Applications in Scientific Computing
Assignment 6: Random numbers and Monte-Carlo integration

530.390.13

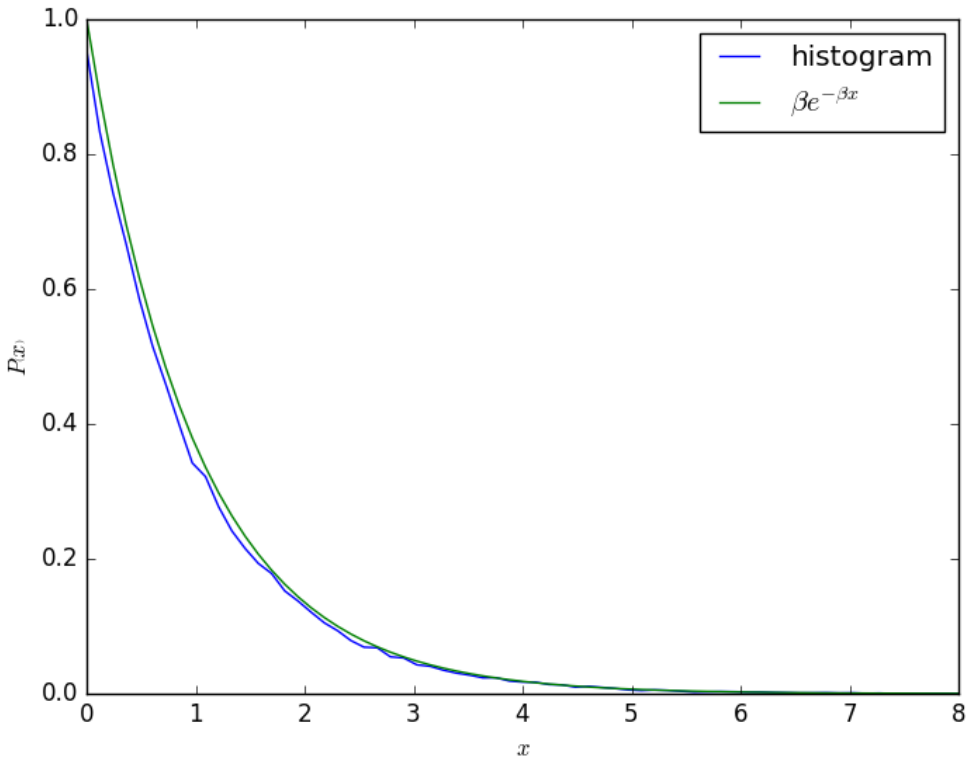
Due: Tuesday 19 January 2016

Submit all code by committing it to the directory `assignments/assignment5` in your `530.390.13` GitHub repository. For a reminder of how to use Git, refer to the repository file `notes/using-git`.

1. Write a function to generate a histogram of the values in an array `A` using `N` bins. This can be accomplished by dividing the range of the array (the difference between the maximum and minimum values) by `N` so that each bin contains a fraction of the total range. Once the range of each bin is determined, parse `A` and count the number of elements that belong in each bin. Normalize the histogram so that its integral is equal to one and it reports the probability density function. Plot the histogram of an exponential distribution using 100,000 random samples and an appropriate value for `N`. Compare your histogram to the expected probability density function given by

$$f(x;\beta) = \begin{cases} \beta e^{-\beta x}; & x \geq 0 \\ 0; & x < 0. \end{cases}$$

   - See `hist.py` and `rng.py`.



2. Use Monte Carlo integration to compute the center of mass of the intersection of a sphere with radius $R = 1$, given by

$$x^2 + y^2 + z^2 \leq 1,$$

with a box defined by

$$-\frac{1}{2} \leq x \leq 1,\ -\frac{1}{2} \leq y \leq 1,\ -1 \leq z \leq 1.$$

- See `hist.py` and `rng.py`.
- $x_{com} = 0.13765$, $y_{com} = 0.13771$, $z_{com} = 0.00122568$