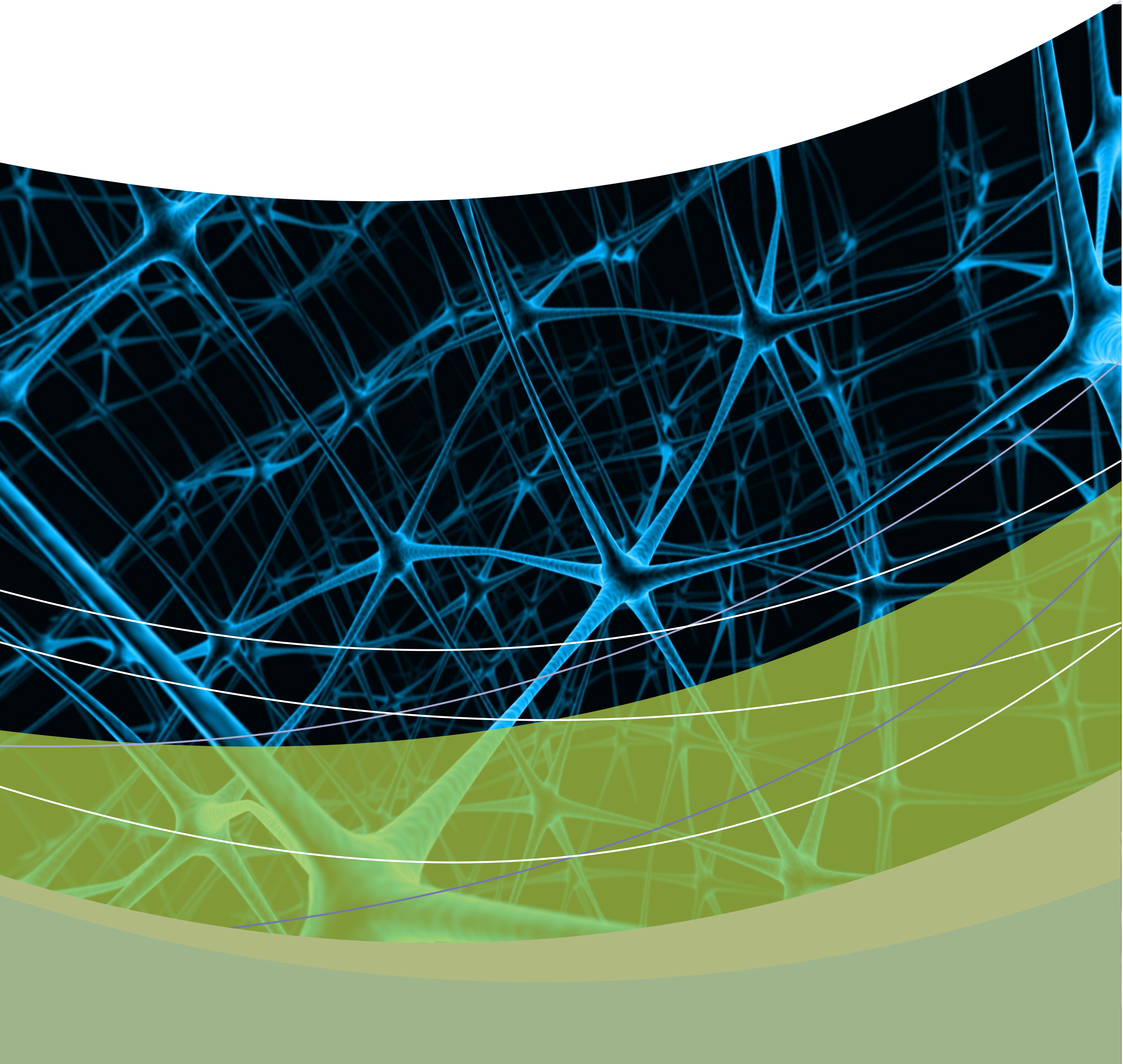
Romanian Institute of Science and Technology

2009 Annual Report



Romanian Institute of Science and Technology

The Romanian Institute of Science and Technology (RIST) is a non-governmental, not-for-profit, independent research institute, founded in 2009.

RIST currently performs research on complex systems, computational, theoretical and experimental neuroscience, biologically-inspired robotics, artificial intelligence and dynamical systems.

RIST aims to provide an appropriate institutional and administrative support for world class scientists that would like to work in Romania and are not satisfied by the conditions offered by existing Romanian research institutions, which are often too bureaucratic. According to a survey performed in 2006 among scientists working in Romania, only 30% were considering that their institutions provide appropriate support for their work. RIST especially welcomes Romanian scientists currently working abroad.

RIST is a grassroots initiative, resulting from the enlargement of the Center for Cognitive and Neural Studies (Coneural), another independent, not-for-profit research institution, founded in 2002 by several Romanian scientists.

Affiliated scientists

- Marius F. Danca
- Răzvan V. Florian
- Ovidiu F. Jurjuț
- Vasile V. Moca
- Raul C. Mureşan
- Sergiu P. Paşca
- Cătălin V. Rusu
- Ioana Ţincaş

Staff

- Cosmina Pavel

Board of directors

- Răzvan V. Florian
- Liviu Giosan
- Raul C. Mureşan

Structure

Experimental and Theoretical Neuroscience Laboratory

The lab explores the brain by means of experimentally recorded data from humans (using EEG) and from the visual cortex of mammals (highly parallel recordings) and also through computer simulations of realistic models of cortical microcircuits. In addition, it develops new, non-conventional techniques of data analysis.

The first important line of investigation is related to the analysis of neuronal data recorded from real brains. The lab explores both high-density EEG data recorded in humans, as well as parallel recordings from mammalian visual cortex. The second line of research investigates neurocomputational principles in simulations of large scale networks of spiking neurons. This includes studies ranging from new biologically-inspired computational models of vision to general studies related to the dynamics of large-scale neuronal microcircuits and issues regarding their computational simulation. Finally, the lab develops new and non-conventional analysis tools for spike-trains, LFP and EEG signals, as well as for the characterization of the complex, non-linear dynamics of neuronal populations.

People: Raul C. Mureşan (group leader) , Vasile V. Moca, Ioana Ţincaş, Ovidiu F. Jurjuţ (on leave at the Frankfurt Institute of Advanced Studies, Germany), Sergiu P. Paşca (on leave at Stanford University).

Neurobotics Laboratory

The lab uses principles revealed by the study of brain and body as a whole integrated system interacting with the world (embodiment, interactivism, constructivism), to build models that on one side are inspired by the functioning of brains, and on the other side are capable of reproducing complex behaviors in embodied systems (robots or robot-like simulations).

The lab has developed several learning rules for spiking neural networks and uses them to train such neural networks for robotic control.

People: Răzvan V. Florian (group leader), Cătălin V. Rusu.

Dynamical Systems

Marius F. Danca studies chaotic dynamical systems.

Publications in 2009

V. V. Moca, B. Scheller, R. C. Muresan, M. Daunderer, G. Pipa. (2009), EEG under anesthesia - feature extraction with TESPAR. *Computer Methods and Programs in Biomedicine* 95 (3), pp. 191-202.

O. F. Jurjut, D. Nikolic, G. Pipa, W. Singer, D. Metzler, and R. C. Muresan (2009), A color-based visualization technique for multi-electrode spike trains. *Journal of Neurophysiology* 102, pp. 3766-3778.

Publications of the Center for Cognitive and Neural Studies in 2009, prior to its affiliation to RIST

M. Dronca, S. P. Pasca (2009). Paraoxonase 1 status, environmental exposures and oxidative stress in Autism Spectrum Disorders. In A. Chauhan, V. Chauhan, T. Brown (editors), "*Autism: Oxidative Stress, Inflammation and Immune Abnormalities*", CRC Press (in press)

G. Esposito, S. P. Pasca (2009). Disruption of social development in children with Autism Spectrum Disorders. In "*Social Development*", Nova Science Publishers (in press)

M. F. Danca (2009), Alternated Julia sets and connectivity properties, *International Journal of Bifurcation and Chaos* 19 (6), pp. 2123-2129.

R. V. Florian, C. V. Rusu (2009), Temporal difference learning does not always lead to STDP. *Frontiers in Systems Neuroscience*. Conference Abstract: Computational and systems neuroscience. doi: 10.3389/conf.neuro.06.2009.03.205

C. V. Rusu, R. V. Florian (2009), Exploring the link between temporal difference learning and spike-timing-dependent plasticity. *Eighteenth Annual Computational Neuroscience Meeting: CNS*2009. BMC Neuroscience* 2009, 10 (suppl. 1), p. 201.

Tincas, I., Visu-Petra, L. A., & Benga, O. (2009). Regulation and anxiety in preschoolers: Contributions from temperament and attentional control. *Society for Research in Child Development Biennial Meeting*, Denver, Colorado, USA.

Highlights

Visualizing Multineuronal Activity Patterns

Spike rastergrams are a simple and efficient tool for visualizing the activity of simultaneously recorded neurons. However, the visual detection of multineuronal spike patterns in these plots is largely dependent on the arrangement of the neurons in the rastergram. This happens because of Gestalt principles that govern our visual system. If neurons that form a particular spike pattern are not neighbors in the rastergram, the detection of that pattern can become difficult due to the activity of the other neurons.

To enable the visual identification of multineuronal spike patterns, defined within a time window, we devised a method to color them based on their reciprocal similarity. For example, if pattern A is similar to pattern B but different from pattern C, then pattern A and B will be assigned similar colors (e.g., red and orange) while pattern C will be assigned a different color (e.g., blue). This way, color becomes a signature of pattern identity and the occurrences of similar patterns can be easily visualized across entire recording sessions.

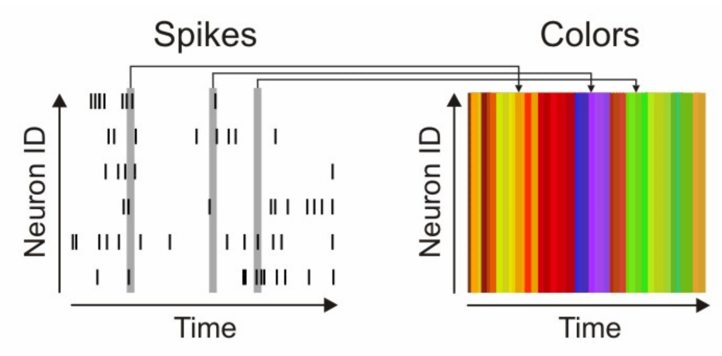


Figure. Transforming simultaneously recorded spike trains into color sequences. For each time window, the spiking activity of all neurons is assessed and then mapped onto a color space using Kohonen maps.

The labeling of spike patterns with colors enables the visualization of each trial as a sequence of colors. Grouping several color sequences by a certain criterion (e.g., stimulus, time of recording) can reveal regions in which similar patterns (colors) occur consecutively along the trial and/or consistently around the same time points across different trials.

This method enables the intuitive visualization of neuronal population dynamics and enables the identification of periods of interest, which can be further subjected to more quantitative analyses. Although it was designed for the visualization of multielectrode spike trains, the method could be applied also to simultaneously recorded continuous signals (e.g., LFP, EEG, MEG).

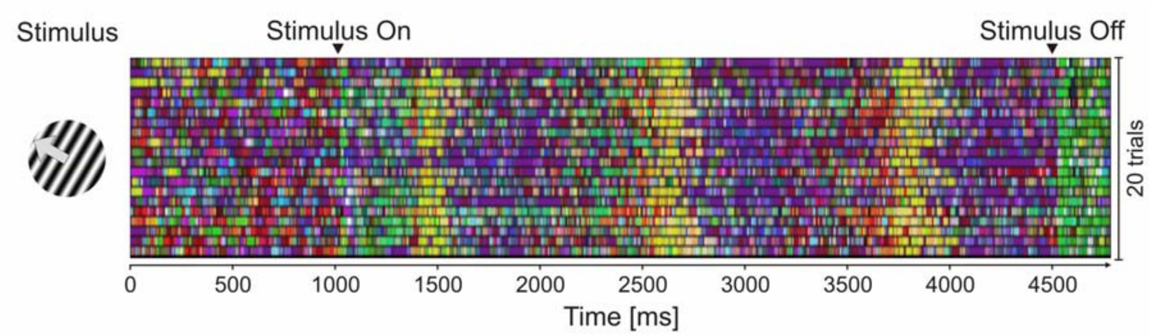


Figure. Color sequences corresponding to trials recorded with the same stimulus (a drifting sinusoidal grating). The three yellow stripes indicate the presence of similar activity patterns at specific time points across all trials.

Further information:

O. F. Jurjut, D. Nikolic, G. Pipa, W. Singer, D. Metzler, and R. C. Muresan (2009), A color-based visualization technique for multi-electrode spike trains. *Journal of Neurophysiology* 102, pp. 3766-3778.

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