# Random Walk assignment
# MATH 210-01, Fall 2021

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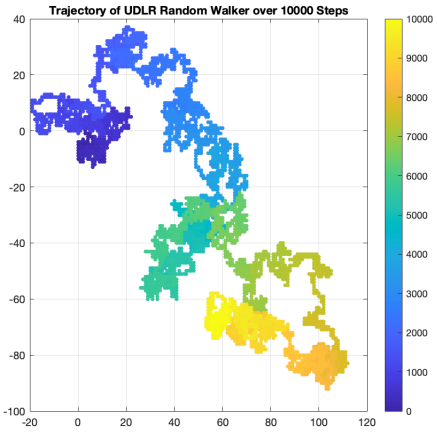
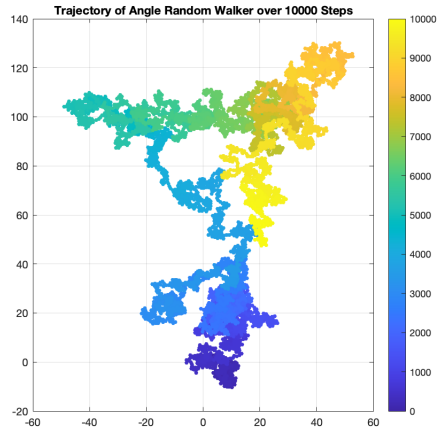
In class we used `two_d_walk_UDLR(num_steps)` and `two_d_walk_angle(num_steps)` to perform "UDLR" and "angle" random walks of length `num_steps`. Both functions return the column vectors `[x, y]` of coondinates encourntered on the walk. Note that the lengths of `x` and `y` are `num_steps + 1`.

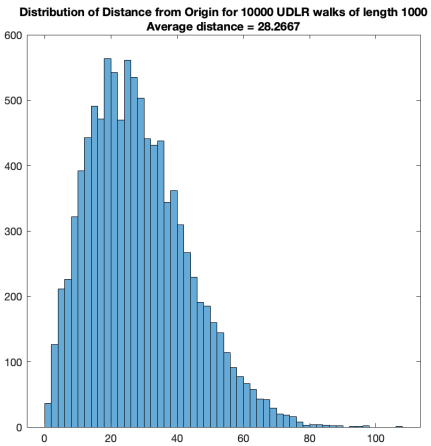
The script `visualize_walks` performs each of the above random walks one time and plots the results in a figure using the `plot()` and `scatter()` functions. An example is shown below for `num_steps = 10000`.

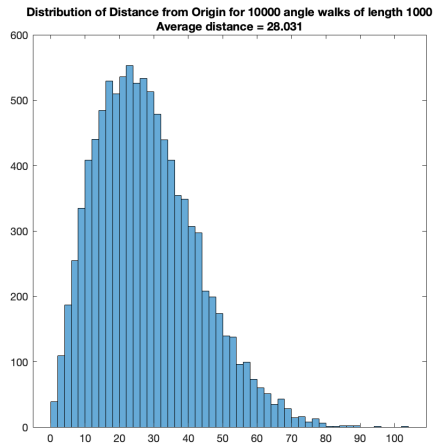



Additionally, we used the function `distance_of_walkers(num_sims,num_steps)` to repeatedly (`num_sims` times) run UDLR and angle walks of length `num_steps` and calculate the final distances from the starting point in the column vectors `[distances_UDLR, distances_angle]`, each of which has length `num_sims+1`.

Using the script `distribution_of_distances()`, we studied the distribution of distances for each type of random walk. An example is shown below for `num_steps = 1000` and `num_sims = 10000`



1. **(30 points)** Create a new function `three_d_walk(num_steps)` that performs a 3-dimensional random walk of length `num_steps`, by starting at the origin $(x, y, z) = (0, 0, 0)$ and rolling a fair 6-sided die to determine the direction of each step (up, down, left, right, front, back). The function should return the column vectors `[x, y, z]` which record the coordinates of each step of the walk.
   Hint: use the `two_d_walk_UDLR(num_steps)` function as a template.

2. **(20 points)** Create a new script `visualize_3_d_walk` that calls your function in 1. and uses the `plot3()` and `scatter3()` functions to visualize the results of a 3-dimensional walk of $10,000$ steps.
   Hint: use the `visualize_walks` script as a template.

3. **(40 points)** Write a script `average_distance_plot` that uses the `distance_of_walkers()` function to perform $10,000$ UDLR and angle walks of length `num_steps` for each value of `num_steps` in the list `10:10:1000`, and returns the average distance from the origin in column vectors `averages_UDLR` and `averages_angle`.

   Your script should also plot the resulting averages against the vector `10:10:1000` on the same axis. Use a red solid line with square markers for the UDLR averages, and a blue solid line with circle markers for the angle average. Include a legend, label your axes appropriately, and include a descriptive title.

4. **(10 points)** Using the graph in 3., hypothesize about the functional relationship between the number of steps in a walk and the average distance of the walker from the starting point. Does the relationship seem to depend on which type of walk (UDLR or angle) is performed?