ASTR 415

Evan Shipley-Friedt

October 27, 2022

Problem Set #4

1

1. Write a function that transforms a uniform deviate into a Rayleigh distributed deviate described by

$$p(y)\,dy = ye^{-y^2/2}\,dy,\ \ y \geq 0.$$

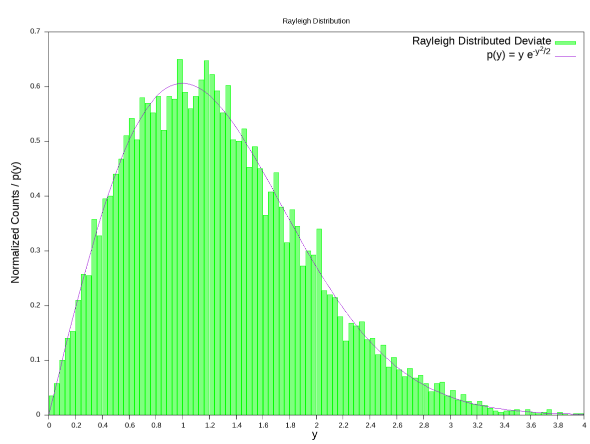
Generate a suitable number of deviates and plot a normalized histogram to test your function (plot the expected Rayleigh distribution over your histogram for comparison).

The Randomly generated points should populate in the area under the probability function $p(y)$. In this case it is the continuous Rayleigh distribution.

$$x = p(y) = \int_0^y y\mathrm{e}^{-y^2/2}dy = 1 - \mathrm{e}^{-y^2/2} \tag{1}$$

$$y = \pm\sqrt{2}\sqrt{ln(1-x)}; \tag{2}$$

Double Precision



2

2. The total mass M of an object of density ρ is given by

$$M = \int_V \rho \, dx \, dy \, dz,$$

where V represents the volume of the object. Using simple Monte Carlo integration, write a program that computes M and its estimated error σ_M if $\rho = 1 + x^2 + 3(y+z)^2$, where the volume of the object V is defined by $x^2 + y^2 + z^2 \leq 9$, $x \geq 0$, and $y \geq -1$. Plot M with errorbars σ_M as a function of the number of points N used in the Monte Carlo integration, for N between 10 and 10^7, in integer powers of 10.