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Modeling Life Insurance Claim Counts Process as HPP & NHPP

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ABSTRACT:- Actuarial Statistics is a developing branch of Statistics, which deals with the methods of mathematical computations related to Insurance Policies. Insurance is a common way of managing risks and the insurance industry has grown rapidly over time. The level of sophistication of Actuarial Science and Financial Mathematics, along with their potential range of applications and analytical skills has increased significantly for identifying, quantifying, understanding, and managing the impact of the financial risks.

Insurance industry owners, especially, consider the components of risk management, such as the premiums- the main income of insurance businesses, reserves, investment planning etc. Also, estimating claims play an important part in each component in the life insurance field.

In this research paper we use Homogeneous Poisson Process and Non-Homogeneous Poisson Process as a model of life insurance claim counting process. The objective of this study is to estimate the parameters of these processes for the claims settled by Life Insurance Corporation of India in Vidarbha region, State of Maharashtra, India.

Keywords:- *Life Insurance Claim Counting Process, Homogeneous Poisson Process and Non- Homogeneous Poisson Process, Estimating Function.*

I. INTRODUCTION

Nowadays, insurance has become a common way of managing risk and insurance industry has grown rapidly over time. Insurance industry owners, especially, consider the components of risk management such as the premium which are the main income of insurance business, reserves, underwriting investment planning, reinsurance planning, etc. Also estimating claim plays an important role in field of life insurance

Policy is the written agreement, contract between the insurer and the insurance company in which the insurance company agrees to pay a certain amount of money to provide cover to policyholders in case of eventualities like accidents, hospitalization, household hazards, Thefts or deaths and insurer agrees to pay premium periodically to the insurance company. The important decision of this contract is the amount of premium, which has to be fixed atthe time of issue of the policy. The premium comprises of three components: Risk component, Management Expenses Component and Investment Component. The Risk component is studied through the Risk Models.

A. The” Poisson process" is a continuous-time counting process $\{N(t), t \geq 0\}$ that possesses the following properties:

- $N(0) = 0$
- Independent increments (the numbers of occurrences counted in disjoint intervals are independent of each other)
- Stationary increments (the probability distribution of the number of occurrences counted in any time interval depends only on the length of the interval)
- The probability distribution of N(t) is a Poisson distribution with rate λ and parameter λt.
- No counted occurrences are simultaneous. Consequences of this definition include:
- The probability distribution of the waiting time until the next occurrence is an exponential distribution.
- The occurrences are distributed uniformly on any interval of time. (Note that N(t), the total number of occurrences, has a Poisson distribution over the non-negative integers, whereas the location of an individual occurrence on $t \in (a, b]$ is uniform.)

- Non homogeneous Poisson process : A stochastic process is a no homogeneous Poisson process for some small value h if
  - $N(0) = 0$
  - Non-overlapping increments are independent
  - $p(N(t+h)- N(t) =1) = \lambda(t)\, h + 0(h)$
  - $p(N(t+h)- N(t) >1) = 0(h)$

For all t and where, in big O notation, . $\frac{o(h)}{h} \to 0 \text{ as } h \to 0$
Properties:

Write N(t) for the number of events by time t and $m(t) = \int_0^t \lambda(u)\,\mathrm{d}u$ for the mean. Then N(t) has a Poisson distribution with parameter m(t), that is for k = 0, 1, 2, 3….

$$\mathbb{P}(N(t) = k) = \frac{m(t)^k}{k!} e^{-m(t)}.$$

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The data on Cause wise death claims of Life Insurance Corporation of India, Vidarbha Region, Maharashtra State, India, for the years 2008-09, 2009-10, 2010-11 and 2011-12 is analyzed. Observing the variation in the number of death claims we separated them according to different groups of causes of deaths and carried out the analysis.

In particular, we analyzed the claims counting process for accidental deaths i.e. cause group V which covers different types of accidental deaths mentioned in the table below:

	Group V
V0	Motor Vehicle Accidents
V1	Other Transport Accidents
V2	Accidental Poisoning
V3	Accidental Falls
V4	Accidents Caused By Fires
V5	Accidental Drowning And Submersion
V6	Accident Caused By Firearm Missiles
V7	Accidents Mainly Of Industrial Type
V8	All Other Accidents- Earth Quake Etc
V9	Suicide And Self-Inflicted Injury

II. ESTIMATION OF INTENSITY FUNCTION Λ (T):

While studying the pattern of number of death claims settled in different financial year, it is observed that the averages of number of claims for different ages of policies are different. That is intensity functions for different ages of the policies for non-overlapping time intervals are different. Therefore instead of Homogeneous Poisson process, we used Non Homogeneous Poisson process model to estimate parametric function λ(t). We used two models for estimating this intensity function:

Model I : λ(t).=a+b * t
Model II : λ(t) =a*t^b , Where t is age of policy at the time of claim and a, b are some constants.

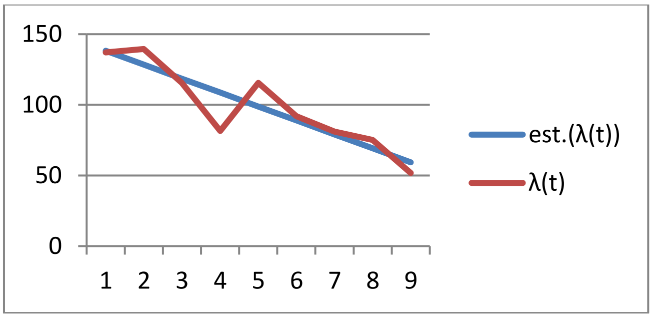
A. *Method for estimating constants:*

We use method of least square for estimating the constants a and b.

- *Model I: Actual and Estimated values of λ(t)*

Table 1. Analysis Table for Model I:

T	Actual Y_t = (o_i)	x=t-6	x*Yt	x^2	Estimated y=a+b * x =(e_i)	(oi - ei)^2/ei
1	137	-4	-548	16	138.2611	0.011502716
2	139.5	-3	-418.5	9	128.3903	0.961335496
3	115.5	-2	-231	4	118.5194	0.076924039
4	81.5	-1	-81.5	1	108.6486	6.783765502
5	115.5	0	0	0	98.77777	2.83093024
6	92	1	92	1	88.90694	0.107607337
7	81	2	162	4	79.0361	0.048799059
8	75.25	3	225.75	9	69.16527	0.535296493
9	51.75	4	207	16	59.29444	0.959930588
	889	0	-592.25	60		12.31609147



After estimating the intensity function λ(t) according to Model I, we test the null hypothesis

H0 : The Model I : λ(t).=a + b * t fits well to the data.
Vs
H1: The Model I : λ(t).=a + b * t does not fit well to the data .
Using Chi- Square test of Goodness of Fit, where

Chi Square =∑(oi - ei)^2/ei

Where,
oi -observed values and
ei - Estimated values

We obtained chi square = 12.31609147 < tabulated value= 21 at 5% level of significance for 9 degrees of freedom.

III. CONCLUSION

H_0 is accepted at 5 % level of significance. Hence we say that the Model I fits well to the data.

Table 2 .Analysis Table for Model II

t	Actual λ(t)	Cumulative λ(t) =(o_i)	log t	log y	(log t)^2	(log t)* (log y)	Est. Cumulative λ(t)=(e_i)	(oi - ei)^2/ei
1	137	137	0	2.136720567	0	0	146.6524	0.635302
2	139.5	276.5	0.30103	2.441695136	0.0906191	0.735023476	263.7352	0.617816
3	115.5	392	0.477121	2.593286067	0.2276447	1.237311902	371.7601	1.101931
4	81.5	473.5	0.60206	2.675319983	0.3624762	1.610703126	474.2934	0.001327
5	115.5	589	0.69897	2.770115295	0.4885591	1.9362275	572.9277	0.450876
6	92	681	0.778151	2.833147112	0.6055194	2.204616968	668.5621	0.231394
7	81	762	0.845098	2.881954971	0.7141907	2.435534498	761.7718	6.83E-05
8	75.25	837.25	0.90309	2.922855156	0.8155715	2.639601225	852.9549	0.289165
9	51.75	889	0.954243	2.948901761	0.9105788	2.813967416	942.4024	3.026116
Total	889	5037.25	5.559763	24.20399605	4.2151594	15.61298611		6.353996

- *Model II : ACTUAL AND ESTIMATED VALUES OF Λ(T)*

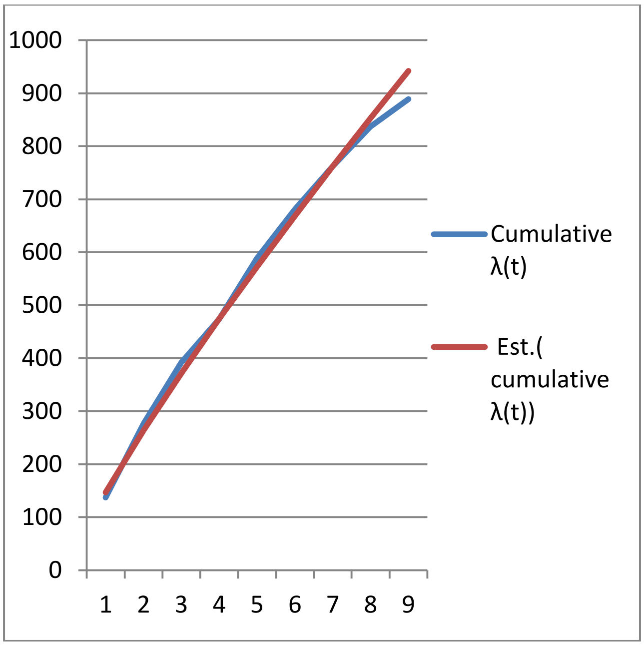


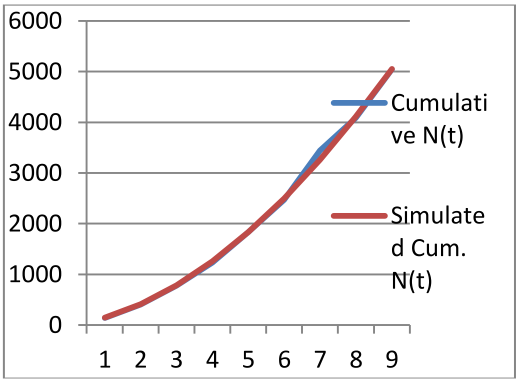
Fig. Simulated Sample path Using NHPP

Simulation of claims

Table 3

t	N(t)	Cumulative N(t)	Simulated Cumulative N(t)
1	138	138	146.6524
2	267	405	410.3876
3	370	775	782.1477
4	456	1231	1256.4411
5	604	1835	1829.3688
6	638	2473	2497.9309
7	772	3445	3259.7027
8	844	4089	4112.6576
9	955	5044	5055.06

- *Sample Trajectory Of Cumulative N(T)*



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After estimating the intensity function λ(t) according to Model II, we test the null hypothesis

H0 : The Model I : $\lambda(t).=a * t^b$ fits well to the data.
Vs
H1: The Model I : $\lambda(t).=a * t^b$ does not fit well to the data
.
Using Chi- Square test of Goodness of Fit, we obtained calculated chi square = 6.353996 < tabulated value= 21 at 5% level of significance for 9 degrees of freedom.
Conclusion: H_0 is accepted at 5 % level of significance. Hence we say that the Model II fits well to the data.

Since calculated chi-square (Model II) < calculated chi-square (Model I), it can be said that Model II : $\lambda(t)=a*t^b$fits better to the data than Model I : $\lambda(t)=a+bt$. Therefore Model II : $\lambda(t)=a*t^b$ is used to estimate intensity functions of NHPP to predict number of death claims by cause V.

Using similar technique, the average amount of claims can be estimated and these can be used to predict the total amount of claims due to cause V.

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