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

B.Tech (CSE Semester IV): Probability and Random Processes (MAT 202)

Special Assignment Abstract Submission #2

- **Group No.: H_B30**
- **Project Area: Biology**
- **Project Title: "Further Results From A Human Model With A Variety Of Pregnancy Outcomes"**
- **Name of the group members:**
  1. Dipika Pawar (AU1841052)
  2. Mayankkumar Tank (AU1841057)
  3. Rahul Chocha (AU1841076)

Abstract

Human Reproduction is a very complex process with a lot of underlying factors affecting the outcome of a pregnancy in many direct and indirect ways. What is the appropriate time during a women's menstrual cycle for the process of fertilisation to occur? Or if the fertilisation occurs then what are the chances that the following pregnancy will terminate with the birth of a healthy child? Will the pregnancy result in a fetal loss (abortion or miscarriage)? What will be the effect of using contraceptives on the birth rate? These are some of the many uncertainties related with the topic of human reproduction. The prediction of these uncertainties present at the various stages of the human reproduction can prove to be helpful in family planning and estimating the number of children a couple are likely to have considering the factors discussed above.

The article uses a fertility based model to predict the outcomes of a pregnancy and the fertilisation process. Previous works on this topic incorporate simpler models which provide great insight in providing an understanding of the changes in the birth rate due to the change in essential parameters like the use of contraceptives, fetal loss, induced abortion, etc. They provide answers for questions like what is the probability of having 3 children in a course of 15 years in the couple uses a contraceptive of 90% effectiveness? These models although highly effective, but provided answer for only a specific case and did not proved to be useful for the general case. The model presented in the paper quantifies the uncertainties related with the entire chain of sequences related with the process of human reproduction. The model also provides the fetal wastage (abortion or miscarriage), and the infertile period which is associated with a pregnancy, and whose length may be variable according to the outcome of the pregnancy (live birth or fetal loss). The article assumes the infertility period associated with the pregnancy to be constant with respect to a particular outcome and provides a probability function for the number of births in say, y years of marriage. The model incorporated uses the theory of Markov Renewal Process to do so. [1]

Based on the work done in the article described above, in our special assignment we wish to predict the various events related with the entire pregnancy process using Markov Renewal Process. The model predicts the probability of having say, r children in y years after marriage, in two stages :

1. **Fertilisation stage.** Predicting that whether fertilisation has occurred or not; assuming that the monthly probability of fertilisation for a married female is constant.

2. **Outcome of a pregnancy.** This stage predicts that if the fertilisation has occurred then what are the chances of it resulting in a live birth and or will it result in fetal loss.

The factors which are included to predict these two stages are:

1. **Fetal Wastage.** It refers to the loss of fetus (fertilised egg) due to abortion, miscarriage or still birth.

2. **Non-susceptible/Infecundable period associated with the pregnancy.** Once the fertilisation occurs, the woman becomes non-susceptible (infertile) to another pregnancy until the end of the pregnancy and sometime after it. The length of the non-susceptible period depends upon whether the pregnancy has terminated in a live birth or in a fetal loss.

Using the above stated factors and assuming homogeneous factors for a group of women (equal parameters), we will predict the outcome of r^{th} pregnancy will be a live birth based on the outcomes of the previous *(r-1)* pregnancies and also predict the probability of having r children in y years after using the Markov Model. The model can be further generalized to calculate the fecundability (fertility) distribution of a population.

References

[1] M. C. SHEPS and E. B. PERRIN, "Further results from a human fertility model with a variety of pregnancy outcomes," *Human Biology*, vol. 38, no. 3, pp. 180–193, 1966. [Online]. Available: http://www.jstor.org/stable/41449260