

ABSTRACT OF THE THESIS ENTITLED
EXPLORATION OF BIOLOGICAL AND COMPUTATIONAL
MODALITIES OF SCIENTIFIC CREATIVITY

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Scientific creativity refers to the ability to transcend traditional boundaries for the generation of innovative ideas that bring forth societal as well as technological progress. The present thesis encompasses a dual objective which involves the exploration of the biological basis of scientific creativity and the demonstration of its artificial genesis through computational means. The thesis is organized into 7 chapters. Chapter 1 provides a comprehensive review of the existing literature on scientific creativity and also discusses the scope of the thesis. Chapters 2, 3, 4, 5 and 6 explore the original contributions by the candidate. Chapter 2 is dedicated to the investigation and classification of scientific creative potential by analyzing the brain connectivity patterns of subjects during a spatial reasoning task using functional Near-Infrared Spectroscopy (fNIRS). Chapter 3 explores the distinction between creative and analytical mindsets by examining brain responses obtained from electroencephalography (EEG). In this study, participants performed a creativity task specifically designed to evoke the Eureka effect—the sudden moment of insight or the ‘Aha!’ feeling that characterizes creative thought. Chapter 4 focuses on classifying subjects into five levels of scientific creative ability, with proficiency in analogical reasoning serving as the key criterion. Chapter 5 presents a computational framework for the artificial synthesis of scientific creativity, demonstrated through the automatic generation of novel mathematical identities. The approach builds on an extended version of the best first search (BFS) algorithm, specifically designed to evaluate and preserve diversity among the generated identities. Chapter 6 advances the study of computational creativity in the scientific domain by presenting a modern Generative Adversarial Network (GAN)-based framework. Chapter 7 serves as the concluding chapter of the thesis and also outlines its future scope.