Shambhavi Singh

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Doctoral Thesis

Analysis of Human Fertility Patterns Using Bayesian Paradigm
Awarded: **June 2025**
Supervisor: **Senior Prof. S.K. Upadhyay**
Institute: Department of Statistics, Banaras Hindu University, India.

- **Major Contributions:** My PhD work was all about the Bayesian exploration of the intricate patterns of human fertility and fecundity, blending probabilistic modelling, demographic theory, and modern computational methods, using both real-world and simulated data.
    - My first work focused on capturing non-standard fertility patterns, including bimodal hump-shaped age-specific fertility rates (ASFR), through Bayesian mixture models. Three models were proposed: a mixture of two Weibull distributions, a Normal-Weibull mixture, and a Normal–Generalized Gamma mixture. Metropolis-Hastings algorithm was employed for posterior computation, and applied to empirical fertility data, demonstrating strong performance in accommodating non-traditional curve shapes.
    - Fertility pattern isn't static, and keeping this in mind we used the logistic distribution as a base to propose new models that adapt to temporal and geographic drift in the ASFR curves using the difference in pre-modal and post-modal variablility. The Bayesian estimation with non-informative priors was done for ASFR data from India, Ireland, and Denmark. Comparative analyses assessed model fit and predictive capability.
    - Recognising the interdependence of parameters in demographic models, we proposed using the Gaussian copula-based prior structure within the Hadwiger fertility model. Bayesian inference was carried out using the Metropolis algorithm, and the methodology was validated through application to observed ASFR data, thus making a significant shift towards realism in demographic modelling.
    - Extended the scope of our work from fertility rates to biological fecundity, we proposed modelling daily probabilities of conception using a Bayesian generalized nonlinear model using the splogit link function (an asymmetric alternative to logit). Biological and behavioural predictors like age, type of mucus secretions and intercourse patterns were integrated in the model. Metropolis-within-Gibbs sampler was used for posterior computation and comparison with standard logit models to highlight advantages in flexibility.
- **Skills Acquired**:
  Bayesian inference and data analysis, mixture models, copula theory, hierarchical modeling, prior elicitation, stochastic simulation (Gibbs, Metropolis), nonlinear regression, demographic data analysis, R programming, scientific writing.

EDUCATION

- **Master of Science in Statistics** Patna, Bihar, India
  Patna University; Percentage: 90.75 *2019*

  Courses studied: Real Analysis, Measure theory and Probability, Linear Algebra, Sample Survey and Statistics for National Development, Distribution Theory and Non Parametric Inference, Linear Models and Regression Analysis, Statistical Computing (C, C++, JAVA), Statistical Inference, Design and Analysis of Experiments, Reliability, Stochastic Processes, Multivariate Analysis, Demography.

- **Bachelor of Science in Statistics** Patna, Bihar, India
  Patna Women's College, Patna University; Percentage: 80.75 *2017*

- **Class** 12^{th} Patna, Bihar, India
  Kendriya Vidyalaya (CBSE); Percent: 89 *2013*

- **Class** 10^{th} Patna, Bihar, India
  Kendriya Vidyalaya (CBSE); CGPA: (10.0/10.0) *2011*

PUBLICATIONS

- **Singh, Shambhavi and Gupta, Akanksha and Upadhyay, Satyanshu K**. *Modelling Human Fertility Using Variance-adjusted Logistic Family of Distributions*. American Journal of Mathematical and Management Sciences (Accepted). *2025*.
- **Pandey, P.K., Dev, P., Singh, S., Gupta, A., Pathak, A., Upadhyay, S.K**. *Bayes Analysis of mRS Follow-up Data in the Presence of Multiple Categories*. Electronic Journal of Applied Statistical Analysis (Accepted). *2025*.
- **Singh, Shambhavi and Upadhyay, Satyanshu K**. *A Bayes Study of Human Fertility Curve Using Mixture of Two Weibull Densities*. Journal of the Indian Society for Probability and Statistics, pp. 1–25. *2025*.
- **Singh, Shambhavi and Gupta, Akanksha and Upadhyay, Satyanshu K**. *Bayes Analysis of Hadwiger Fertility Model Using Markov Chain Monte Carlo Simulation*. Aligarh Journal of Statistics, vol.44. *2024*.

AWARDS AND RECOGNITION

- **INSPIRE Fellowship** Awarded by Department of Science and Technology (DST), Government of India.
- **Junior Research Fellowship (JRF)** Awarded by University Grants Commission (UGC) in July 2022.
- **AIR-79 in GATE (Statistics) 2020** Awarded by National Coordination Board (NCB) for the Department of Higher Education, Ministry of Human Resources Development (MHRD), Government of India.
- **Gold Medal** Awarded by Patna University for getting first rank in M.Sc. Statistics.

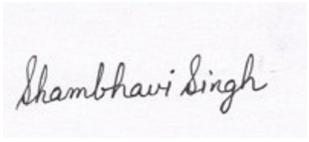
REFEREES

- **Prof. S. K. Upadhyay**
  Senior Professor, Department of Statistics
  Banaras Hindu University, Varanasi, India
  Email: skupadhyay@bhu.ac.in

- **Prof. Akanksha Gupta**
  Assistant Professor, Department of Statistics
  Banaras Hindu University, Varanasi, India
  Email: akanksha.gupta@bhu.ac.in

DECLARATION

I hereby declare that all the information provided above is true to the best of my knowledge and belief.



Shambhavi Singh

Date: July 18, 2025

Place: Varanasi