(12) PATENT APPLICATION PUBLICATION
(19) INDIA
(22) Date of filing of Application :23/12/2024

(21) Application No.202431102344 A
(43) Publication Date : 03/01/2025

(54) Title of the invention : SpacetimeCurvNet: ML Framework for Ontology-Driven Spacetime Curvature Prediction and Educational Insights

(51) International classification :G06N0020000000, G06N0003044000, G06N0003080000, G06N0020200000, G06N0003084000
(86) International Application No :NA
Filing Date :NA
(87) International Publication No : NA
(61) Patent of Addition to Application Number :NA
Filing Date :NA
(62) Divisional to Application Number :NA
Filing Date :NA

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(57) Abstract :
This invention presents a machine learning-based system designed to predict and analyze spacetime curvature in General Relativity more efficiently. By combining ontology embeddings with manifold learning and advanced machine learning techniques, the system bridges symbolic knowledge and numerical data for a deeper understanding of spacetime geometry. Using ontology embedding methods inspired by OWL2Vec, the system captures relationships between key geometric entities like tensors, metrics, and geodesics, transforming this structured knowledge into machine-readable formats. At the same time, manifold learning algorithms, such as Isomap and Locally Linear Embedding (LLE), simplify complex, high-dimensional geometric data derived from spacetime metrics. The framework then applies machine learning models, including tensor regression and Recurrent Neural Networks (RNNs), to predict curvature tensors (like the Riemann and Ricci tensors) and their behavior over time in dynamic scenarios, such as black hole mergers and gravitational wave propagation. By reducing computational complexity and improving prediction accuracy, this invention provides a faster, smarter, and scalable solution for studying gravitational phenomena, advancing research in astrophysics, cosmology, and theoretical physics.

No. of Pages : 15 No. of Claims : 4