**GER1000 QUANTITATIVE REASONING**

**TUTORIAL 1**

*Please work on the problems before coming to class. In class, you will engage in group work.*

1. Let us designate Covid-19 patients aged over 70 years as “old”, and other Covid-19 patients as “young”. Let “D” stand for death from Covid-19.

(a) In Country X, rate(D | old) = 0.25 and rate(D | young) = 0.05. Mark with “X”, the first rate on the top scale, and the second rate on the bottom scale.



|  |  |
| --- | --- |
| OLD |  |
| YOUNG |  |



(i) The overall rate of old patients, rate(old), can be any number strictly between 0 and 1. Indicate the range where rate(D), the overall death rate for X, must be located, and state a reason.

0.05<rate(D)<0.25

The basic rule on rates states that in a population, let A and B be characteristics. The overall rate of B, rate B, always lies between the two group rates: rate (B|A) and rate (B|not A). Based on this, rate (D), the overall death rate for X, must be located in between rate (D|old) and rate (D|young), which ranges from 0.05 to 0.25.

(ii) Suppose that in X, most Covid-19 patients are over 70 years old. Can you be more specific about where rate(D) must be?

0.15<rate(D)<0.25

According to some elaborations on the basic rule on rates, the closer rate (A) is to 100%, the closer rate (B) is to rate (B|A). Based on this, since most covid-19 patients are over 70 years old in X, rate (D) will be closer to rate (D|old) which is 0.25.

(b) In Country Y, rate(D | old) = 0.50, rate(D | young) = 0.35. Mark with “Y”, these rates on the scales above, as before. Like X, rate(old) in Y is also a number strictly between 0 and 1. Explain why it is not possible for rate(D) to be lower in Y than X.

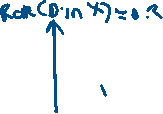
Country X: 0.05<rate(D)<0.25

Country Y: 0.35<rate(D)<0.40

Due to the basic rule on rates, it is not possible for rate (D) to be lower in Y than X. This is because in Y, rate (D) must also be located in between rate (D|old) and rate (D|young) which ranges from 0.35 to 0.5, higher than the one in X.



(c) In Country Z, rate(D | old) = 0.40, rate(D | young) = 0.10. Mark with “Z”, these rates on the scales below, as before. Also mark with “X”, the rates for X on the same scales.



X Z



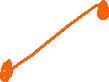
|  |  |
| --- | --- |
| OLD |  |
| YOUNG | X Z |



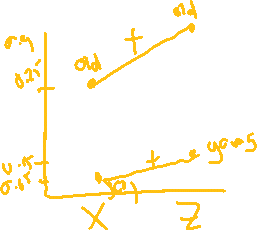
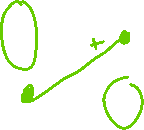
Is it possible for rate(D) to be lower in Z than X? If yes, say something about whether rate(old) should be large or small in the two countries.

Country X: 0.05<rate(D)<0.25

Country Z: 0.10<rate(D)<0.40



Yule-Simpson’s Paradox



Yes, because due to the basic rules on rates, it is possible for rate (D) in Z to be lower than rate(D) in X. This is because rate(D) in Z should range from 0.1 to 0.4, whereas rate(D) in X ranges from 0.05 to 0.25, which shows that there will be some cases where the rate(D) is lower in Z than in X.

*Challenge question (not discussed in tutorial).* Can you propose values of rate(old) for the two countries so that rate(D) is lower in Z than X? The formula is

rate(D) = rate(D | old) rate(old) + rate(D | young) rate(young)

*(i) This problem is inspired by a report that overall Covid-19 death rate is lower in Z than X, but in various age-groups, death rate is higher in Z than X, paradoxically.*

*(ii) For any population with two characteristics A and B, provided both rate(A) and rate(B) are strictly between 0 and 1, rate(B) = rate(B | A) rate(A) + rate(B | not A) rate(not A).*

1. Imagine that you are an intern at a large tuition centre catered to students of age 11 and 12 years. Your employer wants to know if it is worthwhile to invest in iPads to improve students’ proficiency in English. He gives you authority and resources, and asks you to design an experiment on the thousands of customers.

(a) How would you enrol subjects and assign them into two groups?

* Large sample size
* Split two groups: 1)Ipad 2) No Ipad
* Random assignment

1. Take a randomised group of 1000 kids enrolled into the tuition centre
2. Control group (500) – without issuing out the ipads / Treatment groups – (500) issue the use of ipads
3. Use random number generator to assign the student into control and treatment group

(b) How feasible is it to use a placebo, or to implement double-blinding?

Placebo not possible – cannot blind the students

Single blinding (?) – the teachers who mark the assessment

Double blinding is feasible as both the teachers and the students using/not using the ipad can be separated into 2 sessions so students will not be disincentivized and unmotivated to learn english if they were not given the Ipad which might affect their english test scores.

Double blinding – The kids enrolled into the tuition center and the teachers issuing the ipads are not aware of the intentions of the experiments

(i) Will you measure English proficiency twice (before and after the intervention), or will it be sufficient to just measure once (after the intervention)?

Both – Before to see the level of proficiency in English for BOTH the control and treatment group

(ii) How easy is it to generalize your experimental findings to the population of all children of age 11 or 12 years old in Singapore?