If you are using a jupyter notebook (recommended), then keep all your programs in a single notebook. A good programming style is to define a function for one task with clearly defined input (arguments) and output. For plots you may use matplotlib (if you are using python) or gnuplot (if you are using c or fortran) or LsqFit module if you are using Julia.

If you are planning to submit separate programs, then please follow the guideline below:

- Keep all files of a worksheet in a single folder.
- Follow a systematic naming convention. You may name the program files as `Q1.py` or `Q1a.py`, `Q1b.py` for question 1 (if you have created multiple files for a single question). The data file should be named as `Q1-data-a.dat` and so on.
- Finally compress the entire folder as a single `.zip` or `.tgz` (using `tar cvfz archive.tgz folder-name/`, and submit the file in WeLearn.

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1. In this problem, we shall generate a set of random numbers whose distribution (not normalized) is given as

$$w(x) = \frac{1}{1+(x-1)^2} \; \forall x \in \mathbb{R}.$$

   To achieve this we shall use the Metropolis algorithm in the following way:

   (a) Plot the distribution as a function of x to get an idea about its behavior.

   (b) Start a random walk of steps $1e6$ steps from $x_0 \sim 0.5$ (*why?*). We are choosing a starting point which is close to the maximum of this distribution.

      1. Take a step δx by choosing a floating point random number between -1 and 1 (corresponds to a maximum step size 1).
      2. Find
$$a = \min\left[1, \frac{w(x_i+\delta x)}{w(x_i)}\right].$$
      3. Accept the step with a probability a.
      4. Store the result and take the next step.

   (c) Generate the histogram data and normalize it.

   (d) Plot the normalized distribution. On the same plot, draw normalized $w(x)$.

2. Calculate the integral
$$\int_0^1 w(x)\, dx, = \int_0^1 \frac{x^3}{e^x-1}$$
   using *importance sampling* method. You may proceed as follows:

   (a) Choose a trial function of the form
$$\frac{1}{b+(x-x_\circ)^2}$$
   . Choose b and x_{circ} (intuitively).

   (b) Calculate the integral using the importance sampling method.