

## Exercise 21 (8/1/98 ex.1)

When modelling the progression of a special type of tumor it is reasonable to characterize the condition of a patient in one of the following ways

- E1** The patient has preliminary signs.
- S1** The tumor is not insignificant.
- S2** The tumor is serious.
- S3** The tumor is life threatening.
- D1** The patient is dead.

It can be assumed that the progression of the disease for a patient can be summarized by the value of the current state of that patient. If the disease progresses without medical control the weekly progression (i.e. from one week to another) can be described by the following possible state changes, obtained from a larger international study

- $E1 \rightarrow S1 \quad p = 0,05.$
- $S1 \rightarrow S2 \quad p = 0,15.$
- $S2 \rightarrow S3 \quad p = 0,20.$
- $S3 \rightarrow D1 \quad p = 0,20.$

### Question 1

Give based on the information above a mathematical model describing the development of the disease for a patient.

### Question 2

Calculate the expected remaining life time for a patient who just got into state E1 (prestate).

Patients having symptoms as described for one the four stages, were followed weekly at the out-patient clinic to evaluate the need for treatment. Whenever the tumor is detected some kind of surgery will be done. Two different kinds of surgery is possible, dependent on the condition of the patient.

- O1** The tumor was removed without serious complications.
- O2** Removal of the tumor had consequences for other organs.

The probabilities that the tumor is detected and the probability that surgery of type O1 is performed are given below. The probability that surgery of type O2 is performed, knowing the tumor is detected is thus  $1-P(O1)$ .

- E1** The tumor can not be detected.
- S1** The tumor is detected with probability 0.2.  $P(O1)=0.75$ .
- S2** The tumor is detected with probability 0.4.  $P(O1)=0.50$ .
- S3** The tumor is detected with probability 0.6.  $P(O1)=0.15$ .

### Question 3

Derive a revised mathematical model describing the evolution of the disease of a patient which is followed in the outpatient clinic.

### Question 4

Derive an expression for the probability that a patient characterized by S1 will get the tumor removed without serious complications.

### Question 5

Determine the probability that a patient characterized by state S2 will get the tumor removed without serious complications.

### Question 6

Give an expression describing the length of the period of the illness, i.e. the distribution of the time until surgery or death. The expression should not necessarily be an explicit one, it is sufficient to give an expression with all necessary values inserted.