C3 Code with estimate

```
import random, pylab, math

def markov_pi_all_data(N, delta):
    x, y = 1.0, 1.0
    data = []
    for i in range(N):
        del_x, del_y = random.uniform(-delta, delta), random.uniform(-delta, delta)
        if abs(x + del_x) < 1.0 and abs(y + del_y) < 1.0:
            x, y = x + del_x, y + del_y
        if x ** 2 + y ** 2 < 1.0:
            data.append(4.0)
        else:
            data.append(0.0)
    return data

poweroftwo = 20
n_trials = 2 ** poweroftwo
delta = 0.1
data = markov_pi_all_data(n_trials, delta)
errors  = []
bunches = []
for i in range(poweroftwo):
    new_data = []
    mean = 0.0
    mean_sq = 0.0
    N = len(data)
    while data != []:
        x = data.pop()
        y = data.pop()
        mean += x + y
        mean_sq += x ** 2 + y ** 2
        new_data.append((x + y) / 2.0 )
    errors.append(math.sqrt(mean_sq / N - (mean / N) ** 2) / math.sqrt(N))
    bunches.append(i)
    data = new_data[:]
    print(mean / float(N), errors[i], 'mean value, estimate of pi')
pylab.plot(bunches, errors, 'o')
pylab.xlabel('iteration')
pylab.ylabel('apparent error')
pylab.title('Bunching: naive error vs iteration number')
pylab.savefig('apparent_error_bunching.png')
pylab.show()
```

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3.148113250732422 0.0015992492236038547 mean value, estimate of pi
3.148113250732422 0.0021708898965066325 mean value, estimate of pi
3.148113250732422 0.0029542120182203917 mean value, estimate of pi
3.148113250732422 0.003999090012254888 mean value, estimate of pi
3.148113250732422 0.00534960368958548 mean value, estimate of pi
3.148113250732422 0.007025482141658974 mean value, estimate of pi
3.148113250732422 0.008915371335100248 mean value, estimate of pi
3.148113250732422 0.010700770221836766 mean value, estimate of pi
3.148113250732422 0.012195009174369113 mean value, estimate of pi
3.148113250732422 0.012953145654848832 mean value, estimate of pi
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3.148113250732422 0.013285014959294872 mean value, estimate of pi
3.148113250732422 0.013582774213473214 mean value, estimate of pi
3.148113250732422 0.014019809506830967 mean value, estimate of pi

3.148113250732422 0.014423303548323411 mean value, estimate of pi
3.148113250732422 0.013500740227139187 mean value, estimate of pi
3.148113250732422 0.013077424977657 53 mean value, estimate of pi
3.148113250732422 0.008135186430689643 mean value, estimate of pi
3.148113250732422 0.006392389948773339 mean value, estimate of pi
3.148113250732422 0.006112526857637759 mean value, estimate of pi
3.148113250732422 0.007140013312533535 mean value, estimate of pi