

## Group Assignment 06

# Contagious Diseases

# Ebola Outbreak II

We continue with the ebola outbreak from lesson 2. Ten patients are admitted to a hospital. Assume that each patient has a chance of 0.5 of being infected. We define a random variable  $X$  that is the total number of infected patients at day 0.

### Process 1:

Show three different versions of how an outbreak in the hospital can develop over 10 days if:

- Day 1-10: Number of infected patients  $X$  is constant.

This is a stochastic process, we can write it as:

$$Y(n) = X \tag{1}$$

where  $X \sim B(10, 0.5)$  is a random binomial distributed variable and  $n$  is the day ( $n = 1, \dots, 10$ ).

1. Make a Matlab function that generates realizations of the process  $Y(n)$ .
2. Plot three realization of the process.
3. What is the ensemble mean and variance of the process?
4. What is the mean and variance of the process of one realisation?
5. Verify Question 3 and 4 with the Matlab function.
6. Is the process  $Y(n)$  Wide Sense Stationary (WSS), and is it ergodic?

### Process 2:

We now work with a scenario where patients die, are infected and are cured. Show three different versions of how an outbreak in the hospital can develop over 10 days if:

We define another random variable  $W(n)$  that is a discretely uniformly distributed, and can take the values  $\{-2, -1, 0, 1, 2\}$ .

The variables in  $W$  are independent and identically distributed (i.i.d.).

- Day 1: Number of infected patients is  $X$  plus a random variable  $W(1)$ .
- Day 2: Number of infected patients is  $X$  plus a random variable  $W(2)$ .
- $\vdots$
- Day  $n$ : Number of infected patients is  $X$  plus a random variable  $W(n)$ .

This is a stochastic process, we can write as:

$$Y(n) = X + W(n) \tag{2}$$

where  $X \sim B(10, 0.5)$  is a random variable and  $n$  is the day ( $n = 1, \dots, 10$ ). The random variables  $W(1), W(2), W(3), W(4), W(5), W(6), W(7), W(8), W(9)$  and  $W(10)$  are i.i.d. and distributed uniformly such that  $W(n) \in \{-2, -1, 0, 1, 2\}$ .

1. Make a Matlab function that generates realizations of the process  $Y(n)$ .
2. Plot three realizations of the process.
3. What is the ensemble mean and variance of the process?
4. What is the mean and variance of the process of one realisation?
5. Verify Question 3 and 4 with the Matlab function.
6. Is the process  $Y(n)$  Wide Sense Stationary (WSS), and is it ergodic?

**Process 3:**

Work with the outbreak from lesson 2:

1. Day 1: Draw a random sample of the ten admitted patients.
2. Day 2: Assume that on the second day no patients are admitted. Each ebola infected patient either infects or does not infect another person with probability 0.5.
3. Day 3 and onwards: All old and new Ebola patients either infects or does not infect another person with probability 0.5.
4. Show three different realizations of the process for 10 days.
5. Is this process Wide Sense Stationary (WSS), and is it ergodic?