text{event}) = \frac{\text{number of ways it can happen}}{\text{number of possible outcomes}}$$

Example: before a match, the referee flips a coin to decide who kicks off. There are 2 possible outcomes (heads, tails). Your captain calls heads. There is 1 way to win.

$$P(\text{your captain wins the toss}) = \frac{1}{2} = 0.5 = 50\%$$

Try it. A squad has 23 shirts numbered 1 to 23. The kit man grabs one at random. What is the probability it's a number from 1 to 11?

Answer: 11 out of 23, so about 0.48, or 48%.

Penalties: probability from data

Coins are easy. Football is not. A penalty is not "50/50" just because it either goes in or it doesn't.

This is the most common mistake in probability: **two outcomes does not mean equal chances.**

So how do we get a number for a penalty? We look at what happened before. This is called *experimental probability*:

$$P(\text{goal}) \approx \frac{\text{penalties scored}}{\text{penalties taken}}$$

Say a striker took 40 penalties and scored 34.

$$P(\text{goal}) \approx \frac{34}{40} = 0.85 = 85\%$$

In top-level football, roughly three out of four penalties are scored. A specialist like our striker sits above that average.

The complement

If our striker scores 85% of the time, how often do they *not* score? Everything that isn't a goal (saved, wide, off the post) is called the **complement**.

$$P(\text{no goal}) = 1 - P(\text{goal}) = 1 - 0.85 = 0.15$$

This trick is useful because sometimes the opposite is easier to calculate. We'll use it in the next chapter.

> **Try it.** A goalkeeper saves 1 in 5 penalties. What's the probability the next one is *not* saved?
>
> *Answer: 1 - 0.2 = 0.8, or 80%.*

Shootouts: when events stack up

Now the fun part. What's the probability our 85% striker scores **two** penalties in a row?

The two kicks don't affect each other (we'll pretend nerves don't exist). Events like this are **independent**, and for independent events you multiply:

$$P(\text{A and B}) = P(\text{A}) \times P(\text{B})$$

$$P(\text{scores twice}) = 0.85 \times 0.85 = 0.7225 \approx 72\%$$

Notice it went *down*. Every extra thing that has to go right makes the whole chain less likely.

Five takers, all must score

In a shootout, each team usually takes five penalties. Suppose all five of your takers score 80% of the time. What's the probability all five score?

$$0.8 \times 0.8 \times 0.8 \times 0.8 \times 0.8 = 0.8^5 \approx 0.33$$

Only about a **one in three** chance of a perfect five out of five, even with good takers.

At least one miss

Here's where the complement saves time. What's the probability that **at least one** of the five misses?

You could list every possible combination of misses. Or:

$$P(\text{at least one miss}) = 1 - P(\text{all five score}) = 1 - 0.33 = 0.67$$

Two out of three shootouts like this will have at least one miss. That's why shootouts feel so dramatic. The maths says somebody is probably going to be the sad face on the news.

> **Try it.** A team has three takers who score 90% of the time. What's the probability all three score? What's the probability at least one misses?
>
> *Answer: 0.9 × 0.9 × 0.9 = 0.729 (about 73%). At least*

one miss: 1 - 0.729 = 0.271 (about 27%).

Expected goals: probability on the stats sheet

If you watch football on TV, you've seen **xG** (expected goals). It's probability wearing a football shirt.

Every shot gets a probability of being a goal, based on thousands of similar shots in the past: the distance, the angle, whether it was a header, and so on.

Shot	Where from	xG
1	Penalty	0.76
2	Header from a corner	0.08
3	Long shot, 30 metres	0.03
4	One-on-one with the keeper	0.35

A team's xG for the match is just the sum:

$$0.76 + 0.08 + 0.03 + 0.35 = 1.22$$

That means: from chances like these, a team would score about **1.2 goals on average**. Not in every match. On average.

Why xG matters

Say your team lost 0–1 but had an xG of 2.5, while the other team had 0.4. The result says your team was worse. The probability says they were unlucky. Over a whole season, luck tends to even out, and teams with high xG usually end up near the top.

This is the big idea behind probability: **one match is noisy, many matches tell the truth.**

Full time: what to remember

1. Probability is a number from 0 to 1 that says how likely something is.
2. If all outcomes are equally likely, count: ways it can happen ÷ possible outcomes.
3. Two outcomes does not mean 50/50. Use data from the past.
4. The complement: P(not A) = 1 - P(A).
5. Independent events in a row: multiply. The chain gets less likely with every link.
6. “At least one” is usually easiest as 1 - P(none).
7. xG is just probabilities added up. One match is noise, a season is signal.

Next time you watch a shootout, try doing the maths before the first kick. You’ll be surprised how often the “shock miss” was actually the likely outcome.