NOVA SCHOOL OF BUSINESS & ECONOMICS

# 2494 - COMPUTATIONAL THINKING & DATA SCIENCE

**2021-22, Spring Semester**

## Problem Set

**Deadline: March, 16**

1. Write a short Python program that given a list of numbers and a number **n,** check whether the sum of any two numbers from the list is equal to **n** or not.

2. The Capital Link Inc. is considering 10 investments. The streams of cash inflows for each investment and cash required are listed in table 1 and 2, respectively. The cash available for investment is $100000. Capital Link wants to find out the investment policy that maximizes its NPV. All cash outflows occur at the beginning of year 1 and all cash inflows occur at the ends of their respective years. The company uses a 10% discount rate for calculating its NPVs.

| Investment / Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | | | | | | | | | | |
| **2** | | $13440 | $13890 | $13330 | $9320 | $13430 | | | | $12610 |
| **3** | | $16130 | | | $10720 | | | | $14540 | |
| **4** | | $15320 | | | $10080 | $16550 | | | $13230 | |
| **5** | | | | | | $14900 | | | | |
| **6** | $11450 | $13820 | | | $8910 | $13410 | | | | |
| **7** | $10530 | | | | | $12070 | | | $9970 | $13910 |
| **8** | $9690 | $12470 | $9700 | | | $10860 | | $16000 | $9070 | |
| **9** | | | | $14630 | | | $9230 | | $8250 | |
| **10** | | $11260 | | | | | | $14440 | | |

Table 1: Cash flows for each investment

| Investment | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | $14200 | $42700 | $14100 | $15900 | $24200 | $44700 | $3200 | $11000 | $26700 | $15400 |

Table 2: Cash required for each investment

a) Which investments should the company make?

Write a Python program that helps you to solve the problem of Company Link Inc.

*Suggestion: Start by implementing a function that determines the NPV for each investment.*

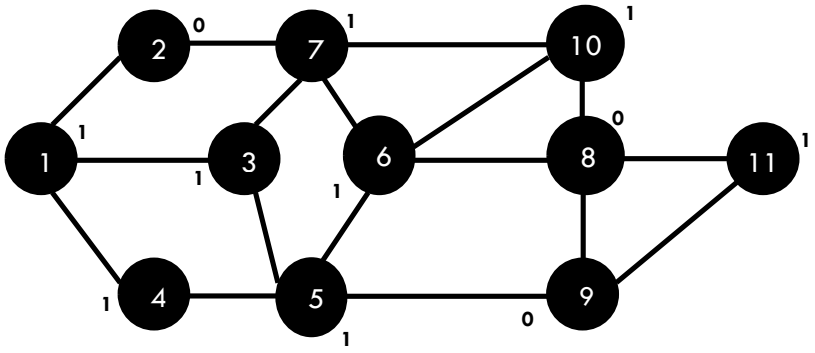
b) Solve the following modifications of the Capital Link Inc.'s problem by making the appropriate changes in your Python code (solve each part independently of the other):

i) Suppose that if investment 1 is selected, then investment 3 must also be selected.

ii) Suppose that at least one of the investments 5 and 6 must be selected.

3. Your country can be represented by $N$ cities connected using $M$ roads. You have to set up a connection for water supply. You set this in one city and water gets transported from it to other cities using the road transport. Certain cities are blocked which means that water cannot pass through this city. Write a Python program that determines the maximum number of cities to which water can be supplied starting on city *k* (this should be an input from the user).

Use the following graph to help you testing your program.




0 means that the city is blocked.

4. A company provides its 300 employees with health insurance under a group plan. For each employee, the probability of incurring medical expenses during a year is 0.9. Bearing this in mind, the number of employees incurring medical expenses during a year has a binominal distribution with $n = 300$ and $p = 0.9$. Focusing on one employee that does incur medical expenses during the year, the total amount for the year has distribution \$100 with probability 0.9 or \$10,000 with probability 0.1. The company has a \$300,000 deductible clause so that each year the insurance company is able to pay the total medical expenses for the group in excess of \$300,000. Simulate 1000 trials and estimate the mean and standard deviation of the amount that the insurance company pays for 2 years.

5. Auditors of a particular bank are interested in comparing the reported value of all 2265 customer savings account balances with their own findings regarding the actual value of such assets. Rather than reviewing the records of each savings account at the bank, the auditors decide to examine a representative sample of savings account balances. The population from which they will sample is given in the file Auditing.xlsx.

   Select a simple random sample of size 100 and construct a 95% confidence interval for the total value of 2265 savings account balances within this bank. Does it include the (known) population total?