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Random Number Analysis in Python using Radioactive Decay

Introduction:

This experiment explores random events and Poisson statistics. The importance of this lab is to look at the statistics of randomly occurring events; in this case, we analyze the radiation that is coming off of a Fiesta plate. We attempt to fit the data in Python using curves of statistical distributions. We also work with histograms to visualize our data.

Method:

Materials:

1. Geiger counter
2. Fiesta plate coated with uranium oxide

Experiment:

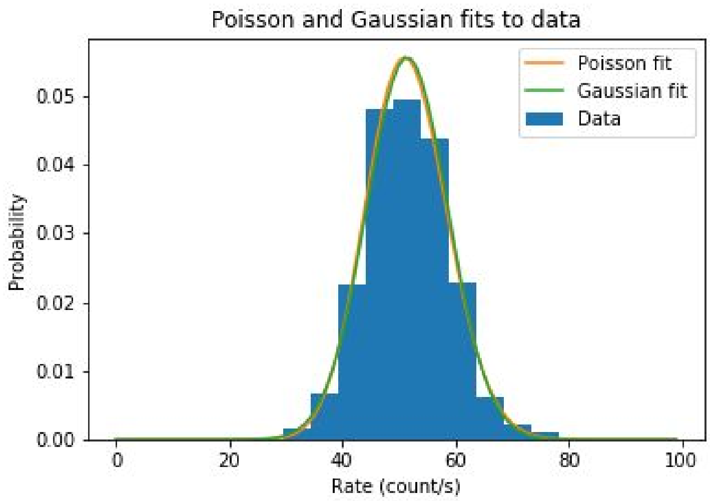
Use the Geiger counter measure the radiation coming off of the plate. Also measure the background radiation separately, taking care to ensure that the radiation from the plate does not contribute any significant amount to the readings. The background radiation and Fiesta plate radiation should be measured in the same space.

Results:

The data was given to us in class, and can be found on Quercus under PyLab5.

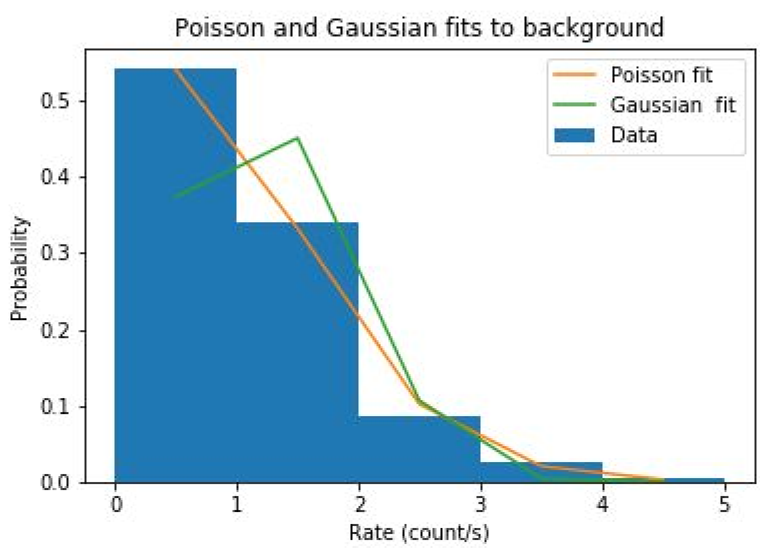
Analysis:

Figure 1.



This graph plots the radiation that is collected from the Fiesta plate. The Poisson and Gaussian fit both fit well to the data. The mean rate is 51.51 counts per second. This was used as the rate parameter for the Poisson distribution, and both the mean and the variance of the Gaussian distribution. There are sufficiently many data points, and by the Central Limit Theorem, the Poisson does indeed converge to a Gaussian (as seen in the plot above).

Figure 2



This graph plots the background radiation that was collected. The mean of the background data is 0.615. The plot suggests that the Poisson fit fits better to the data than the Gaussian fit, but there are too few data points to say anything conclusive. The small number of data points also means that the Poisson fit does not look like that of the Gaussian. Furthermore, the data is asymmetric, whereas the Gaussian distribution is symmetric, which may explain the poor fit.

The equation used in this lab is the Poisson probability mass function $P_{\mu}(n) = e^{-\mu} * \frac{\mu^n}{\Gamma(n+1)}$, where n is the number of particles observed, μ is rate parameter (which also happens to be the mean of the data), and Γ is the gamma function.

A potential source of error is the uncertainty in the measurements of the Geiger counter. We use counting statistics to determine the uncertainty. The error is taken to be the square root of the sum of the variances of the measured decay and the background decay; for this dataset, we calculated an error of 7.49 counts per second.

Conclusion:

In this experiment, our goal was to explore the radiation of uranium oxide in a Fiesta plate. We observe that Gaussian and Poisson distributions are both fit our data fairly well. We also see that the Poisson distribution, for a large number of measurements, tends towards the Gaussian. However, we were unable to perform the same analysis and fitting to the background data, as the number of measurements was insufficient. The data, and our analyis of it, shows that the radiation coming off the Fiesta plate can be describe by Poisson statistics.