IB120/201 - Lab 6

Probability Distributions Pt. 2

Due Date: March 6, 2020

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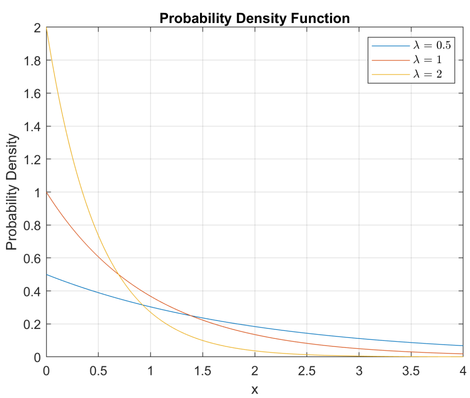
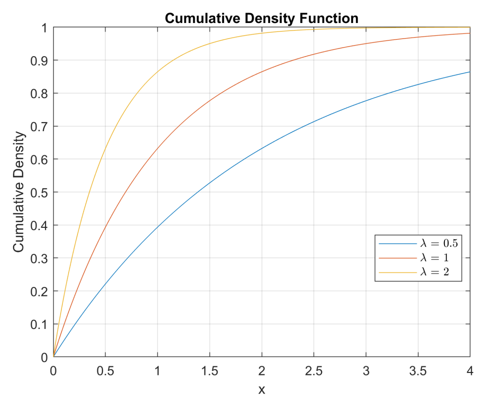
In this lab, we will continue our quest to become familiar with more probability distributions and how to extrapolate meaningful information from them.

Background

We will now move on to primarily look at the exponential distribution, which is found in nature quite a bit. For instance, the rate of decay of a radioactive isotope is exponential. It is defined by the following probability density function:

$$f_X(x) = \begin{cases} \lambda e^{-\lambda x} & x > 0 \\ 0 & \text{otherwise} \end{cases}.$$





Questions

1. From a conceptual standpoint, the *expected value* and the *mean* are the same thing, but in which sort of context or scenario would you use each of these terms? Give examples for both.
2. Why does the cumulative distribution function of the exponential distribution look like a reflection of the PDF? Do the math by hand to prove why that is the case. What assumption about a parameter must be made in order for the CDF to be an inversion about the x-axis?
3. Write a function that creates a logarithmic `seq` (e.g. 1,10,100,1000,...) and populate a vector up to 10 elements. Make random draws from the exponential distribution and plot the variance and expected value of each instance. When does it appear to normalize?
4. Find the variance of the distributions you created in the question above. What is the difference between the variance and the standard deviation?
5. Find the expected value of the exponential distribution using the `dexp` function and also find the expected value of 1000 random draws. Why do you think there is a discrepancy between these two values?

6. Why does the quantile function for the exponential distribution have an undefined expected value?
7. What do we mean by saying that exponential distributions do not have a memory?
8. Name a few examples of when to use the exponential distribution or when it comes up in nature.
9. Create 3 random number generators in R with different seeds and provide the first ten results from each.
10. **BONUS:** Prove how the exponential distribution is a special case of the gamma distribution?
11. **BONUS:** Demonstrate and prove (with a script and visual representations) of how the exponential distribution is memoryless.