

## PLANNED ACTIVITIES

TT-5 trainee

Software architecture and development (I)

### Abstract

The professional to be hired as trainee will work mainly in the design, development, testing, and maintenance of the software tools and databases of the project. More particularly, the trainee will work on the creation of a platform for the design and execution of neuroscience computational data analysis processes, to manage neuroscience experimental data and its provenance information. The trainee will interact with the researchers of the project and will be responsible to help transform the scientific results into open computational resources such as software systems and databases.

### Goals

The trainee will perform activities related to the design, development, testing, and maintenance of open-source software tools developed in NeuroMat to support management and analysis of neuroscience experimental data. NeuroMat has already developed two of such tools: the Neuroscience Experiments Systems (NES, <https://github.com/neuromat/nes>) and the NeuroMat Open Database (NeuroMat DB, <http://neuromatdb.numec.prp.usp.br/>). In their current state, NES and NeuroMat DB focus the management of primary data. However, neuroscience experiments also involve computational data processing and analysis which generate derived data, that should also be appropriately stored and documented.

To address this issue, the trainee will create in NES new modules to register derived data and its provenance information. In these new modules, a computational experiment will be modeled as a *workflow*, i.e. a set of (partially) ordered, interdependent processing activities. Using workflow models, we can document the origin of the derived data while easing the reproducibility of the processes which generated them. To better support workflow life cycle, NES will be integrated to a *scientific workflow management system* (SWfMS). A SWfMS is a system that allows to define, manage, execute and monitor scientific workflows.

In addition to the new functionalities planned to NES, the trainee will also implement new features in NeuroMat DB. For example, the open database will need to be adapted to receive the new data types that will be supported by NES.

The trainee will be prepared by means of the frequent contact with researchers involved with Software Engineering and developers from the IME-USP FLOSS Competence Center. This will provide him/her with expertise on different software development

techniques, enabling him/her to lead high level software development teams.

## Workplan

The planned activities are the following:

1. Definition, together with the project researchers, of the requirements of the new modules to manage derived data and computational data analysis processes;
2. Study and evaluation of existing SWfMSs;
3. Modeling and development of the new modules in NES and integration into a SWfMS;
4. Adapting NeuroMat DB to receive data and metadata from the new modules;
5. Maintenance of the software and databases related to the project;
6. Continuous integration and continuous delivery of the developed components;
7. Coordination of the developed activities with the researchers of the institutions partnering in the project, by means of face-to-face contact, videoconference, and tools for distributed collaboration;
8. Presentation of lectures at internal events and seminars, or events of scientific dissemination, about the progress and results obtained with the software;
9. Support in the preparation of scientific papers for national and international events as well as periodicals describing the implemented software.

Schedule:

Activities TT-5	Year 1		Year 2		Year 3	
	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>
Definition of the new modules	X	X				
Study and evaluation of SWfMSs	X	X				
Design and development of NES new modules	X	X	X			
Integration of NES and the SWfMS		X	X	X		
Adaptation of NeuroMat DB			X	X	X	
Continuous integration and delivery	X	X	X	X	X	X
Maintenance of systems and databases	X	X	X	X	X	X
Coordination of the development team	X	X	X	X	X	X
Presentation of lectures			X	X	X	X
Support in preparation of papers			X	X	X	X

## PLANNED ACTIVITIES

TT-5 trainee

Software architecture and development (II)

### Abstract

The professional to be hired as trainee will work mainly in the design, development, testing, and maintenance of the software tools and databases of the project. More particularly, the trainee will improve two open-source software tools previously developed in NeuroMat, in order to enable them to manage data generated in neuroimaging experiments. The trainee will interact with the researchers to help them to transform their scientific results into open resources such as software systems and databases.

### Goals

The trainee will perform activities related to the design, development, testing, and maintenance of open-source software tools developed in NeuroMat to support management and analysis of neuroscience experimental data. NeuroMat has already developed two of such tools: the Neuroscience Experiments Systems (NES, <https://github.com/neuromat/nes>) and the NeuroMat Open Database (NeuroMat DB, <http://neuromatdb.numec.prp.usp.br/>). NES and NeuroMat DB were initially developed targeting management of data and metadata from electrophysiological experiments (e.g., with EEG, EMG and TMS). However, NeuroMat now is also interested in analyzing data from neuroimaging experiments (such as those generated in structural and functional magnetic resonance imaging – MRI and fMRI, respectively).

To meet this new requirement, the trainee will create in NES a module dedicated to the management of data from neuroimaging experiments. He/she will need to consider existing initiatives to standardize the representation of this type of data, to ensure interoperability with other tools used by the neuroscience community.

The trainee will also adapt the NeuroMat DB to enable it to receive the new types of that will be supported by NES. Moreover, both NES and NeuroMat DB will need to be adapted to use new types of data persistence mechanisms that can operate on a distributed computing platform, capable of providing scalable processing and storage – an indispensable requirement for dealing with neuroimaging (which usually generate large data volumes). There are systems specifically developed for the archiving of neuroimages, such as the free software XNAT (<https://www.xnat.org/about/>). The trainee will evaluate these systems in order to determine which type of solution might be more conveniently integrated with the software architectures used in NES and NeuroMat DB.

The trainee will be prepared by means of the frequent contact with researchers involved with Software Engineering and developers from the IME-USP FLOSS Competence

Center. This will provide him/her with expertise on different software development techniques, enabling him/her to lead high level software development teams.

## Workplan

The planned activities are the following:

1. Study and evaluation of the initiatives to standardize neuroimaging data representation and of systems for neuroimage archiving;
2. Definition, together with the project researchers, of the requirements of the new module to manage data from neuroimaging experiments;
3. Modification of the data persistence solution used in NES and NeuroMat DB, to improve scalability;
4. Modeling and development of the new module in NES;
5. Adapting NeuroMat DB to receive data and metadata from the new module;
6. Continuous integration and continuous delivery of the developed components;
7. Coordination of the developed activities with the researchers of the institutions partnering in the project, by means of face-to-face contact, videoconference, and tools for distributed collaboration;
8. Presentation of lectures at internal events and seminars, or events of scientific dissemination, about the progress and results obtained with the software;
9. Support in the preparation of scientific papers for national and international events as well as periodicals describing the implemented software.

Schedule:

Activities TT-5	Year 1		Year 2		Year 3	
	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>
Study and evaluation of neuroimaging models and tools	X	X				
Definition of the new neuroimaging module		X	X			
Modification of the data persistence solution	X	X	X			
Development of the new neuroimaging module			X	X	X	
Adaptation of NeuroMat DB				X	X	X
Continuous integration and delivery	X	X	X	X	X	X
Coordination of the development team	X	X	X	X	X	X
Presentation of lectures			X	X	X	X
Support in preparation of papers			X	X	X	X

## PLANNED ACTIVITIES

TT-5 trainee

Software integration, testing, packaging, and distribution

### Abstract

The professional to be hired as trainee will work mainly in the integration, automated testing, packaging, distribution, and documentation of the open-source software tools developed in the project. The trainee will interact with the researchers of the project and will be responsible to help them to encapsulate their software results in formats that can be easily distributed and used.

### Goals

The trainee will perform activities related to the the integration, automated testing, packaging, distribution, and documentation of the open-source software tools developed in NeuroMat to support management and analysis of neuroscience experimental data.

NeuroMat has already developed two of such tools: the Neuroscience Experiments Systems (NES, <https://github.com/neuromat/nas>) and the NeuroMat Open Database Web portal (NeuroMat DB, <http://neuromatdb.numec.prp.usp.br/>). In their current state, NES and NeuroMat DB focus the storage of experimental data and metadata. Now, these tools must be extended with data analysis capabilities

NeuroMat researchers are developing different data analysis programs. The trainee will develop mechanisms to encapsulate and make this software openly available to Neuroscience community. Moreover, some of these software will be integrated to NES and NeuroMat DB in the form of plug-ins, generating a platform that supports the combined use of the softwares to create complex analysis processes.

The trainee will be prepared by means of the frequent contact with researchers involved with Software Engineering and developers from the IME-USP FLOSS Competence Center. This will provide him/her with expertise on Free Software testing, packaging, and distribution, enabling him, by the end of the project, to participate in innovative Free Software projects both within academic institutions and in the industry.

### Workplan

The planned activities are the following:

1. Implement in NES and in the NeuroMat DB portal support for the inclusion of data analysis plug-ins;

2. Create guidelines and interfaces for the development of data analysis software that can be plugged into NES and the NeuroMat DB portal;
3. Creation of distribution packages, containers, and virtual machines for easy installation of the software developed in the project;
4. Support in the development of automated tests for the software, including: unit tests, integration tests, acceptance tests, and stress tests;
5. Test of the deployment of the tools on different operating systems;
6. Creation and maintenance of the documentation for the developed software;
7. Preparation of tutorials, manuals, videos and other supporting materials to teach how to use the developed software;
8. Presentation of lectures at internal events and seminars, or events of scientific dissemination, about the activity progress and results;
9. Support in the preparation of scientific papers for national and international events as well as periodicals describing the work results.

Schedule:

Activities TT-5	Year 1		Year 2		Year 3	
	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>
Extension of NES and NeuroMat DB to support plug-ins;	X	X	X			
Creation of guidelines and interfaces for plug-ins;		X	X			
Creation of distribution packages		X	X	X	X	X
Development of automated tests	X	X	X	X	X	X
Development of deployment tests		X	X	X	X	X
Creation of software documentation	X	X	X	X	X	X
Preparation of user supporting material		X	X	X	X	X
Presentation of lectures			X	X	X	X
Support in preparation of papers			X	X	X	X

## PLANNED ACTIVITIES

TT- trainee

Software architecture and development (III)

### Abstract

The professional to be hired as trainee will work mainly in the design, development, testing, and maintenance of the software tools of the project. More particularly, the trainee will work on development of the GoalKeeper Game and analysis tools for related data. The trainee will interact with the researchers of the project and will be responsible to help transform the scientific results into open computational resources such as software systems and databases.

### Goals

The GoalKeeper Game (<http://game.numec.prp.usp.br/>) is a computer game being developed by NeuroMat since June, 2015, associated to the experimental protocols from the projects Abraço (<http://abraco.numec.prp.usp.br/>) and AMPARO (<https://amparo.numec.prp.usp.br/>). Both projects are members of NeuroMat initiative.

In this game, the participant or player must guess where a virtual penalty kicker will shoot the ball. The kicker follows a fixed, potentially stochastic, strategy previously defined by a context tree. The system registers the participant trials. The player must maximize the number of defenses, which is equivalent to identify the context tree used by the kicker.

The game is thus able to collect the reaction times and the error rates rapidly and in large scale, offering an alternative to infer the decision making modes used by the brain.

The GoalKeeper Game is being constantly adapted to new demands and protocols. Being developed incrementally, it is subject to refactoring. There is also the intent to migrate the code to a free software platform, namely *Godot* (<https://godotengine.org/>).

The trainee will work in these tasks:

- Implement new functionalities.
- Adaptation to collect large amount of data simultaneously from several sources, e.g. mobile phones.
- Migration to the *Godot* platform.
- Implementation of new protocols for collecting data.

- Adaptation of the game to provide a more pleasurable experience.

## Workplan

The planned activities are the following:

1. Refactor and complement the current version of the game.
2. Planning the new architecture
3. Implementation of the new version
4. Build a test suit for all the components of the game.
5. Implement the game for IOs phones.
6. Refine the implementation for Android phones.
7. Implement new forms of interaction, using camera or accelerometers
8. Implementação para dispositivos IOs

Schedule:

Activities TT-5	Year 1		Year 2		Year 3	
	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>
Study the current version and the platforms;	X	X				
Refactor the current version;		X	X			
Planning the new architecture;		X	X			
Development of automated tests		X	X	X	X	X
Implementation of the new version;		X	X	X	X	X
Implementation of new mobile versions;			X	X	X	X
Creation of software documentation	X	X	X	X	X	X
Preparation of user supporting material		X	X	X	X	X
Presentation of lectures			X	X	X	X
Support in preparation of papers			X	X	X	X