

2024 Spring –SPCO HW#1

1. Super Lotto 638 (威力彩) is one of the lotteries in Taiwan (<https://www.taiwanlottery.com.tw/Superlotto638/index.asp>). There are two sets of winning numbers. For the first set, there are six winning numbers randomly picked from thirty-eight balls numbered 1 to 38. For the second set, one winning number is selected from 1 to 8 randomly.
 - (a) To win the first prize, all numbers in both sets on the ticket have to be the same of the winning numbers. According to the official website of Taiwan Lottery (http://www.taiwanlottery.com.tw/faq/faq_faq02_detail10.asp#), the probability to win the first prize is about $1/22090000$. Explain why and the exact formula to calculate this probability. What are the assumptions behind the calculation of the probability?
 - (b) To win the third prize, five of the six numbers in the first set have to be the winning numbers and the number in the second set also has to be the winning number, what would be the probability to win the third prize. Explain in detail how you calculate it.
 - (c) Let Event A be the event that all the first-set winning numbers are even numbers; Event B be the event that the second-set winning number is an even number; Event C be the event that there is at least one first-set winning number that is less or equal to 6 and Event D be the event that all the winning numbers in the first-set and second-set are greater than 6. Are these events mutually exclusive or independent?
 - (d) Calculate $P(A)$, $P(A|B)$, $P(A|C)$, $P(C \text{ or } D)$ and $P(C|D)$
2. Find (https://www.taiwanlottery.com.tw/info/download_history.asp) the winning six first-set numbers and the winning second-set number of the latest 50 draws as of 2023/9/28 from the internet and calculate the number of appearances for each of the 38 first-set numbers and the number of appearances for each of the 8 second-set numbers. Rank the numbers with their appearance frequencies (the number of appearances divided by the number of runs) and plot bar-charts to observe the differences among the 38 first-set numbers and the 8 second-set numbers. Calculate the average, medium (find the formula from internet or any text book), maximum, minimum, range (maximum-minimum), and sample variance (find the formula from internet or any text book) of the appearances of the 38 first-set numbers and the 8 second-set numbers. Do the same for winning numbers for the

latest 100 draws as of 2023/9/28 and for the latest 500 draws as of 2023/9/28. Describe and discuss what you observe from the analysis and come up with a strategy of choosing the numbers in the future.

3. Find the estimates of sensitivity and specificity of detecting type A and type B influenza, respectively, by the Rapid Influenza Diagnostic Test (RIDT) from the internet/literature. It is known that the prevalence of type A influenza is 15% and the prevalence of type B influenza is 5% and it's impossible for a person to be infected by both types of influenza at the same time. What would be the probability for a person to be actually infected by the type A influenza given that person is tested positive by the RIDT.