

Random Walk Simulation

Simulation process (Use 2D case as example)

Import the packages

```
import time
import numpy as np
import matplotlib.pyplot as plt
```

Define the function to randomly generate 1 & -1

```
def generate_random_sign():
    n = random.choice([-1, 1])
    return n
```

Define the number of trials of simulation and the samples of random walks in the single trials

Calculate the L1 distance (Manhattan distance) and L2 distance (Euclidean distance)

\$\$ L1 = |x| + |y| \$\$

\$\$ L2 = \sqrt{x^2+y^2} \$\$

```
num_trial, num_samples = 1000, 1000
pos_x, pos_y = 0, 0
l1_dist = []
l2_dist = []

for i in range(num_trial):
    x, y = 0, 0
    for i in range(num_samples):

        x1 = generate_random_sign()
        y1 = generate_random_sign()

        if x1 == 1:
            pos_x += 1

        if y1 == 1:
            pos_y += 1

        x += x1
        y += y1

    l1 = abs(x) + abs(y)
```

```
l1_dist.append(l1)

l2 = np.sqrt(x**2 + y**2)
l2_dist.append(l2)
```

1D Cases

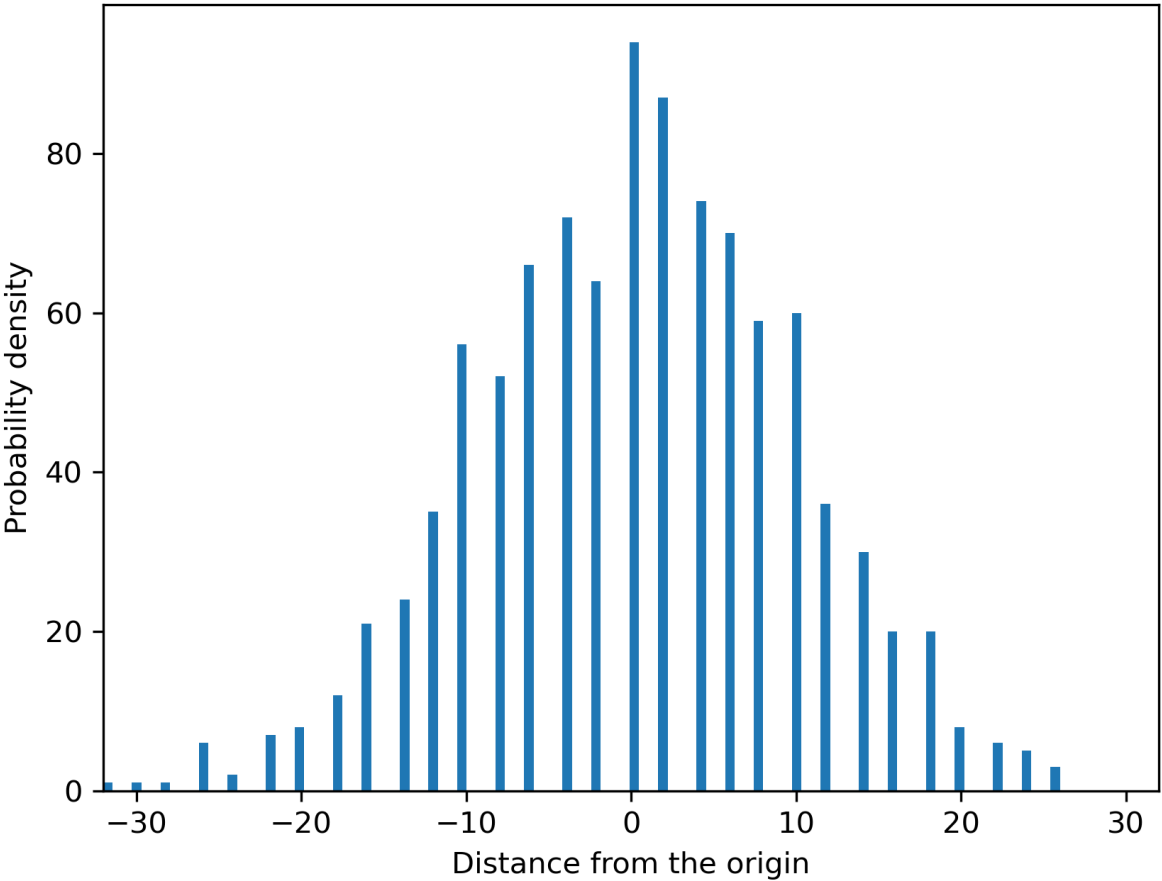
\$1000\ trials, \ 100\ steps\$

Positive percentage for x: 49.9820 %

Calculation time: 0.0572 seconds

	Min distance	Max distance	Average distance	Standard Deviation
Distance	-28	32	-0.04	10.05

Probability density of 1D Random walk, trials = 1000, steps = 100



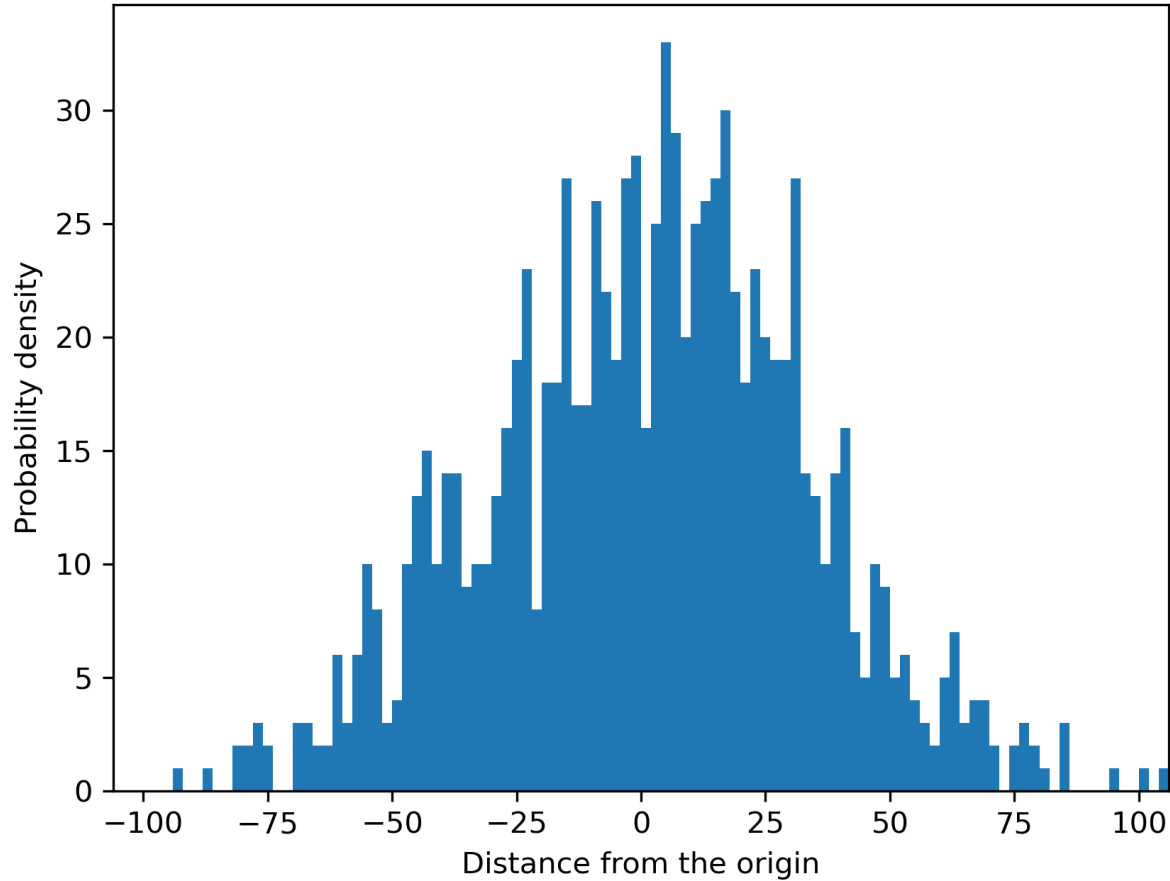
\$1000\ trials, \ 1000\ steps\$

Positive percentage for x: 50.0395 %

Calculation time: 0.6118 seconds

	Min distance	Max distance	Average distance	Standard Deviation
Distance	-94	106	0.79	31.99

Probability density of 1D Random walk, trials = 1000, steps = 1000



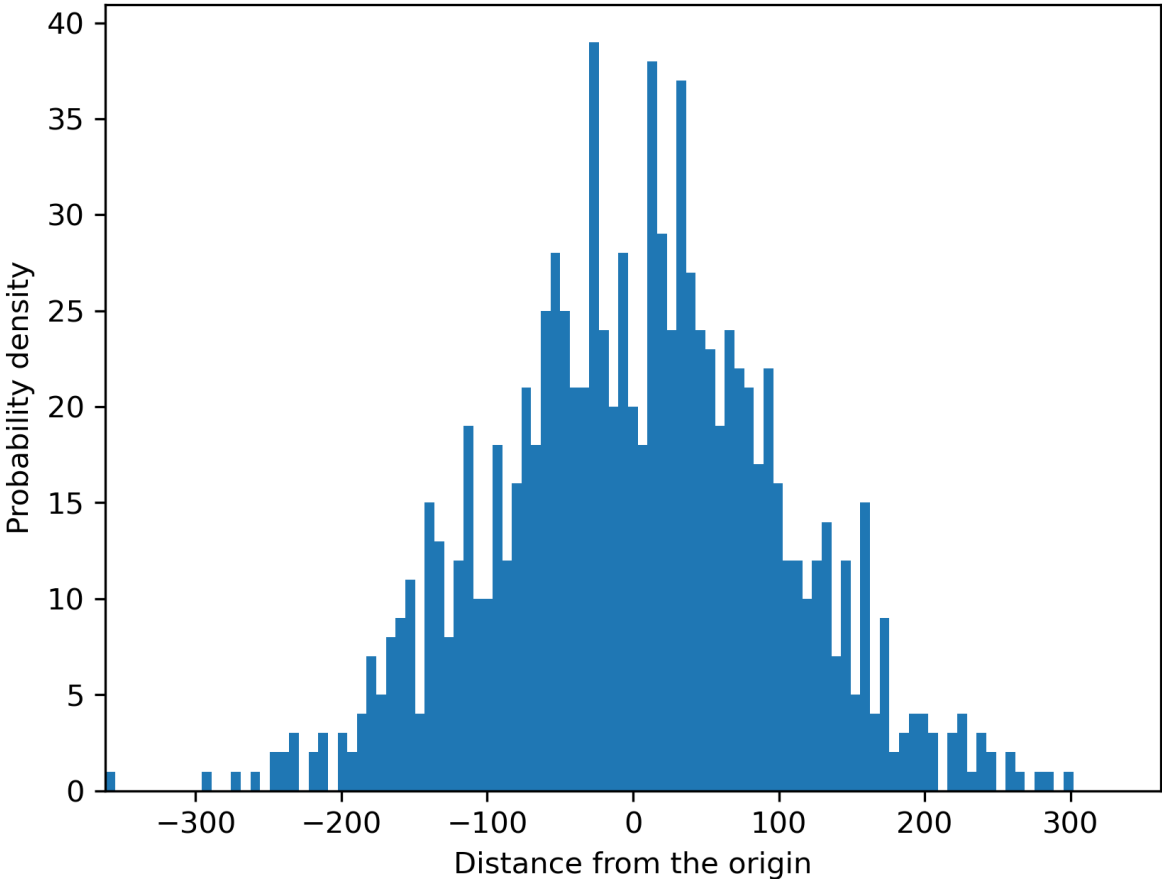
\$1000\ trials, \ 10000\ steps\$

Positive percentage for x: 50.0148 %

Calculation time: 5.8101 seconds

	Min distance	Max distance	Average distance	Standard Deviation
Distance	-362	302	2.97	98.08

Probability density of 1D Random walk, trials = 1000, steps = 10000



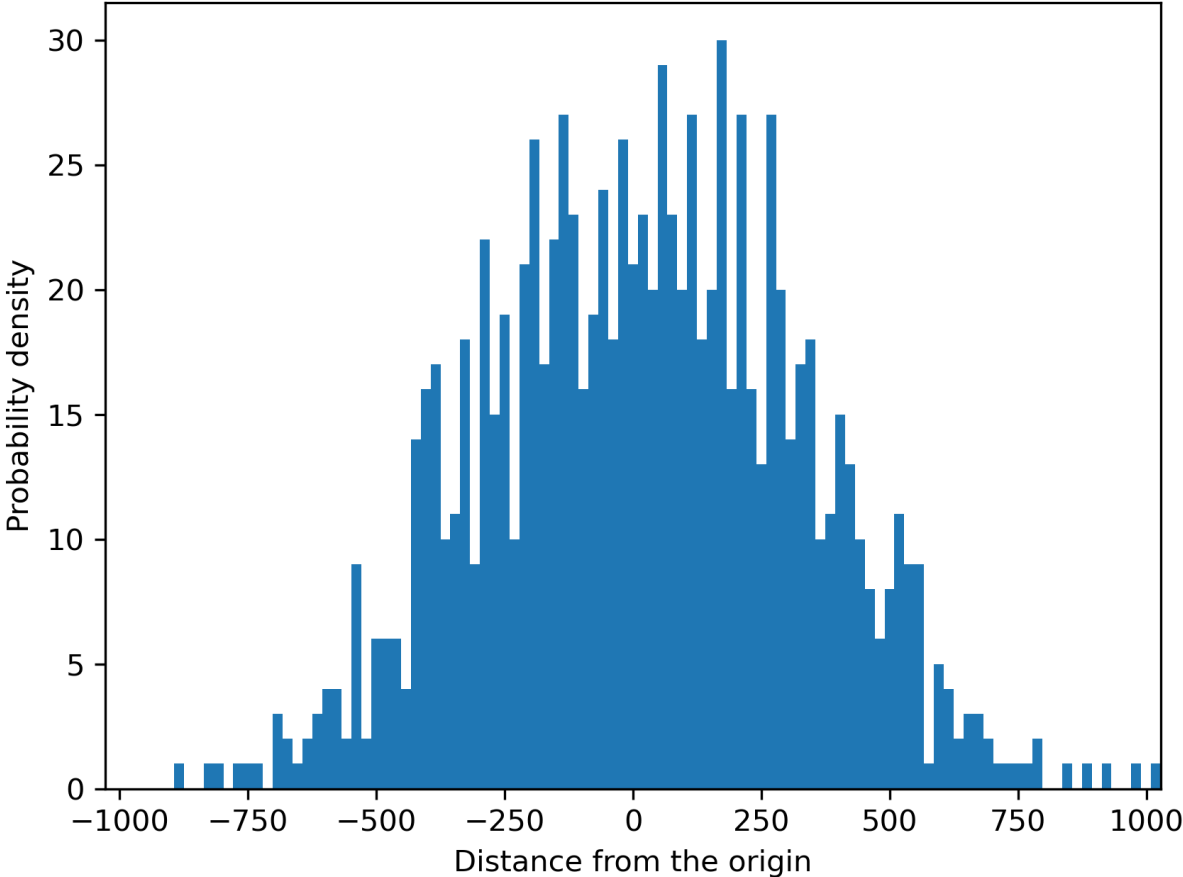
\$1000\ trials, \ 100000\ steps\$

Positive percentage for x: 50.0112 %

Calculation time: 58.9777 seconds

	Min distance	Max distance	Average distance	Standard Deviation
Distance	-894	1028	22.46	308.32

Probability density of 1D Random walk, trials = 1000, steps = 100000



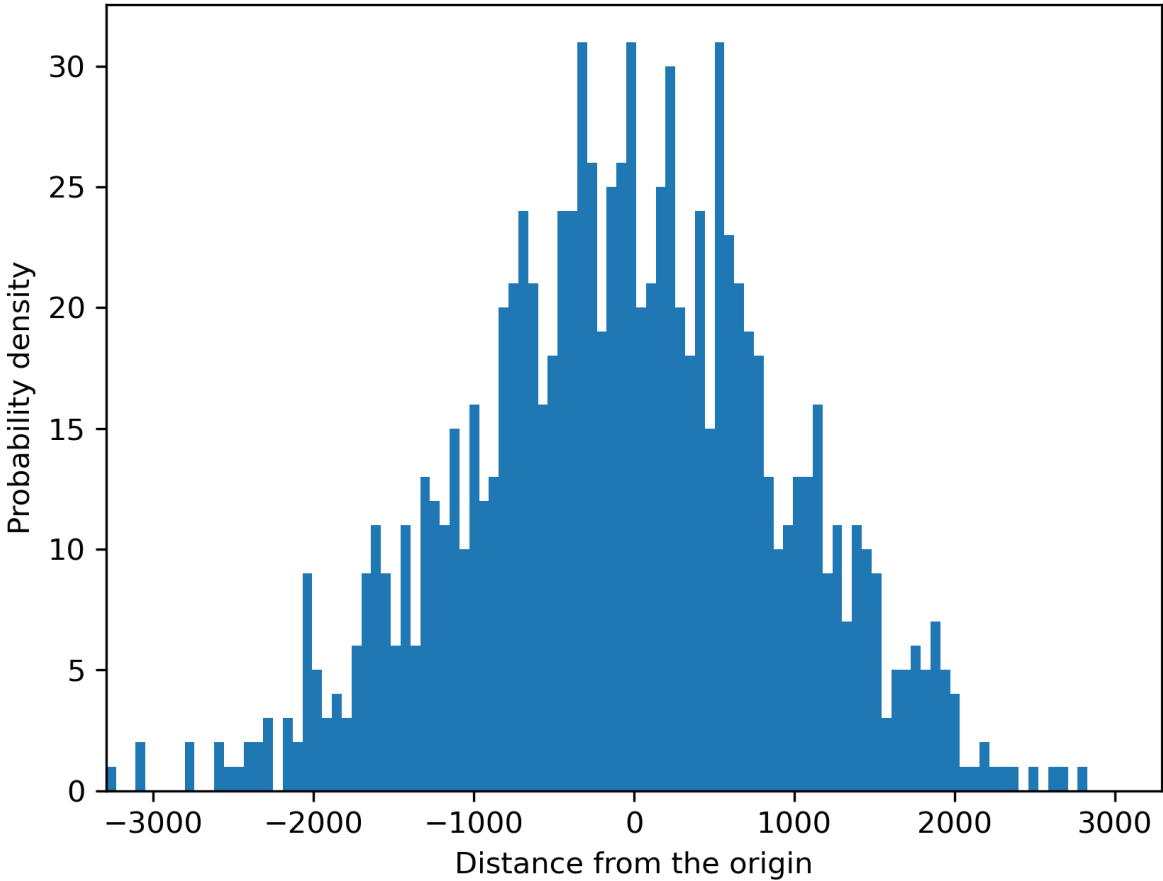
\$1000\ trials, \ 1000000\ steps\$

Positive percentage for x: 49.997 %

Calculation time: 594.1655 seconds

	Min distance	Max distance	Average distance	Standard Deviation
Distance	-3294	2830	-60.24	994.63

Probability density of 1D Random walk, trials = 1000, steps = 1000000



2D Cases

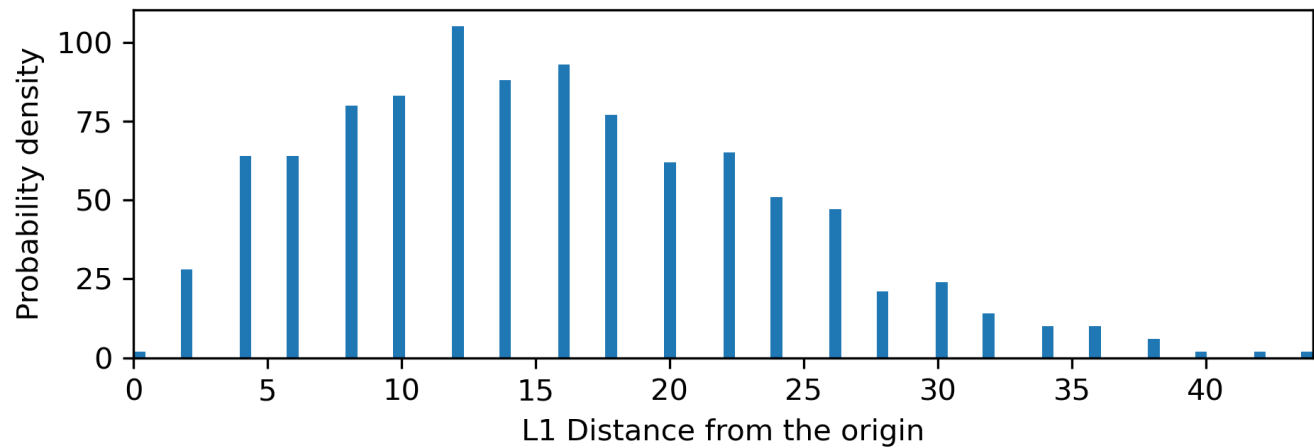
\$1000\ trials, \ 100\ steps\$

Positive percentage for x: 50.1060 %

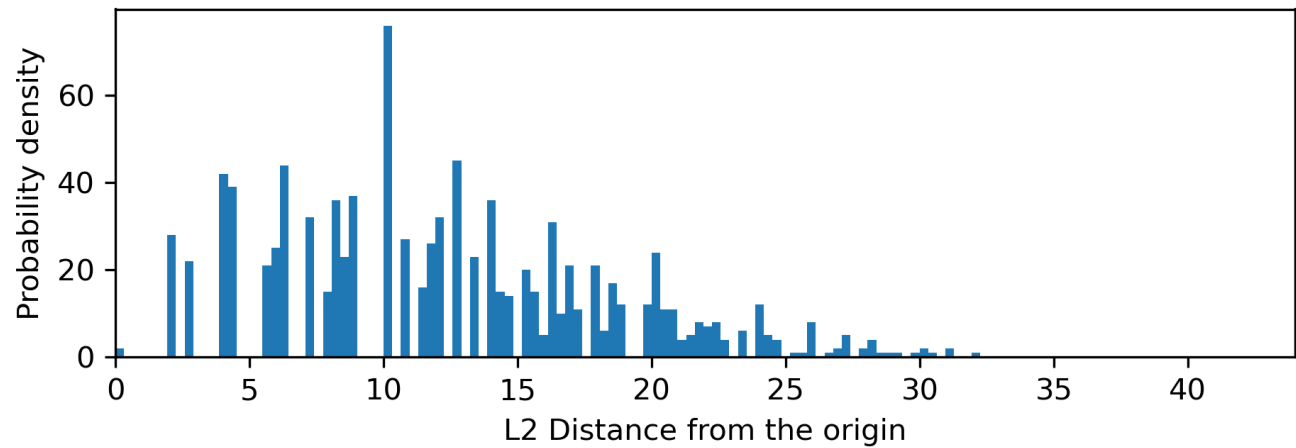
Positive percentage for y: 49.9820 %

Calculation time: 0.1222 seconds

	Min distance	Max distance	Average distance	Standard Deviation
L1	0	44	15.58	8.29
L2	0.0	32.25	12.33	6.33



Probability density of 2D Random walk, trials = 1000, steps = 100



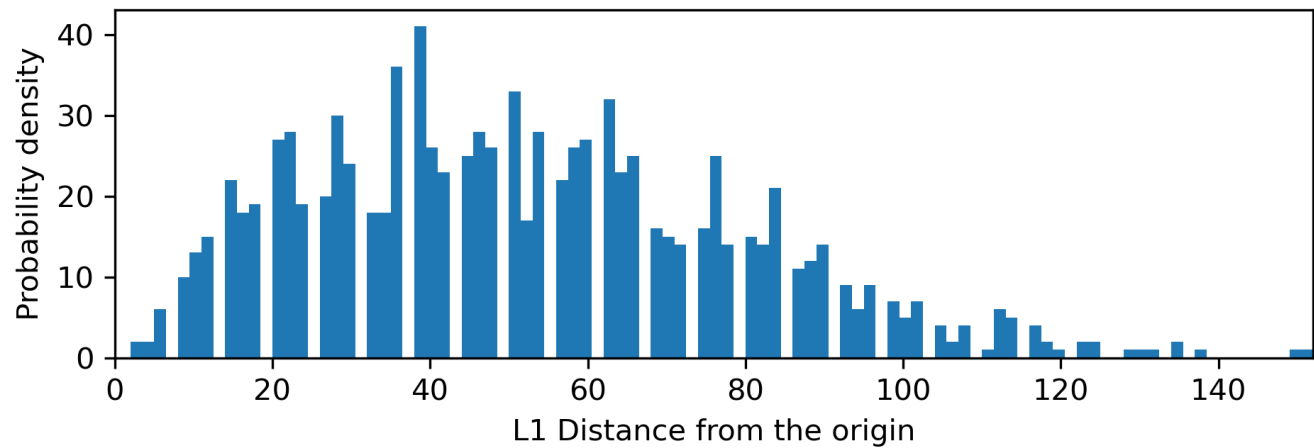
\$1000\ trials, \ 1000\ steps\$

Positive percentage for x: 49.9381 %

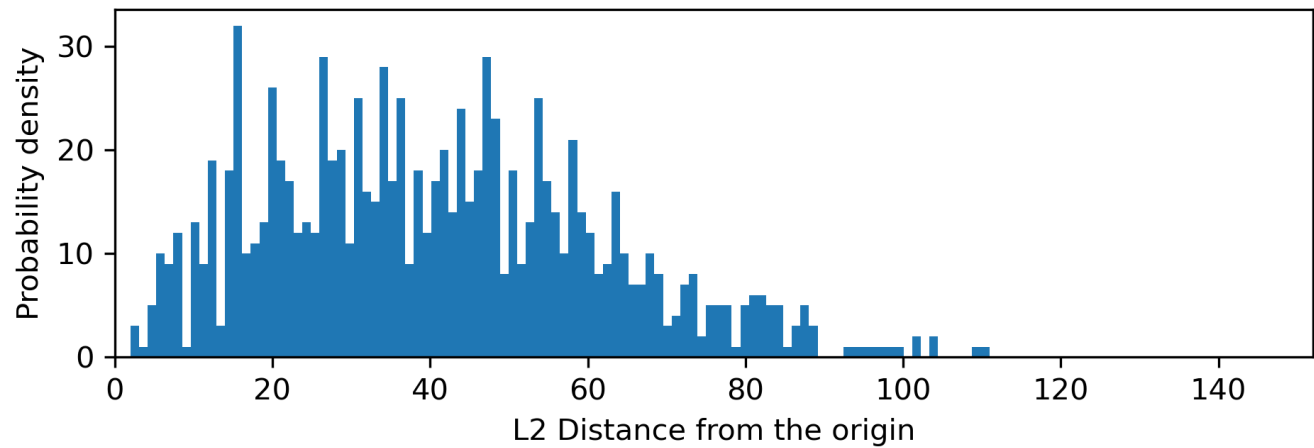
Positive percentage for y: 49.9854 %

Calculation time: 1.2859 seconds

	Min distance	Max distance	Average distance	Standard Deviation
L1	2	152	51.94	27.18
L2	2.0	110.94	40.72	20.91



Probability density of 2D Random walk, trials = 1000, steps = 1000



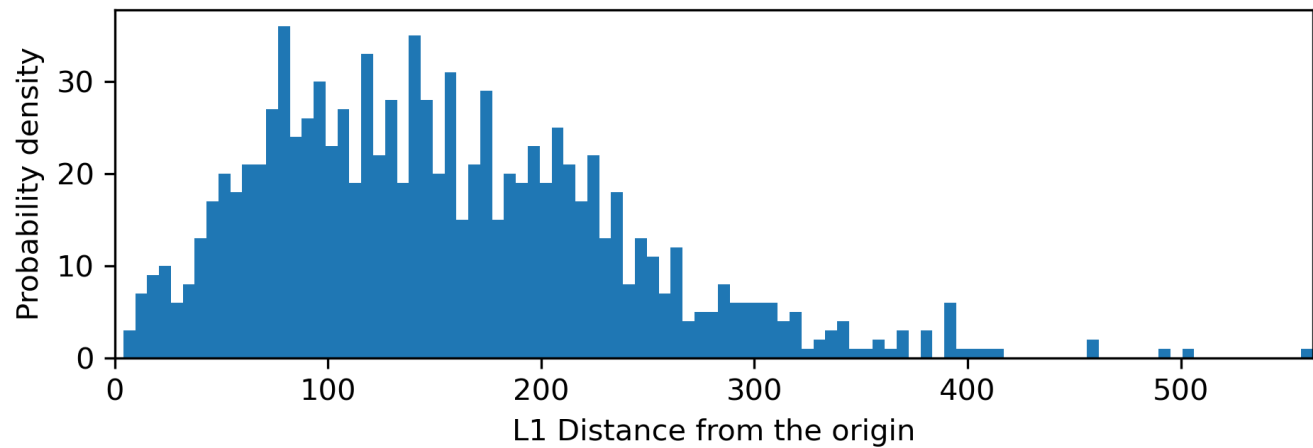
\$1000\ trials, \ 10000\ steps\$

Positive percentage for x: 50.0185 %

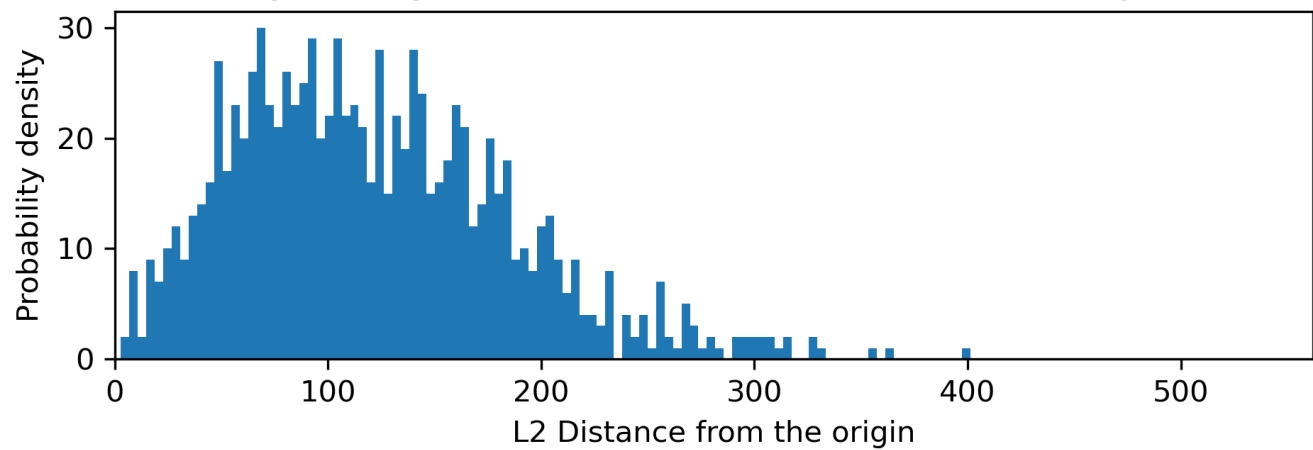
Positive percentage for y: 49.9984 %

Calculation time: 12.3023 seconds

	Min distance	Max distance	Average distance	Standard Deviation
L1	4	562	154.3	84.02
L2	2.83	401.2	121.3	64.52



Probability density of 2D Random walk, trials = 1000, steps = 10000



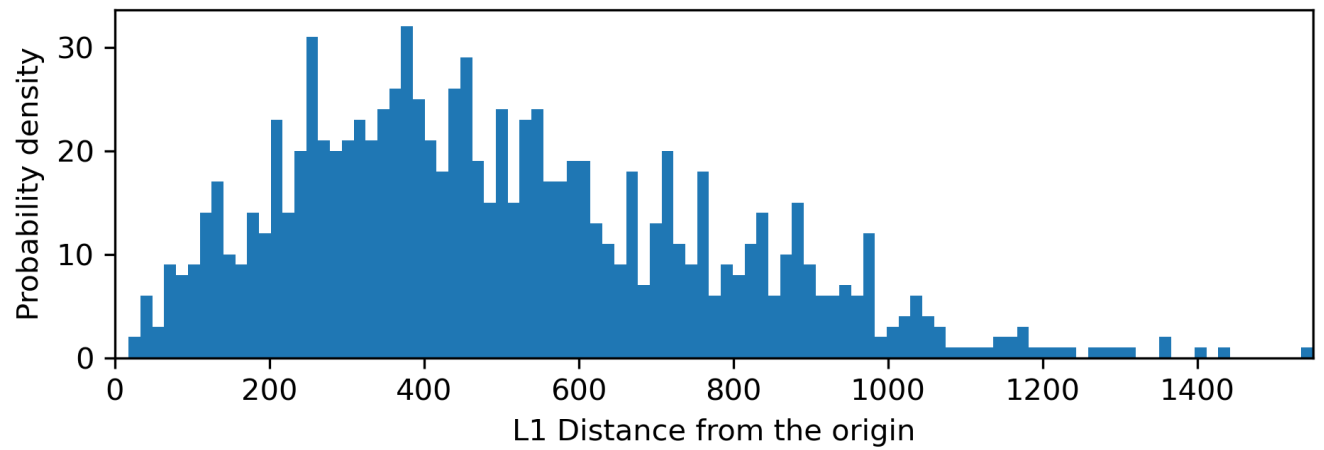
\$1000\ trials, \ 100000\ steps\$

Positive percentage for x: 50.0028 %

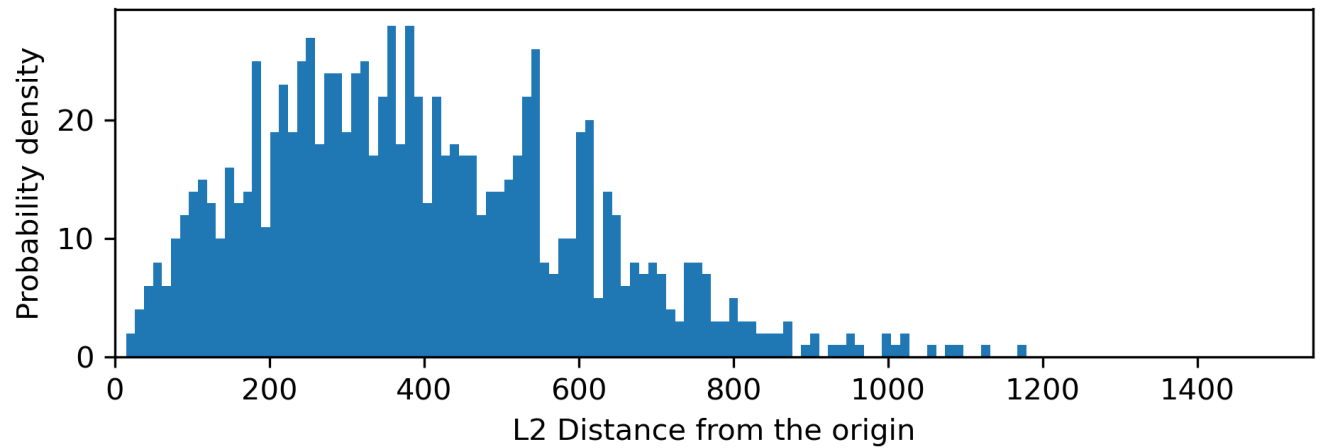
Positive percentage for y: 50.0024 %

Calculation time: 119.857 seconds

	Min distance	Max distance	Average distance	Standard Deviation
L1	18	1550	502.37	268.25
L2	14.56	1178.88	394.84	206.68



Probability density of 2D Random walk, trials = 1000, steps = 100000



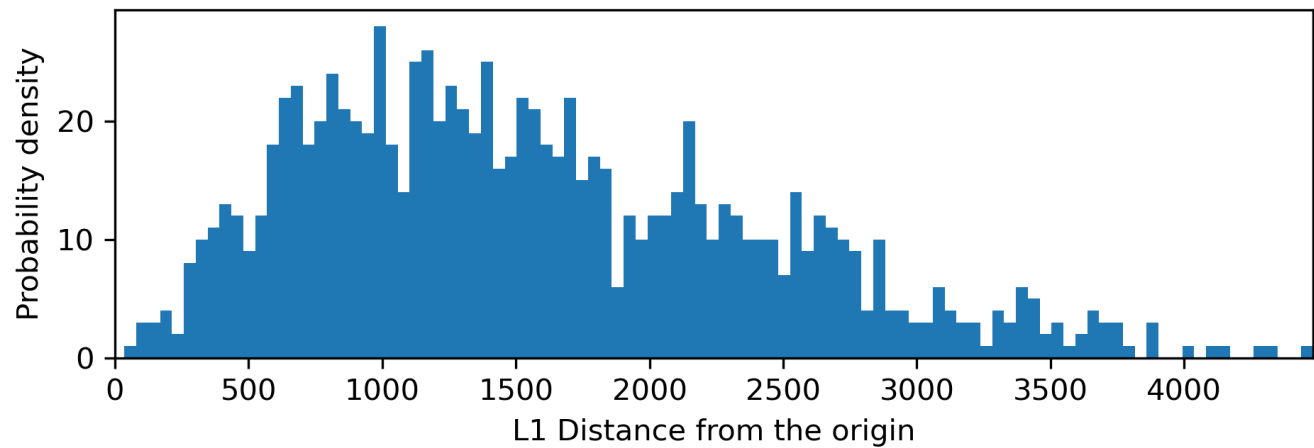
\$ 1000\ trials, \ 1000000\ steps \$

Positive percentage for x: 50.0002 %

Positive percentage for y: 49.9988 %

Calculation time: 1260.8529 seconds

	Min distance	Max distance	Average distance	Standard Deviation
L1	36	4482	1580.94	849.66
L2	25.46	3510.67	1241.52	661.53



Probability density of 2D Random walk, trials = 1000, steps = 1000000

