

MTH 105 Exam #2

Remember to show me how you got any answer marked with a “(w)”!

1. I take a wonderful class at COCC called “Total (Freaking) Fitness”, with the one and only Jump Up Jenny Cruickshank! (if you ever need a 1-credit butt whoopin’, I highly recommend it. 😊). Part of her amazing class is coming up with new and devious ways of taking common exercises and making them even better. One of these beautiful creations is called a “3-2-1 pushup” (we tried to record a Zoom meeting to demonstrate them, but we screwed it up. 😊). The type of pushup to do depends on the numbers that Jenny calls:

- If Jenny calls “3”, you have to fully extend your arms to a plank position:



- If Jenny calls “2”, you have to drop about $\frac{1}{2}$ way to the ground:



- If Jenny calls “1”, you have to hover just above the ground:



She calls out a number about once every 3 seconds, and you have to hold that position until she calls out the next number. These are **awesome** (as you can tell by my pained expressions in the screen grabs up there).

Now, Jenny likes to call out the 1’s, 2’s and 3’s randomly during these exercises. Below are the two sequences (20 numbers each) that I recorded her calling out when we did this workout today. Here’s the first one:

Random Sequence #1																			
1	2	1	3	1	2	1	2	1	2	1	2	3	1	2	3	1	3	2	3

After she finished that one, and I lay, whimpering, on the floor, she said “OK, Sean! Get ready for round 2!”

Random Sequence #2																			
1	3	1	2	2	2	2	3	3	3	2	1	1	2	3	3	2	2	2	3

At this point I was a quivering mass of jelly¹. When I regained enough air in my lungs to talk, I had a question to ask my sensei.

“Hey, Jenny! I thought you were calling **random** numbers!”

“I **was**!”, she replied.

“I dunno, dude – only **one** of those felt random.”

What you’ll do, my rad students, is test **both** sequences of 20 numbers, and decide which seems **more** random.

¹ Generally, the state you’re in after a Total Fit class. **#bestclassEVER**

- a. (1 point) Since there are three numbers, supposedly chosen at random, about what percentage of each sequence should be 1's? 2's? 3's?

Let's check! What percent of the digits in Sequence #1 are

- b. (1 point) 1's?
c. (1 point) 2's?
d. (1 point) 3's?

What percent of the digits in Sequence #2 are

- e. (1 point) 1's?
f. (1 point) 2's?
g. (1 point) 3's?

Well, shoot – only one of them is even *close* to your answer in **a**! Darn it!

But wait! We're forgetting something important!

We need a **margin of error** on those statistics! Those 20 numbers are only a small sample of all possible random numbers Jenny could have called – that means their percentages will have some wiggle room (even calling them “percentages” is a stretch, since there are only 20 of them. 😊). And, since the sample is so small (20), it's gonna be quite a **bit** of wiggle! In fact, it's about **15%**!

Let's use that MOE for the statistics you collected above to fill in the blanks!

- h. (2 points) Jenny is calling between _____ % and _____ % 1's in Random Sequence #1.
i. (2 points) Jenny is calling between _____ % and _____ % 2's in Random Sequence #1.
j. (2 points) Jenny is calling between _____ % and _____ % 3's in Random Sequence #1.
k. (2 points) Jenny is calling between _____ % and _____ % 1's in Random Sequence #2.
l. (2 points) Jenny is calling between _____ % and _____ % 2's in Random Sequence #2.
m. (2 points) Jenny is calling between _____ % and _____ % 3's in Random Sequence #2.

Rad! Unfortunately, that didn't help us tease out the non-randomness of either sequence; since the percentage you got in **a** is within all of those ranges of values for each digit in both sequences, we can't say she deviated **too** much in either one from “the number of 1's, 2's and 3's she should have randomly said”.

Hmmm...go back and take a look at those sequences again – does anything **else** jump out at you right now? If so, great! If not – let's take a look at some more “truly random” sequences in Excel²³⁴⁵⁶!

² Or Numbers.

³ Or Sheets.

⁴ Or Lotus 1-2-3.

⁵ Or Quattro Pro.

⁶ Or whatever other programs y'all are using that I need to learn how to use.

- Open up a blank Excel document (*make sure you don't have any others opened*).
 - Pick any old cell you like and type the formula **=randbetween(1,3)**
 - Press **Enter**. In that cell you'll now see a random digit, between 1 and 3. Rad! If you press the  button, you'll get a new one. Press it a bunch of times! More fun!
 - Drag that formula over so that you get a row of 20 random numbers (like our sequences up there).
 - Press  a bunch until you can answer the question below!
- n. (5 points) Compare the sequences that you're getting in your spreadsheet now with the two original sequences that started this question! Which one of those two most closely resembles the truly random sequences you're generating, and why doesn't the *other* one show that characteristic?
- o. (5 extra points) (w) What's the chance that the other sequence (that is, the one you didn't think was random enough, based on criteria you used in the last question) **was** truly random?⁷
2. In "class", we discussed the average rate of inflation of COCC's tuition over a period of time. And, after that discussion, you may have felt a bit peeved. "How come **we** have to pay so much for tuition? Our tuition went up WAY faster than inflation!!! What **gives**? I have a buddy at (*insert Oregon community college here*) who actually pays **less** than we do at COCC – why?⁸" In this question, I want to break down those concerns, and also give you one more skill that you can use to measure financial quantities more effectively!

I went online and gathered up as much data as I could⁹ about all the Oregon community college tuitions; it's in the spreadsheet for this question (note: to keep it simpler, I only used in-district tuition). Use that data to answer the following!

- a. (3 points) Where did COCC rank (1 through 17, "1" being "most expensive") in **2014**?
- b. (3 points) Where did COCC rank (same ranking system) in **2019**?

Ah, so we're "middling in the ranks". Bummer! But, we're still in the bottom half, so I'm feeling pretty good.

Oh! But wait! We forgot to adjust for cost of living in those various places! I used [this tool](#) to do just that – click on over to the other tab ("adjusted tuition"). Now, it's not perfect, but I used the "overall" cost of living to adjust the tuition cost so that everything is in "Bend Dollars". Here's how I figured it, using Pendleton (hometown of Blue Mountain Community College) as an example:

2020 Cost of Living Calculator: Bend, Oregon vs Pendleton, Oregon

- Overall, Pendleton, Oregon is 30.0% cheaper than Bend, Oregon

So that means that things in Pendleton only cost 70% of what they do in Bend. As an equation, that would look like this:

$$\text{Cost of Something in Pendleton} = \frac{70}{100} * (\text{Cost of That Same Thing in Bend})$$

⁷ For those of you taking later stat classes, this might be your first P-Value! 😊

⁸ To list a few of the questions that a) you all asked and b) I've heard over the years. 😊

⁹ I actually asked HECC (the group that keeps this data) for older data (pre-2014). Still haven't heard back from them.

Or, said a different way:

$$\frac{100}{70} * (\text{Cost of Something in Pendleton}) = \text{Cost of That Same Thing in Bend}$$

So, for Pendleton, I multiplied all the tuitions in their unadjusted list by about 1.42 to get what their tuition *should* have been each year. Like this:

	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>
Blue Mountain (unadjusted)	\$90.00	\$94.00	\$96.00	\$103.00	\$108.00	\$108.00
Blue Mountain (adjusted)	\$128.57	\$134.29	\$137.14	\$147.14	\$154.29	\$154.29

I then did the same thing for all the other towns in the list, and that's what you see in that sheet!

- c. (3 points) Using these more “apples/apples” data, where did COCC rank (1 to 17, with, again, 1 being most expensive) in 2014?
- d. (3 points) How about in 2019?

Yay! I feel *much* better!

- e. (5 points) Which colleges are in cities that have a *higher* cost of living than Bend (according to these new data)? Note: you don't need to do any research about these towns, or even know which towns they are – the spreadsheet math tells you all you need to know.
 - f. (10 points) Using either data set (adjusted or not), create a graph showing all 17 community colleges' tuitions changing year to year across this time range. Make sure to label your axes if Excel doesn't automatically do it for you. Give your graph a good title – and please: make sure that COCC's tuition stands out in some way from the others so it's easy to spot!
3. Recently, I was chatting with a former MTH 105 student about life, and they brought up the ages of students in my class and how *young* them seemed (*all* of you seem young to me, but I digress. 😊). In particular, this student mentioned students “just out of high school”, and that sent me running to the COCC website to do some research. Let's have you do that, as well!
- a. (5 points) Start by visiting [this COCC website](#), and find the number of COCC students in academic year 2019-2020 who graduated high school in 2019. It's near the top of the page!
 - b. (5 points) Now, use the most recent COCC Fact Book (you can find it by searching on the COCC site) to find the most recent “total credit enrollment” of COCC. Note: even though it's the fact book from 2019-2020, it says (on page 13) “2017-2018.”
 - c. (5 points) Using those two numbers, what percent of COCC credit students are recent high school graduates?

OK! So, the vast majority of our students *aren't* right out of high school. Cool! But *that* led me to asking, “Huh – just how old *are* our students here at COCC?”

In the attached spreadsheet, you'll see the results of my research. 😊 Go ahead and open that up now!

- d. **(5 points)** For starters, create a time-series line graph representing this data! Years on the horizontal, ages on the vertical. Make sure your axes are labeled well, you have a good title, and (since there are two different data sets) a legend to differentiate the line graphs. Screen shot it and place it here as your answer!
 - e. **(5 points)** At this point, I think we're all pretty sure how COCC was able to calculate the average age of COCC students (*add up all the ages, and divide by how many students there are!*). How did COCC find the **median** age? Write a couple of sentences!
 - f. **(5 points)** You might notice that the average age of COCC students is always higher than the median age of the same students. Write a couple sentences to convince me why this makes sense, in general!
4. For this last question, let's actually revisit the point at which we started formally discussing probability in MTH 105. You might remember it as "that time I rolled a die 11 times but I thought I had rolled it 10." Regardless of my counting problems, that was our first introduction to the wondrous and sometimes mind-bending world of measuring the unknown.

What made that experiment of rolling dice kinda fun was that we got interesting data in those first 11 rolls: two "gaps", as I called them. That means that, of the 6 possible results I could have gotten when rolling a die multiple times, I didn't see 2 of them. And some of us said, "That seems weird!" Let's measure that weirdness. 😊

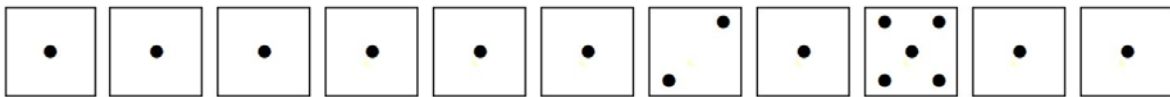
Start by opening the spreadsheet that accompanies this question. In it, you'll see one similar to the one we used in class; however, in this one, I've coded it to count the number of gaps in each of the 11 rolls. You can watch the sheet update by pressing



What I'd like you to do first is to complete the "Cumulative %" column by supplying the proper Excel formulas. There are a couple of ways to do this; feel free to ask if you get stuck! Once you have that done, create a bar graph of the results of that column (with the "# of gaps" on the horizontal). Then, randomize the results until the bars in your graph stabilize!

- a. **(4 points)** Include a screen shot of your bar graph with stabilized data here!
- b. **(5 points)** About what percent of the time should we see 2 gaps in 11 rolls of a die?
- c. **(5 points)** Based on your last answer, was it "weird" to see 2 gaps? Please answer "yes" or "no" and then support your answer! For an extra credit point, answer it both ways with a convincing mathematical answer for each. 😊
- d. **(5 points)** Calculate the average number of gaps that should appear in 11 rolls of a die (no need for work, as I'm assuming you're using Excel to do this one).

Now you might remember (from that series of random videos) how excited I got when we saw this result right here:



I told our son about it, and he got really fired up. I mean, there is only about a 0.0024% of that happening¹⁰, after all.

But he asked me if I could keep the simulator running overnight, to try to get the "5 gaps" case. I smiled and told him "sure."¹¹ And I did; you can see the results of my computer working the simulator for 12 hours at right.

# of Gaps Seen?	Current	Cumulative
0	0	54409
1	1	74545
2	0	21794
3	0	1444
4	0	13
5	0	0

- e. **(extra 2 points)** Assuming my computer can do the same number of trials as that every 12 hours, about how many days will it take, on average, until we get the "5 gap" row to see its first entry?



¹⁰ Show me how I got that probability, and I'll give ya some extra points, for sure!

¹¹ Poor kid. I've ruined him already.