**P2 Final. Drunk A vs Drunk C**

[dnc](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/23266) 2 days ago

For this part, I thought drunk A and C will both produce roughly circular plots around 0. After a quick look I decided Drunk A will make a larger circle so picked plot 4 for it.

This turned out to be correct but looking at it again, I feel like this was a bit lucky. It isn't as obvious as I first thought which code will make the bigger circle. What is the average length of step taken by drunk A and drunk C?

1. [1](javascript:void(0)) [Gareth](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/1820)

2 days ago

I got this one the wrong way round. Drunk C is pretty much straight forward at 0.7 but wasn't sure on Drunk A.

After checking with a bit of code here Drunk A looks to have step length ~0.76 and Drunk C ~0.7

import random

# Drunk A average step from Pythagoras

for i in range(10):

tot=0

for j in range(100000):

tot += ((random.random())\*\*2 + (random.random())\*\*2)\*\*0.5

print tot/100000

# Drunk C average step

for j in range(10):

tot=0

for i in range(100000):

tot += 0.5 + (0.4 \* random.random())

print tot/100000

* + Now I see. With uniform distribution of step size between max and min.

Max step for drunkA is sqrt(2), min step is zero. So average step is 1/sqrt(2)~0.707.

DrunkC max step = 0.9, min step = 1.5, average = 0.7

Very close. Is this small difference all that accounts for the 2 plots?

–posted 2 days ago by [dnc](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/23266)

* + grr, can't edit comments. Drunk C min step = 0.5

–posted 2 days ago by [dnc](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/23266)

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1. [0](javascript:void(0)) [pyTony](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/311172)

2 days ago

Drunk A actully goes around all direction 0 to 1.0 so it's average movement is 0.5 Drunk C move minimally 0.5 and random component maximum 0.4, so it's average movement is (0.5 + 0.9)/2 = 1.4 / 2 = 0.7

As DrunkC has bigger average movement and extreme values are more far in plot 4 I put DrunkC for that and DrunkA for plot 5. That turned out to be wrong answer.

I suspect that the reason is that variation in Drunk C is smaller, because random component is 0.4 vs 1.0 in Drunk A. So my theory for the reason of answer is that variation is likelier to be bigger in the Drunk A case. But how it should have been clear, I do not know, without running the simulation myself.

* + The average movement for Drunk A is 0.5 in each direction North-South and East-West, so the actual length of the movement comes from both components, from Pythagoras.

–posted 2 days ago by [Gareth](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/1820)

* + Ah, I forgot that movement of Drunk A had two vectors, which had to be summed for final vector so (2\*0.5\**2)*\*0.5 = 0.7071... on average, or then I am missing something still.

I am ashamed :(, but I got it now, thanks Gareth... ah I see berzasnon giving also this explanation, thanks for you too!

–posted 2 days ago by [pyTony](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/311172)

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1. [2](javascript:void(0)) [berzasnon](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/54453)

2 days ago

The mean X lenght of the step for drunk A is 0.5, and so is the average Y lenght. So the average distance from the origin will be sqtr(0.5^2+0.5^2) = 0.707106.

For drunk C, the distance from the origin has a constant factor (0.5) plus a random factor from 0 to 4, so you can tell that the average distance from the origin will be 0.7.

So drunk A will make a slighty larger circle than drunk B. I only wish I made those calculations before I answered the question. During the final, and for the sake of time, I miscalculated and failed that part lol

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1. [0](javascript:void(0)) [xor](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/470712)

2 days ago

What you have to realize, and I realized this after answering this one wrong, is that the average for A is smaller\*, but the largest possible value is larger. So you can expect a scatter for C with more points above 0.5 than A, but you can also expect A to have a few points above 0.9. So the wider, distribution will always be from A.

\**This is wrong the average distance A covers is actually larger, even if by a small amount that wouldn't be noticeable in the distribution. So the main point remains, A has noticeably larger possible values.*

* + Good point about the density, but this won't be visibly obvious in a plot of final positions. My first thought was about A having larger possible step sizes and that was enough for me to luck into the right answer. But actually I think A also has a slightly larger average, 0.707 vs 0.7?

–posted 2 days ago by [dnc](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/23266)

* + Ah, at least I was in good company then. But I did work out the correct traversal order, which you missed. I nearly did same thing but worked it out on paper step by step. That is not much to brag about as I did not read the code for buble sort to check where the print actually was, and missed 3 points :(

–posted 2 days ago by [pyTony](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/311172)

* + I challenge that the average for A is smaller, although I'm not 100% sure. My reasoning is in the following post.

–posted 2 days ago by [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

* + @dnc: It's not 0.7 for C. That average is for each coordinate, the average distance is sqrt(https://edx-static.s3.amazonaws.com/mathjax-MathJax-07669ac/fonts/HTML-CSS/TeX/png/Main/Regular/141/0030.pnghttps://edx-static.s3.amazonaws.com/mathjax-MathJax-07669ac/fonts/HTML-CSS/TeX/png/Main/Regular/141/002E.pnghttps://edx-static.s3.amazonaws.com/mathjax-MathJax-07669ac/fonts/HTML-CSS/TeX/png/Main/Regular/141/0037.png https://edx-static.s3.amazonaws.com/mathjax-MathJax-07669ac/fonts/HTML-CSS/TeX/png/Main/Regular/100/0032.png https://edx-static.s3.amazonaws.com/mathjax-MathJax-07669ac/fonts/HTML-CSS/TeX/png/Main/Regular/141/002B.pnghttps://edx-static.s3.amazonaws.com/mathjax-MathJax-07669ac/fonts/HTML-CSS/TeX/png/Main/Regular/141/0030.pnghttps://edx-static.s3.amazonaws.com/mathjax-MathJax-07669ac/fonts/HTML-CSS/TeX/png/Main/Regular/141/002E.pnghttps://edx-static.s3.amazonaws.com/mathjax-MathJax-07669ac/fonts/HTML-CSS/TeX/png/Main/Regular/141/0037.png https://edx-static.s3.amazonaws.com/mathjax-MathJax-07669ac/fonts/HTML-CSS/TeX/png/Main/Regular/100/0032.png  ) = 0.9899

@pyTony: I never stood a chance on that traversal order question, I wasn't even *thinking* of looking at the code, so solving by paper wouldn't have helped me. I just naively trusted the text. -\_-'

–posted 2 days ago by [xor](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/470712)

* + @xor: avg distanced is not .9899. factor in some randomness for the sine and cosine of the angle.

–posted 2 days ago by [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

* + @dnc: Sorry, you're right, it is 0.7.   
    @Dirt: dnc is right. You have to consider both sine and cosine.

–posted 2 days ago by [xor](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/470712)

* + I don't think your correction above is quite right. I believe the different average step length DOES account for the different final position plots. The fact that A has a larger maximum step size and C never has a step size below 0.5 would only show up if you plotted a chart of all the individual steps?

–posted 2 days ago by [dnc](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/23266)

* + @dnc: I don't think it does, the difference is very small. Even averaging the steps I think the amount of cases where a lot of large distances show up would be more significant than the average.

...

I actually stopped myself from posting this before coding the scatter thing just to be sure. I tried with a DrunkC with larger average distance(length = 0.5 + 0.42 \* random.random()) and I can't tell the difference between each DrunkC, DrunkA is still larger, so I don't think it's the average is what's making all that difference.

–posted 2 days ago by [xor](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/470712)

* + Well since you actually put in the effort to code it I must believe you, but I don't understand how in this new case, a larger average step size, produces a smaller accumulated distance.

How many steps did you simulate in each trial? Maybe the difference lies in how quickly they converge on the average, eg. one max size step of drunkA moves the running average further from the theoretical average.

–posted 2 days ago by [dnc](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/23266)

* + can I just ask if anyone else's test question involved sine and cosine for DrunkC? I took the test on the last day, and it's possible they added in the trig element of DrunkC's steps midway. the reason I'm asking is that everyone in this discussion seems to be ignoring the trig element

–posted 2 days ago by [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

* + for example, dnc is saying that C has a minimum step size (I know dnc means absolute value of x and y-component size) of .5. @dnc: in my test question the random number you speak of was always multiplied by the sine(for the x) of a random angle and the cosine(for the y) of the same random angle. which means they could be less than .5, or even negative.

–posted 2 days ago by [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

* + @dnc: I'll share the code, with on condition, you can't change the name of the drunk. ^\_^   
    <http://pastebin.com/w32HurG4>

–posted 2 days ago by [xor](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/470712)

* + Thanks, xor, I'll have a play with that, though me and my antique PC do not enjoy the simulation questions. Perhaps I'll fix myself a massive gin while it runs ;)

@Dirt, the size of step in the Drunk C code is just the value of the variable length, The trig in the return statement just decomposes it into X and Y components using the random angle. This gives it a direction, but doesn't change the length.

–posted 2 days ago by [dnc](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/23266)

* + @dnc: i disagree: there are two different calls to random here: one to scale the length factor and one to choose a random angle. they use different random numbers so you have to separate the two elements

–posted 2 days ago by [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

* + in other words, starting with a length factor of avg. 0.7, we found our x and y values by then multiplying by the sine and cosine of a random angle. the only way all these discussions make sense is if you factor in the randomness of the sine and cosine of a random angle

–posted 2 days ago by [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

* + And I can't believe the sine and cosine of a random angle are as uniformly distributed as random.random()

–posted 2 days ago by [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

* + I'm only focusing on positive sines and cosines here, since we are all talking about one quadrant of the plot, fyi

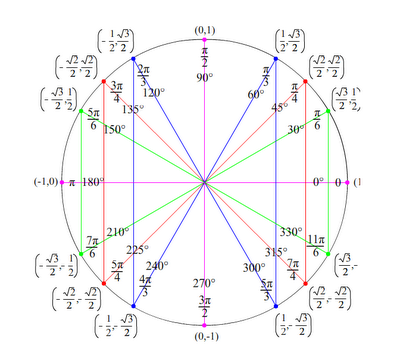
–posted 2 days ago by [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

* + @Dirt Let's consider angle 0, 30 and 45:

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That 1 is what's going to be multiplied by the length, so it won't affect it, just visualize the trigonometric circle. 

–posted 2 days ago by [xor](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/470712)

* + First, I love the chart. thank you. But the only thing you showed by it with your 3 examples ( of 0 and 30 and 45 deg) is that the Pythag.theorem works. But the test question wasn't trying to figure out what the squares of the sine and cosine added up to. It was asking whether the sine and cosine of a random angle varied more or less than random.random(). And they vary less, which I found out by running the simple code in my original post, below.

–posted 2 days ago by [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

* + Furthermore, we aren't even taking into consideration that the absolute values of the sine and cosine of a random angle will vary inversely, which to me (very untrained in stats and math) suggests that if they represent x and y components of a random step then they will produce a tighter plot. Not sure about that last idea-- would need someone to step in here with some solid math

–posted 2 days ago by [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

* + Now, most importantly, everyone who took this class has the tools to check whether .5 is greater than or equal to the absolute value of the sine of a random angle. And that's what you needed to compute here

–posted 2 days ago by [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

* + Meaning: you have to do exactly what you did with your arbitrarily chosen three angles, but with a large enough set of randomly chosen examples between 0 and pi/2

–posted 2 days ago by [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

* + And of course you have to multiply by the other random element of the question, .5-.9

–posted 2 days ago by [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

* + @Dirt I can't take credit for the chart, I just got it from Google. ^\_^   
    The sine and cosine values just alter the angle, they don't cause the final distance to be any longer or shorter, which is the main factor affecting the dispersion of the results.

I'm getting sleepy. ~\_~

Play around with the code I posted above, it's pretty straightforward, just changing a couple of lines you can test every drunk with every relevant parameter.

–posted 2 days ago by [xor](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/470712)

* + @xor: Ok. Just from following your logic though, I get the avg. step distance to be .7 (1, as you pointed out, multiplied by .7, the avg. multiplier in the test question). Whereas the avg distance of the random.random() step is between .76 and .77 (the avg. square root of the sum of two random floats between 0 and 1). Which explains DrunkC producing a slightly tighter plot than DrunkA. This is also consistent with my simpler code, below, which comes up with an avg x or y component of approx .45 (.7 multiplied by positive sines of random angles) vs. the expected .5 component of the random.random() function.

–posted 2 days ago by [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

* + @dirt I think you've got the wrong idea of what that return statement is doing. The takestep method must return an XY coordinate pair, but drunkC generates an length angle pair instead which must be converted, that is all that is done by the line.

return (length \* math.sin(ang), length \* math.cos(ang))

So returned from this function you have an XY pair representing a step. How long is this step? It is

sqrt((length\*sin(angle))\*\*2+(length\*cos(angle))\*\*2).

Since (sinx)^2+(cos)^2 always equals 1, this is just length.

–posted 2 days ago by [dnc](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/23266)

* + Hi, I think watching this lecture again: <https://www.edx.org/courses/MITx/6.00x/2012_Fall/courseware/Week_13/Lecture_22/> may be of value here, especially the part with F.J. Handscomb's data sets.

Looking at a problem only by the measure of an "average" (or any other statistical measure, for that matter) may be misleading in many many cases. If you look at **extremes**, which do happen if the sampled population is large enough, you can see that maximum step size for DrunkA is ~1.4, whereas DrunkC can make it only as far as 0.9.

The #5 plot also seems to be more uniform than #4, which also goes with the notion of DrunkC having less variance in the steps possibly taken.

So hurray for far-going class-A Drunks!

–posted 2 days ago by [matej-sk](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/500850)

* + I agree, and that is a good explanation. Thank you. And as xor points out, we then multiply that result by a random number between .5 and .9, giving us a (fairly tightly-grouped) set of step-distances averaging to .7. But my point was that you guys seemed to be saying that the average step-distance of DrunkA was barely higher, at .707 or so. I feel it is higher, between .76 and .77. Since you shifted the question to the sum of the squares (my code only checked for the average distance of each component) you'll have to recalculate your number to factor in the sums of the squares for the DrunkA random.random() components. Whereas before you were calculating the hypotenuse of two perfectly average components (each .5) and arriving at .707 as an answer for the average step-distance, the actual answer you now need to find is the average hypotenuse for the squares of an entire distribution of random.randoms. Which is why you get something between .76 and .77, and not .707.

–posted 2 days ago by [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

* + @Dirt: This code should shed more light into the math behind the decomposition of the length into x,y values in random direction:
  + import random
  + import math
  + class Drunk(object):
  + pass
  + class DrunkC(Drunk):
  + def takeStep(self):
  + ang = 2 \* math.pi \* random.random()
  + # let's assume average only for now:
  + length = 0.5 + 0.2 #0.4 \* random.random()
  + return (length \* math.sin(ang), length \* math.cos(ang))
  + def lengthofstep(x, y):
  + return math.sqrt(x\*\*2+y\*\*2)
  + print "length = "+str(lengthofstep(\*DrunkC().takeStep()))

Run as many times as you wish.

–posted 2 days ago by [matej-sk](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/500850)

* + @Dirt: about .76 vs .707: You may be right. When summing two uniformly distributed random variables, you do not get a uniform distribution, but rather something a little closer to a Gauss. Now in this case, we're summing the squares of uniform distributions, which makes me even more dizzy at this time of the night :) Maybe you can try and plot some histograms.

I still think this is not the main reason why some DrunkA's get farther. Take, for example a DrunkA, who goes NorthWest 1.4 meters. In his second step, he might choose to go SouthEast, but only for 0.05 meters (high variance of step size). However when DrunkC's angle decides to go back in the direction from where he started, he still has to go at least 0.5m (lower variance). :D

–posted 2 days ago by [matej-sk](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/500850)

* + I mean .77 average is only ~10% more than .7 - but they got even farther in the graphs presented on final. Thus the variance is what seems to play a bigger role here.

–posted 2 days ago by [matej-sk](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/500850)

* + Correction: Sum of two uniform randoms is triangular (becoming more and more Gaussian with more randoms to add together).

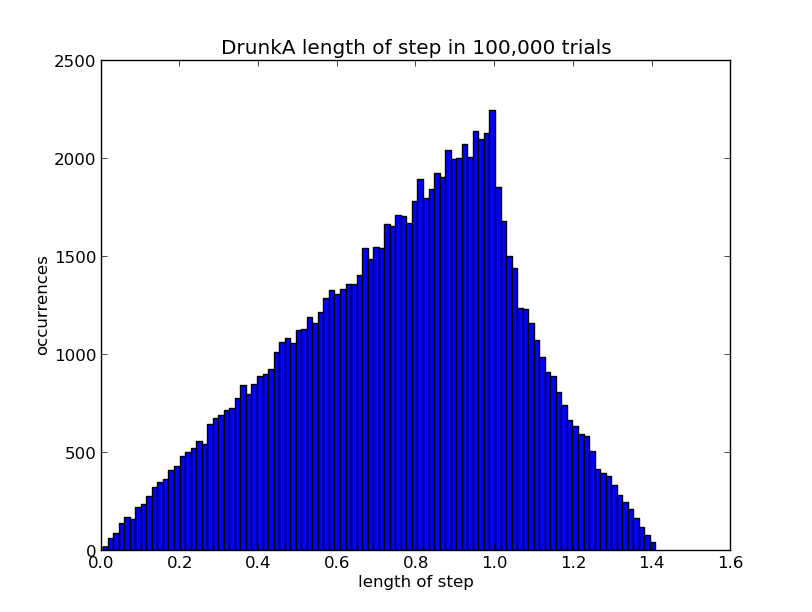
Didn't let me sleep though - Also the sum of two squares of uniform randoms seems to be triangular-ish but with different slopes (here considering only one quadrant of possible directions):

d = [math.sqrt(random.random()\*\*2+random.random()\*\*2) for i in range(100000)]

pylab.hist(d, bins=100)

pylab.show()

–posted 2 days ago by [matej-sk](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/500850)

* + 

–posted 2 days ago by [matej-sk](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/500850)

* + @dirt I didn't realise your other point about DrunkA, I thought you were just mixed up about DrunkC step length being changed by the angle. Now I see what you mean about drunkA. You are right, the average step length of drunkA is approx 0.77 because of the two independent random components.

–posted a day ago by [dnc](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/23266)

* + Very good points. The average step size being slightly smaller for DrunkC than for DrunkA is probably the less important part of the issue in this question. More important is the variance, as you show. I'm picturing two different right triangles: One has sides of 3,4, and 5. The mean of the two shorter sides' lengths is 3.5. Yet its hypotenuse is shorter than the triangle whose sides are 1,5, and sqrt(26) despite the latter's mean being only 3.0 for the short sides.

–posted a day ago by [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

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1. [0](javascript:void(0)) [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

2 days ago

Are you guys taking into account the trig part of the question for Drunk C?

avg = 0

for i in range(10000):

r = random.random()

avg += math.sin(math.pi \* r)

print avg \* 0.7 / 10000

That gives you an avg. length step component (x and y) of about .45 (the .7 comes from the mean of .5 + random.random() \* .4)

Which should leave DrunkC with a slightly tighter graph than DrunkA

* + by the way, using .45 as the avg. step component makes for about .64 as the avg. step length (pythag.theorem)

–posted 2 days ago by [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

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1. [0](javascript:void(0)) [Ikcor](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/501894)

2 days ago

I still don't see the value of this distinction with respect to what we should be learning in a **Python programming class**. Unless you cheated and ran the code you likely got this part of the question wrong.

* + How is it cheating to use code to figure out if .7 \* the sine of a randomly chosen angle is greater or less than .5? This type of thinking (which involves reading the possible answers closely) seems to me to be exactly what this class is about.

–posted 2 days ago by [Dirt](https://www.edx.org/courses/MITx/6.00x/2012_Fall/discussion/forum/users/455435)

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