Reetha Thomas

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Professional Summary

I am currently an **Assistant Professor** at the **Indian Institute of Information Technology Kottayam**, and I have recently completed my postdoctoral research at the **Indian Institute of Management Bangalore**, specializing in climate modeling. My research expertise lies in **nonlinear partial differential equations**, with a strong focus on dynamical systems governed by fractional differential and differential-difference equations. I have made significant contributions to the study of time-space fractional partial differential equations, extending key **analytical techniques** such as Lie Symmetry Analysis and the Invariant Subspace Method.

Beyond theoretical advancements, my research also explores fuzzy differential equations and the mathematical modeling of SIRS epidemiological systems. Recently, I have broadened my focus to the application of deep learning techniques, specifically **Physics-Informed Neural Networks** and **Graph Neural Networks**, to solve nonlinear differential equations. This interdisciplinary approach merges advanced mathematical methodologies with cutting-edge machine learning techniques, significantly enhancing the predictive modeling of complex systems.

Experience

Indian Institute of Information Technology Kottayam, ***Assistant Professor*** *07/2025- Present*

Indian Institute of Management Bangalore, ***Postdoctoral Fellow*** *11/2024- 07/2025*

- *Advisor* : Dr. Soudeep Deb
- *Project*: Hybrid-AI Quantile Regression: Combining Nonparametric Statistical Methods and Physics- Informed Neural Networks for Analysing Spatio-temporal Climate Data

St. George College, Aruvithura, Kottayam, Kerala, **Assistant Professor** 06/2019 - 08/2020, 07/2017 - 11/2017

- Contributed to curriculum development by revising course syllabus, lesson plans, and evaluation methods for Differential Equations and Python programming under the UGC curriculum.
- Promoted interdisciplinary collaboration by facilitating academic and community partnerships, increasing research proposal submissions to external funding agencies.
- Engaged in collaborative research projects with faculty members, fostering a dynamic research environment.
- Implemented innovative teaching methodologies to enhance student learning and comprehension.
- Taught **M.Sc. Mathematics** students (Strength: 15) and **B.Sc. Food Science** students (Strength: 20), adapting teaching techniques to cater to diverse learning needs.

Indian Institute of Information Technology Kottayam, **Teaching Assistant** 08/2020 – 05/2024

- Grading Assignments
- Preparing Course Materials
- Managing Class Discussions
- Handling Administrative Tasks

Education

Indian Institute of Information Technology Kottayam, ***Ph.D. Mathematics*** *09/2020- 10/2024*

- *Advisor*: Dr. T. Bakkyaraj
- *Thesis*: Invariant Analysis and Exact Solutions of Certain Nonlinear Fractional Partial Differential and Differential-Difference Equations
- *Course work*: Fractional differential equations, Lie symmetry analysis, Invariant subspace method, Differential and differential-difference equations

Bharathiar University Coimbatore, Tamilnadu, ***M.Phil. Mathematics*** *11/2017- 12/2018*

- *Advisor*: Dr. S. Narayanammorthy
- *Thesis*: Glucose insulin regulatory model using Runge Kutta and homotopy perturbation methods in fuzzy domain.
- *Course work*: Fuzzy Mathematics, Partial differential equations, Algebra and analysis

Mahatma Gandhi University Kottayam, *MSc Mathematics* *(98%)* *06/2014- 06/2016*

- *Course work*: Linear and Abstract algebra, Partial differential equations, Real analysis, Complex analysis, Functional analysis, Optimization techniques, Topology, Multivariate calculus, Number theory and Cryptography, Graph theory, Operation Research, Mathematical economics, Probability theory

Mahatma Gandhi University Kottayam, *BSc Mathematics* *(93%)* *06/2011- 06/2014*

Kerala State Board, Higher Secondary (**94.5%**) 06/2009- 06/2011

SSLC, Higher Secondary (**100%**) 2009

Achievements

- Awarded the prestigious **Ramanujan Fellowship by the Isaac Newton Institute (INI)** to participate in the programme *"Representing, Calibrating & Leveraging Prediction Uncertainty: From Statistics to Machine Learning"* at the **Isaac Newton Institute for Mathematical Sciences, University of Cambridge**.
- Awarded the **CSIR Direct Senior Research Fellowship (SRF)** in 2024.
- **First Rank** in MSc Mathematics at **Mahatma Gandhi University**.
- Qualified the **State Eligibility Test (SET) for Assistant Professor** in 2018.
- Won the **Best Paper Award** in the *Applied Mathematics* track at the IEEE International Conference on *Technology, Research, and Innovation for Betterment of Society (TRIBES)*.
- Successfully completed the online course "*Building on the SIR Model*" authorized by **Imperial College London** and offered through Coursera.

Publications

1. **Lie symmetry analysis of time fractional nonlinear partial differential equations in Hilfer sense**
   R. Thomas and T. Bakkyaraj
   10.1007/s40314-024-02849-6 *Computational and Applied Mathematics*, vol. 43, no. 353, 2024.
2. **Exact solution of time-fractional differential difference equations: Invariant subspace, Partially invariant subspace, Generalized separation of variables**
   R. Thomas and T. Bakkyaraj
   10.1007/s40314-023-02557-7 *Computational and Applied Mathematics*, vol. 43, no. 51, 2024.
3. **Invariant subspaces and exact solutions: (1+1) and (2+1)-dimensional generalized time-fractional thin-film equations**
   P. Prakash, R. Thomas, and T. Bakkyaraj
   10.1007/s40314-023-02229-6 *Computational and Applied Mathematics*, vol. 42, no. 97, 2023.
4. **Lie symmetry analysis and exact solution of (2+1)-dimensional nonlinear time-fractional differential-difference equations**
   T. Bakkyaraj and R. Thomas
   10.1007/s12043-022-02469-x *Pramana*, vol. 96, no. 4, pp. 1-10, 2022.
5. **A comparative study of Lie symmetry analysis and invariant subspace methods to fractional Hunter-Saxton equation**
   R. Thomas and T. Bakkyaraj
   10.1109/ICFDA58234.2023.10153230 *International Conference on Fractional Differentiation and Its Applications (ICFDA)*, Ajman, UAE, Mar 14, 2023.
6. **Fractional Vasicek Model in Financial Mathematics**
   R. Thomas
   10.1109/TRIBES52498.2021.9751629 *IEEE International Conference on Technology, Research, and Innovation for Betterment of Society (TRIBES)*, Dec 17, 2021.
7. **Modeling and analysis of SEIRS epidemic models using homotopy perturbation method: A special outlook to 2019-nCoV in India**
   R. Thomas, S.A. Jose, R. Raja, J. Alzabut, J. Cao, V.E. Balas
   10.1142/S1793524522500590 *International Journal of Biomathematics*, vol. 15, no. 08, 2022.
8. **An Approximate Mathematical Solution for the Glucose Insulin Regulatory System Using Homotopy Perturbation Method**

R. Thomas and S. Narayanamoorthy
Journal of Dynamics of Continuous, Discrete, and Impulsive Systems, vol. 30, 2023.

9. **Glucose-insulin regulatory model using Runge-Kutta method of order four**
R. Thomas, S. Maheswari, and S. Narayanamoorthy
10.1063/5.0017202 *AIP Conference Proceedings*, vol. 2261, 030069, 2020.
10. **Exact solutions of time-space fractional differential equations involving fractional Laplacian using invariant subspace method**, [Preprint] .
R. Thomas and T. Bakkyaraj.
11. **Study of initial-boundary value fractional partial differential equations using Invariant analysis**,[Preprint].
R. Thomas and T. Bakkyaraj.
12. **Infinitesimal prolongations for Mixed Ψ-Hilfer operators and applications** [Preprint]
R. Thomas, Junior C.A. Soares, Felix S. Costa, and J. Vanterler da C. Sousa.
13. **Fusing nonparametric stochastic model with physics-informed neural networks for prediction of extreme climate events** , Kunal Rai, Archi Roy, David Shulman, Reetha Thomas, Itai Dattner, Soudeep Deb.[Working paper].
Abstract : This paper introduces a framework that combines nonparametric stochastic models with physics-informed neural networks (PINNs) to predict extreme climate events. The framework generates nonparametric quantile estimates, predictions, and confidence intervals, offering insights into uncertainty. It is validated using spatio-temporal rainfall data from India, demonstrating its ability to make accurate predictions while capturing variability. This approach holds significant potential for advancing climate prediction and decision-making in environmental research.
14. **PIGNN-GPR: A Hybrid Machine Learning Framework for Spatio-Temporal PM2.5 Prediction**,Reetha Thomas, Soudeep Deb. [Working paper]

    Abstract : Accurate prediction of PM2.5 concentration is crucial for environmental sustainability and public health, yet neural networks often struggle with interpretability. To address this, we propose a hybrid approach combining Graph Neural Networks (GNNs) and Physics-Informed Neural Networks (PINNs), where PINNs impose physical constraints from the reaction-diffusion-advection equation while GNNs capture spatial dependencies using wind speed and direction. Additionally, we incorporate Inverse Distance Weighting (IDW) for spatial interpolation, SHAP for explainability, and Gaussian Process Regression (GPR) for uncertainty quantification, demonstrating the model's effectiveness using real-world air quality data from Delhi, India.
15. **Continuous-Time Diffusion into GNN-based Portfolio Modeling**, Reetha Thomas, Soudeep Deb. [Working paper]

Teaching Interests

Machine Learning and Data Science: Statistical Learning, Predictive Analytics, Time Series Analysis, Graph Neural Networks, Physics-Informed Neural Networks.

Operations Research and Finance: Financial Mathematics, Mathematical Modeling in Economics and Finance.

Mathematics and Statistics: Linear Algebra, Calculus, Differential Equations, Probability and Statistics, Optimization Techniques.

Presentations

- **September 2025**, *Abstract titled "PIGNN-GPR: A Hybrid Machine Learning Framework for Spatio-Temporal PM2.5 Prediction" accepted for a contributed oral presentation* under the Statistical Applications track at the **Applied Statistics 2025** international conference, University of Primorska, Koper/Capodistria, Slovenia.
- **May 22, 2025**, *Presented the talk "PIGNN-GPR: A Hybrid Machine Learning Framework for Spatio-Temporal PM2.5 Prediction"*, University of Bath, United Kingdom.
- **May 21, 2025**, *Delivered an invited seminar on "PIGNN-GPR: A Hybrid Machine Learning Framework for Spatio-Temporal PM2.5 Prediction"*, Isaac Newton Institute for Mathematical Sciences (INI), University of Cambridge, United Kingdom.
- **May 20, 2025**, *Presented the seminar "PIGNN-GPR: A Hybrid Machine Learning Framework for Spatio-Temporal PM2.5 Prediction"*, University of Reading, United Kingdom.
- **Sep 2023**, *Delivered an invited talk at the periodic Fractional Calculus seminar*, Brazilian Symposium on Fractional Calculus (FC Channel). YouTube Link.

- **Jun 2023**, *A comparative study of Lie symmetry analysis and invariant subspace methods to fractional Hunter-Saxton equation*, 2023 International Conference on Fractional Differentiation and Its Applications (ICFDA), Ajman, United Arab Emirates.
- **Dec 2021**, *Fractional Vasicek Model in Financial Mathematics*, IEEE International Conference on Technology, Research, and Innovation for Betterment of Society, Naya Raipur, India.
- **Jan 2020**, *Glucose Insulin Regulatory Model Using Runge-Kutta Method of Order Four*, International Conference on Advances in Applicable Mathematics (ICAAM 2020), Bharathiar University, Coimbatore, India.
- **Jan 2020**, *Fuzzy Transportation Problem Using Trapezoidal Fuzzy Numbers*, 2nd International Conference on Mathematical Modelling and Computational Methods in Science and Engineering (ICMMCMSE 2020), Alagappa University, Karaikudi, Tamil Nadu, India.
- **Jan 2018**, *Use of Trapezoidal Fuzzy Numbers to Solve Transportation Problem*, International Conference on Computing Sciences (ICCS 2018), Loyola College, Chennai, India.
- **Dec 2017**, *Application of Fuzzy Linear Systems Using Homotopy Perturbation Method in the Medical Field*, International Conference on Applicable Mathematics (ICAAM 2017), Bharathiar University, Coimbatore, India.
- **May 16, 2025**, *Attended the event "Probability and Stochastics with Applications to Biology"*, School of Mathematical Sciences, University of Nottingham, United Kingdom.

Positions of Responsibility

Reviewer: Asian-European Journal of Mathematics (AEJM), Nature Scientific Reports.

Skills

Technologies:
- **Python** – Advanced proficiency
- **Maple** – Advanced proficiency
- **Mathematica** – Intermediate proficiency
- **MATLAB** – Intermediate proficiency
- **R** – Basic proficiency

Languages:
- **English** – Professional proficiency
- **Malayalam** – Native proficiency
- **Hindi** – Conversational proficiency

Soft skills

- Academic research
- Lecturing
- Student research guidance
- Curriculum Development
- Classroom presentations
- Academic advisement

References

Dr. Soudeep Deb, Associate Professor & Chairperson,
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Dr. T. Bakkyaraj, Assistant Professor, IIIT Kottayam
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