Poisson distribution

PreLab submission with a pass grade is required to begin the lab.
Must be submitted not later than right before the start of the lab.

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Section: H4
Date: 10/2/2024

Purpose

To understand the nature of the Gaussian and Poisson distribution functions and their relationship to error analysis.

Readings

Books:
John R. Taylor, "An Introduction to Data analysis", University Science Books. Chapters 10 and 11, and Chapter 3.

Quick Check 11.1

Page 248 of Taylor's book.
On average, each of 18 hens in my henhouse lays 1 egg per day. I check the hens once an hour and remove any eggs that have been laid. Answer the following.

- What is the average number, μ, of eggs found during hourly visits?

Since there are 18 hens, each laying 1 egg per day, you get 18 eggs/day on average.
This corresponds to 18 eggs/24 hours = 0.75 eggs/hour = μ

- Use Poisson distribution to calculate probabilities to find v eggs for v = 0, 1, 2, 3, and 4.
For any event occurring at an average rate of μ in discrete intervals, the probability of observing exactly v of those events is P(v, μ) = μ^v * e^(-μ) / v!

In this case,
P(0, μ) = 0.472
P(1, μ) = 0.354
P(2, μ) = 0.133

P(3, μ) = 0.033
P(4, μ) = 0.006

- The probability to find exactly μ eggs is ??%:
There's no exact probability for 0.75 eggs in a Poisson distribution, but you can use the closest integers (0 and 1) to understand the most likely outcomes based on the mean value of 0.75
P(0, μ) = 47.24%
P(1, μ) = 35.43%
So P(0.75, μ), although undefined by the poisson distribution, would be around 40%

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(* DiscretePlot[PDF[PoissonDistribution[μ],k],{k,0,5},
 PlotRange→All, Frame→True,FrameLabel→{"ν →" ,"Probability Density"}]  *)
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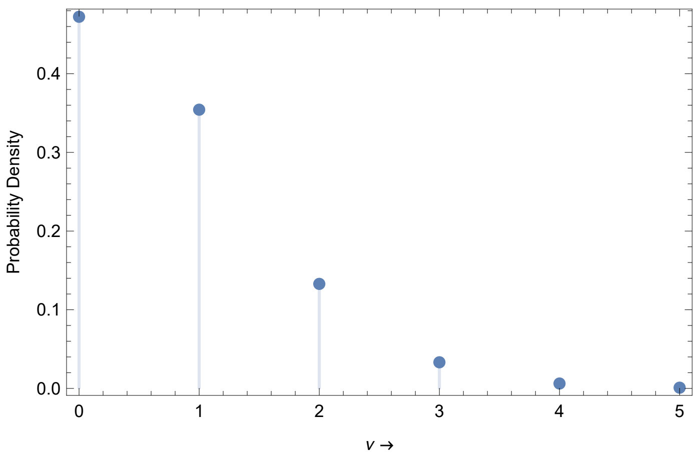

Quick Check 11.2

Page 250 of Taylor's book.
The farmer of Quick Check 11.1 above, observes that in a certain ten-hour period his hens lay 9 eggs. Based on this one observation, answer the following.

- The number of eggs expected in ten hours is 9 ,or between 6 and 12 eggs:

- The rate that would be expected to be ?? ± ?? or between ?? and ?? eggs per hour:
The rate μ=0.9, the standard deviation for possion distribution is $\sqrt{}(\mu)$ = 0.95 eggs/hour

Hence, rate that would be expected to be 0.9 ± 0.95 eggs/hour or between 0 and 1.85 eggs/hour

- The distribution of rate is:
P(v, μ) = μ^v * e^(-μ) / v! where μ=0.9 and v is an integer number of eggs in a particular hour.

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(* DiscretePlot[PDF[PoissonDistribution[μ],k],{k,0,5},PlotRange→All,
 Frame→True,FrameLabel→{"ν →" ,"Probability Density for ?? egs per hour rate"}] *)
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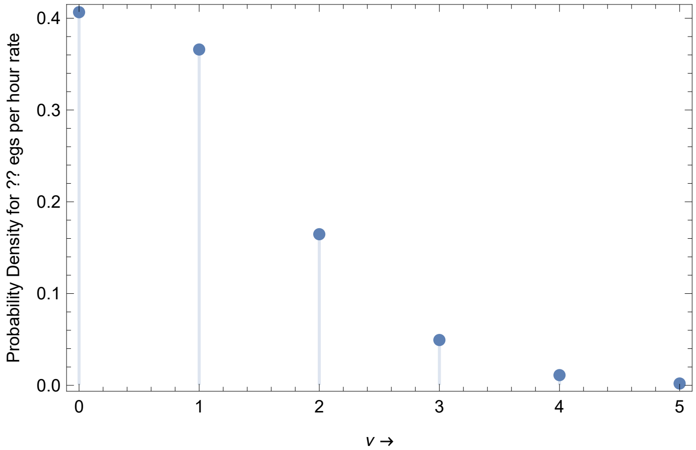

Problem 11.10:

Page 257 of Taylor's book.
Consider a radioactive sample with a rate of r = 20 per minute. What time t we need to count, so we can get the rate with less than 4% uncertainty.

Problem 11.20:

Page 259 of Taylor's book.
The radioactivity of a rock was found to be 225 particle counts in 10 minutes. The radioactivity of the background was found to be 90 particles in 6 minutes.

- What is the activity of the rock in terms of particles per hour with uncertainty?

PlusMinus[?? , ???] 1350±90 particles per hour

- What is the background in terms of particles per hour with uncertainty?

PlusMinus[?? , ???] 900±95 particles per hour

- The rate of the rock, minus the value of the background is equal

PlusMinus[?? , ???]450±131 particles per hour

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(* DiscretePlot[PDF[NormalDistribution[μ, σ],k],{k,0,1000},PlotRange→All,
 Frame→True,FrameLabel→{"ν →" ,"Probability Density for rock rate"}] *)
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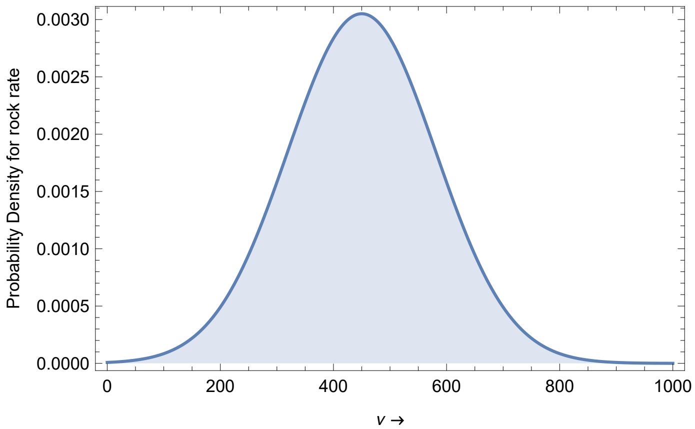

Rutgers 275 Classical Physics Lab
“Poisson distribution”