MMA 863 - Team Assignment

While this is a team assignment, I encourage you to attempt each problem – at least conceptually – before you discuss it as a group. Think about how you would approach it, sketch out, or better yet, propose a solution, and then you can discuss it with your group. This is a group assignment, so other that discussing questions with me, you are not to discuss with anyone or use any resources aside from the course materials and the textbooks.

Questions in Part 1 are worth 2 marks each, ‘why’ you ask, because they are essentially for practice. You might be tempted to attempt to find answers online, but at two marks each, it is likely that this will not help you very much, and will certainly prevent you from getting the benefit from doing them.

Questions in Part 2 are worth 10 marks each. I am pretty confident there are not answers out there – well, not ones that you can trust. (See, I could plant answers out there too, you know, and I know hundreds of former students who could do this on my behalf.)

In all cases, use the processes from class.

Part 1 - 2 marks Each

This assignment covers material up to the end of continuous random variables.

1. I have three six-sided dice in my pocket. They are indistinguishable to look at but one of them is specially weighted (or 'loaded') so that it has a 50% chance of rolling a 6 and a 1/10 chance of rolling any other number.
2. If I randomly pull one of the dice out of my pocket and roll it, what is the probability that I will roll a 6?
3. Suppose I randomly pull one of the dice out of my pocket and roll it and get a 6, what is the probability that the dice was loaded?
4. Bees: I have several hives of bees on my property. They are pretty good bees, at least as far as one can say, but it is hard to tell with bees. I am told that each hive has thousands of bees and that if you hang around too close to a hive, you have about a 1 in 10 chance of being stung per hour. Apparently, bees are not as nasty as you might think and don’t tend to sting unless they are provoked since they die immediately after stinging you. In any case, I have three hives all next to the garage.
   1. I was doing some landscaping and was working near the hives for about two hours. I forgot that they were there so I wasn’t wearing any protective equipment. I didn’t get stung at all. Should I consider myself lucky?
   2. The next day, I got stung by bees three times in a single hour. I am pretty angry about it and am thinking about getting rid of one of the hives – kind of like a warning to the others. If I get rid of one of the hives at random, what is the probability that the bees that stung me all came from that hive?
5. CBC: I was listening to CBC radio as I drove to work the other day. They were speaking about results of a recent survey of 2000 people from a population who owned five major appliances (fridge, oven, dishwasher, washer and dryer). Apparently only 300 of the people they contacted actually responded, but among them, 80% claimed that major appliances ‘these days’ do not last as long as they used to, nor do they last as long as the 10 year average that appliance manufacturers’ association claimed.

Suppose that appliances actually last, on average 10 years, as the manufactures’ association claims. Assume that the lifespan has an approximately normal distribution with standard deviation of 3 years. What percentage of the survey population should have experienced a major appliance failure in fewer than 4 years?

1. “My regular computer keyboard is not working properly. About 30% of the time when I type the letter ‘r’, either as a capital or a lower-case version, the computer actually produces a letter ‘t’. I find this to be really annoying. I have stopped using my computer and have sent it in to be fixed. I wrote this question on my replacement laptop.”
   1. If I had typed the above paragraph (i.e. the part in quotation marks) on my regular computer, what is the probability that I would have more than 2 ‘r’ to ‘t’ typing mistakes?
   2. What is the expected number of ‘t’s in the paragraph above (i.e. the part in quotation marks) if I typed it on my regular computer?

Part 2 - 10 Marks Each

1. You have been working as a supervisor for a customer support center. They have recently taken an interest in analytics, so now is the time to ‘show your stuff’ and finally get that promotion you deserve. The VP in charge has a few problems she would like your help with, based on the data found on tab ‘customer support’. For reasons known only to her, she wants you to use an alpha of 0.03 for any hypothesis tests – don’t ask me why, I just make up the questions.
   1. Can we conclude that the average level of customer support has changed from last year’s average of 3.2?
   2. Can we conclude that the proportion of customers who rate our service as ‘More than Satisfied’ or better has improved from the historical rate of 35%?
   3. Historically our customer base has been 46% male. If that were true, how likely is it that we would see as many males as we see in this sample? Does this result give you any concerns? If so, explain what in a few sentences using course concepts to explain them (i.e. keep it short and to the point) or say there is no basis for concerns.
2. I found myself at the airport, with 13 minutes before I had to board a plane. I thought about grabbing a coffee and a snack at Starbucks for the trip. I like to arrive sedate[[1]](#footnote-1), I hate to be late, I was unsure if I should wait or go to the gate.

The good news is that I know a lot more about Starbucks than most people. The time to serve a customer at this particular Starbucks is approximately normally distributed with a mean of 30 seconds and a standard deviation of 8 seconds. As it happens, I can also see that they have 10 chocolate chip cookies left in stock, and I really want two of them. They have a functionally endless supply of coffee, so at least that should not be a problem.

I also know that I can reach the gate in exactly 5 minutes if I rush. I can see that there are 15 people in line right now.

1. If I join the line right now, what is the probability I will get my coffee in time to make it to the plane on time.
2. The instant I join the line, it occurred to me that people occasionally place orders by a phone app. (Apparently this option is not available to 53-year-old professors or I might have done this and skipped the line.) Any app order that arrives before I place my order will get processed before me and I know from a Chat GPT query that randomly, over time, about 1 cookie order comes in per 3 minutes randomly over time by the app.

To be safe, I asked those in front of me in the line if they planned to order ‘One of those awful chocolate chip cookies’. Only one person in front of me said he would – and I could not talk him out of it.

If the line actually takes the expected amount of time, what is the probability I’ll get my cookies?

1. The year is 2033 and my once cottage industry curry business has grown to become a large and exceptionally profitable company in a way that can only happen in the premise of an exam question.

The automated production line in one of our smaller facilities produces fills and labels 500 ml jars at a rate of 9 per minute for 8 hours per day, 200 days per year. The actual fill level is normally distributed with a mean of 506 ml and a standard deviation of 3 ml.

Once filled, the jars are automatically placed in cases of 12 for shipment to distribution centers and eventually happy curry eaters all over Ontario and into northern New York state.

It turns out that the labeling machine has started to fail occasionally and at random over time. There doesn’t seem to be a pattern to the mislabeling, but, on average, about once every 10 minutes a label is improperly affixed to the jar. This doesn’t bother the customers, but it bothers me – I consider them to be unnecessary defects. (Don’t get me wrong, I’ll still sell the curry – the quality of the food is not affected.)

1. If I inspect 3 cases, what is the probability that I will find any labeling problems?
2. Next year, the regulatory environment will change. The new rules are that 98% of jars have to be filled to at least 500 ml or 95% of cases have to be contain to at least 6000 ml (i.e. 12\*500 ml). I get to choose which whether they test individual jars or cases, but if we are not in compliance or we face a significant fine. Which approach to assessing compliance is best from my perspective and should I be worried?
3. I need to hire some more people to work in my growing curry empire. Naturally, with the great benefits and high salaries, lots of time off and endless supplies of curry – not to mention the prospects of international travel when we open our distribution centers in Brazil, I believe that 90% of people I make an offer to will accept the job – I suppose the rest just don’t like curry.
4. Assuming I am correct how many offers should I make to ensure I get an 80% chance of hiring at least 10 new employees. (Hint: you may need to swap something that is typically a parameter with something that is typically a variable, but remember, what is a variable and what is a parameter is really a matter of modelling choice.)
5. It turns out that only 15% of the candidates are ‘sophisticated curry eaters’. Those folks are able to work as tasters in quality control. Unfortunately, you cannot determine this before you hire folks, since they all claim to be sophisticated curry eaters, but I need at least 3 of them. If I hire 10 employees, what is the probability I’ll have enough tasters?
6. In an uncharacteristic moment of humility, I decided to check the records on the last 50 offers we made and found that 43 of them accepted. Should I lower my expectations on the offer acceptance rate? Perform an appropriate test using all the steps using the method from class.

1. se·date1 /səˈdāt/ adjective: calm, dignified, and unhurried. (Don’t worry, it doesn’t impact the question and is just there so the question has rhyme.) [↑](#footnote-ref-1)