

CEPID Neuromat

Second Report of Activities

July 2014 - July 2015

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1 Introduction

This document presents a report of the activities developed by the Research, Innovation and Dissemination Center for Neuromathematics (CEPID Neuromat) during its second year. This report has three parts:

- Scientific report;
- Dissemination report;
- Technology transfer report.

The activities described in this report are strictly related to the goals announced in the document “Goals for the first two years” submitted to FAPESP in November 2012. In the above mentioned document, the scientific goals for the first two years are described in the subsection *A new mathematical framework for neuroscience*. They are the following:

- Development of a new class of stochastic processes;
- Development of the statistical tools required by this new class of stochastic processes.

Concerning the first goal we have continued to study the new class of stochastic processes introduced in Galves and Löcherbach (2013) to model systems of interacting neurons.

Firstly, we have addressed the issue of hydrodynamic limits. This is a crucial and unavoidable step to understand the time evolution of mesoscopic and macroscopic behavior of the system. Indeed, as we argue in (25)¹, “EEG as well as fMRI data describe the collective behavior of huge subpopulations of neurons. This makes it reasonable to consider a space-time rescaling of the microscopic system reminiscent of what is usually done for interacting particle systems under the name of hydrodynamical limits”. The hydrodynamic limit has been studied in the original model as well as in a spatially structured version (see (1), (22) and (27)).

Secondly, it is important to understand the long time behavior and stability issues of the process in order to be able to predict and classify different behaviors as a function of the parameters. This has been achieved in (5), (22) and (25).

Thirdly, perfect simulation methods are strictly related to the issue of long time behavior. Already studied in the original paper Galves and Löcherbach (2013), it has been extended to the continuous time frame in (26) and in (28). All the aforementioned issues have been discussed and put in perspective in (25).

The new direction of research initiated by Galves and Löcherbach (2013) gave rise to four PhD dissertations. K. Y. Yaginuma’s dissertation was mentioned in the previous report of activities. A. Duarte and G. Ost presented their dissertation at USP in July 2015. The PhD dissertation by P. Hodara will be submitted at the University of Cergy-Pontoise in 2016.

The work on this new subject has consolidated the close ties NeuroMat has with the eminent mathematician E. Pressutti, from GSSI, L’Aquila, who has joined the project.

“*Development of the statistical tools required by this new class of stochastic processes*” was the second goal we announced, and this issue has been pursued in papers (2), (19), (20), (31), (32), (35), (43), (44), (47), (74), (75) and (77).

In (75), we address a basic issue in the scientific project of NeuroMat, conjecturing that the brain assigns models to external stimuli by a procedure which is reminiscent of statistical model selection. The experimental protocol consists in exposing volunteers to rhythmic sequences of beats generated by a random source while the EEG signal is recorded. The research question is whether or not the brain is able to identify the context tree which characterizes the random source producing the stimuli. In order to tackle this question, we had to introduce the notion of a hidden context tree model. This notion has enabled us to find empirical evidence supporting the conjecture that the brain does statistical model selection. This is a main breakthrough we achieved this year. The conjecture that the brain does statistical models is not new—it can be traced back to the pioneer work of von Helmholtz who introduced the notion of “unbewusster Schluss” (“unconscious inference”). However, our approach to the conjecture

¹The numbers in this introduction refer to articles produced by the project and listed on Section 2.1.1, starting on page 6 of this report. Galves and Löcherbach (2013) refers to the article “Infinite systems of interacting chains with memory of variable length—a stochastic model for biological neural nets”. Galves, A., Löcherbach, E. *Journal of Statistical Physics*, **151**(5), 896-921, 2013.

is entirely new. First of all, we introduce a new experimental protocol using context-tree random sources. Secondly, we translate the problem of structure identification by the brain as a context tree selection procedure. Lastly, EEG data being functions that map time into a multidimensional real space, we face the challenge of testing hypotheses in infinite dimensional spaces.

The hidden context tree model appears also in the collaboration we established recently with neurostatistician C. Pouzat, from the University of Paris-René Descartes, who has entered our research team. He is currently co-directing the PhD dissertation of B. Monte on the statistical analysis of neurophysiological data using hidden context tree models.

The model introduced by Galves and Löcherbach (2013) has as one of its components a graph of interactions between regions in the brain in several scales. The features characterizing the graph of interactions at different scales are one of the most important open questions in science. Addressing this question is a priority of the NeuroMat project. That is why to make progress in this direction we are organizing the workshop “Random Graphs in the Brain,” from November 23-7, coordinated by NeuroMat team members C. Pouzat, A. Galves and C. Vargas, along with R. van der Hofstad.

An issue which is common to all statistical problems addressed by NeuroMat is the fact that they deal with very high dimensional data. This is somehow present in most papers we report here, notably in (2), (20), (21), (31), (32), (45), (46) and (49). The remaining papers provide the necessary theoretical background in which NeuroMat research is being developed.

The ensemble of 48 scientific papers accepted or submitted, 21 drafts and 14 communications in meetings with referees presented in this report reflect the scientific advance achieved by NeuroMat in the last year.

The establishment of our High-Performance Computational Center will provide the team with an important new experimental tool. In fact, the simulation of large-scale network models remains a key activity to test analytical results, and the NeuroMat High-Performance Computational Center will be a laboratory allowing to make such tests. Located at the campus of USP at Ribeirão Preto, the acquisition of the new cluster described on Section 2.2.1 has marked the launching of this center. M. Coppelli and O. Kinouchi, respectively from UFPE and USP-RP, have joined the NeuroMat team to contribute to the development of the research agenda associated to our center, which will be coordinated by NeuroMat PI A. C. Roque. NeuroMat PI J. Stolfi will participate as a special advisor in the center. Details on the High-Performance Computational Center are available on the Section 2.2.1.

The scientific achievements we have introduced here remain the expression of a cohesive, collaborative global network of research and exchange. This network brings together scientists from universities in Europe —France (3), Italy (3), Netherlands (3), United Kingdom (1)—, Latin America —Argentina (3), Brazil (8), Uruguay (1)— and the United States (8). A vast proportion of research productions, as presented on Section 2 of this report, has had co-authors from more than one country, thus contributing to put FAPESP’s NeuroMat as a relevant player in the global field of Neuromathematics. An illustration of the international network that NeuroMat is embedded in and is fostering is provided on Figure 1.

The section *Education and Knowledge Dissemination* in the document “Goals for the first two years” announces the following goals:

- Interactive contents for the web portal of the Center;
- Communication channels with researchers, students, teachers and other interested parties
- Videos on neuromathematical issues;
- Exhibitions and shows on Neuromathematics;
- Organization of courses for teachers of mathematics and science to allow for future inclusion of neuromathematical topics in school curricula.

We made substantial progress on all these items during the second year. More specifically, NeuroMat’s dissemination work has been geared toward high-impact education and communication efforts.

Concerning the first goal of the dissemination team, we have provided almost daily updates on NeuroMat online tools. As presented on Section 3.4, NeuroMat’s web portal has become an international reference on Neuromathematics and brain science in general. Online content has been made available to foster interest and to improve the

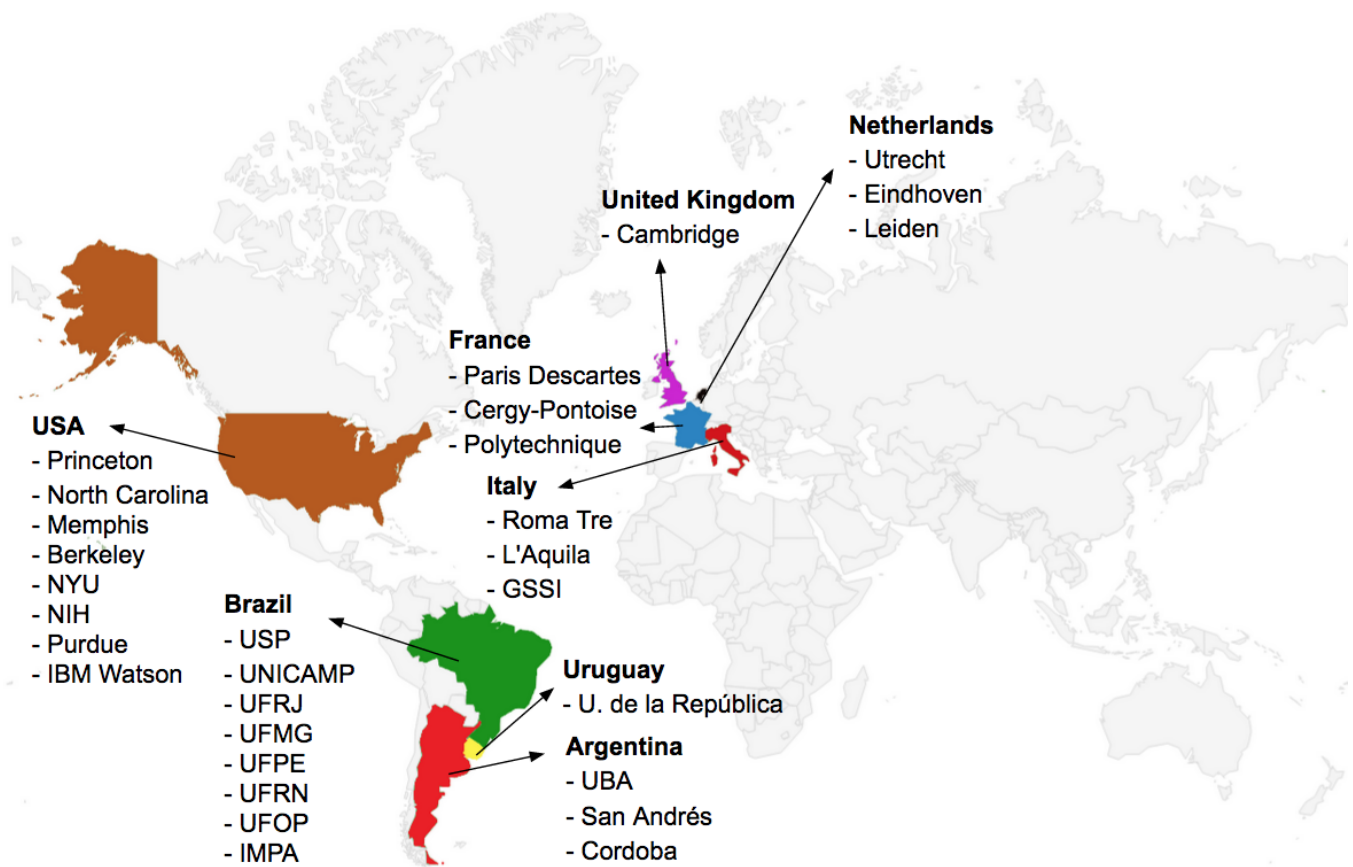


Figure 1: Illustration of FAPESP's NeuroMat global network of scientific, institutional affiliations.

quality of what is made available on topics pertaining to Neuromathematics, with a special emphasis on formats that are compatible with social networks (Facebook posts, short movies, Wikipedia entries, event streaming) and that are easy to grasp specifically to the youth.

The development of a social-network community has been at the forefront of the fulfillment of the expectation of building communication channels with researchers, students, teachers and other interested parties. NeuroMat's Facebook page has currently over 400 followers and provides short notes on science-in-the-making pertaining to Neuromathematics.

It is worth highlighting the importance of NeuroMat's newsletter in relation to the two aforementioned goals of the dissemination team. This is a monthly and in-depth report on advances and breakthroughs in the context of developing a mathematical theory of the brain.

FAPESP's NeuroMat has released one movie and is in the process of concluding edits in two other movies pertaining to advancing Neuromathematics. The production of videos on neuromathematical issues is listed as the third goal of the dissemination team. The movie "Spike Sorting: Ontology Droplet," which was released in June, 2015, has had almost 1,000 viewers and has been acknowledged as Wikimedia Commons Media of the Day.

With respect to the fourth goal of the dissemination team, NeuroMat has led the organizing of the exhibition "Inside the Brain," that addresses regularities and differences between brains from different species. This activity remains a collaborative work FAPESP's CEPID NeuroMat, the Laboratory of Cognitive Science (Labcog) and the Museum of Veterinary Anatomy (MAV), with the support of the Pró-Reitoria de Cultura e Extensão of the University of São Paulo.

The NeuroMat dissemination team has also worked on the development of an online game, whose structure rests upon a context tree model, thus being akin to NeuroMat's key scientific work on EEG signal (75) and even designed to collect new experimental data on the conjecture that the brain is able to identify a structure of a random source producing stimuli.

As it comes to the last goal of the dissemination team —“Organization of courses for teachers of mathematics and science to allow for future inclusion of neuromathematical topics in school curricula”—, ongoing education projects have involved around 440 students and several teachers in public schools in São Paulo, with the intent of strengthening knowledge on statistics and data analysis, in accordance to new expectations of the Mathematics curriculum and introducing topics pertaining to Neuromathematics. Education activities have been a milestone of FAPESP’s NeuroMat scientific dissemination effort and is presented on Section 3.1 of this report.

The major goal of the technology transfer team since the inception of FAPESP’s CEPID NeuroMat has revolved around the development of open computational tools for management, curation and sharing of scientific data and the creation of an open neuroscientific database. The foundational approach to this development has been what is generally called open science, that is, a set of guidelines to guarantee access, use and reliability of research data, results and methods. Thus, the goal of NeuroMat with respect to technology transfer is to generate tools so that all data that is produced by the CEPID is stored in a database that will be made publicly available for the scientific community, in accordance to requirements of privacy for sensitive information. In tune with this general goal of building a public neuroscientific database, the NeuroMat development team has worked on a free software to assist neuroscience research laboratories in routine procedures for data collection, called Neuroscience Experiments System (NES). The progress NeuroMat achieved with respect to technology transfer is described on Section 4.

NES version 0.1 was deployed at Laboratory of Neuroscience and Rehabilitation (LNR) in November 2014, under the coordination of NeuroMat PI C. D. Vargas and K. Braghetto. This version has functionalities involving patient registration and basic experiments management with electronic questionnaires. Since then, 72 patients have been registered in the system, and 187 sets of answers have been given to 8 questionnaires.

NES current version is 0.2.1. In relation to 0.1, there were two main contributions. The first was the implementation of the Research Project entity. Experiments registered in the system are now associated with a research project. The second main contribution is the possibility to represent experimental protocols, which comprises all the definitions of the experimental conditions to which subjects will be submitted. This version should be deployed at LNR and released publicly this following term.

The NeuroMat technology transfer team along with the administrative body have also created a parallel work front aiming to develop a software to support the preparation of annual reports and to serve as a direct liaison between NeuroMat researchers and the project administrative body. This software, called NeuroMat Individual Report of Activities (NIRA), is designed so that NeuroMat members can register and share information on publications, scientific missions and service requests.

2 Scientific report

The scientific activities developed by the Research, Innovation and Dissemination Center for Neuromathematics are presented in this Section. The team of the Center is contributing with high quality original work in the new area of neuromathematics. This fact is reflected in its production, which sums up to

- 24 published or accepted papers,
- 24 submitted papers,
- 21 papers under preparation,
- 14 communications in scientific meetings.

Many young researchers and students have joined the Neuromat team and are being formed in the core of the project. The Center is succeeding in its goal of training researchers in the specialized area of neuromathematics as can be confirmed by the following numbers.

- 2 concluded postdoctoral fellows
- 5 postdoctoral fellows,
- 3 concluded PhD Thesis,
- 1 concluded Master dissertations,
- 13 PhD thesis in progress,
- 5 Master dissertations in progress.

Scientific missions, organization of meetings, training programs, scientific and dissemination seminars are key activities for the growth of scientific areas, allowing the interaction among members of the team and communication with society. In its first year of activities the Center organized the following activities.

- 114 scientific missions,
- 4 scientific meetings and training programs,
- 14 seminars.

The detailed list of research activities developed within NeuroMat in the first year are described below.

2.1 Research results

2.1.1 Articles

Published or Accepted

1. **Hydrodynamic limit for interacting neurons.** *De Masi, A., Galves, A., Locherbach, E., Presutti, E.* Journal of Statistical Physics, **158**(4), 866-902, 2015.
2. **Identifying interacting pairs of sites in Ising models on a countable set.** *Galves, A., Orlandi, E., Takahashi, D. Y.* Brazilian Journal Probability and Statistics, **29**(2), 443-459, 2015.
3. **Rényi entropies and large deviations for the first match.** *Abadi, M. N., Cardeno, L.* IEEE Transactions on Information Theory, **61**(4), 1629-1639, 2015.
4. **Potential well spectrum and hitting time in renewal processes.** *Abadi, M. N., Cardeno, L., Gallo, S.* Journal of Statistical Physics, **159**, 1087-1106, 2015.

5. **A model for neural activity in the absence of external stimuli.** *Duarte, A., Ost, G.* Markov Processes and Related Fields, 2015, to appear.
6. **The onset of data-driven mental archeology.** *Ribeiro, S.* Frontiers in Neuroscience, **8**, 1-2, 2014.
7. **Finite cycle Gibbs measures of permutations of Z^d .** *Armendáriz, I., Ferrari, P. A., Groisman, P. and Leonardi, F.* ArXiv: 1407.6542. Journal of Statistical Physics, **158**(6), 1213-1233, 2015.
8. **A note on conjugate distributions for copulas.** *Fernandez, M., González-López, V. A. Rifo, L.L.R.* Mathematical Methods in the Applied Sciences, 2014, to appear.
9. **Relationship between balance, gait performance and functional outcome in chronic stroke patients: a comparison of left and right lesion.** *Lopes P.G., Lopes J.A.F., Brito C.M., Alfieri F.M., Battistella L.R.* BioMed Research International, to appear.
10. **Graph analysis of verbal fluency test discriminate between patients with Alzheimer's disease, mild cognitive impairment and normal elderly controls.** *Bertola, L., Mota, N. B., Copelli, M. Rivero, T., Diniz, B. S., Romano-Silva, M. A., Ribeiro, S. and Malloy-Diniz, L. F.* Front. Aging Neurosci., **6**, 185, 2014.
11. **On the number of orientations of random graphs with no directed cycles of a given length P .** *Allen, Y. Kohayakawa, G. O. Mota, R. F. Parente.* The Electronic Journal of Combinatorics, **21**(1), 2014.
12. **Tight Hamilton cycles in random hypergraphs, random structures algorithms.** *Allen, P.; Böttcher, J.; Kohayakawa, Y. and Person Y.* Random Structures and Algorithms, **46**, 446-465, 2015.
13. **Synaptic homeostasis and restructuring across the sleep-wake cycle.** *Blanco, W., Pereira, C. M., Cota, V. R., Souza, A. C., Rennó-Costa, C., Santos, S., Dias, G., Guerreiro. A. M. G., Tort, A. B. L., Neto, A. D., Ribeiro, S.* PLOS Computational Biology, **11**(5), 2015.
14. **D2 dopamine receptor regulation of learning, sleep and plasticity.** *França, A. S., Soares, L. B., Muratori L, Nascimento, G., Winne, J., Pereira, C. M., Jeronimo, S. M., Ribeiro, S.* Eur Neuropsychopharmacol, **25**(4), 493-504, 2015.
15. **Sleep deprivation and gene expression.** *da Costa, A. S., Ribeiro, S.* Curr Top Behav Neurosci., **25**, 65-90, 2015.
16. **Multivariate Markov chain predictions adjusted with copula models.** *Fernandez, M.; García, J.E.; González-López, V. A.* Selected to be included in a Book Series devoted to SMTDA2014- with copyright.
17. **Minimum number of edges in a hypergraph guaranteeing a perfect fractional matching and the MMS conjecture.** Large Systems. *Blinovsky, V. M.* Problems of Information Transmission, 2014, **50**(4), 340-349, 2014.
18. **Almost sure convergence of the clumping factor in α -mixing processes.** *Abadi, M., Saussol, B.* Stochastic and Dynamics, to appear.
19. **Predicting upcoming actions by observation: some facts, models and challenges.** *Vargas, C. D., Rangel, M. L., Galves, A.* Neurociências (Rio de Janeiro), to appear.
20. **Biological Motion Coding in the Brain: Analysis of Visually Driven EEG Functional Networks.** *Fraiman, D., Saunier, G., Martins, E. F., Vargas, C. D.* Plos One., **9**, 2014.
21. **Primary motor cortex representation of handgrip muscles in patients with leprosy.** *Sá, V.; Gomes, M. K., Rangel, M. L. S., Sanchez, T. A., Moreira, F. A., Hoefle, S., Souto, I. B., Ledo, A. J. A. C., Fontana, A. P., Vargas, C. D.* PLOS Neglected Tropical Diseases, **9**(7), e0003944, 2015.
22. **On a toy model of interacting neurons.** *Fournier, N., Löcherbach, E.* Ann. I.H.P., 2015, to appear.
23. **Stochastically Perturbed Chains of Variable Memory.** *Garcia, N.L., Moreira, L.* Journal of Statistical Physics, **159**(5), 1107-1126, 2015.

Published articles from the dissemination team

24. **Wikipédia em sala de aula: uma revisão bibliográfica.** *Peschanski, J. A., Diello, M., Carrera, M.* In: SANTANA, B.; PRAZERES, M. *Tecnologias digitais no ensino superior.* São Paulo: FCL, 2015, to appear.

Submitted

25. **Modeling networks of spiking neurons as interacting processes with memory of variable length.** *Galves, A., Löcherbach, E.* arXiv:1502.06446.
26. **Hawkes processes with variable length memory and an infinite number of components.** *Hodara, P., Löcherbach, E.* arXiv:1410.5235.
27. **Hydrodynamic limits for interacting neurons with spatial dependency.** *Duarte, A., Ost, G. Rodríguez, A.* arXiv:1503.05974.
28. **A stochastic system with infinite interacting components to model the time evolution of the membrane potentials of a population of neurons.** *Yaginuma, K. Y.* arXiv:1505.00045.
29. **Minimum number of edges in a hypergraph guaranteeing a perfect fractional matching and the MMS conjecture.** *Blinovsky, V.* arXiv:1310.0989v5.
30. **Powers of Hamilton cycles in pseudorandom graphs.** *Allen, P., Böttcher, J., Hàn, H., Person, Y., Kohayakawa, Y.* arXiv: 1402.0984v2.
31. **A test of hypotheses for random graph distributions built from EEG data.** *Cerqueira, A. Fraiman, D., Vargas, C. D., Leonardi, F.* arXiv:1504.06478.
32. **A model selection approach for multiple sequence segmentation and dimensionality reduction.** *de Castro, B. M., Leonardi, F. G.* arXiv:1501.01756.
33. **Self-sustained spiking activity in a local cortical microcircuit model: effect of layer combination and neuron composition.** *Pena, R. F. O., Ceballos, C. C., Shimoura, R. and Roque, A. C.*
34. **Contrast response functions in the visual wulst of the alert burrowing owl: a single-unit study.** *Vieira, P. G., de Sousa, J. P. M. and Baron, J.*
35. **Nonparametric statistical inference for the context tree of a stationary ergodic process.** *Gallo, S., Leonardi, F.* arXiv:1411.7650v1.
36. **Continuity properties of a factor of Markov chains.** *de Carvalho, W. A. F., Gallo, S. and Garcia, N. L.* arXiv:1409.6168v1.
37. **Dynamic uniqueness and phase transition of chains of infinite order.** *Gallesco, C., Gallo, S. and Takahashi, D. Y.* arXiv:1410.8241v2.
38. **Neurophysiologic predictors of motor function in stroke.** *Simis, M., Doruk, D., Imamura, M., Anghinah, R., Morales-Quezada, L., Fregni, F., Battistella, L. R.*
39. **Postural control of healthy elderly individuals compared to elderly individuals with stroke sequelae** *Authors: Alfieri, F. M., Riberto, M., Lopes, J. A. F., Filippo, T. R. M., Imamura, M., Battistella, L. R.*
40. **Transcranial direct current stimulation combined with aerobic exercise to optimize analgesic responses in fibromyalgia: a randomized placebo-controlled clinical trial** *Mendonça, M. E., Simis, M., Grecco L. C., Battistella, L. R., Baptista, A. F., Fregni, F.*
41. **Cumulative conditional expectation index.** *Fernandez, M.; González-López, V. A.* arXiv:1503.04499v1.
42. **A copula-based partition Markov procedure.** *Fernandez, M.; García, J. E.; González-López, V. A.*

43. **Reduced functional connectivity within the primary motor cortex of patients with brachial plexus injury.** *Fraiman, D., Miranda, M. F., Erthal, F., Buur, P.F., Elschot, M., Souza, L., Rombouts, S. A. R. B., van Osch, M. J. P., Schimmelpenninck, C.A., Norris, D. G., Malessy, M. J. A., Galves, A., Vargas, C. D.* arXiv:1506.07889.
44. **Statistics of dynamic networks: a depth function approach.** *Fraiman, D., Fraiman, N., Fraiman, R.* arXiv:1408.3584.
45. **Creating families of conceptual database schemas using database feature diagrams (DBFDs).** *Moraes, L. C.; Braghetto, K. R.*
46. **Repertoires of spike avalanches in freely-behaving rats are modulated by sleep-wake states and novelty.** *Ribeiro, T. L., Ribeiro, S. and Copelli, M.*
47. **TPRM: Tensor partition regression models with applications in imaging biomarker detection.** *Miranda, M. F., Zhu, H., Ibrahim, J. G.* arXiv:1505.05482.
48. **A wiki-pedagogia: o caso do Projeto Wikipédia da Faculdade Cásper Líbero.** *Peschanski, J. A., Diello, M., Carrera, M.*

Communications in meetings with referee

49. **A non-parametric test of hypotheses for random graph distributions and the discrimination of EEG brain networks.** *Leonardi, F.* Contributed talk in ISNPS 2015 Meeting - International Society for Non Parametric Statistics - Graz, Austria - July, from 12 to 15, 2015.
50. **Differential role of subthreshold conductances on the firing of dorsal cochlear nucleus fusiform neurons.** *Ceballos, C. C., Roque, A. C. and Leo, R.* 9th World Congress of the International Brain Research Organization D IBRO 2015, Rio de Janeiro, Brazil, July 7-11, 2015.
51. **Self-sustained activity lifetime in a cortical network model.** *Pena, R. F. O., Tomov, P., Zaks, M. and Roque, A. C.* 9th World Congress of the International Brain Research Organization IBRO 2015, Rio de Janeiro, Brazil, July 7-11, 2015.
52. **A cortical multi-layered model and the properties of its internally-generated activity.** *Pena, R. F. O., Shimoura, R. and Roque, A. C.* 24th Annual Computational Neuroscience Meeting CNS 2015, Prague, Czech Republic, July 18-23 2015. To appear in BMC Neuroscience, July 2015.
53. **Dynamics of a cortical multi-layered model with cells of different electrophysiological classes.** *Shimoura, R., Pena, R. F. O. and Roque, A. C.* 9th World Congress of the International Brain Research Organization D IBRO 2015, Rio de Janeiro, Brazil, July 7-11, 2015.
54. **Effect of synaptic plasticity on functional connectivity and global activity of a neocortical network model.** *Shimoura, R., Pena, R. F. O. and Roque, A. C.* 24th Annual Computational Neuroscience Meeting D CNS 2015, Prague, Czech Republic, July 18-23 2015. To appear in BMC Neuroscience, July 2015.
55. **Neuromodulation and rehabilitation** *Simis, M.* Rehabilitation Fair and Forum, August 2014, São Paulo, Brazil. Workshop: Neuromodulation and Neuroplasticity: the role of brain stimulation Noninvasive (TMS / tDCS).
56. **Controle postural em pacientes com lesão do plexo braquial.** *Silva, l. S.; Lemos, T.; Lima, D.; Oliveira, l. A. S.; Guedes, J. F.; Rodrigues, E. C.; Vargas, C. D.* In: XXXVIII Congresso Anual da SBNEC, 2014, Búzios. Anais do XXXVIII Congresso Anual da SBNEC, 2014.
57. **Construindo um banco de dados digital no Instituto de Neurologia Deolindo Couto da UFRJ.** *Ramalho, B.; Rangel, M. L.; Silva, L. S.; Pinto, T. P.; Maia, J.; Frare, S. L.; Lazary, E.; Martins, J. V.; Tavares, P. L.; Erthal, F. S.; Vargas, C. D.; Braghetto, K. R.; Nascimento, A.; Correa, J. F. G.* In: XXXVIII Congresso Anual da SBNEC, 2014, Búzios. Anais do XXXVIII Congresso Anual da SBNEC, 2014.
58. **Predicting upcoming events occurring in the space surrounding the body.** *Rangel, M. L.; Souza, l. S.; Frota, l. R.; Oliveira, J. M.; Rodrigues, E. C.; Vargas, C. D.* In: 9th World Congress International Brain Research Organization IBRO, 2015, Rio de Janeiro.

59. **Reduced functional connectivity within the primary motor cortex of patients with brachial plexus injury.** Souza, L., Fraiman, D., Erthal, F., Miranda, M. F., Rombouts, S. A. R. B., Galves, A., Malessy, M. J. A., Vargas, C. D.. In: 9th World Congress International Brain Research Organization IBRO, 2015, Rio de Janeiro.
60. **Balance impairments after brachial plexus injury as assessed through clinical and posturographic evaluation.** Souza, L.; Lemos, T.; Silva, D. C. L.; de Oliveira, J. M.; Correa, J. F. G.; Tavares, P. L. M. S.; Oliveira, L. A. S.; Rodrigues, E. C.; Vargas, C. D. In: 9th World Congress International Brain Research Organization IBRO, 2015, Rio de Janeiro.
61. **Functional markers of electrical activity of the cortex to identify developmental delays of executive functions in prefrontal cortex in adolescents.** Amorim, A. K. J.; Miranda, D.; Quaresma, L.; Botelho, E.; Ceriatte, C.; Pontes, G.; Bahia, C.; Fraiman, D.; Pereira, A. (IBRO 2015 Rio)
62. **Reduced functional connectivity within the primary motor cortex of patients with brachial plexus injury.** Fraiman, D., Erthal, F., Miranda, M. F., Souza, L., Rombouts, S.; Galves, A., Malessy, M., Vargas, C.D. I LATIN AMERICAN BRAIN MAPPING NETWORK MEETING - LABMAN, SP, BRAZIL.

Drafts

63. **Do fast retinal oscillations play a role in vision?** Neuenschwander, S.
64. **Simple and complex cells in the visual wulst of the burrowing owl: two distinct classes or opposite ends of a stimulus-dependent continuum?** de Sousa, J. P. M., Turchetti-Maia, A. L., Vieira, P. G., de Amorim, C. S., Pinto, L. and Baron, J.
65. **Surround suppression in the owl visual wulst** Turchetti-Maia, A. L. and Baron, J.
66. **Self-sustained spiking activity in stochastic neural network models.** Pena, R. F. O., Ceballos, C. C., Shimoura, R., Kinouchi, O. and Roque, A. C.
67. **Modeling the resting-state functional connectivity of the human brain with a stochastic neural network model.** Yaginuma, K. Y., de Reus, M., Fernandez, R., Roque, A. C. and van den Heuvel, M.
68. **Neurophysiologic Correlates of post-stroke emotional disturbance.** Simis, M., Doruk, D., Imamura, M., Brunoni, A. R., Morales-Quezada, L., Anghinah, R., Fregni, F., Battistella, L. R.
69. **Evaluation of body temperature in individuals with stroke sequelae.** Alfieri, F. M., Massaro, A. R., Filippo, T. R. M., Portes, L. A., Battistella, L. R.
70. **Electroencephalographic changes in patients with incomplete spinal cord injury, who underwent treatment with robot-assisted gait training.** Filippo, T., Simis, M., Doruk, D., Imamura, M., Morales-Quezada, L., Fregni, F., Battistella, L. R.
71. **Challenge of choosing assessment for upper limb motor function in stroke rehabilitation trial.** Terranova, T. T., Simis, M., Fregni, F., Battistella, L. R.
72. **Dependency between clinical assessment and kinematic variables assessed with robotic device.** Gonzalez-Lopez, V., Garcia, J., Terranova, T. T., Simis, M., Battistella, L. R.
73. **Methods of neurophysiological assessment using transcranial magnetic stimulation in spinal cord injury patients (review).** Simis, M., Matheus, D. Vita, M., Uchiyama, S., Fregni, F., Battistella, L. R.
74. **Bootstrap context tree model selection.** Galves, A., González-Montoro, A.M.
75. **Retrieving a hidden context tree model from EEG signals.** Ost, G., Duarte, A., Fraiman, R., Vargas, C., Galves, A.
76. **Towards a postural control signature: cortical dynamics analysed in dense array EEG.** Martins, E., Lemos, T., Saunier, G., Fraiman, D., Vargas, C.

77. **Change point detection for high-dimensional regression data with ℓ_1 -regularization.** *Leonardi, F., Bühlmann, P.*
78. **Discrete one-dimensional oriented percolation of intervals.** *Gallo, S., Garcia, N.*
79. **Shortest return time distribution and complexity.** *Abadi, M. e Rada-Mora, A.*
80. **Fundamental theorems for the shortest path between to cylinder sets and entropy.** *Abadi, M. e Lambert, R.*
81. **Consistent estimator for the clumping parameter.** *Abadi, M. e de Melo, M. P.*
82. **Corticospinal excitability is tuned by the observation of grasping towards emotion-laden objects.** *Nogueira-Campos, A. A.; Saunier, G.; Della-Maggiore, V.; Oliveira, L. A. S.; Rodrigues, E. C.; Vargas, C. D.*
83. **Building a public digital database for evaluation and data managing of brachial plexus injured patients.** *Ramalho, B.; Patroclo, C.; Rangel, M. L.; Maia, J., Souza, L.; Schmaedeke, A. C.; Martins, J. V.; Correa, J. F. G.; Braghetto, K.; Nascimento, A.; Erthal, F.; Vargas, C. D.*

2.1.2 Post-doctoral fellows

Concluded

1. Title of the project: Representando a atividade cerebral através de seleção estatística de modelos na classe de sistemas interagentes de cadeias com memória variável.
 - Period: April, 01- 2014 to March, 31-2015
 - Name of the student: Aldana María González Montoro
 - Institution: IME-USP
 - Supervisor: J. Antonio Galves
 - Scholarship: FAPESP – Proc. 2014/04801-0
2. Title of the project: Modelos de cópulas para geração de indicadores educacionais
 - Period: May, 01-2012 – April, 30-2015
 - Name of the student: Mariela Fernández
 - Supervisor: Veronica González-López
 - Institution: IMECC-Unicamp
 - Scholarship: FAPESP – Proc. 2011/18285-6
 - <http://www.bv.fapesp.br/pt/bolsas/133589/modelos-de-copulas-para-geracao-de-indicadores-educacionais/>

In progress

1. Title of the project: Modelando banco de dados complexos: associação entre dados de imagens multi-dimensionais, variáveis clínicas e variáveis contendo informação genética.
 - Period: 01/06/2014 to 31/05/2016
 - Name of the student: Dr. Michelle Ferreira Miranda
 - Institution: IME-USP
 - Supervisor: J. Antonio Galves
 - Scholarship: FAPESP – Proc. 2014/07254-0
2. Title of the project: Predictors of response to treatment for motor sequelae after stroke
 - Period: September 2014 – September 2017 (ongoing)

- Name of the student: Dr. Marcel Simis
 - Supervisor: Linamara Rizzo Battistella
 - Institution: Institute of Physical and Rehabilitation Medicine, General Hospital, Medical School, University of São Paulo
 - Scholarship: No
3. Title of the project: Effects of Motor Learning and Robotic Training of Upper Limbs on Neuroplasticity and Functional Capacity: Blinded Randomized Controlled Trial with Stroke Patients
 - Period: August 2014 – October 2015 (ongoing)
 - Name of the student: Dr. Fábio Marcon Alfieri
 - Supervisor: Linamara Rizzo Battistella
 - Institution: Institute of Physical and Rehabilitation Medicine, General Hospital, Medical School, University of São Paulo
 - Scholarship: No
 4. Title of the project: The Influence of the Cerebellum on Motor Recovery of Stroke Patients: an Electrophysiological Study
 - Period: November 2014 – November 2015 (ongoing)
 - Name of the student: Dr. Rebeca Boltes Cecatto
 - Supervisor: Linamara Rizzo Battistella
 - Institution: Institute of Physical and Rehabilitation Medicine, General Hospital, Medical School, University of Sao Paulo
 - Scholarship: No
 5. Title of the project: Recorrência e entropia
 - Beginning: 02/2015 (ongoing)
 - Name of the student: Alejandra Erika Rada-Mora
 - Advisor: Miguel Natalio Abadi
 - Institution: IME-USP
 - Schollarship: CAPES

2.1.3 PhD dissertations

Concluded

1. Title of the project: Stochastic models in neurobiology: from a multiunitary regime to EEG data.
 - Period: 07/2011- 07/2015
 - Name of the student: Aline Duarte de Oliveira
 - Advisor: Antonio Galves
 - Institution: IME-USP
 - Schollarship: CAPES/CNPq
2. Title of the project: Hydrodynamic limit for spatially structured interacting neurons
 - Period: 07/2011- 07/2015
 - Name of the student: Guilherme Ost de Aguiar
 - Advisor: Antonio Galves
 - Institution: IME-USP

- Scholarship: CAPES/CNPq
3. Title of the project: Teoremas fundamentais para o caminho mais curto entre duas sequências
 - Period: 08/2010- 06/2015
 - Name of the student: Rodrigo Lambert
 - Advisor: Miguel Natalio Abadi
 - Institution: IME-USP
 - Scholarship: CAPES/CNPq/CNRS/BREUDS

In progress

1. Title of the project: Consistent estimation of probabilistic networks
 - Period: From March 2013 (ongoing)
 - Name of the student: Iara Moreira Frondana
 - Supervisor: Florencia Leonardi
 - Institution: IME, University of Sao Paulo
 - Scholarship: CNPq
2. Title of the project: Perfect simulation for probabilistic networks
 - Period: From March 2014
 - Name of the student: Andressa Cerqueira
 - Advisor: Florencia Leonardi
 - Institution: IME-USP
 - Scholarship: Fapesp
3. Title of the project: Processus de particules en interactions avec une infinité de composantes à mémoire d'ordre variable
 - Period: 01/09/2013-31/08/2016
 - Name of the student: Pierre Hodara
 - Advisor: Eva Löcherbach
 - Institution: Université de Cergy-Pontoise
 - France
4. Title of the project: Synaptic transmission between inhibitory interneurons: experimental and theoretical study
 - Beginning: October 4th 2013
 - Name of the student: César Celis Ceballos
 - Advisor: Antonio Carlos Roque da Silva Filho
 - Institution: Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto (FFCLRP), University of São Paulo (USP)
 - Scholarship: CAPES.
5. Title of the project: Mechanisms of epileptiform activity propagation in a large-scale cortical model
 - Beginning: February 26th 2014
 - Name of the student: Rodrigo Felipe de Oliveira Pena
 - Advisor: Antonio Carlos Roque da Silva Filho

- Institution: Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto (FFCLRP), University of São Paulo (USP)
 - Scholarship: FAPESP, Process No. 2013/25667-8
6. Title of the project: Processos de salto com memória de alcance variável e aplicações à modelagem estocástica de redes neurais
- Period: 02/2011 - 09/2015
 - Name of the student: Douglas Rodrigues Pinto
 - Advisor: Antônio Galves
 - Institution: IME-USP
 - Scholarship: CAPES
7. Title of the project: Hidden context tree models: a stochastic modelling of neurobiological data (Título provisório)
- Period: 03/2013 - 02/2017
 - Name of the student: Bruno Monte de Castro
 - Advisor: Antonio Galves
 - Co-advisor: Christophe Pouzat
 - Institution: IME-USP
 - Scholarship: CNPq
8. Title of the project: Analysis of Energy Expenditure Monitoring in Stroke Patients
- Period: December 2012 – December 2016 (ongoing)
 - Name of the student: Christiane Riedi Daniel
 - Advisor: Linamara Rizzo Battistella
 - Institution: FM-USP
 - Scholarship: No
9. Title of the project: Cadeias estocásticas de longo alcance e aplicação em Neurociência
- Period: March 2015 – March 2019 (ongoing)
 - Name of the student: Ricardo Felipe Ferreira
 - Advisor: Alexsandro Gallo
 - Institution: Des-UFSCar
 - Scholarship: Capes
10. Title of the project: Seleção Bayesiana de Modelos de Cópulas
- Period: November 2014 – November 2017 (ongoing)
 - Name of the student: Rarnin Gholi Zadeh
 - Advisor: Veronica Gonzalez-Lopez
 - Institution: IMECC - UNICAMP
 - Scholarship: Capes - July 2015
11. Title of the project: Avaliação da reorganização do cortex motor de pacientes com lesão de plexo braquial com uso da TMS
- Beginning: 2015
 - Name of the student: Bia Ramalho

- Advisor: Cláudia D. Vargas
 - Institution Instituto de Biofísica Carlos Chagas Filho/UFRJ
 - Scholarship: CNPq
12. Title of the project: Plasticidade cerebral apos lesão periférica, um estudo de conectividade funcional
- Beginning: 2014
 - Name of the student: Lidiane Souza
 - Advisor: Cláudia D. Vargas
 - Institution: Instituto de Biofísica Carlos Chagas Filho/UFRJ
 - Scholarship: CAPES
13. Title of the project: Pasticidade cerebral após amputação: efeitos sobre a ressonância motora
- Beginning: 2011
 - Name of the student: Maria Luiza Salles Rangel
 - Advisor: Cláudia D. Vargas
 - Institution Instituto de Biofísica Carlos Chagas Filho/UFRJ
 - Scholarship: CNPq

2.1.4 MSc dissertations

1. Title of the project: Plasticity in a model of the local cortical microcircuit: characterization of the functional network reorganization after focal lesions.
 - Period: 02/2014-ongoing.
 - Name of the student: Renan Oliveira Shimoura.
 - Advisor: Antonio Carlos Roque da Silva Filho
 - Institution: Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto (FFCLRP), University of São Paulo (USP).
 - Scholarship: CAPES.
2. Title of the project: Do fast retinal oscillations play a role in vision? A study in the anesthetized and awake cat.
 - Period: 2013-2015
 - Name of the student:Giovanna Rosso de Manços
 - Advisor: Sérgio Neuenschwander
 - Institution:PG-Neuro, Instituto do Cérebro - UFRN
 - Scholarship:CAPES
3. Title of the project: V1-V4 neuronal interactions during natural vision in the capuchin monkey
 - Period: 2015-ongoing
 - Name of the student:Katia-Simone Nobrega Rocha
 - Advisor: Sérgio Neuenschwander
 - Institution:PG-Neuro, Instituto do Cérebro - UFRN
 - Scholarship:NONE
4. Title of the project: Famílias de esquemas de bancos de dados para experimentos de neurociências
 - Period: 02/2014-ongoing

- Name of the student: Larissa Cristina Moraes
 - Advisor: Kelly Braghetto
 - Institution: Institute of Mathematics and Statistics - University of São Paulo
 - Scholarship: FAPESP
5. Title of the project: Modelo de proveniência de dados para processos de análise em neurociência
- Period: 02/2014-ongoing
 - Name of the student: Andre de Camargo Fernandes
 - Advisor: Kelly Braghetto
 - Institution: Institute of Mathematics and Statistics - University of São Paulo
 - Scholarship:
6. Title of the project: Title of the project: Investigação da sensibilidade superficial e sensação referida em participantes com lesão e reconstrução cirúrgica do plexo braquial
- Period: 2013-2015 (concluded)
 - Name of the student: Bia Ramalho
 - Advisor: Cláudia D. Vargas
 - Institution: IBCCF/UFRJ
 - Schollarship: CNPq

2.2 Project activities

2.2.1 NeuroMat High-Performance Computational Center

NeuroMat has founded a High-Performance Computational Center, located at the Neural Systems Laboratory (SisNe - FFCLRP - USP) coordinated by professor Antonio Roque, having prof. Jorge Stolfi as scientific advisor of the center.

To simulate large-scale network models remains a key activity to test analytical results, and the NeuroMat High-Performance Computational Center will be a laboratory to make such tests. These simulations, that involve dozens and even hundreds of thousands of neurons, enable the investigation of the role of local and global network architectures and of parameters of neurons and synapses on patterns of neuronal activity.

Computational simulations are very important to improve our understanding of neural systems allowing us to explore the behavior of neuromathematical models by performing numeric experiments in realistic architecture and morphological setups. This research strategy, however, demands a large amount of computational resources with high-parallelising capacity.

The cluster purchased presents high speed processing capacity having 4 nodes, each containing eight Intel Xeon processors (E5-2650, v3 family) with 10 cores. Moreover, for each processor there is a 16GB DDR4 memory, also essential to enable fast and large numerical simulations. In order to make efficient use of all processing capacity at multiuser level, the system is provided with specific parallelising software for Fortran/C++. Besides processing capacity, the supercomputer will also improve our numerical and experimental data storage capacity with 6 hard drives of 1TB each. Additionally, it has dedicated units for GPU computing and a 15 KVA Nobreak that provides stability to the purchased equipment.

2.2.2 Meetings and Training Programs

From August 2014 NeuroMat organized 3 scientific events that are listed below.

1. NeuroMat training: Christophe Pouzat on spike sorting

Christophe Pouzat, a CNRS researcher of the Applied Maths Laboratory of the Paris-Descartes University and a specialist in spike sorting, offered a three-day-long training “Spike sorting: What is it? Why do we

need it? Where does it come from? How is it done? How to interpret it?,” at the University of São Paulo, from November 25 to 27, 2014. The Research, Innovation and Dissemination Center for Neuromathematics (CEPID NeuroMat) organized this event with the support of the São Paulo Research Foundation (FAPESP).

This NeuroMat training on spike sorting is directly related to a key challenge of neuroscience. Neuroscientists use extracellular recordings to monitor many neurons while keeping tissue damage at a minimum. But the collected raw data are then mixtures of activities—from many neurons—that have to be separated or sorted before most physiologically relevant questions can be addressed. This unmixing step is what is referred to as “spike sorting” by neurophysiologists. Since extracellular recordings constitute the oldest recording technique available to physiologists, sorting methods have a rather long history that is worth reviewing. The training therefore combined a presentation of the historical development of sorting techniques and ideas (a development that goes hand in hand with the hardware, amplifiers and computers, found in neurophysiology labs) with a description of how to implement them with an open source software like Python. Potential sources of misinterpretations of spike trains, the output of spike sorting procedures, were also discussed.

2. First NeuroMat Young Researchers Workshop

The Research, Innovation and Dissemination Center for Neuromathematics (NeuroMat) held the First NeuroMat Young Researchers Workshop in São Paulo, from May 5 to May 7, 2015. The event aimed at facilitating exchanges between young and senior researchers, and of preparing young researchers for their future challenges in academic life.

The event involved talks on Neurobiology, Physiology, Mathematics, Probability, Statistics, that are part of NeuroMat. Topics that were discussed included how theory of random graphs has been applied to model neural interactions in the brain, techniques to measure the clinical evolution of patients with brachial plexus injuries and statistical model selection and spike sorting.

The First NeuroMat Young Researchers Workshop hosted an “edit-a-thon” on Neuromathematics, on May 5 and 6. An “edit-a-thon,” as defined on the global encyclopedia Wikipedia, is “an event where editors get together to edit and improve a specific topic or type of content, typically including basic editing training for new editors,” thus being a “portmanteau of ‘edit’ and ‘marathon’.” This event was facilitated by members of the Brazilian Wikimedia User Group and revolved around contributing to topics such as the following entries on the Portuguese version of Wikipedia, such as “Neuromatemática”, “Somatotopia”, “Função densidade” and “Cadeias estocásticas com memória de alcance variável”.

A list of organizers and participants and schedule of talks, including short abstracts, is available as an Appendix to this report.

3. Workshop on Stochastic Modeling of Neural Nets and Spike Sorting

The event was held from May 26 to May 28, 2015 in São Paulo, SP. The title of the talks are listed below.

- Antonio Galves (USP, São Paulo) - Modeling networks of spiking neurons as interacting processes with memory of variable length.
- Christophe Pouzat (Paris-Descartes) – Spike Sorting
- Antonio Roque (USP, Ribeirão Preto) - Cortical network models: where do we go now?
- Sergio Neuenschwander (Ice, UFRN, Natal) - Gamma or no gamma: new insights from the visual cortex of the capuchin monkey.
- Jerome Baron (UFMG, Belo Horizonte) - Are simple and complex cells.

Participants had to choose one of the two thematic groups: 1) Stochastic cortical network modeling; 2) Spike Sorting. The meeting activities included discussions, exchange of expertise and experiences to develop mathematical and/or computational renderings of the models and processes discussed. At the final session of the workshop, each group spokespersons presented the main results obtained and the group evaluation on what has been achieved. This was followed by a final discussion on the workshop itself and our future work.

4. LASCON (in preparation)

LASCON is the first and foremost school of computational neuroscience in Latin America. It is a biennial school aimed at introducing advanced undergraduate, graduate students and young researchers, mostly from Latin America, to the use of mathematical and computational methods for modeling neurons and neural networks of the brain. It is an intensive four-week school with morning, afternoon and evening activities.

The morning periods are dedicated to theoretical classes on the fundamentals of neuron and neural network modeling, the afternoon periods are dedicated to hands-on training in computer programs commonly used in neural network simulation and analysis, and the evening periods are dedicated to exercises. The faculty is composed of researchers with large experience in computational neuroscience and the use of these programs.

Besides attending the classes and doing the exercises, students have to carry out small research projects using the tools taught at the school and present them orally at the end of the school. The previous LASCON editions were held at Ribeirão Preto (2006, 2008, 2010 and 2012) and Tibau do Sul (2014) in Rio Grande do Norte State. In 2016 LASCON will return to the State of São Paulo and will be held at the city of São Paulo. Its creator and director, Dr. Antonio Roque, has recently become a NeuroMat PI and Education and Knowledge Diffusion Coordinator. It thus become natural to unite the two efforts, which share the same ideal of teaching and disseminating mathematical neuroscience, and LASCON 2016 and its forthcoming editions in the State of São Paulo will be part of NeuroMat's activities.

The full program of LASCON 2016 can be seen at www.sisne.org/lascon. Student applications are open until September 6, 2015 and the list of confirmed lecturers with their respective topics is given below:

LASCON 2016 lecturers (courses and tutorials)

- Arnd Roth, University College, London, UK — Biophysical modeling of dendritic processing and the NEURON program
- Benjamin Lindner, Humboldt-Universität zu Berlin, Berlin, Germany — Stochastic models in neuroscience
- Bóris Marin, University College, London, UK — Reduced neuron models and phase plane analysis
- Christophe Pouzat, Université Paris Descartes, Paris, France — Spike train analysis
- Demian Battaglia, Aix-Marseille Université, Marseille, France — From the connectome to the chronnectome, via neural dynamics
- Germán Mato, Centro Atómico Bariloche, San Carlos de Bariloche, RN, Argentina — Neural dynamics: from single neurons to networks
- Hannah Bos, Forschungszentrum Jülich, Jülich, Germany — Networks of simple neuron models and the NEST program
- Jannis Schuecker, Forschungszentrum Jülich, Jülich, Germany — Networks of simple neuron models and the NEST program
- John Murray, New York University, New York, NY, USA — Computational psychiatry
- Marco Huertas, University of Texas Medical School, Houston, TX, USA — Models of synaptic plasticity and memory
- Sam Neymotin, State University of New York, New York, NY, USA — Networks of biophysical neuron models and the NEURON program
- Volker Steuber, University of Hertfordshire, Hatfield, UK — Hodgkin-Huxley type neuron models and the neuroConstruct program
- William Lytton, State University of New York, New York, NY, USA — Networks of biophysical neuron models

LASCON 2016 lecturers (invited lectures)

- André Kohn, Universidade de São Paulo, São Paulo, SP, Brazil — ReMoTo: Symulation system of spinal networks and the innervated muscles
- Antonio Galves, Universidade de São Paulo, São Paulo, SP, Brazil — Title to be announced
- César Rennó-Costa, Universidade Federal do Rio Grande do Norte, Natal, RN, Brazil — Place cells, grid cells, and the search for a model of the cognitive map
- Fábio Simões de Souza, Universidade Federal do ABC, Santo André, SP, Brazil — Cracking the olfactory code
- Julián Tejada, Universidade Federal de Sergipe, Aracajú, SE, Brazil — Large-scale biologically detailed model of the dentate gyrus

- Leonardo Maia, Universidade de São Paulo, São Carlos, SP, Brazil — Directed information measures in neuroscience
- Marco Idiart, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil — Title to be announced
- Marcelo Reyes, Universidade Federal do ABC, Santo André, SP, Brazil — Title to be announced
- Mauro Copelli, Universidade Federal de Pernambuco, Recife, PE, Brazil — Critical neural networks
- Sakyasingha Dasgupta, RIKEN Brain Science Institute, Wako, Japan — Signal processing in neural networks that receive or generate noise
- Sergio Neuenschwander, Universidade Federal do Rio Grande do Norte, Natal, RN, Brazil — Title to be announced

2.2.3 Seminars

Title	Speaker	Date
Fluctuation bounds for entropy and entropy production estimators in Gibbs measures	César Maldonado / CMM-Universidad de Chile	Jun 11, 2015
Upper bound for the Probability of singularity of Bernoulli Matrix	Vladimir Blinovskiy / Russian Academy of Sciences	May 21, 2015
Set estimation from reflected Brownian motion	Jacob Ricardo Fraiman Maus / Universidad de la Republica - Uruguay	May 14, 2015
On the shortest path between two strings	Rodrigo Lambert / IME-USP	Apr 30, 2015
Dynamic uniqueness for chains with long range memory	Sandro Gallo / UFSCAR	Apr 23, 2015
Real world models and Glauber-type stochastic dynamics of particle systems in continuum	Elena Zhizhina / Russian Academy of Sciences	Apr 09, 2015
Goodness-of-fit tests for regression models: the functional data case	Wenceslao González Manteiga / Universidad de Santiago de Compostela	Mar 24, 2015
Functional Generalized Regression Models	Manuel Febrero Bande / Universidad de Santiago de Compostela	Mar 23, 2015
Rényi Entropies and Large Deviations for the First Match Function	Miguel Abadi / IME-USP	Mar 19, 2015
Model driven EEG fMRI fusion	Pedro Valdes Sosa / CNEURO-Cuba	Mar 16, 2015
A model for neural activity in the absence of external stimuli	Aline Duarte / IME-USP	Mar 12, 2015
The contribution of callosal circuits to stimulus-driven and ongoing activity close to the visual field's midline	Kerstin Erika Schmidt / UFRN	Nov 04, 2014
Universality and Scaling in brain dynamics in vivo.	Mauro Copelli / UFPE	Sep 04, 2014
Spectral dimension of trees with a unique infinite spine	Stefan Zohren / PUC-RJ	Jun 26, 2014

2.2.4 Scientific missions

To fulfil the international inter-institutional profile of CEPID Neuromat, a number of short-period scientific missions were undertaken within the project scope, as seen below.

Researcher	Scientific mission	Local	Start date	End date
Michelle Ferreira Miranda / IME-USP	Research development	Chapel Hill, NC USA	Jul 25, 2015	Aug 23, 2015
Michelle Ferreira Miranda / IME-USP	Research development	Presidente Prudente, SP	Jul 21, 2015	Jul 23, 2015

Pablo Augusto Ferrari / NUMEC-USP	Research development	São Paulo, SP	Jul 16, 2015	Jul 18, 2015
Jacob Ricardo Fraiman Maus / Universidad de la Republica - Uruguay	Research development	São Paulo, SP	Jul 15, 2015	Jul 18, 2015
Ariadne de Andrade Costa / FFCLRP-USP-Ribeirão	Research development	São Carlos, SP	Jul 15, 2015	Jul 16, 2015
Claudia Domingues Vargas / UFRJ	Research development	São Paulo, SP	Jul 15, 2015	Jul 19, 2015
Lucas Martins Stolerman / IMPA	Research development	São Paulo, SP	Jul 15, 2015	Jul 16, 2015
Roberto Imbuzeiro Moraes Felinto de Oliveira / IMPA	Research development	São Paulo, SP	Jul 15, 2015	Jul 16, 2015
Eva Löcherbach / U-CERGY	Research development	São Paulo, SP	Jul 14, 2015	Jul 30, 2015
Andréia Feitoza de Oliveira	FAPESP Stand in the ExpoT&C	São Carlos, SP	Jul 13, 2015	Jul 15, 2015
Lucas Nascimento da Silva / IB-USP	FAPESP Stand in the ExpoT&C	São Carlos, SP	Jul 12, 2015	Jul 14, 2015
Florencia Graciela Leonardi / IME-USP	Research development	Graz, Austria	Jul 11, 2015	Jul 16, 2015
Jefferson Antonio Galves / IME-USP	Research development	Rio de Janeiro, RJ	Jul 11, 2015	Jul 12, 2015
Osame Kinouchi Filho / FFCLRP-USP-Ribeirão	FAPESP Stand in the ExpoT&C	São Carlos, SP	Jul 11, 2015	Jul 18, 2015
Vinicius Lima Cordeiro / FFCLRP-USP-Ribeirão	FAPESP Stand in the ExpoT&C	São Paulo, SP	Jul 11, 2015	Jul 18, 2015
Aldana González Montoro / NUMEC-USP	Research development	São Paulo, SP	Jul 05, 2015	Jul 11, 2015
Miguel Abadi / IME-USP	Research development	Ribeirão Preto, SP	Jul 01, 2015	Jul 02, 2015
Jefferson Antonio Galves / IME-USP	Research development	Ribeirão Preto, SP	Jul 01, 2015	Jul 02, 2015
Jorge Stolfi / IC-UNICAMP	Research development	Ribeirão Preto, SP	Jul 01, 2015	Jul 02, 2015
Claudia Domingues Vargas / UFRJ	Research development	São Paulo, SP	Jun 24, 2015	Jun 25, 2015
Alexsandro Giacomo Grimber Gallo / UFS-CAR	Research development	São Paulo, SP	Jun 23, 2015	Jun 25, 2015
Claudia Domingues Vargas / UFRJ	Research development	São Paulo, SP	Jun 17, 2015	Jun 18, 2015
Claudia Domingues Vargas / UFRJ	Research development	São Paulo, SP	Jun 10, 2015	Jun 11, 2015
Antonio Carlos Roque da Silva Filho / FFCLRP-USP-Ribeirão	Research development	São Paulo, SP	Jun 09, 2015	Jun 10, 2015
Juliana da Silva Maia / UFRJ	Workshop on Stochastic Modelling of Neural Nets and Spike Sorting	São Paulo, SP	May 26, 2015	May 27, 2015
Bia Ramalho dos Santos Lima / UFRJ	Workshop on Stochastic Modelling of Neural Nets and Spike Sorting	São Paulo, SP	May 26, 2015	May 28, 2015

Claudia Domingues Vargas / UFRJ	Research development	São Paulo, SP	May 26, 2015	May 28, 2015
Antonio Carlos Roque da Silva Filho / FFCLRP-USP-Ribeirão	Research development	São Paulo, SP	May 26, 2015	May 28, 2015
Rodrigo Felipe de Oliveira Pena / FFCLRP-USP-Ribeirão	Workshop on Stochastic Modelling of Neural Nets and Spike Sorting	São Paulo, SP	May 26, 2015	May 28, 2015
Osame Kinouchi Filho / FFCLRP-USP-Ribeirão	Research development	São Paulo, SP	May 26, 2015	May 28, 2015
Renan Oliveira Shimoura / FFCLRP-USP-Ribeirão	Workshop on Stochastic Modelling of Neural Nets and Spike Sorting	São Paulo, SP	May 26, 2015	May 28, 2015
Cesar Augusto Celis Ceballos / FFCLRP-USP-Ribeirão	Workshop on Stochastic Modelling of Neural Nets and Spike Sorting	São Paulo, SP	May 26, 2015	May 28, 2015
Jorge Stolfi / IC-UNICAMP	Research development	São Paulo, SP	May 26, 2015	May 26, 2015
Sergio Neuenschwander Maciel / UFRN	Research development	São Paulo, SP	May 25, 2015	May 28, 2015
Jerome Paul Armand Laurent Baron / UFMG	Research development	São Paulo, SP	May 25, 2015	May 28, 2015
Denise Duarte Scarpa Magalhaes Alves / UFMG	Research development	São Paulo, SP	May 25, 2015	May 27, 2015
Aldana González Montoro / NUMEC-USP	Research development	São Paulo, SP	May 25, 2015	May 30, 2015
Christophe Pouzat / Paris Descartes University	Research development	São Paulo, SP	May 21, 2015	Jun 03, 2015
Yacob Ricardo Fraiman Maus	Research development	São Paulo, SP	May 11, 2015	May 15, 2015
Pablo Augusto Ferrari / NUMEC-USP	Research development	São Paulo, SP	May 05, 2015	May 10, 2015
Bia Ramalho dos Santos Lima / UFRJ	1st NeuroMat Young Researchers Workshop	São Paulo, SP	May 05, 2015	May 07, 2015
Juliana da Silva Maia / UFRJ	1st NeuroMat Young Researchers Workshop	São Paulo, SP	May 05, 2015	May 07, 2015
Maria Luiza Sales Rangel / UFRJ	1st NeuroMat Young Researchers Workshop	São Paulo, SP	May 05, 2015	May 07, 2015
Claudia Domingues Vargas / UFRJ	Research development	São Paulo, SP	May 05, 2015	May 07, 2015
Lidiane Souza da Silva / UFRJ	1st NeuroMat Young Researchers Workshop	São Paulo, SP	May 05, 2015	May 07, 2015
Lucas Martins Stolerman / IMPA	1st NeuroMat Young Researchers Workshop	São Paulo, SP	May 05, 2015	May 07, 2015
Rodrigo Felipe de Oliveira Pena / FFCLRP-USP-Ribeirão	1st NeuroMat Young Researchers Workshop	São Paulo, SP	May 05, 2015	May 07, 2015
Antonio Carlos Roque da Silva Filho / FFCLRP-USP-Ribeirão	Research development	São Paulo, SP	May 05, 2015	May 07, 2015
Lézio Soares Bueno Filho / FFCLRP-USP-Ribeirão	1st NeuroMat Young Researchers Workshop	São Paulo, SP	May 05, 2015	May 07, 2015
Renan Oliveira Shimoura / FFCLRP-USP-Ribeirão	1st NeuroMat Young Researchers Workshop	São Paulo, SP	May 05, 2015	May 07, 2015

Osame Kinouchi Filho / FFCLRP-USP-Ribeirão	Research development	São Paulo, SP	May 05, 2015	May 07, 2015
Cesar Augusto Celis Ceballos / FFCLRP-USP-Ribeirão	1st NeuroMat Young Researchers Workshop	São Paulo, SP	May 05, 2015	May 07, 2015
Hector Julian Tejada Herrera / UFS	Research development	São Paulo, SP	May 04, 2015	May 10, 2015
Verônica Andrea González-López / UNICAMP	Research development	São Paulo, SP	May 04, 2015	May 07, 2015
Jesus Enrique Garcia / UNICAMP	Research development	São Paulo, SP	May 04, 2015	May 07, 2015
Hjalmar Turesson / UFRN	Research development	São Paulo, SP	May 03, 2015	May 09, 2015
Claudia Domingues Vargas / UFRJ	Research development	São Paulo, SP	Apr 29, 2015	May 02, 2015
Alexsandro Giacomo Grimber Gallo / UFS-CAR	Research development	São Paulo, SP	Apr 23, 2015	Apr 24, 2015
Antonio Carlos Roque da Silva Filho / FFCLRP-USP-Ribeirão	Research development	São Paulo, SP	Apr 16, 2015	Apr 16, 2015
Claudia Domingues Vargas / UFRJ	Research development	São Paulo, SP	Apr 15, 2015	Apr 16, 2015
Dario Augusto Borges Oliveira / UFRJ	Research development	São Paulo, SP	Apr 05, 2015	Apr 18, 2015
Claudia Domingues Vargas / UFRJ	Research development	São Paulo, SP	Mar 25, 2015	Mar 26, 2015
Wenceslao González Mantega / Universidad de Santiago de Compostela	Research development	São Paulo, SP	Mar 21, 2015	Mar 25, 2015
Manuel Febrero Bande / Universidad de Santiago de Compostela	Research development	São Paulo, SP	Mar 21, 2015	Mar 25, 2015
Pedro Valdes Sosa / CNEURO-Cuba	Research development	São Paulo, SP	Mar 16, 2015	Mar 17, 2015
Claudia Domingues Vargas / UFRJ	Research development	Belo Horizonte, MG	Mar 16, 2015	Mar 17, 2015
Guillem Via Rodriguez / Universidad Autónoma de Barcelona	Research development	São Paulo, SP	Mar 14, 2015	Mar 29, 2015
Lidiane Souza da Silva / UFRJ	Research development and 1st Latin American Brain Mapping Network Meeting	São Paulo, SP	Mar 12, 2015	Mar 15, 2015
Lidiane Souza da Silva / UFRJ	1st Latin American Brain Mapping Network Meeting	São Paulo, SP	Mar 12, 2015	Mar 15, 2015
Claudia Domingues Vargas / UFRJ	1st Latin American Brain Mapping Network Meeting	São Paulo, SP	Mar 11, 2015	Mar 14, 2015
Dario Augusto Borges Oliveira / UFRJ	Research development	São Paulo, SP	Mar 08, 2015	Mar 21, 2015
Diogo de Carvalho Pedrosa / ICMC-USP-São Carlos	Research development	São Paulo, SP	Mar 08, 2015	Mar 21, 2015

Diogo de Carvalho Pedrosa / ICMC-USP-São Carlos	Research development	São Paulo, SP	Feb 23, 2015	Feb 26, 2015
Jefferson Antonio Galves / IME-USP	Research development	Paris, França	Feb 20, 2015	Feb 27, 2015
Diogo de Carvalho Pedrosa / ICMC-USP-São Carlos	Research development	São Paulo, SP	Feb 13, 2015	Feb 27, 2015
Jefferson Antonio Galves / IME-USP	Research development	Paris, França	Feb 09, 2015	Feb 16, 2015
Diogo de Carvalho Pedrosa / ICMC-USP-São Carlos	Research development	São Paulo, SP	Feb 02, 2015	Feb 13, 2015
Antonio Carlos Roque da Silva Filho / FFCLRP-USP-Ribeirão	Research development	São Paulo, SP	Jan 27, 2015	Jan 28, 2015
Jefferson Antonio Galves / IME-USP	Research development	Rio de Janeiro, RJ	Jan 16, 2015	Jan 17, 2015
Claudia Domingues Vargas / UFRJ	Research development	São Paulo, SP	Dec 10, 2014	Dec 11, 2014
Evandro Santos Rocha / NUMEC-USP	Research development	Rio de Janeiro, RJ	Dec 03, 2014	Dec 04, 2014
Claudia Domingues Vargas / UFRJ	Research development	São Paulo, SP	Nov 25, 2014	Nov 26, 2014
Victor Hugo Oliveira e Souza	Research development	São Paulo, SP	Nov 25, 2014	Nov 28, 2014
Lucas Martins Stolerma / IMPA	Research development	São Paulo, SP	Nov 24, 2014	Nov 27, 2014
Michelle Ferreira Miranda / IME-USP	Research development	Chapel Hill, NC USA	Nov 19, 2014	Dec 05, 2014
Christophe Pouzat / Paris Descartes University	Research development	São Paulo, SP	Nov 17, 2014	Nov 30, 2014
Claudia Domingues Vargas / UFRJ	Research development	São Paulo, SP	Nov 05, 2014	Nov 07, 2014
Sergio Ocazonez / UFRN	Research development	São Paulo, SP	Nov 02, 2014	Nov 06, 2014
Kerstin Erika Schmidt / UFRN	Research development	São Paulo, SP	Nov 02, 2014	Nov 06, 2014
Michelle Ferreira Miranda / IME-USP	Research development	Rio Claro, SP	Oct 22, 2014	Oct 22, 2014
Claudia Domingues Vargas / UFRJ	Research development	São Paulo, SP	Oct 22, 2014	Oct 23, 2014
Claudia Domingues Vargas / UFRJ	Research development	São Paulo, SP	Oct 15, 2014	Oct 18, 2014
Daniel Fraiman Borrazas / Universidad de San Andrés	Research development	São Paulo, SP	Oct 14, 2014	Oct 20, 2014
Claudia Domingues Vargas / UFRJ	Research development	São Paulo, SP	Oct 08, 2014	Oct 10, 2014
Rosa Franquet Calvet / Universidad Autónoma de Barcelona	Research development	São Paulo, SP	Oct 06, 2014	Oct 17, 2014
Claudia Domingues Vargas / UFRJ	Research development	São Paulo, SP	Sep 24, 2014	Sep 25, 2014

Jesus Enrique Garcia / UNICAMP	Research development	São Paulo, SP	Sep 12, 2014	Sep 12, 2014
Kelly Rosa Braghetto / IME-USP	XXXVIII Reunião Anual da SB-NeC – Sociedade Brasileira de Neurociências e Comportamento	Rio de Janeiro, RJ	Sep 10, 2014	Sep 13, 2014
Bruno Monte de Castro / IME-USP	18th EEGLAB Workshop	Rio de Janeiro, RJ	Sep 06, 2014	Sep 14, 2014
Jerome Paul Armand Laurent Baron / UFMG	Research development	São Paulo, SP	Aug 31, 2014	Sep 06, 2014
Claudia Domingues Vargas / UFRJ	Research development	São Paulo, SP	Aug 27, 2014	Aug 29, 2014
Eva Löcherbach / UCERJ	Research development	São Paulo, SP	Aug 26, 2014	Sep 06, 2014
Roberto Imbuzeiro Moraes Felinto de Oliveira / IMPA	Research development	São Paulo, SP	Aug 21, 2014	Aug 22, 2014
Jefferson Antonio Galves / IME-USP	Research development	Natal, RN	Aug 13, 2014	Aug 17, 2014
Bruno Monte de Castro / IME-USP	Summer School on “Physics and Neuroscience”	Natal, RN	Aug 10, 2014	Aug 16, 2014
Michelle Ferreira Miranda / IME-USP	Summer School on “Physics and Neuroscience”	Natal, RN	Aug 10, 2014	Aug 16, 2014
Aldana González Montoro / NUMEC-USP	Summer School on “Physics and Neuroscience”	Natal, RN	Aug 10, 2014	Aug 17, 2014
Jefferson Antonio Galves / IME-USP	37th Conference on Stochastic Processes and their Applications	Buenos Aires, Argentina	Jul 27, 2014	Aug 02, 2014
Claudia Domingues Vargas / UFRJ	Research development	São Paulo, SP	Jul 23, 2014	Jul 25, 2014
Michelle Ferreira Miranda / IME-USP	Research development	Rio de Janeiro, RJ	Jul 18, 2014	Jul 24, 2014
Dario Augusto Borges Oliveira / UFRJ	Research development	São Paulo, SP	Jul 15, 2014	Jul 30, 2014
Aldana González Montoro / NUMEC-USP	Research development	Natal, RN	Jul 14, 2014	Jul 22, 2014
Lucas Martins Stoleran / IMPA	Research development	São Paulo, SP	May 05, 2014	May 07, 2015

3 Dissemination report

3.1 Milestone: NeuroMat Educational Activities

One of the main outreach activities of NeuroMat is the dissemination of scientific knowledge on mathematics and neuroscience to the public. A key element of this endeavor is the development of educational activities involving school teachers and students. Brazilian primary and secondary students have traditionally displayed a low performance in international tests of basic education (e.g. Programme for International Student Assessment - PISA), and this is having a significant negative impact on the growth and development of the nation.

Our strategy to contribute to improve this situation is to coordinate activities with great potential of directly affecting students' and teachers' perception and attitude towards science and mathematics. These activities involve training courses for teachers and promotion of hands-on science activities in schools. In parallel, we also develop extra school activities to enhance science awareness among the population at large.

Besides our engagement in educational activities for school children and the public in general, NeuroMat is also concerned with the dissemination of the use of mathematical and computational tools to approach neuroscience problems among the academic community. The activities mentioned above constitute what we will call educational activities in this report. Below we give a description of NeuroMat's educational activities in the period.

3.1.1 Training courses for teachers

NeuroMat offered in April 2015 a free course to public school teachers entitled "Estatística e Neurociências para a Sala de Aula: construção de práticas pedagógicas." The course was held at the Municipal School Desembargador Amorim Lima, in São Paulo, which is a NeuroMat partner in our education initiative. The course was divided into two modules of six hours each, one for statistics and the other for neuroscience.

The first module took place on April 11 and was coordinated by Dr. Lisbeth Cordani (Instituto de Matemática e Estatística - USP), who has a long term experience in teaching and training middle and high school teachers in statistics, and Dr. André Frazão (Instituto de Biologia - USP), who is developing new educational resources on neuroscience.

They were helped in their activities by Drs. Daniela Scarpa and Suzana Ursi (Instituto de Biologia - USP) and USP students supported by scholarships from Programa Institucional de Bolsa de Iniciação à Docência (PIBID) of Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES). Forty teachers and educators participated of the training course, and the general evaluation was that the quality of the course was very good. Further information on the activities developed in the course can be seen at <http://neuromat.numec.prp.usp.br/content/neuromat-organizes-meeting-strengthen-relationship-between-public-schooling-and-contemporary>.

The course will be continued with eight more hours in August, so that teachers and educators will have a 20-hour course. The expectation is that participants of the course will receive an original NeuroMat course booklet.

3.1.2 Science activities in schools

NeuroMat members Drs. Daniela Scarpa and Suzana Ursi (IB-USP) have coordinated PIBID projects in partnership with four public schools in São Paulo area. These projects are aimed at increasing the awareness of school students in neuroscience and environmental questions using, among others, mathematical and statistical tools.

These projects have involved four high school teachers (one per school), approximately 350 students in the four schools, and 28 USP undergraduate students with PIBID scholarships (7 students per school). With NeuroMat support, student groups at the schools are developing hands-on science projects which will result in portable demonstration experiments (products).

Undergraduate students participated in the course offered in April. Elements of this workshop have been used as a source for actions that were developed in schools, either as conceptual content approach (senses, its relations with other systems) or as procedural content (such as use of quantitative approaches to investigate different aspects of nature). In July, undergraduate students are developing four didactic sequences, which will be applied in schools.

In parallel to this action, a pilot initiative on statistics is being developed with the Municipal School Desembargador Amorim Lima. Since February 2015, students from the 8th grade (approximately 90 students divided in four groups) have had one hour per week of activities on statistics, such as measuring and collecting data and representing them – including the use of computers and free softwares (Libre Office Calc), interpretation of graphs, research on public databases, data based journalism and probability. These activities (that sum almost 80 hours of work in class, 20 per group) are being created or adapted by Simone Bega Harnik and supported by Lisbeth Cordani and three mathematics teachers of the partner school Amorim Lima. It is expected that this activity shall lead to the creation of an open website with content and production of this initiative.

The table below summarizes the ongoing NeuroMat projects in schools:

School	District	Area of the action	Grade	Students involved	Undergraduate monitors
Emef Deputado César Arruda Castanho	Jardim Cambara	Neuroscience and biology	7th	70	7
Emef Prof.a Ileusa Caetano Silva	Jardim Educandário	Neuroscience and biology	6th	70	7
EE Canuto Do Val	Barra Funda	Neuroscience and biology	8th	140	7
Emef Desembargador Amorim Lima	Vila Gomes	Neuroscience and biology	8th	70	7
Emef Desembargador Amorim Lima	Vila Gomes	Statistics	8th	90	1

An expected activity to happen during the second term of 2015 is an exhibition of projects from the four schools. Some of them will be selected by a committee of NeuroMat members and school teachers, and are expected to be shown at a science fair to be held at USP in November 2015.

3.1.3 Extra school activities

The Brain Awareness Week is a global campaign to increase public awareness of the progress and benefits of brain research. It happens every March and in 2015 it was from March 16-22. NeuroMat participated for the first time in this campaign with three activities coordinated by Drs. Antonio Galves and André Frazão and the postdoctoral fellow Ludmila Rodrigues, with lectures and debates in three schools of São Paulo.

3.2 Milestone: NeuroCineMat

FAPESP’s CEPID NeuroMat dissemination team has been working on three movies. These remain original productions to present aspects of the work pertaining to Neuromathematics. “Spike Sorting: Ontology Droplet” was released in June, 2015. A short movie on Open Science and a filmed document of an experiment on brain and rhythms should be released in the fall, 2015. “Spike Sorting: Ontology Droplet” has been seen as the first of a series of what has been called a NeuroCineMat initiative.

“Spike Sorting: Ontology Droplet” is a nine-minute-long introduction and step-by-step presentation of a mathematical technique to identify and classify neuronal spikes. It features Prof. Christophe Pouzat, a researcher of the Applied Maths Laboratory of the Paris-Descartes University and a specialist in spike sorting. The movie is available with subtitles in English (original language) and in Portuguese on Wikimedia Commons and Youtube, respectively at https://commons.wikimedia.org/wiki/File:Spike_Sorting,_Christophe_Pouzat,_NeuroMat.webm and <https://www.youtube.com/watch?v=vSydfDvsewY>. Wikimedia Commons is an online repository of images and media

files that are used on Wikipedia and across Wikimedia projects in all languages. Released under a Creative Commons license (CC BY-SA 3.0), the movie may be freely shared, as long as original attribution is properly specified.

This NeuroMat movie was acknowledged as “Media of the Day” (June 10) on Wikimedia Commons and displayed on the front page of over 200 related websites. A list of websites that have published the NeuroMat movie is available on the aforementioned link to Wikimedia Commons. Produced and edited as relatively easy-to-grasp content, the movie was made available on Wikipedia entries on spike sorting in English and Portuguese. In June, these Wikipedia entries and the Wikimedia Commons file had together 795 views. On Youtube, the movie was viewed 153 times in June.

The production of this film on spike sorting remained a by-product of a collective effort around the NeuroMat training “Spike sorting: What is it? Why do we need it? Where does it come from? How is it done? How to interpret it?,” at the end of November, 2014. An international landmark, this training attracted the interest of a wide audience; more information on this event is available at <http://neuromat.numec.prp.usp.br/content/goals-challenges-and-horizons-spike-sorting>.

The image shows a screenshot of a Wikimedia Commons page. On the left is the standard Commons sidebar with navigation links. The main content area is titled "File:Spike Sorting, Christophe Pouzat, NeuroMat.webm". Below the title, there are download and usage options. The central part of the page features a video player with a thumbnail showing a 4x4 grid of Principal Component Analysis (PCA) plots. A play button is overlaid on the center of the grid. To the right of the video, there is a text box stating: "PCA is available in the free software R (library stats, function prcomp) and in other statistical packages." Below the video player, there is a "Summary" section with a table containing the following information:

Description	English: Spike sorting: an ontology droplet
Date	3 June 2015
Source	Own work
Author	Joalpe

At the bottom of the page, a yellow banner contains the following text: "This file was selected as the **media of the day** for 10 June 2015. It was captioned as follows: **English:** Mathematician Christophe Pouzat explains the technique to sort neuronal spikes. Other languages

Figure 2: Copy of the Wikimedia Commons page of “Spike Sorting: Ontology Droplet,” a NeuroMat movie released in June, 2015. At the bottom, the acknowledgment of the Wikimedia Commons for the high quality of the movie (Media of the Day award).

A NeuroMat movie on open science, a foundational pillar to advancing Neuromathematics, is available on: <https://vimeo.com/132956939> (password: paraaprovação). This film is still under production, so it is not available to the public yet.

A NeuroMat movie on an experiment on rhythms and brain patterns, based on an original research by NeuroMat

members, is available on: <https://vimeo.com/132960118> (password: paraaprovação). This film is still under production, so it is not available to the public yet.

3.3 NeuroMat media exposure

Activities from FAPESP'S CEPID NeuroMat were featured in fifteen external media outlets since July 1st, 2014. Summing this up to the results of media exposure from the last report NeuroMat was the object of 26 news pieces in two years.

Three news pieces from this current report are worth highlighting. Karina Toledo, from Agência FAPESP, produced in December, 2014 a piece on the launching of NeuroMat's software Neuroscience Experiments System, which was reprinted in hundreds of media outlets and sparked a general interest in this technological product, including foreign science and technology journalists. Paula Rothman, from INFO Exame, published an in-depth paper on NeuroMat's internal dynamics and research agenda, which contributed to advancing in the direction of connecting high-level scientific work and broad audiences. Aline Naoe, from USP Online, produced a video on NeuroMat's First Young Researchers Workshop, which was featured at the University of São Paulo's front page.

References to NeuroMat in media outlets were related to the work on neuroscientific public databases within NeuroMat (5), the development of a mathematical theory of the brain (3), NeuroMat's Wikipedia Initiative (3), the work on NeuroMat's scientific dissemination (2) and NeuroMat events (2). The NeuroMat clipping is available at: <http://neuromat.numec.prp.usp.br/news>.

Title	Authors	Media outlet	Topics	URL	Date
Centros de Pesquisa, Inovação e Difusão (Cepids) estarão na 67 ^a reunião da SBPC	Unidentified authors	Blog da USP	NeuroMat Research Event	http://www.usp.br/imprensa/?p=50902	Jul 08, 2015
Busca por uma teoria matemática do cérebro reúne jovens cientistas na USP	Aline Naoe	USP Online	NeuroMat Research Event	http://neuromat.numec.prp.usp.br/content/video-neuromat-young-researchers-meeting	May 08, 2015
Cálculo Nervoso	Paula Rothman	Info Exame	Mathematical theory of the brain: NeuroMat model	http://neuromat.numec.prp.usp.br/content/nervous-calculus	Apr 28, 2015
NES - NeuroMat - Browser-based data collection	Unidentified authors	Labrigger	Neuroscientific public databases: NeuroMat technological transfer	http://neuromat.numec.prp.usp.br/content/nesc-neuromat-browser-based-data-collection	Feb 05, 2015
NeuroMat lança o Neuroscience Experiments System	Alexandre Moura	Paraíba Online	Neuroscientific public databases: NeuroMat technological transfer	http://neuromat.numec.prp.usp.br/content/neuroscience-neuromat-releases-neuroscience-experiments-system-nes	Jan 10, 2015

Centro da USP desenvolve software livre para o gerenciamento de dados de experimentos em neurociência	Unidentified authors	Wikinews	Neuroscientific public databases: NeuroMat technological transfer	http://neuromat.numec.prp.usp.br/content/research-center-university-sao-paulo-launches-open-source-software-manage-neuroscientific	Jan 05, 2015
Software livre ajuda a gerenciar dados de experimentos em Neurociência	Karina Toledo	Agência FAPESP	Neuroscientific public databases: NeuroMat technological transfer	http://neuromat.numec.prp.usp.br/content/free-software-helps-data-management-neuroscience-experiments	Dec 12, 2014
Sidarta Ribeiro dissemina ciência	William Melo	Revista Circuito	NeuroMat and scientific dissemination	http://neuromat.numec.prp.usp.br/content/prof-sidarta-ribeiro-spreads-neuroscience	Nov 14, 2014
Neuromat oferece curso de medição de disparos neuronais	Unidentified authors	Mente e Cérebro	Mathematical theory of the brain: NeuroMat model	http://neuromat.numec.prp.usp.br/content/neuromat-offers-training-spike-sorting	Nov 11, 2014
Wikipédia pode reinventar as provas escolares	André Jorge de Oliveira	Revista Galileu	NeuroMat Wikipedia Initiative	http://neuromat.numec.prp.usp.br/content/wikipedia-may-invigorate-educational-activities	Sep 11, 2014
Ciência para todos: entrevista com o Prof. Ernst Hamburger	Antonio Augusto Passos Videira, Sofia Moutinho	Ciência Hoje	NeuroMat and scientific dissemination	http://neuromat.numec.prp.usp.br/content/science-all-interview-prof-ernst-wolfgang-hamburger	Aug 01, 2014
A Wikipédia, um bem público global	João Alexandre Peschanski	Boletim Cidadania	NeuroMat Wikipedia Initiative	http://neuromat.numec.prp.usp.br/content/neuromathematics-through-new-technologies	Aug 01, 2014
A ciência precisa ser aberta	Kelly Rosa Braghetto	ARede	Neuroscientific public databases: NeuroMat technological transfer	http://neuromat.numec.prp.usp.br/content/science-must-be-open	Aug 01, 2014
Centro de pesquisa da USP investe em difusão científica 'wiki'	Unidentified authors	Wikinews	NeuroMat Wikipedia Initiative	http://neuromat.numec.prp.usp.br/content/research-center-invests-wiki-scientific-dissemination	Jul 16, 2014

NeuroMat estuda como cérebro processa estímulo externo	Aline Naoe	Agência USP de Notícias	Mathematical theory of the brain: NeuroMat model	http://neuromat.numec.prp.usp.br/content/neuromat-investigates-how-brain-processes-external-stimuli	Jul 16, 2014
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Agência FAPESP
NOTÍCIAS
AGENDA
VÍDEOS
ASSINE

Software livre ajuda a gerenciar dados de experimentos em Neurociência

12 de dezembro de 2014

Por Karina Toledo

Agência FAPESP – O Centro de Pesquisa, Inovação e Difusão em Neuromatemática ([NeuroMat](#)) – um dos CEPIDs apoiados pela FAPESP – acaba de lançar o primeiro módulo do software livre Neuroscience Experiments System (NES), que auxilia na organização, controle e gerenciamento de dados neurofisiológicos clínicos e experimentais.

Essa primeira versão da ferramenta, disponível para download no site <https://github.com/neuromat/nas>, foi concebida para oferecer uma interface amigável para o armazenamento de dados clínicos e avaliações médicas de pacientes e voluntários de experimentos. Além disso, há uma interface para o gerenciamento dos questionários eletrônicos aplicados nas pesquisas.

“O software integra um projeto de construção de um banco de dados neurofisiológicos público, organizado pelo CEPID NeuroMat, uma iniciativa pioneira em Neurociência. Além disso, esperamos que essas iniciativas facilitem a cooperação entre pesquisadores”, disse Kelly Rosa Braghetto, professora do Departamento de Ciência da Computação do Instituto de Matemática e Estatística da Universidade de São Paulo (IME-USP) e membro do grupo responsável pelo desenvolvimento do NES.

Criado em 2013 na USP, o NeuroMat reúne cerca de 50 pesquisadores de áreas como Matemática, Ciência da Computação, Estatística, Neurociência, Biologia, Física e Comunicação, de universidades brasileiras e estrangeiras. O objetivo do grupo é integrar modelagem matemática e Neurociência, em busca de uma maior compreensão do funcionamento do cérebro humano.

De acordo com Braghetto, o primeiro módulo do software NES foi construído usando como modelo os experimentos conduzidos no Instituto de Neurologia Deolindo Couto (INDC), da Universidade Federal do Rio de Janeiro (UFRJ), sob a coordenação da professora Claudia Vargas, uma das pesquisadoras principais do CEPID.



Programa está sendo desenvolvido pela equipe do Centro de Pesquisa, Inovação e Difusão em Neuromatemática (NeuroMat), um dos CEPIDs apoiados pela FAPESP. Primeiro módulo já está disponível para download (foto: Juan Ojeda)

Figure 3: Copy of pages from “Software livre ajuda a gerenciar dados de experimentos em Neurociência,” by Karina Toledo, Agência FAPESP, 12/12/2014.



Figure 4: Copy of the University of São Paulo's front page in May, 2015, featuring a video on NeuroMat's First Young Researchers Workshop



Figure 5: Copy of pages from “Cálculo Nervoso,” by Paula Rothman, INFO Exame, 04/28/2015.

3.4 NeuroMat web portal

The NeuroMat web portal received a total of 5,422 users and 27,405 page views from July, 1, 2014 to July, 5, 2015. 59,19% of these users are automatically computed as new visitors, which suggests that the portal has reached new audiences. In the last report, 2,057 users and 19,531 page views had been recorded. This data is made available through a web analytics applet.

The NeuroMat web portal was launched in early February, 2014, and a design and framework update is expected to be undertaken. The web site was built in two languages: Portuguese and English. The effort of translating the texts is based on the principle of the internationalization of science, in special mathematics, neuroscience and neuromathematics produced in Brazil. The main results of this communication outlet are:

	1st NeuroMat report (2014)	2nd NeuroMat report (2015)
Users	2,057	5,422
Page views	19,531	27,405
Sessions	3,897	8,981
Pages per session	5.01	3.05
Average time on each session (minutes)	5.33	3.20
Non-Brazilian users	44,32%	48,23%

3.5 Online lectures

FAPESP's CEPID NeuroMat has released seven online lectures since October, 2014. This is part of NeuroMat's general engagement to offer broad access to research in the making. Lectures are available at: <http://neuromat.numec.prp.usp.br/lectures>.

Title	Lectures	Date	URL
Functional Regression Analysis	Manuel Febrero Bande, Univ. de Santiago de Compostela, Spain	Apr 10, 2015	http://neuromat.numec.prp.usp.br/content/functional-regression-analysis
Goodness-of-fit tests for regression models: the functional data case	Wenceslao González-Manteiga, Univ. de Santiago de Compostela, Spain	Apr 10, 2015	http://neuromat.numec.prp.usp.br/content/goodness-of-fit-tests-regression-models-functional-data-case
An introduction to the storage of experimental data in neuroscience	Kelly Braghetto (DCC-IME-USP) and Amanda Nascimento (DC-UFOP)	Mar 24, 2015	http://neuromat.numec.prp.usp.br/content/introduction-storage-experimental-data-neuroscience
Spike sorting: What is it? Why do we need it? Where does it come from? How is it done? How to interpret it?	Prof. Christophe Pouzat, Applied Maths Laboratory of the Paris-Descartes University	Nov 24, 2014	http://neuromat.numec.prp.usp.br/content/spike-sorting-what-it-why-do-we-need-it-where-does-it-come-how-it-done-how-interpret-it
Mathematical and computational challenges of neuroscience	Michelle Miranda and Evandro Santos Rocha, NeuroMat	Oct 29, 2014	http://neuromat.numec.prp.usp.br/content/mathematical-and-computational-challenges-neuroscience
An elementary introduction to the stochastic modelling of symbolic chains	Antonio Galves, NeuroMat principal investigator and professor at the University of São Paulo's Institute of Mathematics and Statistics	Oct 20, 2014	http://neuromat.numec.prp.usp.br/content/elementary-introduction-stochastic-modelling-symbolic-chains
Data Provenance and Scientific Workflow Management	Kelly Rosa Braghetto, University of São Paulo's Department of Computer Science	Oct 16, 2014	http://neuromat.numec.prp.usp.br/content/data-provenance-and-scientific-workflow-management

NeuroMat has also provided full access to presentations in conferences and workshops it organized, a total of 24 slideshows from the First NeuroMat Young Researchers Workshop, in May, 2015, that adds up to 23 presentations from the First Workshop of FAPESP’s Center for Neuromathematics, in January, 2014.

3.6 Online streaming

FAPESP’s CEPID NeuroMat has provided live and non-live streaming of special events. This includes:

- 5 videos of the First NeuroMat Young Researchers Workshop, published on May, 13, 2015. Live viewers: 280; Non-live viewers: 160; Hours of transmission: 14,2. Language: English. Available at <http://neuromat.numec.prp.usp.br/content/streaming-first-neuromat-young-researchers-workshop>.
- 3 videos of NeuroMat’s training “Spike sorting: What is it? Why do we need it? Where does it come from? How is it done? How to interpret it?,” published on December, 4, 2014. Live viewers: 2007; Non-live viewers: 201; Hours of transmission: 5,1. Language: English. Available at <http://neuromat.numec.prp.usp.br/content/spike-sorting-prof-christophe-pouzats-2014-training>.

3.7 NeuroMat newsletter

The NeuroMat newsletter has had 17 issues since it was first released in February 2014. It runs monthly, generally being sent to subscribers at the end of each month. All issues may be read at: <http://neuromat.numec.prp.usp.br/newsletter/neuromat>. The general structure of the newsletter remains having one or more core articles that show aspects of research in the making or important initiatives that NeuroMat is involved with, a list of new media references to NeuroMat and scientific publications, and position opportunities and other pertaining information.

The NeuroMat newsletter is distributed to around 550 people —150 people subscribed to the newsletter since last report. Topics that are covered in special articles are at the forefront of what NeuroMat achieves, including advances in research, technological transfer and scientific dissemination.

Key articles that were produced exclusively to the newsletter are:

Title	Topics	URL	Date
“Spike Sorting,” a NeuroMat movie	NeuroMat and scientific dissemination	http://neuromat.numec.prp.usp.br/content/spike-sorting-neuromat-movie	Jul 30, 2015
Advances in the modelling of a system of interacting neurons	Mathematical theory of the brain: NeuroMat model	http://neuromat.numec.prp.usp.br/content/advances-modelling-system-interacting-neurons	May 31, 2015
First NeuroMat Young Researchers Workshop: a kickoff for renewed collaborations in Neuromathematics	NeuroMat Research Event	http://neuromat.numec.prp.usp.br/content/first-neuromat-young-researchers-workshop-kickoff-renewed-collaborations-neuromathematics	May 26, 2015
NeuroMat organizes meeting to strengthen the relationship between public schooling and contemporary science	NeuroMat and scientific dissemination	http://neuromat.numec.prp.usp.br/pt-br/content/neuromat-realiza-encontro-para-fortalecer-dialogo-entre-educacao-basica-e-ciencia	Apr 30, 2015

A NeuroMat Statistics and Neuroscience course to contribute to public school teaching	NeuroMat and scientific dissemination	http://neuromat.numec.prp.usp.br/content/neuromat-statistics-and-neuroscience-course-contribute-public-school-teaching	Feb 27, 2015
The virtuous cycle of research, communication and education: an interview with Prof. Antonio Carlos Roque	NeuroMat and scientific dissemination	http://neuromat.numec.prp.usp.br/content/virtuous-cycle-research-communication-and-education-interview-prof-antonio-carlos-roque	Jan 30, 2015
NeuroMat scientific dissemination to emphasize new media technologies	NeuroMat and scientific dissemination	http://neuromat.numec.prp.usp.br/content/neuromat-scientific-dissemination-emphasize-new-media-technologies	Jan 26, 2015
MEPHunter, a free software for signal visualization and analysis	Neuroscientific public databases: NeuroMat technological transfer	http://neuromat.numec.prp.usp.br/content/mephunter-free-software-signal-visualization-and-analysis	Dec 18, 2014
A NeuroMat software, NES makes the headlines	Neuroscientific public databases: NeuroMat technological transfer	http://neuromat.numec.prp.usp.br/content/neuromat-software-nes-makes-headlines	Dec 18, 2014
Goals, challenges and horizons of spike sorting	Mathematical theory of the brain: NeuroMat model	http://neuromat.numec.prp.usp.br/content/goals-challenges-and-horizons-spike-sorting	Nov 28, 2014
NeuroMat develops an open-source software for the management of neuroscience experimental data	Neuroscientific public databases: NeuroMat technological transfer	http://neuromat.numec.prp.usp.br/content/neuromat-develops-open-source-software-management-neuroscience-experimental-data	Oct 31, 2014
LimeSurvey, a key tool for open-science data building	Neuroscientific public databases: NeuroMat technological transfer	http://neuromat.numec.prp.usp.br/content/limesurvey-key-tool-open-science-data-building	Oct 20, 2014
NeuroMat shares team members' lectures	NeuroMat and scientific dissemination	http://neuromat.numec.prp.usp.br/lectures	Oct 19, 2014
NeuroMat releases report of first-year activities	NeuroMat and scientific dissemination	http://neuromat.numec.prp.usp.br/content/neuromat-releases-report-first-year-activities	Oct 09, 2014
The challenges of making news reports on cutting-edge, ongoing science	NeuroMat and scientific dissemination	http://neuromat.numec.prp.usp.br/content/challenges-making-news-reports-cutting-edge-ongoing-science	Sep 30, 2014
NeuroMat researcher develops Bayesian models to make sense of brain patterns in EEGs	Mathematical theory of the brain: NeuroMat model	http://neuromat.ime.usp.br/content/neuromat-researcher-develops-bayesian-models-make-sense-brain-patterns-eeegs	Sep 30, 2014

NeuroMat researchers to take part in Scientific Festival at São Paulo	NeuroMat and scientific dissemination	http://neuromat.numec.prp.usp.br/content/neuromat-researchers-take-part-scientific-festival-s-ao-paulo	Sep 29, 2014
Follow NeuroMat on Facebook and Youtube	NeuroMat and scientific dissemination	http://neuromat.numec.prp.usp.br/content/follow-neuromat-facebook-and-youtube	Aug 25, 2014

3.8 NeuroMat Facebook page

The NeuroMat Facebook page (<https://www.facebook.com/neuromathematics>) remains a communication tool created to disseminate through short texts and media content events, news and other types of information on NeuroMat projects and members. Publications on this social network platform are made daily. Since its creation (9/20/2014), the page has reached approximately 400 likes organically (without paid aids).

Some of the most impactful posts are listed below:

Published	Post	Reach	URL
Apr 28, 2015	EVENT: Researchers from at least four universities will come to talk on advances and challenges of developing Neuromathematics, from May 5 to 7, at the University of São Paulo...	610	https://www.facebook.com/neuromathematics/posts/851301851597297
Jun 30, 2015	ARTS - Juan Ojea, a plastic artist, has created this image to represent NeuroMat. The composition was based on the photo of the masterpiece "Planet", by Leon Ferrari...	371	https://www.facebook.com/neuromathematics/photos/a.738376036223213.1073741828.689929331067884/879146865479462/?type=1&theater
May 27, 2015	NEWS - NeuroMat hosts, from May 26 to May 28 the Workshop on Stochastic Modelling of Neural Nets and Spike Sorting, in São Paulo. There are talks and work sessions with researchers from institutions in Brazil and France...	333	https://www.facebook.com/neuromathematics/posts/862821983778617
Apr 24, 2015	EVENT: Sandro Gallo from UFSCar, gives a talk in the probability seminar at Numec. The event occurred on April 23, at 2 pm. The title of the talk was "Dynamic uniqueness for chains with long range memory"...	247	https://www.facebook.com/neuromathematics/posts/849402768453872
Jul 02, 2015	EVENT - Aline Duarte de Oliveira, a NeuroMat researcher, presents her PhD public defense on 17th July, 10:30 A.M. Her doctoral advisor is Prof. Antonio Galves and Professors Pablo Augusto Ferrari (IME-USP), Eva Löcherbach (Université de Cergy-Pontoise), Jacob Ricardo Fraiman Maus (Universidad de la República) and Claudia Domingues Vargas (UFRJ) will be the jury members...	243	https://www.facebook.com/neuromathematics/posts/881028538624628

Jun 24, 2015	TEAM MEMBERS - NeuroMat researcher Aldana González Montoro has assumed a position in Facultad de Matemática, Astronomía y Física at Universidad Nacional de Cordoba in Argentina. She keeps working and collaborating with NeuroMat team...	234	https://www.facebook.com/neuromathematics/photos/a.738376036223213.1073741828.689929331067884/878700352190780/?type=1&theater
May 11, 2015	A short video on the goals of the First NeuroMat Young Researchers Workshop, produced by Aline Naoe, from USP Online. This video is currently a highlight at the front page of the University of São Paulo's webpage. (In Portuguese)...	222	https://www.facebook.com/neuromathematics/posts/856450764415739
Jul 04, 2015	WORK IN PROGRESS - Profs. Antonio Galves, Miguel Abadi and Jorge Stolfi visited, 1st and 2nd July, Profs. Antonio Roque, Osame Kinouchi and other members of NeuroMat at USP in Ribeirão Preto. Here we can see part of the researching process. The aim of this scientific meeting was to discuss a computer model of the cortex based on the stochastic model recently proposed by Galves and Eva Löcherbach...	212	https://www.facebook.com/neuromathematics/posts/883011341759681

3.9 NeuroMat Wikipedia initiative

FAPESP's CEPID NeuroMat has continued its effort around a Wikipedia Initiative, which was launched in 2014. As stated in the previous report, "This Initiative aims at ensuring that articles on Neuromathematics (research, terminology, theory) are up-to-date, complete, and written in a style that is neutral and appropriate for the general public, as well as based on reliable sources, and assessing Neuromathematics-related articles and tagging them appropriately when problems are found." Accomplishments on this initiative since last report were:

- the organization of a NeuroMat edit-a-thon, on May 5 and 6, 2015. An "edit-a-thon," as defined on the global encyclopedia Wikipedia, is "an event where editors get together to edit and improve a specific topic or type of content, typically including basic editing training for new editors," thus being a "portmanteau of 'edit' and 'marathon'." During this NeuroMat activity, attendees organized groups and worked on specific entries in the Portuguese version of Wikipedia, such as "Neuromatemática", "Somatotopia", "Função densidade" and "Cadeias estocásticas com memória de alcance variável" An assessment of this activity may be found on a special [Wikipedia page](#) and on [NeuroMat's 16th Newsletter](#).
- a systematic uploading of pictures and movies pertaining to NeuroMat activities on the free, open repository of images Wikimedia Commons. A consequence of this is that several pictures that were produced by the NeuroMat scientific dissemination team have been used to illustrate entries on scientific matters on Wikipedia and other platforms. An illustration is that the picture that is featured on the entries in several languages on Ernst Hamburger remains a NeuroMat production.
- a continuous effort to improve content on Wikipedia and other Wikimedia platforms, especially in Portuguese and English. This includes the creation of the Portuguese entry "Classificação de disparos neuronais" (Spike Sorting) on Wikipedia, in the context of the production of the movie "Spike Sorting: Ontology Droplet" and the creation of the Portuguese entry "Neuromatemática" (Neuromathematics) on Wiktionary.
- two scientific productions —one accepted, one submitted— on the use of Wikipedia and other Wikimedia platforms as tools for education and scientific dissemination. These pieces are listed on the NeuroMat scientific report.

3.10 NeuroMat game development

NeuroMat has developed an online game to bring together dissemination and science. Provisory called “Neuro-penalty,” the game rests upon mathematical tools that are at the core of NeuroMat’s scientific endeavor.

In the game, the user takes the role of a goalkeeper and has to find out the strategy pattern of an automated kicker. The pattern is a chain, with memory of variable length, thus being akin to NeuroMat’s scientific work. Game results —type of decision, rate of success— could lead to datasets to be interpreted scientifically.

The game development has started in June, and a first version is expected to be over in early August. The game will be available on portable devices and computers. The source code is open.

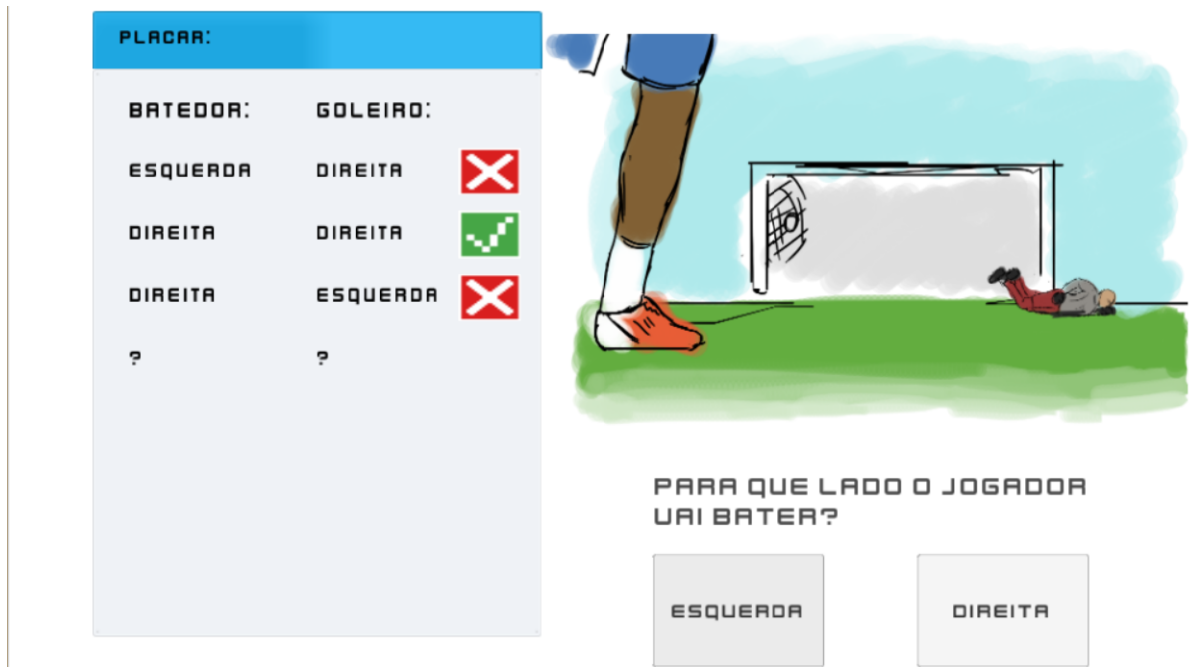


Figure 6: Screenshot of NeuroMat’s game provisorily called “Neuro-penalty.”

3.11 Exhibition “Inside the Brain”

“Inside the Brain” is an exhibition at the São Paulo Museum of Anatomy, that is developed as a partnership between FAPESP’s CEPID NeuroMat, the Laboratory of Cognitive Science (Labcog) and the Museum of Veterinary Anatomy (MAV), with the support of the Pró-Reitoria de Cultura e Extensão of the University of São Paulo, that shows the logic of life as it relates to the nervous system, in order to understand the functioning of the central nervous system. This is event is open and aimed at the general public.

From the perspective of neuroscience, the exhibition addresses the relationship between brain and body mass as well as the shape of the brain along the natural selection of species. For instance, the exhibition explores the relationship between brain mass and body weight of a human being, an ostrich and a shark; the body mass remains relatively similar, between 70 and 120 kg, but brain masses are utterly different. Another illustration is the comparison between a rat (*Rattus norvegicus*), a pirarucu and a boa, which have a similar brain mass, about 2 grams, but dissimilar body weights.

The content is explored through the use of silhouettes and acrylic brain replicas in real size, explanatory panels a showcase with preserved brains, a totem with explanatory content, an original video called “What we hope to find in our heads” and replicas of animal brains that have sensitive wire connections that enable visitors to approach

and touch interacting with such structures.

This activity is coordinated by A. Oliveira (LABCOG), A. Helene (LABCOG/NeuroMat), A. Galves (IME/NeuroMat) and M. Silva (MAV).

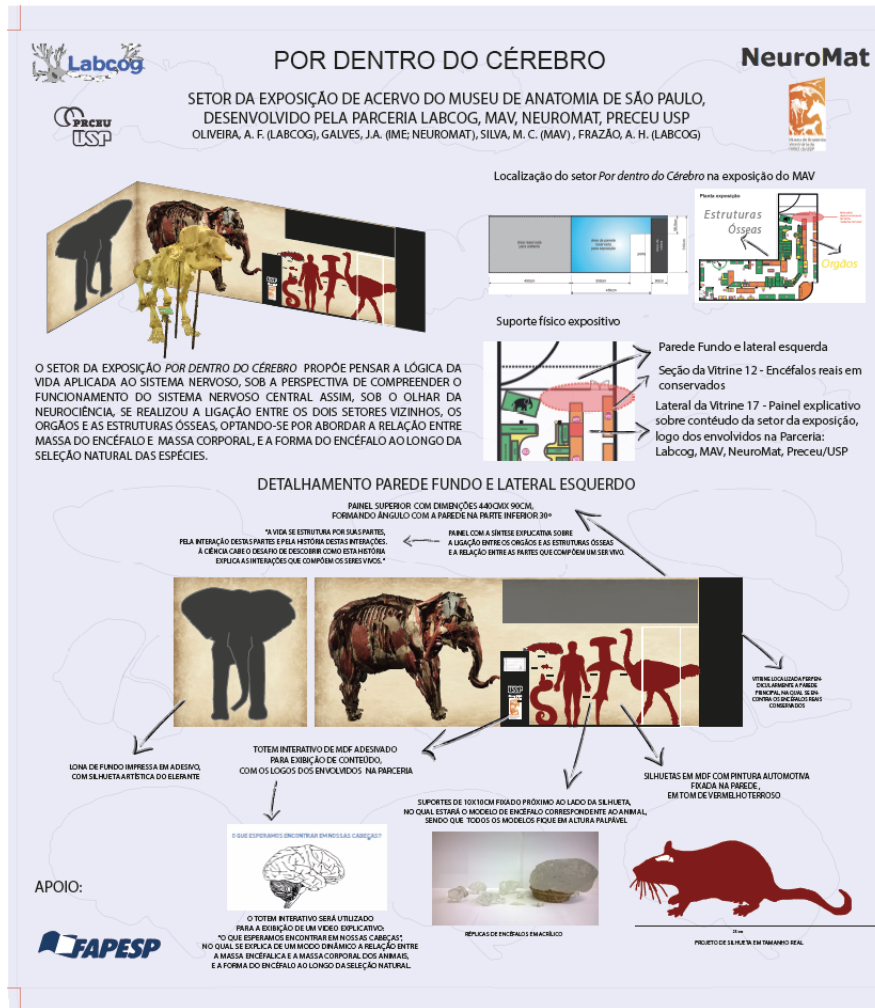


Figure 7: A dissemination poster of the NeuroMat exhibition “Inside the Brain,” that was shown at the SBPC’s 2015 ExpoT&C.

4 Technology transfer report

One of the NeuroMat's main goals is to develop computational tools for management, curation and sharing of scientific data. Since the beginning of the project, we are developing data management software tools in order to enable scientists to store their data in databases, in a standardized and secured manner, and to provide recovery facilities to the users who want access these data. This high-quality scientific data that is being collected and generated in the scope of the project, after the anonymization of the sensitive information, will feed an open database that will be made publicly available via a Web portal. Section 4.1 details the activities related to this goal during the second year of the project.

In response to a need identified during the preparation of NeuroMat's first Report of Activities, the NeuroMat technology transfer team along with the administrative body have created a parallel work front aiming to develop a software to support the preparation of annual reports. This software, called *NeuroMat Individual Report of Activities* (NIRA), is designed so that NeuroMat members can register and share information on publications, scientific missions and service requests. Section 4.2 gives more information about NIRA.

4.1 Neuroscience Experiments System - NES

The NeuroMat development team has devoted its efforts to the design and development of a conceptual database model and a free software for management of clinical and neuroscience experimental data. The software under development was initially named *Laboratory Web Application* and later renamed to *Neuroscience Experiments System*, or NES. We develop NES to assist neuroscience research laboratories in routine procedures for data collection. The model of the NeuroMat database supports the reproducibility of experiments, enables comparison of data across studies, and keeps data provenance. In addition, it promotes standardized formats for experiments and analyses reporting. The usage of a Database Management System (DBMS) in the implementation of the database improves the efficiency and security of the data storage. All data managed by NES are stored in a local database of the lab, with restricted access. NES helps to record quality data, which can later be analyzed, shared or reused more correctly and easily.

The current features available at NES were designed and evaluated based on requirements collected at *Laboratory of Neurociencie and Rehabilitation* (LNR) of the *Institute of Neurology Deolindo Couto* (INDC), at *Federal University of Rio de Janeiro* (UFRJ). But these features were implemented in such a way that they could benefit any neuroscience laboratory.

NES is a web application, implemented using the Django Web framework [3], and written in Python [9]. Its source-code is available on the NeuroMat GitHub account: <https://github.com/neuromat>. We use the Bootstrap framework [2] to generate the application layout and make it responsive, adjusting the web pages dynamically according the device used (desktop, mobile, tablet). The NES database is being implemented as a relational database in the open-source DBMS PostgreSQL [7].

A considerable part of the data analyzed in neuroscience experiments is collected by means of paper-based questionnaires. These ad-hoc questionnaires are generally designed by the scientists specifically for the studies that they are conducting. To deal with this problem and also to provide more quality and security to data collected through questionnaires, we use an electronic questionnaires management system. In the project, we have adopted LimeSurvey [6] to create and manage the electronic questionnaires. LimeSurvey is an open-source, web server-based software that enables users to develop and publish on-line surveys and collect responses. It supports advanced question types, including multiple answers question, date question, and file submission.

In order to facilitate the control of the questionnaires' administration and to centralize the access to the clinical and experimental data of a laboratory, NES is integrated with LimeSurvey.

We give detailed explanation about different versions of NES and its features in Section 4.1.1. Since it was installed in INDC, in November 2014, researchers have used the system to register patients and manage the questionnaires answered by them. More details about the NES usage in INDC are provided in Section 4.1.2. Then, we present how the database has evolved in Section 4.1.3 and how the software has evolved in Section 4.1.4. We also include an explanation about the development tools in use (4.1.5), other activities performed (4.1.6), the development team (4.3), and the work plan for the next activities (4.1.7).

4.1.1 NES version history

Version 0.1 On November the 5th 2014 we finished deploying NES version 0.1 in INDC. This version has functionalities developed to attend the initial needs of INDC, involving patient registration and basic experiments management with electronic questionnaires, namely:

- **Patient Registration:** identification; localization with search by zip-code; social-demographic data with social class calculation; and social history information.
- **Medical Record Registration:** diagnosis registration using the International Classification of Diseases (ICD) and possibility to include details, clinical analysis results and medical report.
- **Experiment Management:** experiment registration and configuration of the electronic questionnaires from the LimeSurvey.
- **Management of Questionnaire Administration:** integration with LimeSurvey to manage the administration of patient questionnaire.
- **User Management:** user registration based on groups and permissions configuration.

This is the version currently in use by physiotherapists, doctors, and researchers (see Section 4.1.2) of INDC.

Version 0.1.1 The use of version 0.1 has naturally led to the detection of some bugs, which were always reported by users to the software development team for corrections. Two of them caused a stronger impact on the use of the system and had the correction deployed as version 0.1.1 on April the 2nd 2015. This way, the users did not have to wait until version 0.2 became ready. Both errors were related to the way an answer for a questionnaire is showed.

Version 0.2 This version received most of the attention of the development team during this second year of the project. The evolution of the database and software resulting from this version are described in Sections 4.1.3 and 4.1.4, respectively.

Version 0.2.1 While developing a new version of a software, changes in the database schema may be time consuming. A schema migration tool provides a migration layer that helps developers with this task. Unfortunately, only in Mid-February we started using a tool that takes care of the schema changes that have arisen from the evolution of NES. We have chosen to use South [10], the most popular schema migration tool for Django. NES version 0.2.1 is simply a version that has all the functionalities of version 0.2 and includes the South support for handling all the schema changes since deployment of version 0.1. This is the version in which the development team is working on, and the one that will be deployed at INDC in August.

4.1.2 Production environment: NES usage at INDC

Before the NES installation, LimeSurvey was used by the *Laboratory of Neurociencia and Rehabilitation* (LNR) researchers in order to digitize the questionnaires that were previously designed on paper. However, these questionnaires were actually administrated only after the NES installation because of the questionnaire management support it offers. Since the NES installation, 72 patients have been registered in the system, and 187 sets of answers have been given to 8 questionnaires.

Figure 8 shows the current physical architecture of the system, which is divided into three locations: laboratory clients, server machine and backup server machine. The clients, located in *Campus Praia Vermelha*, access the application via browsers, installed in computers or tablets. The purpose of develop the NES application to be used in a small device, as a tablet, can be seen in this example, where the application can be accessed in the lab or in the physiotherapy room. In the server machine, all the HTTP requisitions are handled by an Apache 2 HTTP Server[1]. We have installed a digital certificate on Apache 2 in order to provide only HTTPS access to the applications configured in this server. NES and LimeSurvey applications were configured to attend HTTPS requisitions through the Apache 2. Both NES and LimeSurvey databases are hosted in a PostgreSQL [7] server, a well-known *Database Management System* (DBMS). In the same server machine, the questionnaires are maintained

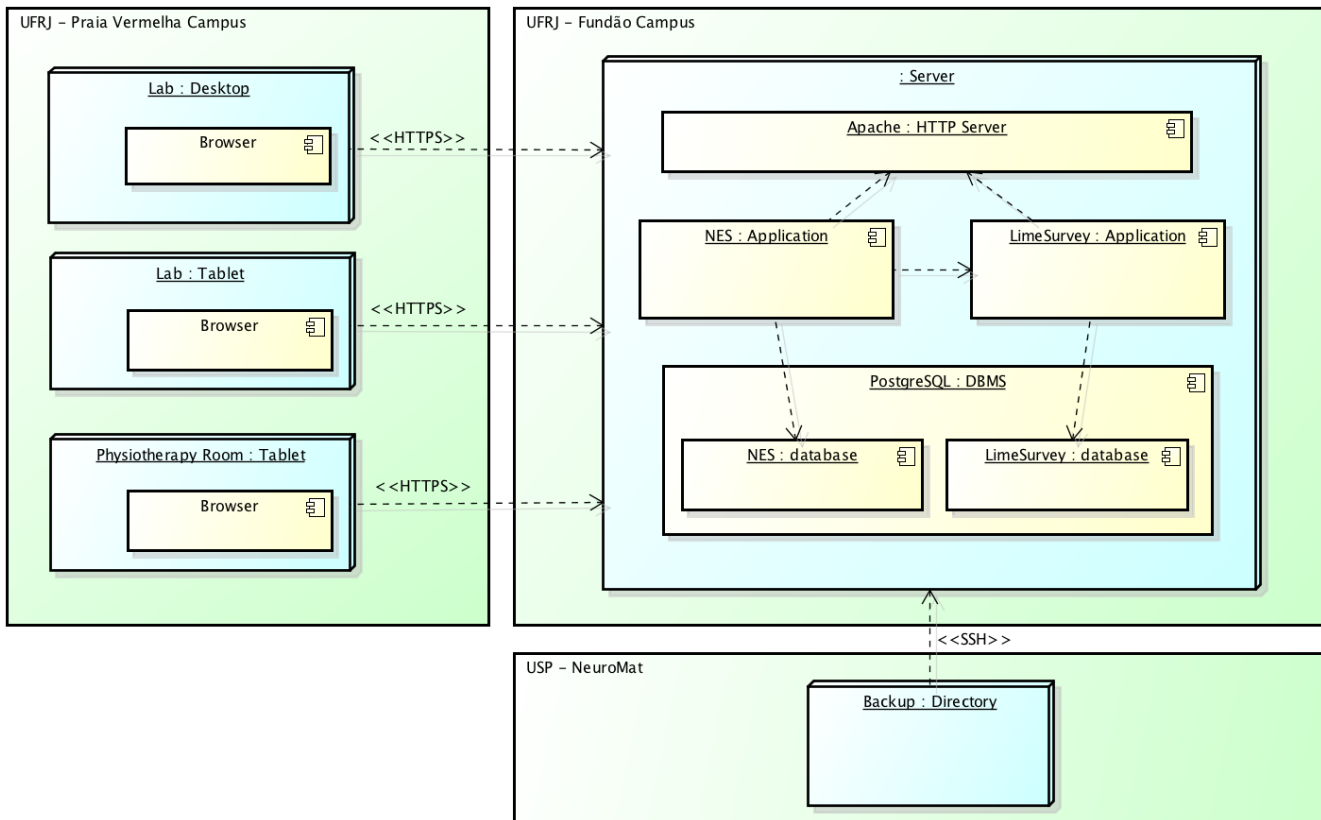


Figure 8: NES physical installation architecture at LNR Lab

in the LimeSurvey application, which is integrated with NES through an Application Programming Interface (API) provided by the LimeSurvey itself. This integration helps the management and administration of clinical and experimental questionnaires. Apart from the operation, there is a routine to backup the databases (NES and LimeSurvey) and the files uploaded to the system. Provisionally, until we have an appropriate server in the Lab, the backup is performed in a server located in a NeuroMat environment at USP.

Since April 2015, the development team has weekly meetings with the LNR-INDC team in order to improve the usage of the installed version, answering questions and getting information about reported bugs. The development team also uses the meetings to gather new requirements to be considered in the development of new versions of the system.

4.1.3 Evolution of the database

The NeuroMat databases are being designed to store both experimental data and their provenance information (i.e., experimental protocol data and other orthogonal information). In order to accommodate all these data with so varied nature and facilitate the evolution of the database, we initially divided the database structure into five modules:

- Organizational Structure – to store data about the researchers, laboratories and projects that conduct the experiments;
- Experimental Protocol – to store data describing the experiments, their overall goals and their design (including the experimental conditions, stimuli, tasks, etc.);
- Electrophysiological Data Acquisition – to store data acquired by electrophysiology equipments such as EEG, EMG and stabilometry machines;
- Behavioral Data Acquisition – to store data from behavioral responses collected from the subjects in the experiments;

- Documents – to store papers, articles, reports, and other documents that are direct products of the analyses made over the experimental data.

However, many other tables not included in these modules had also to be created to support the functionalities presented in the description of version 0.1, in Section 4.1.1. Examples of this are the tables related to the *Patient Registration* and the *Medical Record Registration* functionalities. Figure 9 shows these tables differentiating the ones that were already created in version 0.1 (in blue) from those created in version 0.2 (in yellow).

As explained in the next section, most of the efforts made aiming the evolution of NES were concentrated in the *Experimental Protocol* module of the database. Figure 10 shows its tables differentiating the ones that were already created in version 0.1 (in blue) from those created in version 0.2 (in yellow).

4.1.4 Evolution of the software

The main features added to NES during this last year are listed in this section.

The Research Project entity of the Organizational Structure Module was implemented. A research project contains a title (required), a description (required), a start date (required), an end date, a list of keywords, a list of experiments, and an owner. Figure 11 is a screenshot of NES form for registering research project data. The owner of a research project is the researcher that has created it.

NES defines six groups of users to better control permissions to access the functionalities of the system: *Administrator*, *Attendant*, *Physiotherapist*, *Doctor*, *Junior Researcher*, and *Senior Researcher*. Regarding the access to research projects, a *Junior Researcher* can view all the information about all research projects registered in the system, but he/she can only change, delete, or add information in its own research projects; and a *Senior Researcher* can change, delete, and add information in any research project. Regarding other functionalities of the system, an *Administrator* can manage users; an *Attendant* can manage information about patients or participants of experiments; a *Physiotherapist* has the same permissions of an *Attendant*, plus the permission to view medical record data, the permission to manage questionnaires, and the permission to manage responses to questionnaires that are not part of an experiment; a *Doctor* has the same permissions of a *Physiotherapist*, plus the permission to add medical record data; and *Junior* and *Senior Researcher* also have the same permissions of a *Physiotherapist* plus the permission to manage responses to questionnaires that are part of an experiment and the permission to manage subjects of an experiment.

Besides belonging to a research project, experiments now have also some associated provenance information. Each experiment has one or more groups of subjects, which in turn are associated with an experimental protocol and, optionally, with a diagnosis using the International Classification of Diseases (ICD). The experimental protocol is the most important feature of version 0.2.1. It comprises all the definitions of the experimental conditions to which subjects will be submitted. An experimental protocol is composed by steps, which can be of the following types: instruction, pause, questionnaire, set of steps, stimulus, task for the subject, and task for the experimenter. The root of an experimental protocol is always a set of steps, which can organize its children (sub-steps) in a sequential or parallel way. Figure 12 is a screenshot showing a set of steps in an experimental protocol registered in NES. Each defined step can be reused as many times as needed in the definition of the experimental protocol of the same or other groups of subjects of the experiment. Each use of a step in a sequential set of steps has a fixed or random position.

Questionnaires are still the only way to collect data using NES. However, to allow better control over different categories of questionnaires, a Questionnaire Management Module was implemented. NES now supports questionnaires that are not related to an experiment, such as questionnaires that collect patient personal information and clinical evaluations.

Some other improvements resulted from demands of researches from INDC based on their use of version 0.1:

- Patient Registration Module is now a Participant Registration Module, so that participants of experiments can also be registered even without being patients;
- Ability to register multiple phone numbers (including an optional note for each) for each participant, and a note that indicates the origin of the patient;
- Several usability improvements and bug fixes;

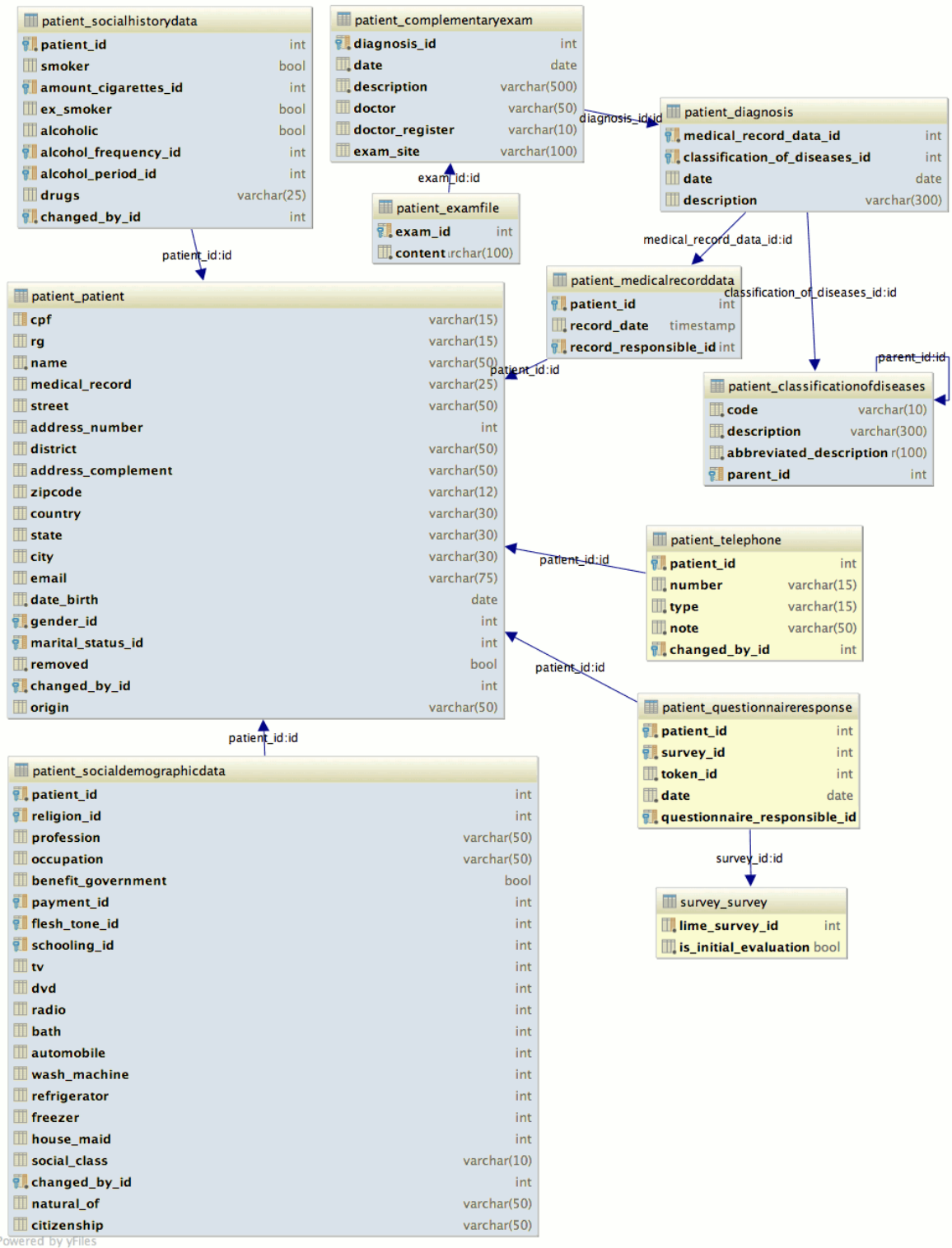
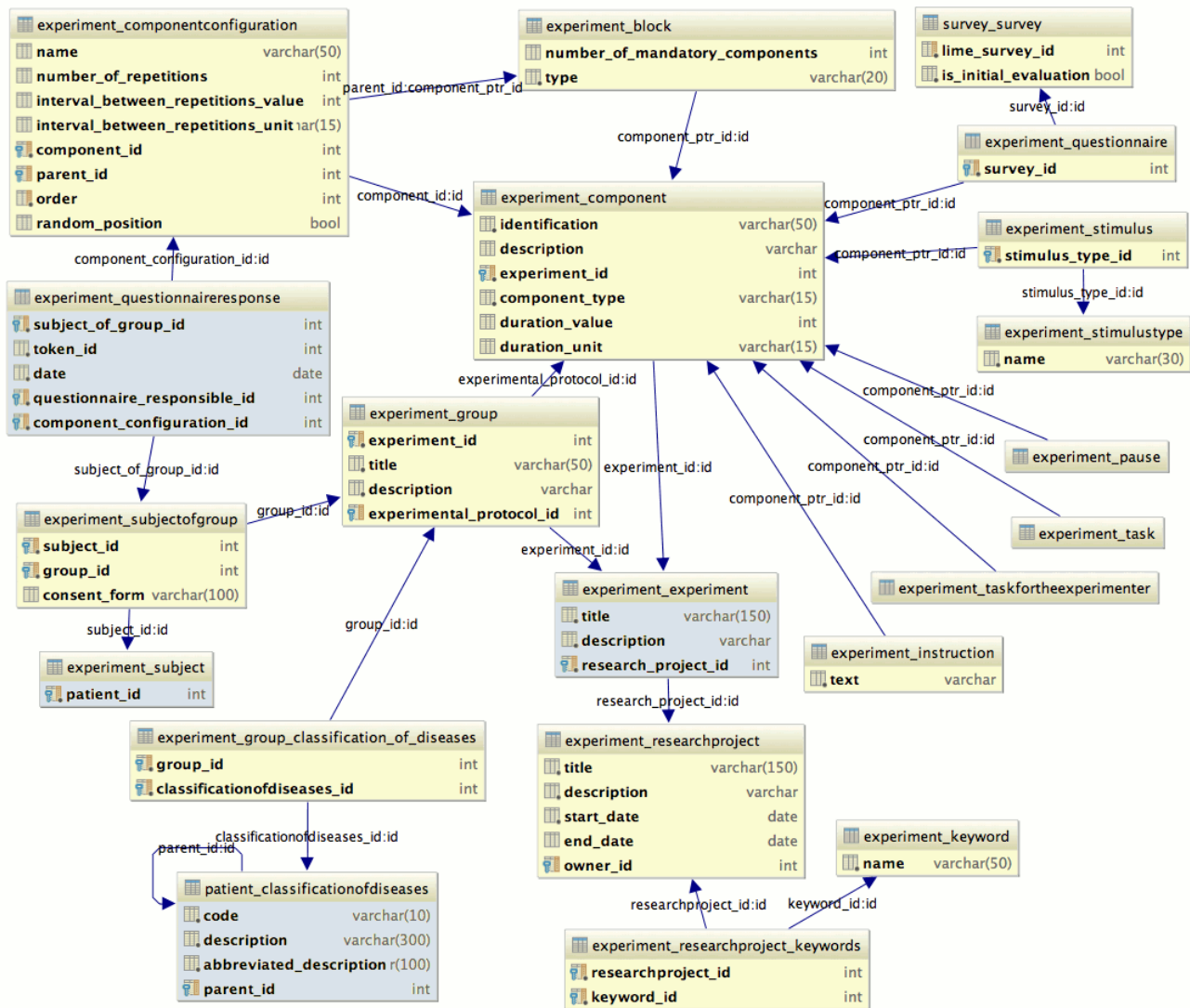


Figure 9: Database model showing tables related to the patient module. Tables in blue were present in version 0.1 and tables in yellow were created for version 0.2.



Powered by yFiles

Figure 10: Database model showing tables related to the experiment module. Tables in blue were present in version 0.1 and tables in yellow were created for version 0.2.

NES dlogopedrosa

Home / Estudos / Brachial Plexus Injury (BPI)

Participantes

Usuários

Estudos

Questionários

Contato

Informações básicas do estudo

Título *

Data de início * **Data de fim**

Descrição *
 Brachial plexus injury (BPI) occurs primarily by automobile accidents in young people, affecting motor and sensory nerves for upper limb. The main treatments are intense physical therapy and surgical reinnervation of the brachial plexus. BPI is an important model to investigate mechanisms of brain plasticity following peripheral injury.

Responsável

[Editar](#)

Palavras-chave

Experimentos

Título	Descrição
Touch Treshold and Referred Sensation in BPIs	Investigation of Touch Treshold and Referred Sensation in Brachial Plexus Injuries. Responsible: Bia Ramalho dos Santos Lima

[Inserir novo](#)

[Excluir](#) [Voltar](#)

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Figure 11: Research project screen in NES, showing basic information about a research project, its list of keywords, and the list of related experiments.

NES diogopedrosa

Home / Estudos / Brachial Plexus Injury (BPI) / Touch Treshold and Referred Sensation in BPIs / Patients Group / Root of the protocol

Estudos

Informações sobre o conjunto de passos

Identificação * Duração
 Root of the protocol 0

Descrição

Organização dos subpassos * Quantidade de passos obrigatórios *
 Em uma sequência De forma paralela Todos

[Editar](#)

Passos com posição fixa

Tipo	Passo	Nome do uso	Ordem	Remover
Tarefa para o experimentador	Subject preparation		↓	×
Tarefa para o experimentador	Machine preparation		↓ ↑	×
↳ 2 posições para passo aleatório agrupadas				
Instrução	Instruction for the observation block		↓ ↑	×
Conjunto de passos	Observation block		↑	×

[Inserir passo](#)

Passos com posição aleatória

Tipo	Passo	Nome do uso	Remover
<input checked="" type="checkbox"/> Tarefa para o sujeito	Rest state with closed eyes		×
<input checked="" type="checkbox"/> Tarefa para o sujeito	Rest state with opened eyes		×

[Inserir passo](#)

[Excluir](#) [Voltar](#)

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Figure 12: Screen that shows the root of the experimental protocol of one of the groups of a study. It shows a sequential set of steps with two of the steps having a random execution position.

Two other activities made by the development team were the creation of a Python script to populate the database with basic initial data, such as group of users and possible flesh tones and marital status of participants, and the parametrization of the contact information page, so that the information to be shown is accessed from the local settings file of each NES installation. Both activities help deployment of NES in the servers of other research groups that want to start using the system.

4.1.5 Software tools used to support the development

Project management tool In the beginning of the project, the development team adopted the Agilefant as the project management tool. After some time, the development team also adopted Trello, to complement the Agilefant with a Kan-ban view. However, because Agilefant frequently failed, the development team has changed both tools for Jira [5] and, as Jira also provides Kan-ban view, it already includes all the features the development team needs. In order to use the tool without no cost, we had to prove that all software that NeuroMat develops, such as NES and NIRA, is under an open-source license. In this way, Atlassian, the company that develops Jira, gave us an one year license for use Jira. Another benefit of using Jira is that any person can follow the NES development and can even create a new issue through the Web interface of the tool, since the access for the issues of the project is public.

Continuous integration tool Jenkins [4] tool supports our main needs for continuous integration and development. This tool has a lot of resources, that can be added by means of Plug-ins, and help the development team to evaluate the quality of the produced code, as showing the code coverage by tests and code violations report. The following configurations were made to offer us support during the project development:

- Creating Jobs (item project) for continuous integration for branch repository
- Mail notification when failures occurs during the build generation/automated tests
- Run automated tests
- Statistic of code coverage, amount of tests, etc.
- Statistics of amount of builds generated to failed and normal
- Statistics of lines of code
- Statistics of code violations based on PEP8
- Deploy in development/homologation/production environments

Source code version control tool All the software developed by NeuroMat, such as NES and NIRA, is an open-source software and its source-code is available on the NeuroMat GitHub account: <https://github.com/neuromat>. Also, on the NeuroMat GitHub repository can be found a wiki that contains software documentation, such as installation and user guides. By means of the NeuroMat GitHub repository, anyone can see or download the source code of the stable version or even the last version developed.

Integrated Development Environment (IDE) All developers in the team use the same Integrated Development Environment, PyCharm [8], a Python IDE that allow code analysis besides support to the Django framework and other productive tools, e.g., test coverage report. Since we develop open-source software, we got a license to use PyCharm without costs.

4.1.6 Other activities

Installation at INDC On November the 5th 2014 we concluded the installation of NES in the *Laboratory of Neuroscience and Rehabilitation* (LNR). All the activities were made remotely with the authorization of the server administrator.

Training Soon after the installation, some usage instructions were given by e-mail and Skype to potential users and an on-site training was made on December 4th 2014.

Documentation In May 2015, we started writing the documentation of the system. We decided to divide it into three parts:

- Installation: Shows the step-by-step required to install NES in a new location;
- LimeSurvey: Explains how LimeSurvey, an open source system for online question-and-answer surveys, can be used in a way that allows future integration with NES;
- User Guide: Explains the utility and how to use the features of NES.

Current version is available at the wiki of the GitHub account of the project: <https://github.com/neuromat/nas/wiki>. An effort to complete it will be made just after the release of version 0.2.1.

Video tutorial In addition to the documentation, we plan to create a set of video tutorials showing step-by-step how to create LimeSurvey questionnaires that can be used with NES. The first part is already recorded and is currently in the edition process.

Think aloud After reaching a comprehensive version of the system, we conducted usability tests using the *think aloud protocol* [11] with two researchers of INDC. The evaluations allowed the detection of a number of issues, which could be dealt before the end of version 0.2.1.

4.1.7 Work plan for the next activities

As next steps regarding software development in NeuroMat, we have planned a set of short term activities and a set of midterm activities:

Short term activities For the next NES version, we prioritize non-functional requirements in order to improve the quality of code and update our software architecture, as follows:

- A Django system is formed by Web Apps. Due to evolution of the code during development, the main app of NES should be renamed and another app of NES need to be deleted. These restructuring should be done to improve maintainability;
- Update all components of our software architecture - Python, Django, PyCharm, Bootstrap, PostgreSQL, LimeSurvey - in order to benefit from the resources introduced in their newer versions.

Another non-functional requirement planned for the next version is Internationalization of the graphical interface (e.g, to provide the graphical interface both in Brazilian Portuguese and English).

In terms of functional requirements, we will start the development of features to support advanced data searches. In our activities plan, we divided the development in parts, e.g., search of experiment participant candidates by personal information (as gender and age), by social-demographic information (as social class), by social information (as smoker or not), by medical evaluation (if the participant has/had some disease), or by answers for a specific questionnaire.

Besides, in order to help new NES users, we planned to improve the documentation available in our wiki, writing new guides and creating video tutorials.

Finally, we planned some time to bug fixes. For the next version, those bugs that had minor impact in the NES usage were planned to be fixed. In addition, if the current version, 0.2, has errors in the production environment, we will have to create an intermediary version, as version 0.1.1, to fix them.

Midterm activities For NES, the midterm planned activities are the implementation of more software interfaces for the database module of organizational structure and new software interfaces for the database module of electrophysiological data acquisition.

For the NeuroMat Repository and Web Portal, the planned activities are the development of data integration tools (to extract data from local laboratory databases and feed the NeuroMat central database) and web interfaces that will enable the public access to the repository data. This involves the study of tools, architecture definition, interfaces definition, development of tools and routines to support data integration and data search in large volumes of data.

In addition, since a new module will be included in the NeuroMat database to store neuroimaging data, there are also planned activities regarding the study and development of software architectures and tools to support the efficient storage and manipulation of medical images.

4.2 NeuroMat Individual Report of Activities - NIRA

The *NeuroMat Individual Report of Activities* (NIRA) began to be developed in October 2014, and the main goals of this system are twofold. Firstly, it works as a flow organizer and a tool to consolidate the annual report of activities, bringing up types of information that one should include in such report (i.e., scientific missions - 2.2.4 - and seminars - 2.2.3). A substantial part of the text of this report has already been generated through NIRA outputs. Secondly, it serves as a direct liaison of each researcher in NeuroMat and the project administrative body, especially in the identifying and processing of needs of NeuroMat-related activities.

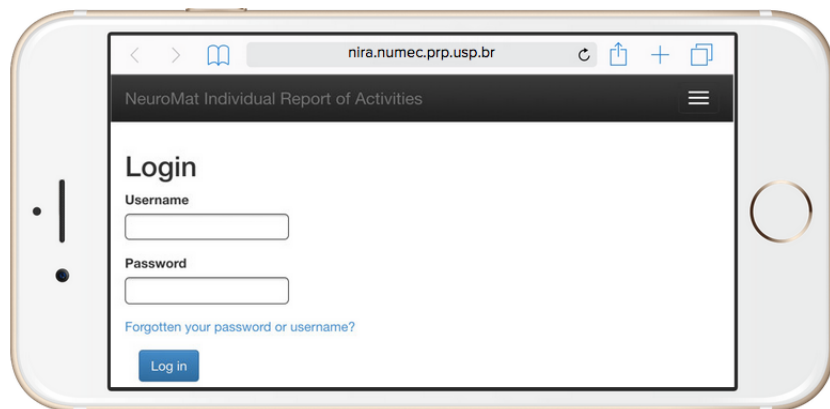


Figure 13: NIRA provides an optimal viewing and interaction experience across a wide range of devices.

NIRA is a web application, implemented using the Django Web framework [3], and written in Python [9]. It is an open source software and its code can be seen at <https://github.com/neuromat/nira>. The Bootstrap framework [2] is used to generate the application layout and make it responsive, adjusting the web pages dynamically according to the device used (desktop, mobile, tablet). The NIRA database is being implemented as a relational database in the open-source DBMS PostgreSQL [7].

4.2.1 NIRA's versions

- Version 0.1 was released in December 2014. This version has a module on which researchers are able to order equipment, supplies, etc., and request reimbursements, daily stipends and travel tickets, as well as apply for participating in scientific events. All requests are sent to and reviewed by the administrative team. They define whether or not the request will be granted, considering NeuroMat's scientific project and often in direct contact with FAPESP's administrative team.
- Version 0.2 will be released at the end of July, 2015. This version has a module called Project Activities that has information on events, seminars and training courses organized by the NeuroMat team or of which

NeuroMat members have taken part. Another module in the new version is the Dissemination module. It is fed by news that were published in different media outlets which mention the work done within NeuroMat. Both modules are used to generate data to the annual report of activities of the project.

4.2.2 Next planned activities

The system is under development and new modules should be created to help in the preparation of other report topics.

We also plan to disseminate NIRA amongst other CEPIDs, so that this software can contribute to the creation of their activities report. Furthermore, NIRA can also contribute to organize the administrative work flow of other research organizations. Since NIRA's code is open, other organizations can eventually adapt its features and functionalities to their specific needs.

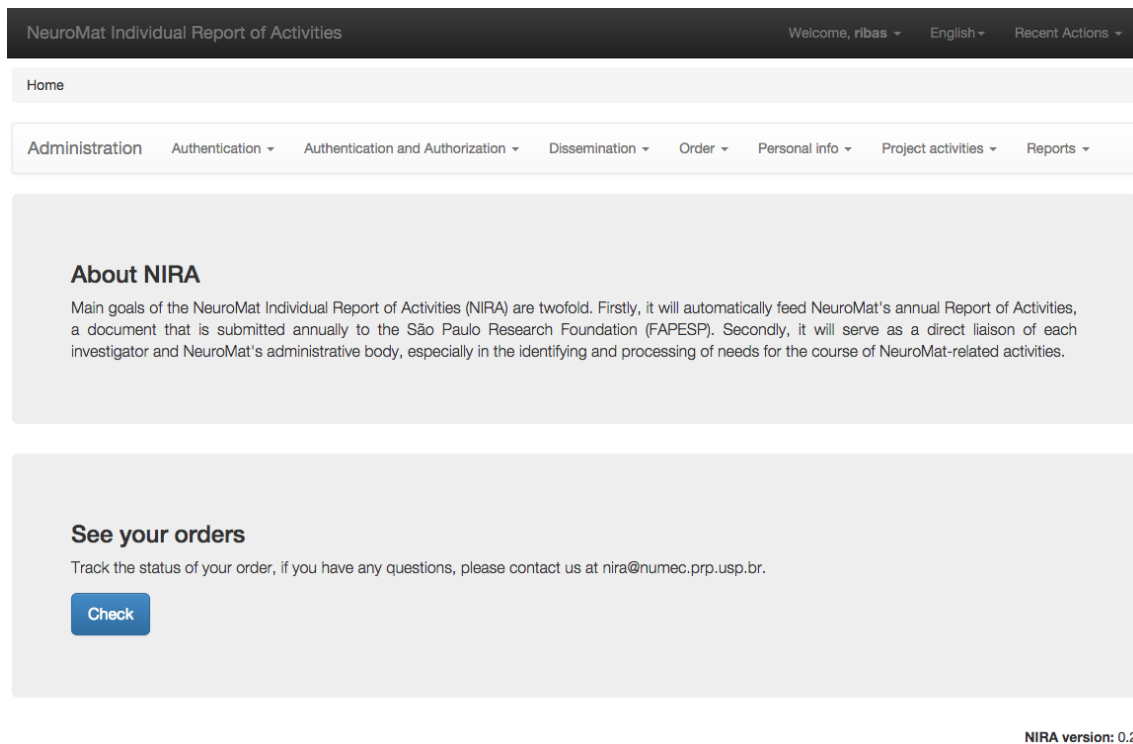


Figure 14: NIRA's home page.

4.3 About the development team

Several developers participated in the NeuroMat's development team between October 2014 and July 2015:

- Carlos Eduardo Ribas – expert in architecture and software development – Since August, 2013 until now (USP employee);
- Diogo de Carvalho Pedrosa – expert in architecture and software development – Since February, 2015 until now (NeuroMat FAPESP TT5 grant since Apr/15 until now²);
- Evandro Santos Rocha – expert in architecture and software development – Since April, 2014 until now (NeuroMat FAPESP TT5 grant since May/14 until now³);

²The individual report is attached to this report.

³The individual report is attached to this report.

- Larissa Cristina Moraes – master-degree student on Computer Science at IME-USP – Since April, 2014 (FAPESP Master grant since Nov/14 until now);
- Rômulo José Franco – expert in architecture and software development – June, 2014 until September, 2014 (NeuroMat FAPESP TT5 grant since Jun/14 until Sep/2014);
- Sueli dos Santos Rabaça – expert in architecture and software development – Since July, 2015 until now (NeuroMat FAPESP TT5 grant candidate⁴);
- Yoshio Mori – undergraduate student on Computer Science at IME-USP – Since August, 2013 until November, 2014.

These professionals have been working under the supervision of Prof. Fabio Kon and Prof. Kelly R. Braghetto from IME-USP.

⁴The work plan is attached to this report.

References

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- [6] LimeSurvey – the free and open-source survey software tool. <http://www.limesurvey.org>. Last access: July 16th, 2015.
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- [11] Jakob Nielsen. *Usability Engineering*. Morgan Kaufmann Publishers Inc., San Francisco, CA, USA, 1993.