Patent Search

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Inventor

Name	Address	Country	Nationality
Dr. N.N.V.Sakuntala, Assistant Professor in Mathematics / Department of S&H, St. Peter's Engineering College.	St. Peter's Engineering College, Dullapally, Maisammaguda, Medchal, Secunderbad, Hyderabad, Telangana-500100.	India	India
P.L.R.Kameswari, Assistant Professor / Department of Mathematics, Shri Vishnu Engineering College for Women.	Shri Vishnu Engineering College for Women, Vishnupur, Bhimavaram, West Godavari District, A.P-534202.	India	India
S.Sai Pushpa Latha, Assistant Professor in Mathematics / Department of S&H, St. Peter's Engineering College.	St. Peter's Engineering College, Dullapally, Maisammaguda, Medchal, Secunderbad, Hyderabad, Telangana-500100.	India	India
Dr.P Hima Bindu, Vice Principal / Professor in Mathematics, Department of H&S, Shadan Women's College of Engineering & Technology (Autonomous).	Shadan Women's College of Engineering & Technology (Autonomous), Khairatabad, Hyderabad, Telangana-500004.	India	India
Sreelatha Dandanayakula, Assistant Professor in Mathematics / Department of H&S, Guru Nanak Institutions Technical Campus.	Guru Nanak Institutions Technical Campus, Ibrahimpatnam, R.R Dist, Hyderabad, Telangana-501506.	India	India
M.Umarani, Assistant Professor in Mathematics / Department of H&S, Guru Nanak Institutions Technical Campus.	Guru Nanak Institutions Technical Campus, Ibrahimpatnam, R.R Dist, Hyderabad, Telangana-501506.	India	India
Dr. P. Srilatha, Associate Professor / Department of Mathematics, Institute of Aeronautical Engineering.	Institute of Aeronautical Engineering, Dundigal Road, Hyderabad, Telangana-500043.	India	India

Applicant

Name	Address	Country	Nationality
Dr. N.N.V.Sakuntala, Assistant Professor in Mathematics / Department of S&H, St. Peter's Engineering College.	St. Peter's Engineering College, Dullapally, Maisammaguda, Medchal, Secunderbad, Hyderabad, Telangana-500100.	India	India
P.L.R.Kameswari, Assistant Professor / Department of Mathematics, Shri Vishnu Engineering College for Women.	Shri Vishnu Engineering College for Women, Vishnupur, Bhimavaram, West Godavari District, A.P-534202.	India	India
S.Sai Pushpa Latha, Assistant Professor in Mathematics / Department of S&H, St. Peter's Engineering College.	St. Peter's Engineering College, Dullapally, Maisammaguda, Medchal, Secunderbad, Hyderabad, Telangana-500100.	India	India
Dr.P Hima Bindu, Vice Principal / Professor in Mathematics, Department of H&S, Shadan Women's College of Engineering & Technology (Autonomous).	Shadan Women's College of Engineering & Technology (Autonomous), Khairatabad, Hyderabad, Telangana-500004.	India	India
Sreelatha Dandanayakula, Assistant Professor in Mathematics / Department of H&S, Guru Nanak Institutions Technical Campus.	Guru Nanak Institutions Technical Campus, Ibrahimpatnam, R.R Dist, Hyderabad, Telangana-501506.	India	India
M.Umarani, Assistant Professor in Mathematics / Department of H&S, Guru Nanak Institutions Technical Campus.	Guru Nanak Institutions Technical Campus, Ibrahimpatnam, R.R Dist, Hyderabad, Telangana-501506.	India	India
Dr. P. Srilatha, Associate Professor / Department of Mathematics, Institute of Aeronautical Engineering.	Institute of Aeronautical Engineering, Dundigal Road, Hyderabad, Telangana-500043.	India	India

Abstract:

Abstract This studies introduces a unique Bayesian inference framework tailored for Stochastic Differential Equations (SDEs), addressing key challenges in parameter estimation accuracy and uncertainty quantification. Through the mixing of superior computational strategies, along with adaptive sampling and excessive-order numerical techniques for SDE discretization, our method complements the performance and reliability of Bayesian inference in complex stochastic systems. Experimental validation turned into accomplished the use of each artificial and actual-international dataset, encompassing a range of programs from monetary modelling to organic structures. The proposed Bayesian inference technique demonstrated substantial enhancements in parameter estimation accuracy and uncertainty quantification compared to conventional methods. Specifically, our methodology executed a discount in estimation error by means of up to 30% for key parameters throughout examined fashions. Furthermore, uncertainty quantification measures provided by means of our technique exhibited narrower self-belief periods with the aid of about 25%, indicating a more unique estimation of model uncertainty. A comparative evaluation with conventional SDE solving techniques highlighted the blessings of our Bayesian framework, showcasing a more advantageous capacity to contain prior expertise and observational facts successfully. This turned into mainly obvious in scenarios with sparse or noisy data, where our approach continuously outperformed current tactics in phrases of both accuracy and computational performance. The adaptive sampling mechanism delivered within our framework drastically reduced computational time through up to forty%, facilitating faster convergence to the real parameter values.

Complete Specification

Description:Bayesian Inference for Stochastic Differential Equations with Uncertainty Quantification and Parameter Estimation

Field and Background of the Invention

Stochastic Differential Equations (SDEs) are a cornerstone within the modelling of structures motivated by way of random techniques, pivotal for a wide variety of disciplines including physics, finance, engineering, and existence sciences. These mathematical constructs permit for the incorporation of inherent randomness in time-established phenomena, providing a greater nuanced and sensible representation of complicated dynamics in natural and artificial structures. Unlike traditional differential equations, which expect deterministic pathways, SDEs introduce stochastic additives to seize the unpredictability intrinsic to many strategies, which includes monetary market fluctuations, climate styles, and biochemical reactions in dwelling cells. The essence of SDEs lies of their potential to model the evolution of structures over time underneath the effect of each deterministic traits and stochastic noise. This dual nature allows researchers and practitioners to simulate and are expecting the behaviour of systems where uncertainty performs an important role. The packages of SDEs are huge and varied, demonstrating their software in predicting stock market moves, expertise populace dynamics in ecology, and modelling the unfold of sicknesses, among others. The mathematical method of an SDE commonly involves a glide term, representing the systematic, predictable component of the gadget's dynamics, and a ramification term, taking pictures the random fluctuations. This method not handiest helps a deeper expertise of complex systems, however, additionally aids in the improvement of techniques for control and optimization underneath uncertainty. In parallel with the advancement of SDEs, Bayesian inference has emerged as a powerful statistical framework for updating the chance estimates of a hypothesis as extra evidence or records becomes available. This method is particularly beneficial in the context of SDEs for parameter estimation and prediction. Bayesian inference integrates

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