Python DeCal Homework 6

Due Monday March XX, 2024

1 Random Plots

This problem in an exercise in plotting random data. First you must generate three lists of random numbers, each 40 elements long with values ranging from 0 to 100. Then make two stacked vertical subplots. The top plot should plot one list of random data in orange and with a line width of 10 and another list in red and dashed. The bottom plot should be a scatter plot of the final list with magenta diamonds as the marker. In each case the x coordinate should be the position in the list.

2 van der Waals Gas

A Van der Waals gas is a model of gas particles that takes into account the interaction of the particles and the volume the particles take up. Like the ideal gas law, it relates pressure, volume, amount of gas and temperature. The equation is

$$\left(P + a\frac{n^2}{V^2}\right)(V - nb) = nRT \quad (1)$$

Where P is pressure, V is volume, T is temperature, n is number of moles, R is the ideal gas constant and a, b are parameters. The value of R is $0.083144\frac{barL}{molK}$

Make a colormap plot of the temperature of one mole acetone for given volume and pressure. The pressure should vary between 1 and 10 bar and the volume should vary between 10 and 30 liters. For acetone $a = 16.02\frac{barL^2}{mol^2}$ and $b = 0.1124\frac{L}{mol}$. Make sure your axes labels have the correct values. Also make use of ‘vmin‘ and ‘vmax‘ to show detail in your color map and add a color bar to the map

3 Monte Carlo π

Did you know that we can calculate the value of π by generating random numbers? We first generate a whole bunch of random points in a 1x1 square with the corner at the origin. Then we see how many of the points are within a distance 1 of the origin. There points all fall in a quarter of a circle centered on the origin. Then using the relation

$$\frac{N_{in}}{N} \approx \frac{A_{qc}}{A}$$

we can calculate π from the ratio of the areas of a quarter circle and the square.

Calculate the value of π using this procedure for N = 1e3, 1e4, 1e5, 1e6, and print your results. Also create a plot of these points for N = 1e4. The points within the quarter circle should all be one color and the points outside should also be a different color. Also please make sure your plot is a square and put the value of pi from that run on your plot as text.