School of Engineering and Applied Science (SEAS), Ahmedabad University

B.Tech(CSE) Semester IV: Probability and Stochastic Processes (MAT 277)

- Group No : BB14
- Guided by: Professor Dhaval Patel
- Group Members :
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- Project Title: Probabilistic distribution of births over a certain period of time

1 Justify how Probabilistic Models are used in your project. How is uncertainty modeled?

The aim of our project was to estimate the probability of at-least r live births in given span of time and the mean difference between two live births. Probability concepts used for our modelling are *Binomial Distribution, Geometric Distribution, Poisson Distribution, Probability Mass Function (PMF) and Cumulative Mass Function (CMF).*

Modelling of Uncertainties

Many uncertain events occur before, during and after pregnancy like the *Coital Frequency*, *Fertile Period during Menstrual Cycle* , *Conception*, *Fetal Losses*, *Number of births over a certain period of time.*

The Coital Frequency is modelled using *Poisson Random Variable* and λ will be the mean daily probability of intercourse in a month of 30 days. The fertile period is considered to be 4-5 days. The probability of fetal loss is considered to be fixed in order to find the pregnancy leading to live birth for different intervals of time (in years).

Probability of conception is assumed to be fixed in the base article but we have modelled it using *Geometric Distribution, PMF* and *CMF* as part of our innovation work. Using *Binomial Distribution* where probability of success is the probability of conception and using *Cumulative Distribution Function* over all ranges of X and v where as X describes the event of a live birth and v describes the event of a fetal loss, we modelled the probability of at-least r live birth in a t given years over various mortality rates. Also our model estimates the mean difference between two live births in a span of different t years

2 New things done in the coding part, excluding the shared code.

Code Changes -1

- Probability of conception is taken constant in the base paper assuming they have used contraceptives. So we have modelled the probability of conception as our innovation part.
- We have taken certain new parameters like coital frequency, fertile period, menstrual cycle length, no. of coital acts during fertile period, no. of days when at least one coital act happened in the fertile period, Prob. of fetal loss.
- Based on those parameters we modelled the probability conception for low, intermediate and high cycle based on the cycle length and from that we have estimated the effective probability of conception (fecundability).
- That probability we have used in our main model and find the probability of at-least r live birth in t years of time and plotted the graph for the same.

Code Changes -2

- In the base paper the author varies the number of fetal loss over a period of time and derives the probability of r births in y years. By taking the similar approach as the author we varied the number of births over the period of time to get the probability mass function of fetal loss.

Code Changes -3

- We have estimated the mean month for the occurrence of r-live birth. For that we have taken into account the gestation period and postpartum in-fecundability period to be constant.
- From that we have estimated the mean difference between two live births in terms of months.

3 Contribution of team members

3.1 Technical contribution of all team members

Tasks	Jinesh Salot	Kathan Shah	Nipun Patel	Poojan Gandhi	Rohan Parikh	Samkit Kundalia	Tirth Patel
Recreating Results of Base Paper	✓	✓	✓	✓	✓	✓	✓
Coding for Innovation Part	✓		✓	✓			✓
Integrating Innovation into the existing model		✓		✓	✓	✓	✓

3.2 Non-Technical contribution of all team members

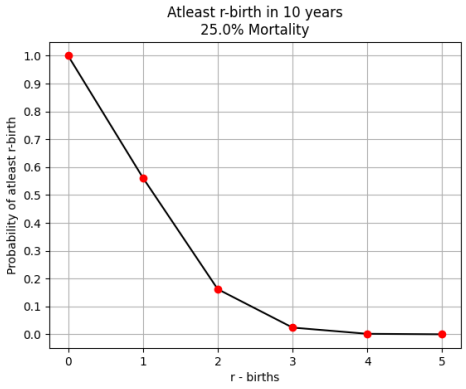
Tasks	Jinesh Salot	Kathan Shah	Nipun Patel	Poojan Gandhi	Rohan Parikh	Samkit Kundalia	Tirth Patel
Research for Innovation	✓	✓	✓	✓	✓	✓	✓
Concept Map -1	✓	✓		✓			✓
Meeting with Medical Experts		✓	✓		✓	✓	
Report	✓		✓		✓	✓	✓

4 Any innovation done considering the society/neighborhood problem?

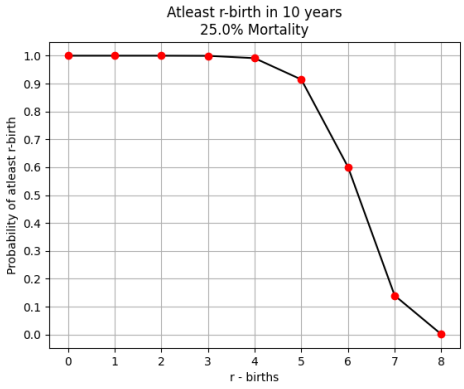
After consulting medical professionals for the project, we got to know their perspective and how serious the issue is. We also interacted with a couple who faced an undesirable pregnancy outcome. This is a very serious yet less talked about problem because of the sensitivity involved.

We realised that in our case study, between the theoretical models and practical results - there were vast differences. Due to the complexity of many factors involved - the base paper assumed many of them to be constant. However, we wanted to try to minimize the gap between reality and theory as much as possible.

Family planning is always something that is of vital importance to any couple. A part of our model also focuses on the effect of using contraceptives for couples. The following are the quantified results of our learnings:



(a) Probability of Conception=0.01 (Using Contraceptive)(From Base Article)



(b) Probability Of Conception = 0.27 (Derived from Model)(Innovation work)

Figure 1: Side-by-side comparison of effect on Pregnancy upon using Contraceptions

We hope our effort to solve this problem serves as a pillar to future studies and groups in understanding it. With further research and understanding of interdisciplinary domains surrounding it - we believe that, our model can be of vital importance to the society. The immediate benefit of our work can be taken advantage

of by stakeholders like patients, doctors, gynaecologists, obstetricians and medical societies and institutions.

5 Enumerate the inferences derived from user-centric perspective.

We find the probability of conception using the length of the cycle, number of fertile days in that cycle and number of coital acts in that cycle as a factor. This will be useful to couples for family planning by calculating the probability of conception when they use contraceptives.

We have calculated the mean number of months between two live births given the probability of conception (considering that the couple is using contraceptives) taking the mortality rate of fetuses as a factor. This would be useful to couples who use contraceptives and want to know the chances of the number of births of the child and also the time interval of birth between them even after using contraceptives.

Fetal Mortality Rate	Mean number of months between two live-births(Base Paper)	Mean number of months between two live-births (New Model)
0%	114	17.701
10%	125.6	18.6681
25%	148.7	20.6018

- Even after using the contraceptive, couples should at least expect 1 child as the expected values of births are 1.5, 1.4 and 1.2 for probability of fetal mortality=0,0.1,0.25.
- For couples who want to have a child there is a 20% chance that over a 15 year period they will have 2 or 3 Stillbirths/Miscarriages.
- By modelling the probabilities of r births in y years we can see that even using contraceptives (thus reducing the probability of conception to 0.01) for a period of 10 years there is 0.6273 probability that at least 1 child is born.

References

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[2] Weinstein, Maxine, et al. *"Components of age-specific fecundability."* . Population Studies 44.3 (1990): 447-467.

[3] Wood, James W., and Maxine Weinstein. *"A model of age-specific fecundability."*. Population Studies 42.1 (1988): 85-113.

[4] Lam, David A., Jeffrey A. Miron, and Ann Riley. *"Modeling seasonality in fecundability, conceptions, and births."*. Demography 31.2 (1994): 321-346.