

# Time in Models

## Differential Equations

College of the Atlantic. February 2, 2026

Today we are going to think about time and rates in model. We'll start with a warm-up problem.

I take a piece of scrap paper, crumple it up, and while sitting in my office chair, I attempt to throw it into the recycling bin in my office. The probability that I make the shot is  $1/3$ . If I miss the shot, I return to my chair and attempt the shot again. If I miss again, I again return to my chair and try to make the shot. And so on.

Throughout all this, the probability that I make the shot remains  $1/3$ . I do not learn. In math terms, we would say that this process is *memoryless*.

1. What is the probability  $p(1)$  that I make the shot in the first try?
2. What is the probability  $p(2)$  that I make the shot in two tries?
3. What is the probability  $p(3)$  that I make the shot in three tries?
4. What is the probability  $p(n)$  that I make the shot in  $n$  tries?
5. What is the probability that I make the shot after an infinite number of attempts? Write this using words and math.
6. Sketch  $p(n)$  as a function of  $n$ . Note that  $n$  is discrete. That is,  $n = 1, 2, 3, \dots$
7. What is the average or expected number of attempts it will take for me to make the shot?

Now consider a different situation. There is a constant probability per unit time that a piece of computer hardware fails. Let's say that there is a 10% chance per month of failure. Note, though, that the piece of hardware could fail at *any* instant of time, not just exactly at 1 month, 2 months, and so on.

Answer the above questions but for this new scenario. In what ways\* is this scenario different from the first one?

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\*Hint: It's very different. But it's also sorta the same