A Scientific Study on Virus Hepatitis Type C Using the Markov Chain

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Abstract

This paper aims to introduce a study on Markov chain that the Russian scientist presented Markov and how to benefit from it in medical institutions, studying the time series of a number of injuries with hepatitis type C as Markov chain by taking samples from the (Ministry of Health/ Department of Communicable Diseases), in order to build issue according to the Markov's chain and depending on the number of cases that are represented. Hence, the possibility of defining the transition matrix representing it with a tree diagram and study its characteristics in terms of universe whether or not it is primitive, ergodic and reducible.

Key words

Stochastic processes, Random Processes, Markov chain.

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1. Introduction

Calculation method for prediction using time series provided by the Russian scientist Markov (1856-1922). Markov came up with a new method. This method includes dependence on the present value to predict chain values in the future not depend on the pervious values or historical values of the studied chain. In this paper we shall try to highlight on some of what come in Markov chain and his equations to show the possibility of benefiting from them and applying them in the medical field. In the financial world and workers are considered Markov chain is difficult while the true concept of this chain gives us the opposite. This chain is considered as simple, easy nature it is able to explain the most complex natural phenomena. The Markov chain is a random sequence of events in which the probability of each event depends directly on the preceding event and does not depend on events of its past.

1.1. Research Objective

The aim of this research is to represent data of the numbers of cases of hepatitis Virus type (C) in Iraq in the form of Markov model. Furthermore, we study and discuss the characteristics resulting from that model.

That is this equation can be written according to the Markov logic as follows:

$$P_{jr} = P_r\{x_{n+1} = k \mid x_n = j\}$$, where:

p_{jr} : Represent the conditional portability of a random process of the value equal to (k) in step (n+1) given its the value of (j) in the step (n) and this clearly means that there is a discontinuous parameter space for the random process that is $[x_n; n=0,1,2...]$ $x_n = j$: means the random process of the value of (j) in the time (n) or step (n).

$x_{n+1} = k$: means the random process of the value (k) in the step (n+1).

In the case of clearly defined Markov chain see the following:

Markov chain means (the value of the phenomenon in the future it depends only on the present value and not on the previous or historical value).

The simplest example is close to the minds of our dear students; if we want to plan for the fourth years' students, a statistic for the coming year then we have to rely on the third stage statistics not on the number of the second stage or the first stage students.

Transitional possibilities can also move one step from state or value in the time of (n) to state or value of (k) in the time of (n+1) assuming these probabilities are stable over time. Transitional possibilities can be represented, which represents from (E_j) to (E_k) in a way that is more appropriate and arrange them in the form of a square matrix. See the following

	0	1	2	3	4	5	…….
0	p_{00}	p_{01}	p_{02}	p_{03}	p_{04}	p_{05}	
1	p_{10}	p_{11}	p_{12}	p_{13}	p_{14}	p_{15}	
2	p_{20}	p_{21}	p_{22}	p_{23}	p_{24}	p_{25}	
3	p_{30}	p_{31}	p_{32}	p_{33}	p_{34}	p_{35}	
4	p_{40}	p_{41}	p_{42}	p_{43}	p_{44}	p_{45}	
5	p_{50}	p_{51}	p_{52}	p_{53}	p_{54}	p_{55}	
. . .							

p_{00}: means the probability of process in state 0 and remain in state 0.

p_{01}: means the probability of process in state 0 and remain in state 1.

p_{04}: means the probability of process in state 0 and remain in state 4.

p_{06}: means the probability of process in state 0 and remain in state 6.

The matrix (p) can be defined as follows:

First: It is possible to name (p) as homogeneous transitions or stochastic matrix because all transitional possibilities are fixed and independent of time, and the possibilities

(p_{jk}) must such that the following conditions:

(1) $\Sigma p_{jk} = 1$, for each $j, k \in E$,

(2) $p_{jk} \geq 0$, for each $j, k \in E$.

Second: The matrix (P) can be defined as a square matrix for all possibilities which defined for all . We can call the matrix (P) as Markov matrix and also by achieving the above conditions.

2. Basic Concepts

2.1. Random Process [1]

The random process is a family of a set of random variables that are inferred by the evidence of m where denoted by .

2.2. Time Series[1]

If the indicative set M in the stochastic process represents the time, then the random set is called the time series and the time series is continuous time if it is $-\infty<m<\infty$ and it is denoted by $\{X(m)\}$. Also, if it is discrete values , then the time series is called Discrete time series and it is symbolized as or abbreviated as .

2.3. Markov chain [2]

It is a series of random variables with a discrete value which represents the conditional distribution of the value of by achieving the values of random variables ,it depends on the value of only, and in a clear mathematical

expression

2.4. The Primitive Matrix [3]

The transitional probability matrix is said to be primitive matrix if it has self-value equal of self-(1) and the rest of the other values are lower than the absolute value self-values are found by solving the following system; .

2.5. Closed Set [4]

Let be a subset of a state space then is closed if where for all a positive integer values.

2.6. Irreducible Matrix [5]

Let P be any transition matrix, then P is called reducible matrix if it is possible to find a partial closed matrix of this matrix. Conversely, P is called irreducible matrix.

2.7. The State of Connected: [4]

We say and are connected and denoted by , if there exist two integers numbers such that

2.8. Theorem (1): [5]

Markov chain is irreducible if and only if all cases are connected.

2.9. The Ergodic Chain [2]

Markov chain is Ergodic if it is possible to move from every case to every case. The transfer does not necessarily have to be one-step. In other words, markov chain is Ergodic if it is primitive and irreducible.

3. Applied and Statistical Side

We will work here to find the time series and study the number of cases of hepatitis virus type C in Iraq according to the Markov chain where we were provided with data from the Ministry of Health-Department of Transitional Diseases which represents the monthly rates of the number of people with hepatitis virus type C for both sexes from 2013 to 2016 and for all ages. We will work to find Markov chain formula from the given data in the following way: at the first we know the step and the state of the number of patients in order to formulate a Markov chain and then several assumptions are made to cover the cases and the movement of these cases which include the number of patients to formulate the transition matrix. In this work the state was defined as the number of patients with hepatitis C virus for period of four years the stat was defined as increasing the number of patients from one-time period to another. The following Table (1) explains the age groups from one year to more than (45) years.

Table (1):The age groups

Class	State
0-4	T_1
5-14	T_2
15-45	T_3
More 45	T_4

Through the above assumptions, the number of patients for both sexes and these with hepatitis type C can be classified for several consecution yours to obtain the following Table (2).

Table (2):Number of patients in the age groups

	T_1	T_2	T_3	T_4
2013	33	154	600	410
2014	24	95	166	261
2015	40	115	639	423
2016	32	42	368	246

Where includes all the different cases for the Markov chain for all age groups. Now, we need data describing the movement of patients individually over time to find transition matrix. This data is not available to us and the reason is that patients are not reviewed regularly by health centers. As for what is available from the data, it gives information about the total number of patients of different ages. Here it is taken a period of one year, it is an appropriate time for transition matrix that can be formulated with appropriate assumptions in order to represent patient's movement between different age groups, they are as follows:

First: Any patient who reaches the state remains in it.

Second: Any patient in gets old, he will be in the higher level of (i.e).

Third: The emergence of a decrease in the number of patients is the result of their transition to the state of which is a state of recovery from illness. By using this data for a period of one years, we can obtain Table (3) which represents the number of patient in cases for (2013-2014). The Table (3) shows the number of patients within cases for (2013-2014).

Table (3): Number of patients for (2013-2014).

Stats	T_1	T_2	T_3	T_4
2013	33	154	600	410
2014	24	95	166	261

Therefore, it is possible to show the estimated movement of patients from one case to another during the period (2013-2014) as shown in a Table (4)

Table (4): The estimated movement of patients for (2013-2014).

2014/2013	T_0	T_1	T_2	T_3	T_4	Rows
T_0	0	33	154	464	0	651
T_1	0	0	0	24	0	24
T_2	0	0	0	95	0	95
T_3	0	0	0	17	149	166
T_4	0	0	0	0	261	261
Columns	0	33	154	600	410	

In the same way the other Tables for (2014-2015) and (2015-2016) are found. By adding the Tables according to the rule of adding matrices, we get the following Table (5) which shows that the estimated movement of patients from 2013 to 2016.

Table (5): The estimated movement of patients for (2013-2016).

T_k / T_{k-1}	T_0	T_1	T_2	T_3	T_4	Sum Rows
T_0	0	73	269	838	0	1180
T_1	40	0	0	56	0	96
T_2	115	0	0	137	0	252
T_3	516	24	95	212	326	1173
T_4	0	0	0	162	768	930
Sum Columns	671	97	364	1405	1094	

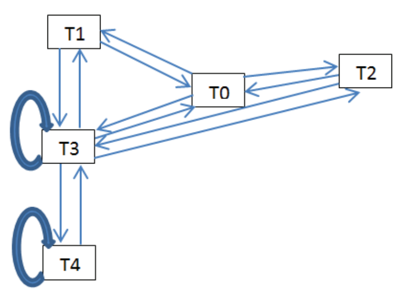
And from the Table (5); we divide the elements of each row into the sum total of rows in which they fallow as a result we will get a random matrix which called probability matrix which reflects to us initial assumptions about the movement of patients where , are ended cases.

The following Table shows the transition matrix for the number of patients infected with hepatitis virus type of C.

Table (6): The transitional matrix of the patients with hepatitis type C

	T_0	T_1	T_2	T_3	T_4
T_0	0	0.069	0.228	0.710	0
T_1	0.417	0	0	0.583	0
T_2	0.456	0	0	0.544	0
T_3	0.44	0.02	0.081	0.181	0.278
T_4	0	0	0	0.174	0.826

transition matrix can be represented by Table which explains the characterizations of the Markov chain represented by probity matrix (P).



Diagraph (1): Transition matrix

4. Ergodic

In this paragraph we will try to show as to whether the Markov chain of patients with hepatitis virus of type (C) is Ergodic or not. We must prove that the transition matrix is primitive and irreducible. Also, from Theorem (1), we find that the transition matrix is irreducible and the reason is because it is connected and accessible from any case to all cases it contains one closed set and to prove that the transition matrix is primitive we have to find the self-values for the matrix P and prove these values are equal to one and the rest of the values are the less than the absolute value. In order to find self-values we follow the next system solution, and by solving the above system we obtain the following self-values:

$\lambda_1 = -0.510$

$\lambda_1 = -0.199$

$\lambda_1 = 0$

$\lambda_1 = 0.715$

$\lambda_1 = 1.001$

From these values, we find the matrix is not primitive and therefore it is not ergodic. Hence the applied method is correct and compatible with this disease is not fixed in increase or decrease in the age group for all governorates of Iraq. This is because of the different in health awareness at the same age group like using tattoos and other habits without knowing its risks and negative effects while these habits are almost non-existent for the most age groups, in other regions either because of health awareness or religious deterrence.

5. Conclusions

Through our study of the time series of the number of cases of hepatitis virus type C in Iraq and data recorded for all Iraqi governorates, it was found that the series is not ergodic and the possibility of infection with this disease is fluctuating between the age groups of several health centers in different regions and for the same one Iraqi province, because the lack of health awareness of the causes of disease transmission to the population of a particular region makes it more vulnerable than others to the spread of this epidemic disease. Also, the genetic factor, which is the transmission of the disease from the affected mother to her child, which appears in the first age group (T1) in the transmission matrix where it is few, and then the number of infected people increases in time periods more than twice when moving to other age groups, see (T2, T3). Also, for some time periods that may reach zero status, which is the result of death or recovery, see (T4). Therefore, external factors are more influential than the genetic factor and these results are reasonable, which indicates the efficiency of the method and model used in this study.

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