Research, Innovation and Dissemination Centers

RIDC NeuroMat

Report of Activities - 3rd Evaluation by the International Committee

Period covered by this report: August 2017 – August 2022

Contents

1. RIDC Identification

RIDC name: Research, Innovation and Dissemination Center for Neuromathematics (NeuroMat)

Grant number: 2013/07699-0

Host institution: Instituto de Matemática e Estatística da Universidade de São Paulo

Associated institutions: Aalto University; Centre National de la Recherche Scientifique - CNRS (Lyon and Strasbourg); Forschungszentrum Jülich; Gran Sasso Science Institute (GSSI); IBM Thomas J. Watson Research Center; National Institute of Neurological Disorders and Stroke (NIH); New York University Shanghai; Universidad de Buenos Aires; Universidad de la República; Universidad de San Andrés; Universidade Estadual de Campinas (UNICAMP); Universidade Federal do ABC (UFABC); Universidade Federal do Pará (UFPA); Universidade Federal de Pernambuco (UFPE); Universidade Federal do Rio de Janeiro (UFRJ); Universidade Federal do Rio Grande do Norte (UFRN); Universidade Federal do Rio Grande do Sul (UFRGS); Universidade Federal de São Carlos (UFSCar); Università di Roma "La Sapienza"; Université Côte d'Azur; Université Paris 1 (Panthéon-Sorbonne); University of California, Berkeley; Faculdade Cásper Líbero.

Webpage: http://neuromat.numec.prp.usp.br

Principal Investigator/Center Director: Jefferson Antonio Galves

Vice Director: Pablo Augusto Ferrari

Co-Principal Investigator(s): Antonio Carlos Roque da Silva Filho; Claudia D. Vargas; Ernst Hamburger (*in memoriam*); Fernando da Paixão; Jorge Stolfi; Oswaldo Baffa Filho; Pablo Augusto Ferrari.

Education and Knowledge Dissemination Coordinator: Fernando Jorge da Paixão Filho

Technology Transfer Coordinator: Antonio Carlos Roque da Silva Filho

RIDC Executive Manager:

Manager of Education and Dissemination of Knowledge:

Manager of Technology Transfer:

Administrative assistants: Lourdes Vaz da Silva Netto - IME/USP; Vera Lúcia Ribeiro - IME/USP (until retirement on January 4, 2022).

The Research, Innovation and Dissemination Center for Neuromathematics (RIDC NeuroMat) is a center of mathematics which has as mission to develop the new mathematics needed to construct a Theory of the Brain accounting for the experimental data gathered by neuroscience research. Mathematician Antonio Galves coordinates this center. Hosted by the University of São Paulo, the RIDC NeuroMat was established in 2013 with support from the São Paulo Research Foundation (FAPESP), grant 2013/07699- 0, which will last until July 2024.

The RIDC NeuroMat has an interdisciplinary team, bringing together researchers in mathematics, computer science, statistics, neuroscience, biology, physiotherapy, medicine, physics, and communication, among other disciplines. RIDC NeuroMat leads a worldwide university network,

with ramifications that sprawl to several high-level research institutions in Brazil, Latin America, the United States, Europe, and China. Most research output has had co-authors from more than one country, thus contributing to put NeuroMat at the center of a blossoming international scientific cooperation around Neuromathematics.

Alongside a research team that focuses on the scientific challenges pertaining to Neuromathematics, NeuroMat has active technology-transfer and dissemination teams. The technology-transfer effort is concentrated on devising tools for diagnosing and clinical guidelines for neurological conditions, and on developing free, open-source computational tools to manage and compile experimental and clinical data. This development team is part of a joint effort to create an international open database for neuroscientific data. The dissemination-team effort includes a non-static web portal (Creative Commons license), open multimedia productions and training projects with public-school teachers. A distinctive feature of this effort is that it relies on web-2.0 media tools as a means of communicating on-the-go scientific endeavors as well as involving a scientific and broad community around bridging the high-level science that this RIDC develops and general audiences.

Pablo Augusto Ferrari (UBA and USP), Antonio Carlos Roque da Silva Filho (USP), Fernando Jorge da Paixão Filho (UNICAMP), Ernst Wolfgang Hamburger (USP, *in memoriam*), Jorge Stolfi (UNICAMP), Claudia Domingues Vargas (UFRJ), and Oswaldo Baffa Filho (USP) remain co-principal investigators, along with PI Antonio Galves (USP). David Brillinger (UCBerkeley), Francesco Guerra (Università di Roma "La Sapienza"), Leonardo Cohen (National Institute of Neurological Disorders and Stroke), Markus Diesmann (Jülich Institute of Neuroscience and Medicine), and Wojciech Szpankowski (Purdue and NSF Center for Science of Information) take part in NeuroMat's International Advisory Board.

NeuroMat's main laboratory and offices are located on a three-story building, with approximately 1,000 square meters, at 1171 Prof. Luciano Gualberto Avenue, at USP's central campus, in São Paulo. NeuroMat's main building which was renovated and extended (+175 square meters) to support new laboratory facilities; the construction cost was BRL R$ 1,603,339 and was fully covered by USP, MaCLinC grant (recipient: Antonio Galves). NeuroMat has set up a Simulation Laboratory (SimLab) and a TMS experimental facility at the USP's Ribeirão Preto campus. Multiuser experimental facilities in São Paulo and Ribeirão Preto are being planned. NeuroMat's administrative staff team is currently composed of one administrative assistant. This position is supported by USP.

2. Scientific Report

2.1- RIDC Mission

The mission of NeuroMat is to develop the new mathematics which is deemed necessary to account for a Theory of the Brain, accounting for the full experimental data gathered by neuroscience research. The long-term objective is to understand and explain complex neuroscientific phenomena, with focus on plasticity mechanisms underlying learning and memory neurorehabilitation and rewiring. This Neuromathematics is envisioned, at this time, as conjoining probability theory, combinatorics, statistics, and neuroscience. This requires the definition of a full new class of mathematical models to describe and explain in a parsimonious way the different scales of neural activity and the relationship between them. The construction of these models should occur together with the development of suitable statistical and computational methods, including model selection principles and results.

2.2- Executive Summary

The main goal of NeuroMat is to build the new mathematical, statistical, and computational framework which is necessary to address the challenges of neurobiology. Activities presented in this report strictly relate to the goals announced in the document submitted to FAPESP in November 2012, in the third and final step of the selection process. The general goals of this research project are the following:

• Development of new classes of stochastic processes which are necessary to model brain functioning.

• Development of the statistical tools required by this new class of stochastic processes.

Detailed progresses on these two goals were thoroughly reported in the documents:

- First Report of Activities 2013-2014,
- Second Report of Activities 2014-2015,
- Complementary Form 2013-2015,
- Third Report of Activities 2015-2016,
- Complementary Form 2015-2017,
- Fourth Report of Activities 2016-2017,
- NeuroMat: first 5 next 6,
- 2018 Statement of Impact (SoI),
- Fifth Report of Activities 2017-2018,
- Sixth Report of Activities January 2019- July 2019
- Seventh Report of Activities August 2019-October 2020,
- Eighth Report of Activities November 2020-August 2021,
- Ninth Report of Activities August 2021-August 2022,
- Project for the period 2018-2024.

These documents were carefully reviewed by FAPESP. The SoI is a summary of main activities and highlights our main achievements. This statement is still up-to-date and informs substantially this report, along with relevant parts of the document for the renewal of the RIDC NeuroMat by FAPESP, the "Project for the period 2018-2024."

The progresses achieved in the first term of the RIDC have opened up the path for a new stage of development. Despite all the challenges posed by the COVID-19 pandemics, NeuroMat continued with the construction of innovative applications of the new stochastic models and statistical tools developed in the previous years, aiming at concrete questions of Neuromathematics and computational modeling in neurobiology, electroencephalographic recordings analysis, and neurorehabilitation therapy. Research highlights and corresponding published works are listed below, in the appropriate section. Since the last evaluation by the International Committee, the NeuroMat research team has:

• published 211 articles;

• published 2 books;

• had 14 PhD dissertations concluded and 9 in progress;

• had 5 MA thesis concluded and 1 in progress;

• presented 25 communications in meetings with referees.

A full list of publications since the inception of NeuroMat can be viewed at NeuroMat's Google Scholar page (https://goo.gl/LvZV4f).

In parallel to the mathematical and theoretical biological developments which are necessary to foster the scientific project of NeuroMat, the RIDC has also sustained two laboratories. In April 2016, NeuroMat launched a new research facility: the NeuroMat Simulation Laboratory (SimLab). The simulation of large-scale network models remains a key activity to test analytical results, and the NeuroMat SimLab allows for such tests, providing the NeuroMat team with a new experimental tool to test and construct large-scale computational implementations of NeuroMat's newly developed models. The SimLab is installed at the Laboratory of Neural Systems (SisNe) of the Department of Physics of USP Ribeirão Preto, under the direction of NeuroMat PI and Technology transfer coordinator A.C. R. da Silva Filho (USP-Ribeirão Preto). In July 2017, NeuroMat launched an Electroencephalography Laboratory, with an EEG DC actiCHamp 128CH System. The creation of NeuroMat's EEG lab was made possible by the expansion of the building, through a grant from the University of São Paulo (matching funds). A TMS facility equipped with a robotic arm started operations in 2020 at USP Ribeirão Preto and two multiuser experimental facilities equipped with high end equipment for data acquisition are being planned.

2.3 – Research Results Highlights

2.3.1 - RIDC Main Accomplishments

1. Introduction of a new class of stochastic processes to model spiking neural networks (Galves and Löcherbach, 2013). These processes are now part of the research agenda of several centers worldwide. Our contributions to this new field include: (i) identification of mathematical conditions assuring the processes' existence together with design of a perfect simulation algorithm for their numerical implementation (Galves and Löcherbach, 2013). (ii) results on the hydrodynamical limit of processes belonging to this class (De Masi et al. 2014). (iii) existence of phase transition for a specific instantiation of these models (Ferrari et al. 2018). (iv) introduction of a novel estimator of the interaction graph for models in this class and proof of its strong consistency. (Duarte et al. 2019b; De Santis et al. 2022). (v) introduction of a microscopic model that describes short term plasticity in a large homogeneous network of interacting neurons (Galves et al. 2020).
2. Introduction of a new mathematical approach to the classical conjecture that the brain retrieves statistical regularities from sequences of stimuli, based on sequences of random objects driven by chains with memory of variable length (Duarte et al. 2019a; Hernández et al. 2021). These processes are good candidates to model the relationship between sequences of stimuli and sequences of suitably parsed brain signals and behavioral states. The approach offers new promising research directions: (i) identification of brain sensitivity and reaction to sequences of stimuli beyond the possibilities offered by current averaging-based methods; (ii) new experimental protocols in which physiological or behavioral data are recorded while the subject is exposed to sequences of stimuli generated by a stochastic chain with memory of variable length; (iii) new perspectives in clinical neuroscience by identification of different signatures in response to structured sequences of stimuli in neurological disorders.
3. Application of the Goalkeeper Game (see Section 3) to identify gait impairments in people with Parkinson's disease. As described in Stern et al. (2020), the Goalkeeper Game showed better predictive capacity than the traditional Montreal Cognitive Assessment (MoCA) test in assessing gait performance under complex conditions in people with Parkinson's disease as measured with the Dynamic Gait Index (DGI). This suggests a possible use of the Goalkeeper game as a screening instrument to identify gait impairments in people with Parkinson's disease.
4. Development of the open-source software NES-Neuroscience Experiments System (Ruiz-Olazar et al. 2021). This software enables researchers to efficiently perform the management of their experimental data in a secure and user-friendly environment, providing a unified repository for the experimental data of an entire research group and allowing for efficient data sharing.
5. Construction of a robot arm to deliver transcranial magnetic stimulation (TMS) to specific cortical sites (see Section 3). The major achievement so far in this field was the assembly of the robotic arm in accordance with the standards designed by our team (Souza et al. 2018; 2022). The robot communication, control, and safety layers are available at https://github.com/biomaglab/Robot_TMS. Three camera systems (Polaris, Polhemus and Claron) were adapted to control the robot to record the position of the head and coil.

Moreover, all the routines to interface the robotic arm with the InVesalius neuronavigator were developed and evaluated. Now, we can fully automate TMS procedures, like motor mapping. First results are impressive and performance tests are being done now.

6. The Center Director, A. Galves, and the Associate Investigator F. Leonardi, together with the colleagues from UNICAMP, C. Galves, J. E. Garcia and N. L. Garcia, were the winners of the first edition of the Johannes Kepler award from Sociedade Brasileira de Matemática Aplicada e Computacional (SBMAC) for the publication of the article "Context tree selection and linguistic rhythm retrieval for written texts", in the journal *Annals of Applied Statistics* (Volume 6, Number 8 1 (2012), 186-209). This SBMAC award was named Johannes Kepler because the Society considered Kepler to be the first data scientist in history and this article was considered meritorious from the perspective of Data Science.
7. NeuroMat former PhD student, Victor Hugo de Oliveira e Souza, received the Award Jose Leite Lopes from the Brazilian Physical Society as the best PhD thesis of 2020. His thesis was called: "Development of instrumentation for neuronavigation and stimulation transcranial magnetic field". This PhD thesis was directed by NeuroMat PI Oswaldo Baffa Filho. He also received the Early Career Researcher Award at the 22nd International Conference on Biomagnetism, Birmingham, UK.
8. NeuroMat PIs A. Galves and C. D. Vargas, jointly with associate investigators E. Löcherbach and C. Pouzat, have successfully led an application for the Institut Henri Poincaré (IHP) Thematic Program. From February 27 to April 7, 2023 at the IHP in Paris, NeuroMat will gather hundreds of scientists from around the world to discuss "Random Processes in the Brain: from Experimental Data to Math and Back" . This event is an opportunity for consolidating in a global context the research agenda NeuroMat put forward with support from FAPESP, which sparked affiliated centers such as the recently established Université Côte d'Azur NeuroMod Institute led by NeuroMat member P. Reynaud-Bouret and in which A. Galves acts as a member of the think tank. In preparation to the IHP Thematic Program, NeuroMat is conducting the webinars "Pathways to the 2023 IHP Thematic Program Random Processes in the Brain".
9. The NeuroMat dissemination team released 401 YouTube videos from 2017 to 2022 (until October). Content on the NeuroMat YouTube channel was seen 305,330 times during this period. The NeuroMat investment in video making, and the associated production and view figures, was a means of spreading and deepening science dissemination in a context of new social practices and sociabilities that have emerged with the COVID-19 pandemic.
10. The NeuroMat achievements in human resources training include the organization of the last two editions of the Latin American School on Computational Neuroscience (LASCON) in 2018 and 2020 , the Pathways webinars (see highlight 8), the NeuroMat online seminars 2020 , the NeuroMat/NeuroMod webinars 2020 , the Second NeuroMat Young Researchers Workshop , the Mathematical and Simulation Modeling in Neuroscience Workshop , the Random Structures in the Brain Workshop , and the meeting "Numeracy in Brazil: diagnoses and perspectives" . Between 2017 and 2022, NeuroMat has had 24 postdoctoral fellows supported by scholarships (22 from FAPESP, 1 from FAPERJ, and 1 from CNPq) and had 14 PhD theses and 6 MSc dissertations defended.

2.3.2 - Corresponding published works

1. De Masi, A.; Galves, A.; Löcherbach, E.; Presutti, E. Hydrodynamic limit for interacting neurons. *Journal of Statistical Physics*, **158**, 866-902, 2015.
2. De Santis, E.; Galves, A.; Nappo, G.; Piccioni, M. Estimating the interaction graph of stochastic neuronal dynamics by observing only pairs of neurons. *Stochastic Processes and their Applications*, **149**, 224-247, 2022.
3. Duarte, A.; Fraiman, R.; Galves, A.; Ost, G.; Vargas, C.D. Retrieving a context tree from EEG data. *Mathematics*, **7**, 427, 2019ª.
4. Duarte, A.; Galves, A.; Löcherbach,; Ost, G. Estimating the interaction graph of stochastic neural dynamics. *Bernoulli*, **25**, 771-792, 2019b.
5. Ferrari, P.A.; Galves, A.; Grigorescu, I.; Löcherbach, E. Phase transition for infinite systems of spiking neurons. *Journal of Statistical Physics*, **172**, 1564-1575, 2018.
6. Galves, A.; Löcherbach, E. Infinite systems of interacting chains with memory of variable length – a stochastic model for biological nets. *Journal of Statistical Physics*, **151**, 896-921, 2013.
7. Galves, A.; Löcherbach,; Pouzat, C.; Presutti, E. A system of interacting neurons with short term synaptic facilitation. *Journal of Statistical Physics*, **178**, 869-892, 2019.
8. Hernández, N.; Duarte, A.; Ost, G.; Fraiman, R.; Galves, A.; Vargas, C.D. Retrieving the structure of probabilistic sequences of auditory stimuli from EEG data. *Scientific Reports*, **11**, 3520, 2021.
9. Ruiz-Olazar, M.; Rocha, E.S.; Vargas, C.D.; Braghetto, K.R. The Neuroscience Experiments System (NES) – a software tool to manage experimental data and its provenance. *Frontiers in Neuroinformatics*, **15**, 768615, 2021.
10. Souza, V.H.; Matsuda, R.H.; Peres, A.S.C.; Amorim, P.H.J.; Moraes, T.F.; Silva, J.V.L.; Baffa, O. Development and characterization of the InVesalius Navigator software for navigated transcranial magnetic stimulation**.** *Journal of Neuroscience Methods*, **309**, 109-120, 2018.
11. Souza, V.H.; Nieminen, J.O.; Tugin, S.; Koponen, L.M.; Baffa, O.; Ilmoniemi, R.J. TMS with fast and accurate electronic control: measuring the orientation sensitivity of corticomotor pathways. *Brain Stimulation*, **15**, 306-315, 2022.
12. Stern, R.B.; d'Alencar, M.S.; Uscapi, Y.L.; Gubitoso, M.D.; Roque, A.C.; Helene, A.F.; Piemonte, M.E.P. Goalkeeper game: a new assessment tool for prediction of gait performance under complex condition in people with Parkinson's disease. *Frontiers in Aging Neuroscience*, **12**, 50, 2020.

3. Innovation and Knowledge Transfer Report

Link to the RIDC Intellectual Property webpage: https://neuromat.numec.prp.usp.br/intellectual-property/.

The focus of this area is on the development of supporting tools for the diagnosis and neurorehabilitation research being conducted by the AMPARO and ABRAÇO initiatives on Parkinson's disease and brachial plexus injury, respectively. These tools are the Goalkeeper Game, and the robot arm for accurate real-time positioning of a TMS coil on the head.

The AMPARO initiative (amparo.numec.prp.usp.br): The NeuroMat focus area on Parkinson's disease is called AMPARO Initiative, or Rede de Apoio NeuroMat a Amigos e Pessoas com Doença de Parkinson. It is led by NeuroMat researcher Maria Elisa Pimentel Piemonte (FM-USP). There have been over 300 posts on the AMPARO Facebook page, normally in video format. The initiative has launched a podcast providing life histories and specialized information on Parkinson's disease and wellbeing. AMPARO also coordinated the first Brazilian study to assess the impact of COVID-19 on people with Parkinson's disease, which relied on data collected from 14 centers distributed over all regions of the country.

AMPARO and the Goalkeeper Game: AMPARO's team is using the Goalkeeper Game to study putative novel relationships between the main cardinal Parkinson's disease symptom, bradykinesia, and implicit probabilistic learning and lack of ability in automatic motor control. The study aims at developing a new measure and typology to establish the limits between normal decline associated with aging process and abnormal alterations associated with the onset of the pathological process of Parkinson's disease. In particular, a study conducted by AMPARO members and published in the journal *Frontiers in Aging Neuroscience* showed that the Goalkeeper Game has a superior predictive power in assessing gait performance under complex condition in people with Parkinson's disease than the well-established Montreal Cognitive Assessment (MoCA) test. The clinical implication of this work is to offer a free and friendly tool for noninvasive screening in people with Parkinson's disease.

The ABRAÇO initiative (abraco.numec.prp.usp.br): NeuroMat's brachial plexus injury focus area is called ABRAÇO Initiative, or Ação NeuroMat para a Lesão do Plexo Braquial. It is led by NeuroMat CO-PI Claudia Domingues Vargas (INDC/UFRJ). There have been over 150 posts on the ABRAÇO Facebook page.

ABRAÇO and the Goalkeeper Game: ABRAÇO's team is using the Goalkeeper Game to study mechanisms of plasticity in the brain after brachial plexus injury aiming at developing new tools to assess plastic changes in the brain induced by this traumatic injury. In the motor context, prediction can be seen as an automatic process of choosing and implementing a next step in a sequence of events. Tests are being conducted with healthy human subjects playing the Goalkeeper Game to determine which parameters of the context tree generating stochastic sequences of events in the Goalkeeper Game are best associated with the optimal processing of sequences of motor events. Data collection from brachial plexus injury patients has already started to investigate how this injury interferes in the ability to predict events. The main aim is to use the Goalkeeper Game as a tool for rehabilitation of brachial plexus injury patients.

ABRAÇO and TMS: This endeavor involves a collaboration between ABRAÇO's members and Neuromat CO-PI Oswaldo Baffa Filho (FFCLRP/USP) and R. Ilnomiemi (Aalto) for the development

of a closed-loop robotic system for the positioning of a TMS coil on a subject's scalp. Besides the technological aspects of this initiative, the ABRAÇO team is developing a new protocol to test whether the primary motor cortex (M1) holds the memory of a sequence of TMS pulses driven by a stochastic chain. If so, it should be possible to recover in the motor evoked response (MEP) a signature of a sequence of TMS pulses applied in M1.

The Goalkeeper Game: An innovation spin-off from NeuroMat's research project is the Goalkeeper Game. In this game, the player takes the role of a goalkeeper in a penalty shootout and must guess the position in the goal (left side, right side, or center) where the ball will hit after being kicked by the opponent. The game consists of a sequence of penalty kicks in which a context tree model generates the ball positions. As the player (the goalkeeper) succeeds in guessing the right sequence, the complexity of the context tree model increases and the game becomes more difficult. The goalkeeper game has a potential to be used as a diagnosis and rehabilitation tool in neurology, and the NeuroMat technology transfer team is currently evaluating its applicability in its two main clinical development fronts: Parkinson's disease and brachial plexus injury (see above). Entertainment versions of the Goalkeeper Game have been made available for desktop and mobile play at: game.numec.prp.usp.br.

TMS and robot arm: TMS is extremely sensitive to the exact coil position and orientation, and to small involuntary movements of the subject. As a solution to this problem, NeuroMat researchers led by CO-PI Oswaldo Baffa Filho (FFCLRP/USP) and R. Ilnomiemi (Aalto) are developing a closed-loop system of robotic stimulator positioning in the brain. A closed-loop system is a set of mechanical or electronic devices that automatically regulates a variable to the desired state, without human interaction. Closed-loop systems are designed to automatically achieve and maintain the desired condition (exit condition), comparing it to its condition at the given moment (real condition). The system is coupled to the InVesalius Navigator, which is the first free and open source neuronavigation software to guide brain stimulation and is already in use by institutions like Stanford University (USA), Aalto University (Finland), and the Federal Universities of Rio de Janeiro and Juiz de Fora (Brazil). In its current state of development, the robot arm can be instructed to move to a desired place on the scalp and apply the stimulation while keeping the coil on the same position even if the head moves.

4. Dissemination Report

NeuroMat's scientific dissemination activities in the period 2017-2022 have established and sustained a media infrastructure for digital communication on topics pertaining to the center's research agenda and technology transfer lines of action. Our media production has intensified in the context of the pandemic, with the aim of ensuring the cohesion of the team in a situation of social distance and of expanding the circulation of quality scientific content in an environment of consolidation of a disinformation ecosystem in Brazil. Milestones and highlights are presented in this report.

Milestones

Our milestones in scientific dissemination activities in the 2017-2022 period are presented in the table below.

Activity	Production	Impact	Main link
Videos	401 videos released	305,330 views on Youtube and, Facebook	https://www.youtube.com/user/neuromathematics
Podcasts	11 episodes released	3,866 plays on Spotify	https://podcast.numec.prp.usp.br/
Websites	7,103 content pages	473,142 views	https://neuromat.numec.prp.usp.br/
Social media	on average, four posts per week	24,404 views / 1,608 followers	https://www.facebook.com/neuromathematics
Media exposure	343 PR outreach	201 articles	https://neuromat.numec.prp.usp.br/content/category/news/
Wikimedia Commons initiative	2,696 contributed files	2,227,669 views per month, on average (from 2019 to 2022)	https://glamwikidashboard.org/NEUMAT
Wikipedia initiative	102K words added	322 million views	https://outreachdashboard.wmflabs.org/campaigns/neuromat/programs

FAPESP Journalism fellowships

The NeuroMat dissemination activity has been organized relying on FAPESP's journalism fellowships. Since 2017, 18 journalism fellows have been supervised. Their work has included the development of experimental projects in science communication and the publication of research papers in science communication. Noteworthily, fellows have later engaged professionally with science communication, mostly on digital outlets, or joined an academic path about journalism and science.

Wikimedia in Brazil

As NeuroMat has become one of the largest institutional contributors to Wikimedia projects, the largest institutional contributor for content on mathematics, a growing group of open-knowledge contributors and supporters have rallied around the center's activities. From this process Wiki Movimento Brasil (WMB), the Brazilian affiliate of Wikimedia, emerged. Today, this affiliate is a formal organization with an annual budget of several million reais. Several employees of WMB and even of the Wikimedia Foundation were at some point fellows or student employees at NeuroMat.

Faísca NeuroMat

Faísca NeuroMat is a series of 12 live videos presenting scientific concepts and debates to a wide audience, normally connecting science from the NeuroMat team to trending topics in the news, which were set up during the pandemic. Episodes were led by Fernando J. Paixão and featured a NeuroMat member to talk about their research and answer questions from the public. Topics included modeling COVID-19 dissemination, consensus-building in social media and diagnosis of schizophrenia. Broadcasts have been watched by 7,248 people so far. One journalism NeuroMat fellow was involved.

Videos: https://www.youtube.com/playlist?list=PLXUXkbNfNLDYLr6R480lafiKTqJDqds0C

"**A matemática do cérebro" podcast**

The NeuroMat main podcast, called A matemática do cérebro, is a sustained initiative to produce podcasts focusing on research interfaces within the NeuroMat team. These interfaces relate to two main topics: the Galves-Löcherbach neural model, and the Statistician Brain conjecture. Eduardo Vicente coordinates the initiative, and ten episodes have been released. Three journalism NeuroMat fellows were involved.

Episodes: https://open.spotify.com/show/5mlqTkoim4rg7apScVW5AM

Science journalism MOOC

The NeuroMat team has developed a massive open online science-journalism course infrastructure on Wikiversity, consistent with FAPESP's science journalism fellowship curriculum expectations and freely available for students willing to specialize in science journalism from NeuroMat and other research centers. The course development was led by João Alexandre Peschanski and 104

students so far have enrolled. Content was produced under the supervision of the NeuroMat science team. Four journalism NeuroMat fellows were involved.

The MOOC technology the NeuroMat team has developed has grounded an independent research project on Wikimedia and audiology, funded by FAPESP (2021/06902-2).

Course: https://w.wiki/3H3G

Scientometrics

An open-linked data platform to showcase the NeuroMat scientific production has been developed. Based on a crowdsourced scientometric methodology, the platform allows for visualizations of scientific contributions and for querying measures of impact. It gathers a total of 3,671 items. The web platform is replicable to other contexts. One journalism NeuroMat fellow was involved in this initiative.

Platform: https://vitrine.numec.prp.usp.br/

5. List of additional funding sources, except FAPESP

Source of resources, except FAPESP (public or private, national or international funding agencies, universities, companies, etc)	Equipament costs (verba de capital)	Other direct costs (verba de custeio)	Professor Salaries	Staff Salaries	Scholarships
NUMEC-MaCLinC-USP – 2011-2024	R$1.488.925,25	R$503.096,75			R$ 18.633,84
Projeto Temático FAPERJ/E_03/2013 Coordenador: Ricardo Gattass - UFRJ Financiamento coletivo Colaboradora: Cláudia Vargas Vigência: 2013-2017	R$110.000,00 (Montante efetivamente gasto)	R$90.000,00 (Montante efetiva-mente gasto)			
FAPERJ- Apoio às Instituições de Ensino e Pesquisa Sediadas no RJ/E_29/2014 – Proc.– E26/010.002902/2014 Vigência:2015-2017 Coordenação: Cláudia Vargas	R$33.130,00 (Montante efetivamente gasto)	R$89.000,00 (Montante efetiva-mente gasto)			
FINEP-PROINFRA 2010/Convênio FINEP/CT-INFRA – Processo: 01.12.0308.00 – Sub-projeto 04 Financiamento individual - Vigência: 2015-2018 Coordenação: Cláudia Vargas	R$330.000,00 (Montante efetiva-mente gasto	R$392.414,00 (Montante efetiva-mente gasto			
FINEP-PROINFRA 2010/Convênio FINEP/CT-INFRA – Processo: 01.12.0308.00 – Financiamento coletivo Vigência: 2016-2022 Coordenação: Cláudia Vargas	R$1.300.000,00	R$2.069.816,00			
FAPERJ-2018-20120 –Apoio à pesquisa clínica em Hospitais de Ensino e Pesquisa sediados no RJ/E_17/2016 -Proc. E-26/010.002474/2016 – Vigência: 2018-2020 Coordenação: Cláudia Vargas	R$102.118,40 (Montante efetiva-mente gasto)	R$43.814,63 (Montante efetiva-mente gasto)			
FAPERJ-03/2018 -Programa Cientista do Nosso Estado (CNE) Processo: E-26/202.785/2018 – CNE 2018 – Vigência 2018-2023 Coordenação: Cláudia Vargas		R$129.000,00			
FINEP Apoio Institucional 03/2016 Processo: FINEP 0354/16 Coordenador: Luiz Bevilacqua (COPPE/UFRJ) Financiamento Coletivo Instituição de Execução: COPPE/UFRJ Colaboradora: Cláudia Vargas Vigência: 2017-2019		R$1.000.000,00 (Montante efetiva-mente gasto)			
Pronex/FAPERJ 2016 – Processo: E-26/010.0012.001238/2016 Coordenador: Ricardo Gattass - UFRJ Financiamento coletivo Instituição de Execução: IBCCF/UFRJ Colaboradora: Cláudia Vargas Vigência: 2017-2023		R$528.622,17			
CNPq Universal – Processo 426579/2016-0 Coordenadora: Kelly R. Braghetto – IMEUSP Instituição de Execução: IME-USP Colaboradora: Cláudia Vargas Vigência: 06/2017 – 06/2020		R$27.000,00 (Montante efetiva-mente gasto)			

FAPERJ-Programa Redes de Pesquisa em saúde no Estado do Rio de Janeiro – E_15/2019 Coordenador: Wilson Savino Financiamento Coletivo REDENEURIN Vigência: 2019-2024 Membro: Cláudia Vargas		R$600.000,00			
LASCON 2018 Agência (privada): IBRO Vigência: 13/12/2017 - 23/03/2018	--	R$52.000,0 (Montante efetiva-mente gasto)			
LASCON 2020 Agência (privada): IBRO Vigência: 02/12/2019 - 12/02/2020	--	R$ 53.811,00 (Montante efetiva-mente gasto)			
Chamada Universal 01/2016 - Processo: 407471/2016-2 – Vigência:2017-2020	R$30.000,00	R$ 54.000,00 (Montante efetiva-mente gasto)			
PROBRAL CAPES/DAAD – Edital nº 13/2018 – 88887.198747/2018-00 (Migrado - SICAPES3) R$156.250,00 Vigência: 01/01/2019 -31/12/2022		R$156.250,00			270.689,52
USP			16.781.381,32	1.915.642,17	6.000,00
IME-USP		R$1.385.769,98			
UNICAMP			6. 344.133,59		
UFRJ			1.988.256,49		
UFRN			2.721.809,66		
UFSCar			1.848.892,17		
UFG(Jataí)			588.031,80		
UFRGS			1.094.694,41		
UFPA			12.897,80		
UFPE			1.252.330,61		
UFABC			853.742,55		
UNIFESP			619.756,17		
CNPq-BPP					878.900,00 577.800,00 (Ad.Bancada)
CNPq – PhD					275.000,00
CNPq- IC					36.600,00
CAPES – MSc					190.500,00
CAPES - PhD					R$ 466.400,00
FAPERJ - IC					5.250,00
FAPERJ - Postdoc					51.250,00
Total	R$1.984.173,65	R$8.474.594,53	34.105.926,57	1.915.642,17	2.777.023,36
Overall Total	R$49.257.360,28				

6. Evaluation of Institutional Support

The University of São Paulo, in accordance with the agreement that led to the creation of the RIDC NeuroMat, has created a position for an assistant professor at the Department of Statistics of IME-USP, in an area strictly associated to the research agenda of the RIDC NeuroMat, stochastic modeling of neural biological data. Aline Duarte de Oliveira holds the position, since 1/9/2018.

Secondly, USP offered in 2021 another Assistant Professor position to each USP departments hosting an RIDC. In our case, this position was assigned to the Department of Statistics at IME-USP, and the selection procedure will be over by next year.

The University of São Paulo has consistently supported NeuroMat efforts. Firstly, USP assigned an executive manager to NeuroMat, Magda Chang, from October 2015 to September 2017.

Both the positions of the executive manager and the assistant professor are counterparts of USP to FAPESP's support to NeuroMat. USP had previously assigned three other staff personnel to NAP NUMEC/MacLinC, coordinated by Antonio Galves, which was at the origin of the NeuroMat project. Carlos Eduardo Ribas is an IT analyst (IME/USP - Procontes), from August 2013 to September 2017; Lourdes Netto (IME/USP) is an administrative assistant who was assigned to NAP NUMEC/MacLinC by the direction of IME-USP; and Vera Lúcia Ribeiro who was assigned to NAP NUMEC/MacLinC by the direction of IME-USP, from June 2017 to January 2022.

Currently, the RIDC NeuroMat only has one USP-funded staff position, held by Lourdes Netto. Several efforts have been made to have another staff member to work as an executive manager and a manager of the dissemination area. These efforts have not been successful yet.

7. Publications / citations URL

MyResearcherID: https://www.webofscience.com/wos/author/record/J-2428-2015

Google Scholar: https://goo.gl/LvZV4f

8. International Advisory Board Reports

International advisory board reports are available at:

https://files.numec.prp.usp.br/public/assessments

Password: neuromat2017