[Copia] UNPA-CLE - Prot. 164060-11/10/2024 - Rep. Decreti n. 10403/2024

Allegato 1

Scheda di partecipazione per l'assegnazione di fondi per Progetti di Ricerca sviluppati da singoli Ricercatori – Anno 2024

TITOLO DELLA RICERCA	Diffusion-driven coherent structures in brain dynamics: mathematical modelling for neural biology

PAROLE CHIAVE	
1	Brain dynamics
2	Neural biology
3	Reaction-diffusion
4	Turing instability
5	FitzHugh-Nagumo model

PROPONENTE

COGNOME E NOME	Rizzo Rossella
RUOLO	RTDA
E-MAIL	rossella.rizzo@unipa.it
SSD	MATH-04/A

EVENTUALI COLLABORAZIONI

N.	COGNOME E NOME	RUOLO	UNIVERSITA'/ORGANIZZ. ESTERNA
1	Marco Sammartino	PO	Università degli studi di Palermo
2	Giulia Marcon	RTDA	Università degli studi di Palermo
3	Plamen Ch. Ivanov	Research Professor	Boston University, USA
4	Roman Romero-Ortuno	MD, PA	Global Brain Health Institute, Trinity College Dublin, Irlanda

SCOPO, DESCRIZIONE E RISULTATI ATTESI DELLA RICERCA

Stato dell'arte (max 10 righe):
The aging of the population has led to a progressive allocation of resources for the prevention and treatment of neurodegenarative disorders, such as Alzheimer's, Parkinson's, Multiple Sclerosis. In this context, the formulation of a unifying theoretical framework, capable of capturing the neural dynamics that govern cognitive processes, is essential to develop biomedical technologies for early diagnosis and specific treatment. A fundamental reference model in the mathematical description of neuronal activity is based on the FitzHugh-Nagumo and Wilson-Cowan equations, which are the basis of more complex neural models capable of justifying a wide range of neurobiological phenomena. Specifically, coupling these models with diffusive effects can best describe the neuronal electrical activity and the basic mechanism of information transmission in neuronal networks with long-range interactions.

Obiettivi, ipotesi e metodologia (max 12 righe):
The main goal of this proposal is the development of a physical-mathematical model of electrodynamics of continuous media that describes the spatio-temporal evolution of electrical impulse, which travels from neuron to neuron in a complex integrated network of long-range interactions. We intend to employ fractional reaction-diffusion systems to describe the formation of self-organized stationary coherent structures in neural networks. The study will proceed at 3 levels: (i) bifurcation analysis of the model to identify critical threshold, wavelength, amplitude, and form of the pattern; (ii) numerical simulations, obtained through pseudo-spectral numerical methods, to validate the results of the analysis and to investigate the impact of the anomalous diffusion term on the model; (iii) comparison of our simulated results with experimental data to provide a reliable scenario of neural electrical activity. We aim to establish a gold standard for neural networks long-range interactions under physiological conditions, to favor the easier individuation of a pathological scenario for early diagnosis.

Risultati attesi (max 5 righe):
The aim of the project is to develop a physical-mathematical model to describe the electrical activity in neural network dynamics. This model is expected to constitute the basis of a unifying theoretical framework for long-range interactions in neuronal networks. This study aims to reproduce and classify brain dynamics to identify or predict the onset of pathological states.

Caratteristiche di interdisciplinarietà del progetto (max 5 righe):
The project is part of the development of an intelligent specialization of diagnostic, predictive and analysis methodologies in the health sector. The aim is to create a bridge between mathematical modelling and neural biology and healthcare. Collaborators to this project include physical mathematicians and statistician from University of Palermo, physicists from Boston University and medical doctors from Global Brain Health Institute and Trinity College Dublin.

DESCRIZIONE DEL PRODOTTO DELLA RICERCA (tipologia, collocazione editoriale, co-autore straniero eventualmente previsto, tempi attesi)

Research paper on super-diffusion-driven patterns in the FitzHugh-Nagumo model – expected to be submitted in top rank journals in the field such that Applied Mathematics and Computation (Q1) or Mathematical Models and Methods in Applied Sciences (Q1) – co-authored with Prof. Ivanov (BU, USA) and/or Prof. Romero-Ortuno (TCD, Ireland) – 12 months.

FINANZIAMENTO RICHIESTO (max 1.500,00 €)	1.500,00 €

DESCRIZIONE DELLE SPESE PREVISTE

Estimated expenses: - Travel cost: this item considers travel and subsistence costs to attend periodical project meetings (€500); - Conference Fee: this item cost is the fees to attend annual conferences (€1,000).

Il sottoscritto, proponente del progetto, dichiara:

- di non avere disponibilità di fondi di ricerca per un importo superiore a 5.000 €;

Luogo e data Palermo, 08/11/2024

Firma