PHYS 3142 Spring 2021
Computational Methods in Physics
Assignment 4
Due: 11:59 p.m. 7th Mar. 2021

Before you submit your assignment, do remember:

1. the due day
2. submit a report which contains your figures and results along with your code
3. make sure your code can run
4. do not forget to write comments in your codes.
5. label your figures and describle your results

The basic scoring rubric is :

1. **If you submit the assignment after the deadline or do not submit the report, you can only get up to 80% of grade**
2. **If there is any kind of plagiarism, all of the student involving will get zero mark! (except that the one can really prove the code is written by himself or herself and others copied it without telling him or her)**

1. vaccine's efficacy

It was reported that Pfizer and Moderna′s vaccine′s efficacy is more than 95%. (data from `https://www.fda.gov/media/144416/download`)

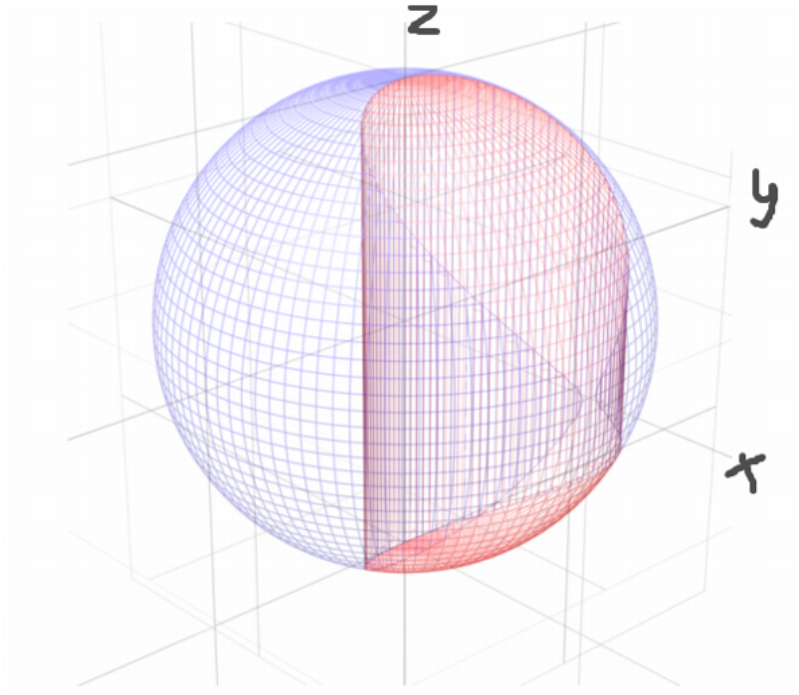
The test is composed of a total of 43,448 (21720 vaccine, 21728 placebo) participants whose age are older than 16, regardless of duration of follow-up. For participants without evidence of SARS-CoV-2 infection prior to 7 days after Dose 2, vaccine efficacy(VE) against confirmed COVID-19 occurring at least 7 days after Dose 2 was 95.0%.

The case split was 8 COVID-19 cases in the BNT162b2 group(vaccine group) compared to 162 COVID-19 cases in the placebo group. However, There are still 3410 total cases of suspected but unconfirmed COVID-19 in the overall study population, among which, 1594 occurred in the vaccine group while 1816 in the placebo group.

What is the VE if we have the PRC false negative rate $\alpha = 0 \sim 0.5$? Please make a 2d plot and clearly label the axis. (You need to at least discretize the value of α from 0 to 0.5 for 100 points)

2. Monte Carlo calculation

Find the volume of the intersection of a sphere and a cylinder, using Monte Carlo techniques. The sphere has radius 1 and is centered at the origin. The cylinder has radius 1/2, and its axis is perpendicular to the x axis and goes through the point (1/2, 0, 0). (See the following figure) Report your uncertainty.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