Bioelectronics Retina Mathematical Optimization-Simulation for Integrate Model with Brain Evolutionary Pre-Hypotheses

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ARTICLE INFO	ABSTRACT
Published Online: **26 October 2023** Corresponding Author: **Dr. F Casesnoves PhD**	Constrained evolutionary optimization algorithms for Integrate and Fire (IAF) classical retina model are programmed. The techniques applied are Pareto-Multiobjective (PMO) methods. Genetic Algorithm (GA) software is developed based on literature neuro-bioelectronics experimental dataset. Results take in handle subroutines functions and matrix-algebra method for setting constraints. Results show PMO 2D imaging charts and numerical values for IAF model, with optimal values for I_S Input Current (IC) parameter. Bioelectronics applications for human vision improvements and extrapolation to life-origin pre-hypotheses are briefed.

I. INTRODUCTION AND OBJECTIVES

Integrate and Fire (IAF) classical retina model constitutes a base for more improved ones in electronics nerurophisiology [1,2]. It is built from a Integral Equation of First Class. The main parameters are the membrane voltage, $V_m(t)$, the neuronal membrane capacity, C_m, and the input stimulus current, I_s (t). All of them are function of time principally. The refractory period, usually set in miliseconds, constitute also an essential parameter in neuronal physiology and these neural network models. The Leaky Integrate-and-Fire Model is a subsequent evolution of IAF that is based on an ordinary differential equation [1,2].

The objectives of this study are to optimize the I_s (t) parameter for a series of values of the other ones by using artificial intelligence programming with Genetic Algorithms (GA) Pareto-Multiobjective software [3-10] .

The method is based on GA-PMO software developed previously in other research field. The results comprise a series of numerical data with 2D graphics for GA-PMO optimization dataset.

Grosso modo, the IAF model was optimized with modern IA-GA methods and PMO techniques. Results show acceptable figures and applications in neural bioelectronics networks and modelling are briefed. An extension of previous computational results in Nonlinear Pareto-Multiobjective GA optimization was applied.

II. MATHEMATICAL AND COMPUTATIONAL METHODS

The objective function applied, [1-2, 3-10] based on IAF model is,

$$\text{min imize Chevyshev } L_1 \text{ objective function,}$$

$$\left\| I_S - \frac{r\, C_m \times (V_\theta - V_r)}{1 - r\, T_{ref}} \right\|;$$

$$\text{subject to,}$$

$$\text{Table 1 constraint s;}$$

where,

C_m (mF): neuron membrane capacity.
I_s (t) (mA): Input current.
T_{REF} (ms) : Refractary time.
V_r (mV) : Reset potential.
V_θ (mV) : Threshold Potential.
r (ms) : Firing rate.

(Algorithm 1, Casesnoves 2022)

The input data is presented at Table1. All figures belong to standard values [1,2].

Table 1.- Parameters setting for the study [1,2].

NUMERICAL DATASET	
PARAMETER	**VALUE/INTERVAL**
C_m mF	1×10^{-6}
I_s (t) mA	[1.2 , 1.7]
T_{ref} ms	5
V_r mV	45
V_θ mV	60
r ms	[112.9 , 160.00]

III.   OPTIMIZATION RESULTS

Results are presented in 2D GA graphics and numerically, Table 2. These are 2D Graphical and Numerical predictions. Graphical results for 2D evolutionary PMO optimization are shown in Figures 1,2.

2D GA Results

Graphics at Figures 1,2 show results for stopping criteria, maximum contraints, % criteria met, distance among individuals, and fitness of each individual. All of them show acceptable results for pareto 1 and pareto 2 functions.
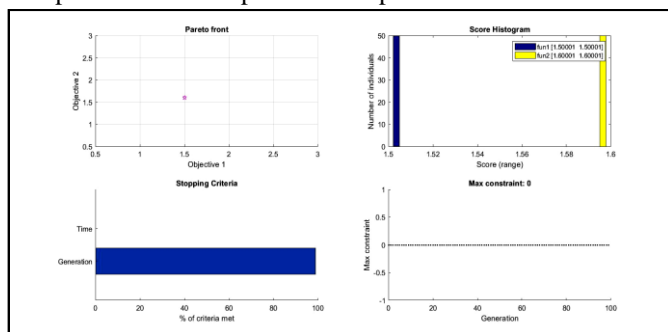

Figure 1.- Results for stopping criteria, maximum contraints, and % criteria met. Both pareto functions show approximate results.
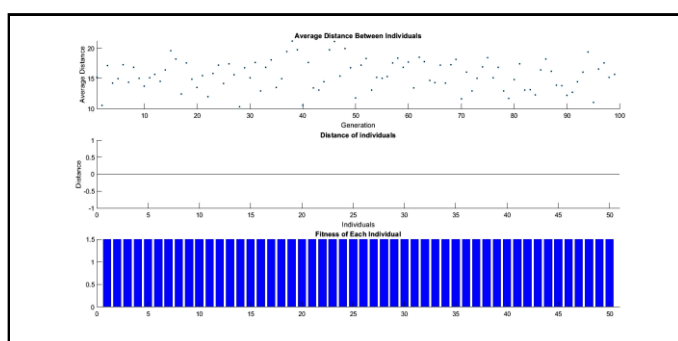

Figure 2.- Results for distance among individuals, and fitness of each individual.

Numerical Results

All numerical results are included in Table 1. Optimal intervals are detailed. Residuals are acceptable.

Table 2.-Dataset from programming software results.

NUMERICAL RESULTS DATASET	
PARAMETER	**VALUE/INTERVAL**
OPTIMAL I_s (t) mA	[1.1000 , 1.5853]
The number of points on the Pareto front	50
OPTIMAL r ms	[112.900 , 152.0320]

IV.   BIOELECTRONICS APPLICATIONS AND NERUROPHYSIOLOGY OF HUMAN BRAIN-THINKING PRE-HYPOTHESES

This section deals with the extrapolation of brain and retine neurophysiology to human thinking pre-hypotheses. That is, some primary pre-hypothesis in human-thinking evolutionary paradigms, namely:

why, because of which, for what humans think, and why humans have survival instinct?

These primary pre-hypotheses are based on Darwin theories [21], and can be understood as a cautious initial attempt to understand a few questionings of life creation and the surge of human cognitive thinking and reasoning.

 The most important central questioning is: **why humans do not know almost nothing about human brain functioning and at the same time humans are using it for thinking and reasoning?** . That is, why humans use a 'thinking-machine' and ignore its operation?.

why we think?: primary hypothesis: the nature wisdom might have made human brain, and humans actually ignore the key of that wisdom almost at all. That crucial knowledge might have been acquired from the universe matter and energy to develop the cognitive system. Then, at earth planet, the atoms, molecules, and chemical compounds found the water and environmental conditions to combine one another, with 'trials and errors method' until a random combination created the first micro-organism life. The further stage might have been a second stochastic search for reproduction of those initial forms of life. All these processes/stages might have taken millions of stochastic trials during millions of years.

Therefore, earth life type might be one type among unknown universe kinds of life. That is, plants life might constitute a different life nature because as a result of a different series of stochastic chemical phenomena the plants life surged. That might imply that there is not superior or inferior categories of life, but mostly what might exist is an extensive variety of life types, or classes. Even the 'life'

concept might be different at other universe zones, and other unknown life types might exist within the inmense universe size. The universe matter and energy might be, therefore, the starting stage for life creation during millions of years.

For what we think? : intelligent life might not be proven exclusive in humans provided the former statements, cautious pre-hypotheses. For example, plants can survive in environmental conditions, e. g., artic zones, where human life without machines, energy, and housing is impossible for subsistence. Also plants might have developed the motion-reproduction along the planet much more time before/better than humans. Therefore humans might have got the reasoning ability as a second specie-survival stage after the primary thinking creation. The cognitive-thinking might also have surged after millions of random trials during millions of years to improve the survival capacity of humans. Firstly, the life might have surged, secondly the reproduction faculty might have become, thirdly, the reasoning and cognitive faculty might have surged.

Remark: mathematical stochastic optimization idea for evolutionary biology does not belong to author. It was discovered long time ago. However, without any mathematical background. Example [21, page 62],

> But the variability, which we almost universally meet with in our domestic productions, is not directly produced, as Hooker and Asa Gray have well remarked, by man ; he can neither originate varieties, nor prevent their occurrence ; he can only preserve and accumulate such as do occur. Unintentionally he exposes organic

For what we think?: reasoning faculty could have been developed along the evolution stages to increase the survival probability of humans. How?. Perhaps with the method of random 'trials and errors' among the molecular biology and biochemical components of neurons. Perhaps the cell differentiation of neurons changes and improves along successive generations, in the same way than the body shape, bones structures, and anatomical-physiological characteristics change from generation to next generation.

Why we have to think to understand-discover our proper thinking-cognitive system?: that might be a subsequent developing step after the creation of thinking ability. That is, to become to detect and discover the clues of our brain might be a further step towards survival improvement. Then, to use the brain to learn our proper brain mechanisms might be an evolutionary stage to increase our specie-survival probabilities. The 'trials and errors method' that actually we are using to discover the enigmas of the human brain, and the simulation of it with artificial intelligence and robotics might constitute the current human stage for specie survival. The 'trials and errors method' at humans brain to want research might be an unconcious molecular biology process within neurons that might appear conscious to humans but in reality is guided-performed by the matter and energy

unknown wisdom (by humans at the moment) developing-properties in the universe. An example of the nature faculty to adapt on the most extreme conditions almost without oxygen and maximum optimization for saving energy is the ocean abyssal fish. The cautious hypothesis might be summarize as follows: earth life process might have started as a chemical process subject to earth material and climate conditions which has been and is being developed continuously along millions of years.

Specie survival might be a trend to keep the life creation initial process. The reproduction resembles a chemical reaction from sperm added to an egg cell (ovule) that create an embryo, and Survival instinct might be the preservation of the chemical reactions that caused the origin of life. The pleasure of reproduction might be a catalysis invention of the specie to keep the survival. At life origin, the atoms and molecules within a water-environment had a tendency to combine one another in the optimal way and with selection of parts. That might have happened at firs life micro-organism formation. Following this concept the human males might search for the best female human to keep the especie reproduction for survival instinct. In many cases, fertility might be associated unconsciously with beauty.

Following these ideas the human historical wars might be considered a species selection process among different races and cultures. The competitive human brain might have been developed by nature to obtain successive survival improvements from generation to generation.

Overall, the nature might select any evolutionary change always as the optimal one. This has implications in many induced biology fields. For example, the human modifications on earth ecosystem that actually are showing sharp evident proofs in terms of climate change, might generate in future or near future unpredictable consequences. In other words, the earth climate change might bring extrapolated earth fluctuating changes, that might not be predicted by current investigations. The climate changes might lead to unpredictable new microorganisms, bacteria, virus, etc. These might cause unpredictable epidemic diseases for non-inmunized human, and new illnesses. Recently, proofs and evidences of this idea have been discovered. In summary, the human interaction within the earth planet might create a number of eco-evolution derivations that might be seriously risky in future.

V.   DISCUSSION AND CONCLUSIONS
The objective of the study was to optimize IAF model with refractory period for standard experimental data. The method was PMO optimization and the software was designed specially for that model based on previous radiotherapy PMO programs.

Results give a low residual for both pareto functions. Running time is acceptable and 2D graphics show 100% criteria met.

In brief, an initial PMO optimization was performed for IAF model and neurophysiological pre-hypotheses for neuroscience of brain thinking was presented with applications.

VI. SCIENTIFIC ETHICS STANDARDS

Important ethical remark: this primary article is under author's scrutiny and any mistake, if occurs and is found, will be clarified in subsequent publications. Radiotherapy references are included as they are the programming base. Model is a slight modification from several authors [1,2], based also on [3-10] techniques. Mathematical Algorithm 1 is modified from [1,2]. Methods in software for these publications were created by Dr Casesnoves in 2021-2. This article has previous papers information, from [3-10], whose inclusion is essential to make the contribution understandable. This study was carried out, and their contents are done according to the International Scientific Community and European Union Technology and Science Ethics [11-14]. References [11-14]: 'European Textbook on Ethics in Research'. European Commission, Directorate-General for Research. Unit L3. Governance and Ethics. European Research Area. Science and Society. EUR 24452 EN. And based on 'The European Code of Conduct for Research Integrity'. Revised Edition. ALLEA. 2017. This research was completely done by the author, the computational-software, calculations, images, mathematical propositions and statements, reference citations, and text is original for the author. When a mathematical statement, algorithm, proposition or theorem is presented, demonstration is always included. When a formula is presented, all parameters are detailed or referred. If any results inconsistency is found after publication, it is clarified in subsequent. When a citation such as [Casesnoves, 'year'] is set, it is exclusively to clarify intellectual property at current times, without intention to brag. The article is exclusively scientific, without any commercial, institutional, academic, religious, religious-similar, non-scientific theories, personal opinions, political ideas, or economical influences. When anything is taken from a source, it is adequately recognized. Ideas and some text expressions/sentences from previous publications were emphasized due to a clarification aim [11-14].

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Dr Francisco Casesnoves earned the Engineering and Natural Sciences PhD by Talllinn University of Technology (started thesis in 2016, thesis Defence/PhD earned in December 2018, official graduate Diploma 2019). He works as independent research scientist in computational-engineering/physics. Dr Casesnoves earned MSc-BSc, Physics/Applied-Mathematics (Public Eastern-Finland-University, MSc Thesis in Radiotherapy Treatment Planning Optimization, which was developed after graduation in a series of Radiation Therapy Optimization-Modelling publications [2007-present]). Dr Casesnoves earned Graduate-with-MPhil, in Medicine and Surgery [1983] (Madrid University Medicine School, MPhil in Radioprotection Low Energies Dosimetry [1985]). He studied always in public-educational institutions, was football player 1972-78 (defender and midfielder) and as Physician, supports healthy life and all sports activities. Casesnoves resigned definitely to his original nationality in 2020 for ideological reasons, democratic-republican ideology, and ethical-professional reasons, and does not belong to Spain Kingdom anymore. His constant service to the International Scientific Community and Estonian technological progress (2016-present) commenced in 1985 with publications in Medical Physics, with further specialization in optimization methods in 1997 at Finland—at the moment approximately 100 recognized publications with approximately 62 DOI papers. His main branch is Computational-mathematical Nonlinear/Inverse Methods Optimization. Casesnoves best-achievements are the Numerical Reuleaux Method in dynamics and nonlinear-optimization [books 2019-2020], The series of Radiotherapy Improvements for AAA superposition-convolution model, the Graphical and Interior Optimization Methods [2016-8], the new Computational Dissection-Anatomical Method, [2020], invention of Forensic Robotics [2020-2021], and Molecular Effect Model for High Temperature Superconductors [2020]. Dr Casesnoves scientific service since 2016 to the Free and Independent Republic of Estonia for technological development (and also at Riga technical

University, Power Electrical and Electronics Department) is about 55 physics-engineering articles, two books series, and 1 industrial radiotherapy project associated to Europe Union EIT Health Program (Tartu University, 2017). Treatment planning Optimization Invention of Isodoselines was created