The Poisson Distribution: Details

1 So far, we've seen how the **Binomial Distribution** gives us probabilities for sequences of binary outcomes, like **2** out of **3** people preferring pumpkin pie, but there are lots of other **Discrete Probability Distributions** for lots of different situations.

2 For example, if you can read, on average, **10** pages of this book in an hour, then you can use the **Poisson Distribution** to calculate the probability that in the next hour, you'll read exactly **8** pages.

The equation for the **Poisson Distribution** looks super fancy because it uses the Greek character **λ**, ***lambda***, but lambda is just the average. So, in this example, **λ** = **10** pages an hour.

$$p(x \mid \lambda) = \frac{e^{-\lambda}\lambda^{x}}{x!}$$

NOTE: This '**e**' is **Euler's number**, which is roughly **2.72**.

x is the number of pages we think we might read in the next hour. In this example, **x** = **8**.

3 Now we just plug in the numbers and do the math...

...and we get **0.113**. So the probability that you'll read exactly **8** pages in the next hour, given that, on average, you read **10** pages per hour, is **0.113**.

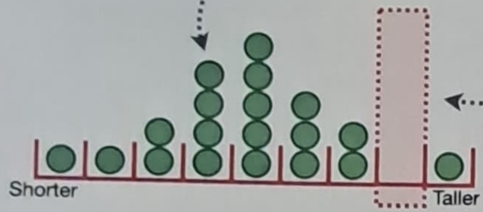
$$p(x = 8 \mid \lambda = 10) = \frac{e^{-\lambda}\lambda^{x}}{x!} = \frac{e^{-10}10^{8}}{8!} = \frac{e^{-10}10^{8}}{8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1} = 0.113$$

BAM!!!

Discrete Probability Distributions: Summary

1 To summarize, we've seen that **Discrete Probability Distributions** can be derived from histograms...

...and while these can be useful, they require a lot of data that can be expensive and time-consuming to get, and it's not always clear what to do about the blank spaces.



2 So, we usually use ***mathematical equations***, like the equation for the **Binomial Distribution**, instead.

$$p(x \mid n, p) = \left(\frac{n!}{x!(n-x)!}\right)p^x(1-p)^{n-x}$$

The **Binomial Distribution** is useful for anything that has binary outcomes (wins and losses, yeses and noes, etc.), but there are lots of other **Discrete Probability Distributions**.

3 For example, when we have **events** that happen in discrete units of time or space, like reading **10** pages an hour, we can use the **Poisson Distribution**.

$$p(x \mid \lambda) = \frac{e^{-\lambda}\lambda^x}{x!}$$

4 There are lots of other **Discrete Probability Distributions** for lots of other types of data. In general, their equations look intimidating, but looks are deceiving. Once you know what each symbol means, you just plug in the numbers and do the math.

BAM!!!

Now let's talk about **Continuous Probability Distributions**.

(2) The Poisson Distribution:

∴ so far we have seen how the Binomial Distribution gives us probabilities for sequences of binary outcomes like 2 out of 3 people preferring pumkin pie, but there are lot of other discrete probabilities Distribution for lots of different situations.

i.e if you read on average 10 pages of this book in an hour ~~they~~ then you can use the Poisson distribution to calculate the probability that in the next hour you will read exactly 8 pages.

$$\boxed{P(x \mid \lambda) = \frac{e^{-\lambda} \lambda^{x}}{x!}}$$

x = no. of pages we think we might read in the next hour. = 8 in this case.

e = Euler's number ≈ 2.72

λ = average, which is 10 in this case

$\therefore \quad p(x=8 \mid \lambda=10)$

$$= \frac{e^{-\lambda}\lambda^{x}}{x!}$$

$$= \frac{e^{-10}(10)^{8}}{8!}$$

$$= \frac{e^{-10}\,10^{8}}{8\times7\times6\times5\times4\times3\times2\times1} = \underline{\underline{0.113}}$$

$\therefore$ the probability that you will read exactly 8 pages in the next hour given that on average you read 10 pages per hour is $\underline{\underline{0.113}}$