GITHUB: https://github.com/BraydanNewman/MXB261_PST

PART 1 CODE
main.m

```
%% Plot 1
N = 100;
P = "1";

subplot(2,2,1)
[results] = ball_drop(1/3, 1/3, 1/3, N, P);
bar(results)
ylabel('Number of Particles', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Probabilities (s = w = e = 1/3): ', 'FontSize', 20)

subplot(2,2,2)
[results] = ball_drop(2/3, 1/6, 1/6, N, P);
bar(results)
ylabel('Number of Particles', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Probabilities (S = 2/3, w = 1/6, e = 1/6):', 'FontSize', 20)

subplot(2,2,3)
[results] = ball_drop(3/5, 3/10, 1/10, N, P);
bar(results)
ylabel('Number of Particles', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Probabilities (s = 3/5, w = 3/10 e = 1/6):', 'FontSize', 20)

subplot(2,2,4)
[results] = ball_drop(3/5, 1/10, 3/10, N, P);
bar(results)
ylabel('Number of Particles', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Probabilities (s = 3/5, w = 1/10, e = 3/10):', 'FontSize', 20)

sgtitle(["2D Biased Random Walk", "Praticals = 100, Starting Position = Middle (1)"], 'FontSize',
25)

%% Plot 2
N = 200;
P = "1";

subplot(2,2,1)
[results] = ball_drop(1/3, 1/3, 1/3, N, P);
bar(results)
ylabel('Number of Particles', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Probabilities (s = w = e = 1/3):', 'FontSize', 20)

subplot(2,2,2)
```

```
[results] = ball_drop(2/3, 1/6, 1/6, N, P);
bar(results)
ylabel('Number of Particles', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Probabilities (S = 2/3, w = 1/6, e = 1/6):', 'FontSize', 20)

subplot(2,2,3)
[results] = ball_drop(3/5, 3/10, 1/10, N, P);
bar(results)
ylabel('Number of Particles', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Probabilities (s = 3/5, w = 3/10 e = 1/6):', 'FontSize', 20)

subplot(2,2,4)
[results] = ball_drop(3/5, 1/10, 3/10, N, P);
bar(results)
ylabel('Number of Particles', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Probabilities (s = 3/5, w = 1/10, e = 3/10):', 'FontSize', 20)

sgtitle(["2D Biased Random Walk", "Praticals = 200, Starting Position = Middle (1)"], 'FontSize',
25)

%% Plot 3
N = 100;
P = "rand";

subplot(2,2,1)
[results] = ball_drop(1/3, 1/3, 1/3, N, P);
bar(results)
ylabel('Number of Particles', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Probabilities (s = w = e = 1/3):', 'FontSize', 20)

subplot(2,2,2)
[results] = ball_drop(2/3, 1/6, 1/6, N, P);
bar(results)
ylabel('Number of Particles', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Probabilities (S = 2/3, w = 1/6, e = 1/6):', 'FontSize', 20)

subplot(2,2,3)
[results] = ball_drop(3/5, 3/10, 1/10, N, P);
bar(results)
ylabel('Number of Particles', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Probabilities (s = 3/5, w = 3/10 e = 1/6):', 'FontSize', 20)

subplot(2,2,4)
[results] = ball_drop(3/5, 1/10, 3/10, N, P);
bar(results)
ylabel('Number of Particles', 'FontSize', 20)
```

```
xlabel('Bins', 'FontSize', 20)
title('Probabilities (s = 3/5, w = 1/10, e = 3/10):', 'FontSize', 20)

sgtitle(["2D Biased Random Walk", "Praticals = 100, Starting Position = Random (rand)"],
'FontSize', 25)

%% Plot 4
N = 200;
P = "rand";

subplot(2,2,1)
[results] = ball_drop(1/3, 1/3, 1/3, N, P);
bar(results)
ylabel('Number of Particles', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Probabilities (s = w = e = 1/3):', 'FontSize', 20)

subplot(2,2,2)
[results] = ball_drop(2/3, 1/6, 1/6, N, P);
bar(results)
ylabel('Number of Particles', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Probabilities (S = 2/3, w = 1/6, e = 1/6):', 'FontSize', 20)

subplot(2,2,3)
[results] = ball_drop(3/5, 3/10, 1/10, N, P);
bar(results)
ylabel('Number of Particles', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Probabilities (s = 3/5, w = 3/10 e = 1/6):', 'FontSize', 20)

subplot(2,2,4)
[results] = ball_drop(3/5, 1/10, 3/10, N, P);
bar(results)
ylabel('Number of Particles', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Probabilities (s = 3/5, w = 1/10, e = 3/10):', 'FontSize', 20)

sgtitle(["2D Biased Random Walk", "Praticals = 200, Starting Position = Random (rand)"],
'FontSize', 25)
```

ball_drop.m

```
function [results] = ball_drop(s, w, e, N, P)
    board_height = 99;
    board_width = 99;

    game_board = zeros(board_height, board_width);

    for ball_index = 1:N

        if P == "rand"
            start_x = randi([1, board_width]);
```

```
    elseif P == "1"
        start_x = (board_width + 1) / 2;
    end

    current_x = start_x;
    current_y = board_height;

    next_x = current_x;
    next_y = current_y;

    stopped = false;

    while ~stopped
        u = rand;
        if u < w
%           LEFT
            temp = current_x - 1;
            if temp < 1
                temp = board_width;
            end

            if game_board(temp, current_y) ~= 1
                next_x = temp;
            end
        elseif u < w + e
%           RIGHT
            temp = current_x + 1;
            if temp > board_width
                temp = 1;
            end

            if game_board(temp, current_y) ~= 1
                next_x = temp;
            end
        elseif u < w + e + s
%           DOWN
            next_y = current_y - 1;
            if game_board(next_x, next_y) == 1 || next_y == 1
                game_board(current_x, current_y) = 1;
                stopped = true;
            end
        end
        current_x = next_x;
        current_y = next_y;
    end
end

results = zeros(1, board_width);
for i = 1:board_width
    results(i) = sum(game_board(i,:));
end
```

```
end
```

PART 2 CODE
main.m

```
%% Plot 1
bins = 20;
samples = 1000;
[KLD1, KLD2, X, b, X1,b1] = sampling(bins, samples);

KLD1
KLD2

subplot(1, 2, 1)
bar(X, b)
ylabel('Probability', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Given Data Probability Distribution', 'FontSize', 20)

subplot(1, 2, 2)
bar(X1, b1)
ylabel('Probability', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Sampled Data Probability Distribution', 'FontSize', 20)

sgtitle(["Sampling from Experimental Data", "Bins = 20, Samples = 1000"], 'FontSize', 25)

%% PLot 2
bins = 10;
samples = 1000;
[KLD1, KLD2, X, b, X1,b1] = sampling(bins, samples);

KLD1
KLD2

subplot(1, 2, 1)
bar(X, b)
ylabel('Probability', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Given Data Probability Distribution', 'FontSize', 20)

subplot(1, 2, 2)
bar(X1, b1)
ylabel('Probability', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Sampled Data Probability Distribution', 'FontSize', 20)

sgtitle(["Sampling from Experimental Data", "Bins = 10, Samples = 1000"], 'FontSize', 25)

%% Plot 3
bins = 40;
samples = 1000;
```

```
[KLD1, KLD2, X, b, X1,b1] = sampling(bins, samples);

KLD1
KLD2

subplot(1, 2, 1)
bar(X, b)
ylabel('Probability', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Given Data Probability Distribution', 'FontSize', 20)

subplot(1, 2, 2)
bar(X1, b1)
ylabel('Probability', 'FontSize', 20)
xlabel('Bins', 'FontSize', 20)
title('Sampled Data Probability Distribution', 'FontSize', 20)

sgtitle(["Sampling from Experimental Data", "Bins = 20, Samples = 1000"], 'FontSize', 25)
```

sampling.m

```
function [KLD1, KLD2, X, b, X1,b1] = sampling(bin, N)
    % Set Up
    load("sampledata2023.mat");

    figure(1)
    h = histogram(Data0, bin);
    b = h.Values / length(Data0);
    c = cumsum(b);
    X = h.BinEdges(1:bin)+h.BinWidth/2;

    rng(4)
    DataNew = zeros(1, N);
    for i = 1:N
        u = rand;
        index = find(c>u,1);
        DataNew(1,i) = X(index);
    end

    figure(2)
    h1 = histogram(DataNew, bin);

    b1 = h1.Values / length(Data0);
    X1 = h1.BinEdges(1:bin)+h1.BinWidth/2;

    KLD1 = 0;
    for i = 1:bin
        KLD1 = KLD1 + b(i) * log(b(i)/b1(i));
    end

    KLD2 = 0;
    for i = 1:bin
```

```
        KLD2 = KLD2 + b1(i) * log(b1(i)/b(i));
    end
end
```