

NEURO INFORMATICS 2016



Program & Abstracts

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Program & abstracts

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Welcome to Neuroinformatics 2016, the annual INCF congress.

Neuroinformatics 2016 comes to Reading, UK and is organized in collaboration with the UK Node on September 3-4. Join us for keynotes from top neuroscientists, community sessions and posters/demos mingling sessions.

We welcome researchers in all fields related to neuroinformatics, including data- and knowledge-bases of the nervous system from molecular to behavioral levels; tools for the acquisition, analysis, and visualization of nervous system data; and theoretical, computational, and simulation environments for modeling the brain. This meeting is especially useful for anyone who is developing neuroscience tools and methods, working on better ways to handle neuroscience data and looking for cross-disciplinary collaborations.

Program Committee: Prof. Alan Evans (Chair), Dr. Ingo Bojak, Dr. Clare Mackay, Dr. Yong He, Prof. Giorgio Ascoli, Prof. Wim Vanduffel, Prof. Kenneth Harris, Prof. Katrin Amunts, Dr. Michael Hawrylycz, Prof. Pedro Valdes-Sosa

Table of Contents

Demo

21	D13 Decoding musicianship from neural processing of musical features
25	D01 Using the SpineML toolchain to simulate an integrated brain and biomechanical model of the oculomotor system
27	D05 NES: a free software to manage data from neuroscience experiments
30	D03 Versatile format and tools for comprehensive data organization in neuroscience
32	D02 From GUI to GPU: a toolchain for GPU code generation for large scale Drosophila simulations using SpineML
34	D04 KANPHOS platform: a new platform in INCf J-Node for neural phosphoproteomics
36	D12 MAV-seq: platform for the NGS data workflow management and automation
39	D11 Neuroinformatics infrastructure for data sharing developed in J-Node
41	D07 Raining fire upon modelling difficulties: PyRhO in the cloud
44	D09 SciCrunch: a cooperative and collaborative data, information, and resource discovery portal for scientific communities
47	D15 Widening the focus. A methodological approach towards a whole-brain neuroanatomic similarity of personality traits
49	D10 BiCAmon: activity monitoring tool on 3D connectome structures for various cognitive architectures
54	D06 Web-based neuron morphology viewer as an aid to develop new standards for neuron morphology file formats

-
- 56** D08 Virtual reality visualisation of a biologically realistic anatomical and functional model of the tadpole spinal cord

Investigator presentation

- 60** IP02 Detection and cortical localization of ictal signatures using electroencephalogram signals
- 62** IP04 Mechanisms underlying different onset patterns of focal seizures
- 64** IP06 Computational challenges for the analysis of intracranial pressure and heart rate data in traumatic brain injuries patients
- 71** IP10 Contributions from white and grey matter on structural connectomes of temporal lobe epilepsy patients
- 72** IP08 Determining epilepsy surgery targets through connectome-based computer simulations
- 74** IP03 Common neural coding across domains of decision making identified by meta-analysis
- 76** IP01 Statistical uncertainty and sensitivity analysis of intracellular signaling models – through approximate Bayesian computation and variance based global sensitivity analysis
- 80** IP19 Simulating word acquisition and semantic grounding in a neuroanatomically realistic, Hebbian-learning, spiking neural network model of the cortex
- 81** IP05 Easy-to-use GPU acceleration of neural network simulations with GeNN
- 85** IP21 Automatic analysis (AA): efficient and transparent multimodal neuroimaging workflows
- 87** IP07 Linking computational models to experimental data with the Brain Operation DataBase (BODB)
-

-
- 89** IP12 Measuring complex brain networks structure
- 94** IP14 Relating extrinsic connections to the intrinsic architecture of the cerebral cortex
- 95** IP09 Neuroscience gateway – cyberinfrastructure providing supercomputing resources for large scale computational neuroscience research
- 99** IP16 Reconstructing and simulating neocortical microcircuitry
- 100** IP15 A symmetry-based method to infer structural brain networks from probabilistic tractography data
- 103** IP13 An information theoretic framework for neuroimaging data analysis: stimulus modulations, representational interactions, and causal communication of specific information content
- 105** IP11 Over a unified connectivity estimator for intra and inter-frequency couplings through symbolic transfer entropy: a MEG resting-state analysis
- 108** IP17 Whole brain fMRI activity at a high temporal resolution: a novel analytic framework
- 110** IP20 Detailed computational modeling of the developmental self-organization of neuronal structure and function
- 112** IP18 Virtual reality visualisation of a biologically realistic anatomical and functional model of the tadpole spinal cord

Poster

- 116** P04 A Wilson–Cowan model of oscillatory activity in essential tremor
- 118** P02 Task-related modulation of functional connectivity networks of Alzheimer’s disease and mild cognitive impairment patients
-

-
- 121** P05 A comparative analysis of indexing of mental workload by using neuro-driving tools based on EEG measurements coupling with the eye-tracking system
- 124** P01 Machine learning in fMRI classification
- 125** P03 Using stacked autoencoders for the P300 component detection
- 128** P06 Computational challenges for the analysis of intracranial pressure and heart rate data in traumatic brain injuries patients
- 135** P08 Principal component discriminant analysis of mild cognitive impairment in Parkinson's disease reveals early functional changes in the resting state
- 139** P33 A single Markov-type kinetic model reliably accounts for the macroscopic currents of all human voltage-gated sodium channel isoforms
- 141** P23 A stochastic version of the Potjans–Diesmann cortical column model
- 143** P27 Algorithmic optimisation of neuron generator parameters
- 147** P17 Characterising non-renewal stochastic dynamics by an iterated first-passage time approach
- 148** P25 Classification and segmentation of cells in anatomic and time lapse microscopic images based on geometrical features and machine learning
- 150** P21 Computational modeling of pathological layer formation in neurodevelopmental disorders
- 152** P07 Decoding musicianship from neural processing of musical features
- 156** P13 Developing software tools for parameter fitting and validation of neuronal models
-

159	P19 Dynamical neuronal gains produce self-organized criticality in stochastic spiking neural networks
160	P31 Efficient numerical simulation of neuron models with spatial structure on graphics processing units
163	P15 Establishment of the estimation method of the neural network using CMA-ES for elucidating the neural mechanism of a silkworm moth brain
167	P11 Modeling the UPR in neurodegeneration
169	P35 Optimization of synaptic transmission during long-term plasticity explains expression loci
170	P09 Simulating a biologically accurate model of the honeybee olfactory system on the GPU
173	P73 Simulation of plasticity damage in the cerebellar cortex during cerebellum-driven tasks
178	P37 High-resolution brain image registration on a distributed computing system in the brain/MINDS project
180	P39 Constructing terminologies for the INCF neuroimaging data model (NIDM)
183	P12 A method for evaluation of neural structure based on reconstruction and its application to an interneuron in the honeybee brain
185	P10 Three-dimensional reconstruction of brain images from serial sections using the Possum framework
187	P41 Challenges in designing workflows for reproducible analysis of electrophysiological data – usage of community tools
189	P43 Stimulus evoked layer-specific activity in vitro and in silico in the rat somatosensory cortex
191	P22 Cross-species prediction of macroscale connectivity of mammalian cortices

-
- | | |
|------------|--|
| 193 | P14 Describing assessments and experiment metadata with the neuroimaging data model (NIDM) |
| 198 | P20 High-resolution subregion parcellation of subthalamic nucleus based on voxel-level connectivity |
| 200 | P26 MSL: mining published scientific literature for the extraction and classification of text and images to support IR capabilities |
| 203 | P24 NNMF connectivity microstates: a new approach to represent the dynamic brain coordination |
| 206 | P18 Open science at the Montreal Neurological Institute – LORIS and CBRAIN |
| 208 | P16 Research community software tool sharing and collaboration for Neuroscience |
| 209 | P28 Anatomical and topological expression analysis of the mouse transcriptome in the virtual 3D MRI image spaces of the postnatal brain stages |
| 211 | P34 Database integration pipeline for highly reliable spatial gene expression patterns |
| 214 | P32 Interactive quality and pre-processing pipeline for ATAC-seq data |
| 216 | P30 Relating the transcriptional and structural architecture of mouse cortical areas |
| 218 | P47 Perspectives of ontology-based search server for making an intelligible list of metadata to represent target neuroinformatics contents in J-node |
| 220 | P45 ReproNim: a center for reproducible neuroimaging computation to support resource discovery, interoperability, and replicable results |
-

-
- 222** P49 The CARMEN (Code Analysis Repository and Modelling for E-Neuroscience) project for collaborative sharing of data and analysis tools in electrophysiology: reviewing an early co-laboratory
- 225** P36 Incorporating the connectome into large-scale neuro-computational models to simulate neuroimaging experiments of visual and auditory short-term memory
- 227** P38 On the spatial dynamics of a network spike in neuronal cultures
- 229** P59 Adaptive HRF and BF approaches to fNIRS activation analysis
- 231** P69 Divergent functional network deficits during an attention-executive task in Lewy body dementia and Alzheimer's disease
- 234** P67 Effective connectivity analysis in fronto-centro-parietal network during altered levels of consciousness
- 238** P57 FSL-based hybrid atlas promotes activation weighted vector analysis in functional neuroradiology
- 241** P61 Functional connectivity analysis of working memory during a mental arithmetic task
- 244** P65 Functional connectivity of resting state as a biomarker for working memory performance
- 246** P63 Interlocking fMRI and Allen Brain Atlas: paving the way for new investigations of structural-functional relationships in (transgenic) mice
- 249** P55 NeuroRetriever: automatic single-neuron reconstruction from fluorescent images
- 250** P71 Region-of-interest estimation using convolutional neural network and long short-term memory for functional near-infrared spectroscopy data
-

253	P51 Standardizing neuroimaging atlas formats
255	P53 Using a temporal decomposition technique to investigate dynamic changes in subnetworks derived from resting state fMRI during generalized spike-and-wave discharges: an EEG-fMRI pilot study
257	P42 Full-scale simulation of a cortical microcircuit on SpiNNaker
259	P40 Neuromorphic hardware in action: comparing the implementation of a spiking multivariate classifier model on three neuromorphic platforms
261	P44 Assessment of locomotor activity in mice brain
262	P52 Atlas based visualization of fiber orientations in the rat brain derived from 3D polarized light imaging
267	P50 From integration to visualization of multisite brain data on brain-CODE
272	P46 Functional connectivity during working memory task performance
273	P54 Using virtual reality to visualize MRI images of the human brain
275	P48 Visualization of brain connectivity during emotion induction
281	Legal, ethical and technical challenges of international clinical data sharing: The Center-TBI experience

Program

	Saturday, September 3	Sunday, September 4	Monday, September 5
9.00	WELCOME	UK NODE PRESENTATION	OPTIONAL TOURS Windsor Castle OR Stonehenge and Salisbury
9.15	TRACK A INFORMATICS I: DATA SYSTEMS <small>coffee break</small>	TRACK E INFORMATICS III: VISUALIZATION <small>coffee break</small>	
10.55	TRACK B INFORMATICS II: COMPUTING SYSTEMS	TRACK F INFORMATICS IV: FROM SINGLE NEURONS TO LARGE SCALE NETWORKS	
12.05	DISCUSSION <small>lunch</small>	DISCUSSION <small>lunch</small>	
13.30	TRACK C NEUROIMAGING I TRACK D COMPUTATION AND COGNITION: FROM PHYSIOLOGY TO NEURAL PROCESSING <small>coffee break</small>	TRACK G BRAIN DISORDERS I TRACK H NORMAL DEVELOPMENT/ COGNITION I <small>coffee break</small>	
15.10	TRACK C NEUROIMAGING II TRACK D COMPUTATION AND COGNITION: FROM NEURAL PROCESSING TO PSYCHOLOGY	TRACK G BRAIN DISORDERS II TRACK I TRAUMATIC BRAIN INJURY	
16.20	DISCUSSION	DISCUSSION	
17.30	POSTER AND DEMO RECEPTION	POSTER AND DEMO RECEPTION	
19.30			

Day 1: Saturday, September 3

- 09:00 - 09:15

Opening statement: Alan Evans, Program committee chair
- 09:15 - 10:25

Track A - Informatics I: Data systems
- 09:15 - 09:45

Keynote: **Jean-Baptiste Poline** «Moving grounds: The evolution of neuroinformatics, statistical, and sociological aspects and their interactions in brain imaging research»
- 09:45 - 10:05

Amitava Majumdar «Neuroscience gateway – cyberinfrastructure providing supercomputing resources for large scale computational neuroscience research»

10:05 - 10:25 James J Bonaiuto «Linking computational models to experimental data with the Brain Operation DataBase (BODB)»

10:25 - 10:55 Coffee

10:55 - 12:05 Track B - Informatics II: Computing systems

10:55 - 11:25 Keynote: **Tristan Glatard** “Web platforms for high-throughput neuroimaging analyses: state of the art and future directions”

11:25 - 11:45 James P Turner “Easy-to-use GPU acceleration of neural network simulations with GeNN”

11:45 - 12:05 Tibor Auer “Automatic analysis (aa): efficient and transparent multimodal neuroimaging workflows”

12:05 - 12:35 Roundtable discussion

12:35 - 13:30 Lunch

Parallel sessions in the afternoon

13:30 - 14:40 Track C - Neuroimaging I

13:30 - 14:00 Keynote: **Markus Axer** “3D-Polarized light imaging – The structural connectome goes microscopic”

14:00 - 14:20 Constantine Dovrolis “A symmetry-based method to infer structural brain networks from probabilistic tractography data.”

14:20 - 14:40 Niels Janssen “Whole brain fMRI activity at a high temporal resolution: A novel analytic framework”

13:30 - 14:40 Track D - Computation and cognition: from physiology to neural processing

13:30 14:00 Keynote: **Claudia Clopath** “Emergence of subnetworks in plastic recurrent networks”

14:00 - 14:20 Manisha Chawla “Common neural coding across domains of decision making identified by meta-analysis”

14:20 - 14:40	Olivia Eriksson "Statistical uncertainty and sensitivity analysis of intracellular signaling models - through approximate Bayesian computation and variance based global sensitivity analysis"
14:40 - 15:10	Coffee
15:10 - 16:20	Track C - Neuroimaging II
15:10 - 15:40	Keynote: Nikolaus Kriegeskorte "Deep neural networks: a new framework for modelling brain information processing"
15:40 - 16:00	Stavros I. Dimitriadis "Over a unified connectivity estimator for intra and inter-frequency couplings through symbolic transfer entropy: A MEG resting-state analysis"
16:00 - 16:20	Robin A. A. Ince "An information theoretic framework for neuroimaging data analysis: stimulus modulations, representational interactions and causal communication of specific information content"
15:10 - 16:20	Track D - Computation and cognition: from neural processing to psychology
15:10 - 15:40	Keynote: Peter Dayan " Neurocomputational Modeling in Psychiatry"
15:40 - 16:00	Sobana Wijeakumar "Simultaneous modeling of brain and behavior using dynamic field theory: Probing the neural dynamics of response selection Simultaneous modeling of brain and behavior using dynamic field theory: Probing the neural dynamics of response selection"
16:00 - 16:20	Massimiliano Garagnani "Simulating word acquisition and semantic grounding in a neuroanatomically realistic, Hebbian-learning, spiking neural network model of the cortex"
16:20 - 17:00	Roundtable discussion
17:30 - 19:30	Poster session and drink reception (complimentary, refreshments served)

Day 2: Sunday, September 4

- 09:00 - 09:15** UK Node presentation. Leslie Smith
- 09:15 - 10:25** **Track E - Informatics III: Visualization**
- 09:15 - 09:45 Keynote: **Hanchuan Peng** "Massive scale neuroinformatics"
- 09:45 - 10:05 Ester Bonmati "Measuring complex brain networks structure"
- 10:05 - 10:25 Marius Varga "Virtual reality visualisation of a biologically realistic anatomical and functional model of the tadpole spinal cord"
- 10:25 - 10:55** Coffee
- 10:55 - 12:05** **Track F - Informatics IV: From Single Neurons to Large-Scale Networks: Connecting Micro Macro Scales**
- 10:55 - 11:25 Keynote: **Jeffrey Krichmar** "Towards a modeling framework for the efficient creation, simulation and analysis of brain functions"
- 11:25 - 11:45 Srikanth Ramaswamy "Reconstructing and simulating neocortical microcircuitry"
- 11:45 - 12:05 Claus Hilgetag "Relating extrinsic connections to the intrinsic architecture of the cerebral cortex"
- 12:05 - 12:35** Roundtable discussion
- 12:35 - 12:45** **Trellis** spotlight presentation. Lou Woodley
- 12:45 - 13:30** Lunch

Parallel sessions in the afternoon

- 13:30 - 14:40** **Track G - Brain Disorders I**
- 13:30 - 14:00 Keynote: **Helen Mayberg** "The evolving role for imaging in optimizing treatment for depression"
- 14:00 - 14:20 Yujiang Wang "Mechanisms underlying different onset patterns of focal seizures"
- 14:20 - 14:40 Piyush Swami "Detection and cortical localization of ictal signatures using electroencephalogram signals"
-

15:10 - 16:20	Track G - Brain Disorders II
15:10 - 15:40	Keynote: Martijn van den Heuvel “Integrative hubs in the connectome”
15:40 - 16:00	Peter Neal Taylor “Contributions from white and grey matter on structural connectomes of temporal lobe epilepsy patients”
16:00 - 16:20	Marcus Kaiser “Determining epilepsy surgery targets through connectome-based computer simulations”
13:30 - 14:40	Track H - Traumatic Brain Injury
13:30 - 14:00	Keynote: Acquiring and analysing data in TBI: Challenges and opportunities David Menon , University of Cambridge, UK
14:00 - 14:20	Computational challenges for the analysis of intracranial pressure and heart rate data in traumatic brain injuries patients Pietro Lio , University of Cambridge, UK
14:20 - 14:40	Legal, ethical and technical challenges of international clinical data sharing: The Center-TBI experience Jeannette Söderberg , INCF, Sweden
14:40 - 15:10	Coffee
15:10 - 16:20	Track I - Normal Development / Cognition
15:10 - 15:40	Keynote: Typical and atypical development of large-scale brain networks Vinod Menon , Stanford School of Medicine, USA
15:40 - 16:00	Detailed computational modeling of the developmental self- organization of neuronal structure and function Roman Bauer , Newcastle University, UK
16:00 - 16:20	Keynote: The functional and neural architecture of object concepts Yanchao Bi , Beijing Normal University, China
16:20 - 17:00	Roundtable discussion
17:30 - 19:30	Poster session and drink reception (complimentary, refreshments served)

Speakers

Markus Axer

Forschungszentrum Jülich, Jülich, Germany

Will talk about:

3D-Polarized light imaging – The structural connectome goes microscopic

Session:

C. Neuroimaging I



Claudia Clopath

Imperial College, London, United Kingdom

Will talk about:

Emergence of subnetworks in plastic recurrent networks

Session:

D. Computation and cognition: from neural processing to psychology



Tristan Glatard

McGill University, Montreal, Canada

Will talk about:

Web platforms for high-throughput neuroimaging analyses: state of the art and future directions

Session:

B. Informatics II: Computing systems



Nikolaus Kriegeskorte

University of Cambridge, Cambridge,
United Kingdom

Will talk about:

Deep neural networks: a new framework for
modelling brain information processing

Session:

C. Neuroimaging II



Vinod Menon

Stanford School of Medicine, Stanford,
California, United States

Will talk about:

Typical and atypical development of large-
scale brain networks

Session:

H. Normal development/cognition I



Jean-Baptiste Poline

University of California Berkeley, Berkley,
United States

Will talk about:

Moving grounds: The evolution of
neuroinformatics, statistical, and sociological
aspects and their interactions in brain imaging
research

Session:

A. Informatics I: Data systems



Yanchao Bi

Beijing Normal University, Beijing, China

Will talk about:

The functional and neural architecture of object concepts

Session:

H. Normal development/cognition I



Peter Dayan

University College London, London, United Kingdom

Will talk about:

Neurocomputational Modeling in Psychiatry

Session:

D. Computation and cognition: from physiology to neural processing



Jeffrey L. Krichmar

University of California Irvine, Irvine, United States

Will talk about:

Towards a modeling framework for the efficient creation, simulation and analysis of brain functions

Session:

F. Informatics IV



Helen Mayberg

Emory University, Atlanta, Georgia, United States

Will talk about:

The evolving role for imaging in optimizing treatment for depression

Session:

G. Brain disorders I



Hanchuan Peng

Allen Institute for Brain Science,

Will talk about:

Massive Scale Neuroinformatics

Session:

E. Informatics III: Visualization



Martijn van den Heuvel

University Medical Center Utrecht, Utrecht, the Netherlands

Will talk about:

Integrative hubs in the connectome

Session:

G. Brain disorders II



David Menon

University of Cambridge, Cambridge, United Kingdom

Will talk about:

Acquiring and analysing data in TBI:
Challenges and opportunities

Session:

I. Traumatic brain injury

Presentation types

Poster

Preliminary poster measurements are W110 cm x H180 cm. The materials required for mounting posters will be provided.

Demo

Each demo station consists of a table, chairs, poster board, electrical supply, and internet access via broadband LAN.

Investigator presentation

The Program committee will select 24, 20-minute presentations from submitted abstracts with priority given to abstracts for tracks:

- A – Informatics I: Data systems
 - B – Informatics II: Computing systems
 - C – Neuroimaging
 - D – Computation and cognition
 - E – Informatics III: Visualization
 - F – Informatics IV: From single neurons to large-scale networks: Connecting micro macro scales
 - G – Brain disorders
 - H – Normal development/cognition
-

IP06 Computational challenges for the analysis of intracranial pressure and heart rate data in traumatic brain injuries patients

Giovanna Maria Dimitri¹, Helena Andres¹, Shruti Agrawal², Adam Young³, Peter Smielewski⁴, Peter Hutchinson⁵, Marek Czosnyka⁴, Christina Haubrich^{4,6}, Pietro Lió¹

¹Computer Lab, University of Cambridge, Cambridge, UK

²Pediatric Department, University of Cambridge, Cambridge, UK

³Neurosurgery, Addenbrooks Hospital, University of Cambridge, Cambridge, UK

⁴Brain Physics Lab, University of Cambridge, Cambridge, UK

⁵Head Neurosurgery, University of Cambridge, Cambridge, UK

⁶Neurology, RWTH Aachen University, Aachen, Germany

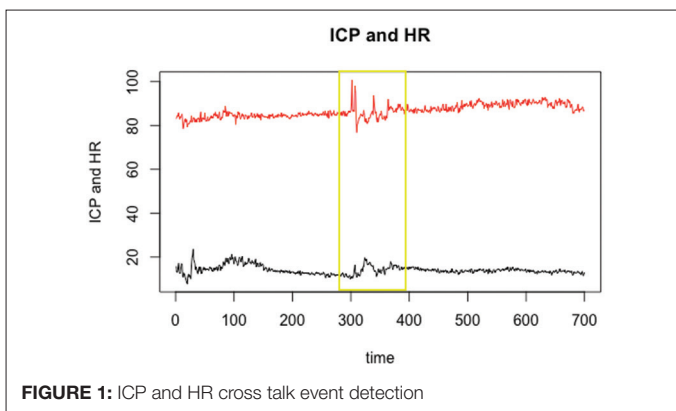
giovanna.maria.dimitri@gmail.com

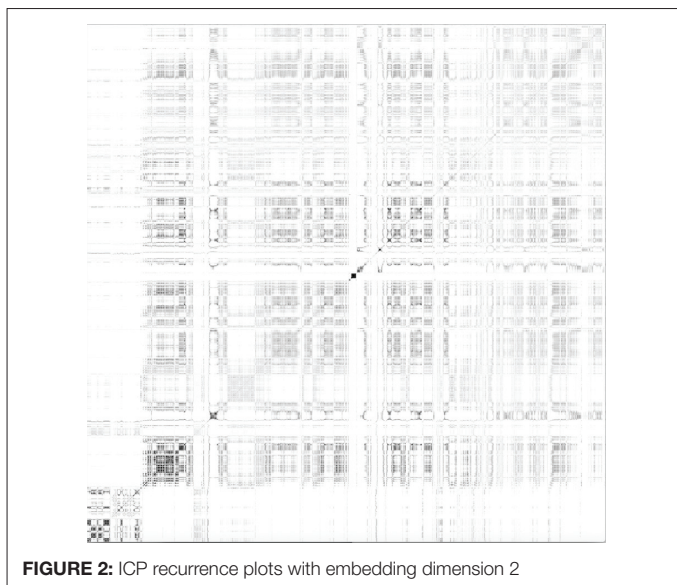
Background and motivation: Intracranial pressure (ICP) after severe brain injuries or similar life threatening conditions can be continuously monitored (Hu et al., 2009). The ICP signal contains useful information to predict life threatening conditions such as intracranial hypertension. So far, monitoring approaches are focusing mainly on the relationship between arterial blood pressure and intracranial pressure. Own observation in pediatric patients however, showed that changes in heart rate have direct influence on the ICP. Our hypothesis therefore is that the HR–ICP relationship can be quantified via complex event processing methods. A few works concentrate on the capability of identifying a model describing the intracranial system behaviour. For example, in Hu et al. (2007a), the authors present an estimation algorithm based on hidden state estimation approach and non linear Kalman filters to estimate unobserved variable given some measurements such as ICP and cerebral blood flow velocity (CBFV). What might be interesting is understanding the interrelationship between ICP and other measures of the monitored patients. For example, in Hu et al. (2008), the authors present ApEN an algorithm based on the adaptive calculation of approximate entropy, integrated with a causal coherence analysis that is able to exploit the potential interaction between ICP and R wave intervals (Hu et al., 2008). Interesting in this sense is also (Hu et al., 2007b) where the authors extract indices from beat to beat mean intracranial pressure measurements and intervals between consecutive normal sinus heart beats (ICP and RR intervals). Starting from the visual observation that heart rate and ICP present peaks at similar points, we applied several statistical methodologies to identify such co-occurrences of peaks and the relationships existing between the two time series. Moreover we are currently investigating the relationship existing also with the other variables monitored. This preliminary

analysis performed appear to be promising and we are now extending our work to perform online peaks detection of ICP peaks considering the relationship between the ICP and HR.

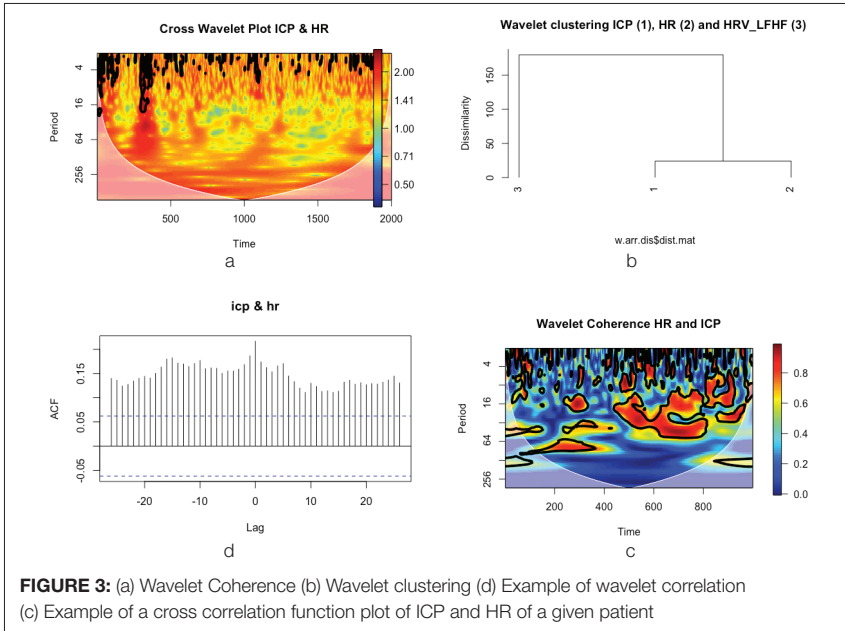
Data: ICP and additional variables monitored: The dataset we are working on is composed by 38 pediatric patients with traumatic brain injury. For all of the patients, we have the following parameters: abp mean arterial pressure (mmHg), HR heart (rate/min), ICP intracranial pressure (mmHg), AMP intracranial pulse pressure amplitudes, HRVLFHF heart rate variability (ratio low frequency power/high frequency power, HRhfRel percentage of high frequency power, CPP cerebral perfusion pressure (mmHg). The time series are sampled at a rate of $1.2E-05/s$.

Methods and findings: To test and evaluate our initial hypothesis regarding the relationships existing between heart rate pressure and intracranial pressure, we performed a wide range of different statistical analysis. As shown in Figure 1, the two series of HR and ICP show a similar behaviour in the peaks patterns. (1) Figure 1: ICP and HR cross talk event detection to further investigate the similar behaviours, we firstly performed an analysis in terms of recurrence plots (RP). RP is a statistical analysis technique used for nonlinear data. The data are visualized through a graph in a square matrix (column and rows represents a pair of times), where the elements are representation of the times at which a state of the dynamical system recurred (<http://www.recurrence-plot.tk/glance.php>). Mathematically, RP represents the time stamps in which the phase space trajectory of the system that we are considering passes through the same area in the phase space (<http://www.recurrence-plot.tk/glance.php>) (Eckmann et al., 1987). Figure 2: ICP recurrence plots with embedding dimension 2. The recurrence quantification analysis is a method that quantifies the number and duration of recurrences of





a dynamical system presented by its state in the phase space trajectory. Some of these measures include the Recurrence Rate (RR), Determinism (DET), Laminarity (LAM), Ratio (RATIO), Trapping Time (TT), Divergence (DIV), Entropy (ENTR), and Trend (TREND). A further description about these measures can be found in (<http://www.recurrence-plot.tk/glance.php>). The first visualisation and analysis of the recurrence plots (see Figure 2) indicate that there is an existent time pattern, the determinism of the system is significant. Therefore, it is possible to find a model that successfully predicts the behaviour of the series, and can be integrated with other variables such as the Heart Rate. This method can also be further extended by using integrative measurements. Similar to the diagonal-wise defined recurrence rate, the other measures based on the diagonal lines (DET, L, ENTR) can be defined diagonal-wise. These definitions are useful to study interrelations or synchronisation between different systems (using recurrence plots or cross recurrence plots), for instance, the first application could be integrating ICP and HR recurrence or cross recurrence plots. An additional analysis we performed was the one considering the cross correlation function. Cross correlation represents the similarity between two signals, as a function of the shift or temporal translation applied to one of the two signals (Grinsted et al., 2004) 2 (<https://en.wikipedia.org/wiki/Cross-correlation>). We performed the cross correlation function between the two time series ICP and HR to further analyse the values of the



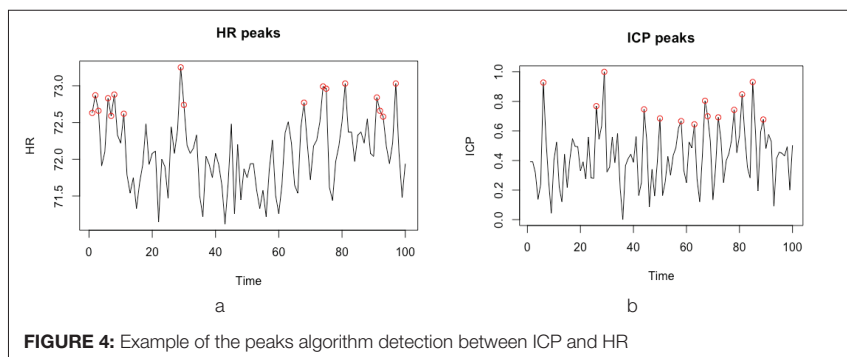
correlation between them. As we can see from Figure 3, there is a correlation between the two time series, therefore this additional exploratory statistical analysis further suggest our initial intuition of a possible relationship between the two signals.

Wavelets analysis and wavelet coherence: A further analysis we performed for understanding the relationship between two time series is the Wavelet Coherence, that is a method able to determine and to visualize areas with high common power (i.e., high common correlation) between two time series (<http://www.fil.ion.ucl.ac.uk/wpenny/course/array.pdf>). Before performing such test, we checked for the normality of the two time series considering the Shapiro Wilcox Test for normality. Since the test showed normality in the data proposed, we performed the Wavelet Coherence between the two time series, as we can see from Figure 3. The resulting plot shows particularly interesting characteristics. In fact, it identifies regions (in red) where the two signals are highly correlated and it also tells us in which time instants such correlation happens. This is particularly useful for our analysis, considering the fact that we are looking for correlation in particular time instances (i.e., when peaks occur). Therefore, such time instances could be revealed by the Wavelet Coherence graphs. Moreover, we performed two additional analyses with wavelets, involving the wavelets

correlations and the wavelet clustering. In the first case, the wavelet correlation showed a high correlation between the ICP and HR as we can see from Figure 3. In the case of clustering, so far we have analysed the wavelet power clustering considering three time series HR, ICP, and HRVLFHF. As we can see from the Figure 3, the ICP and HR are clustered together (1 and 2 in the tree) and further from the time series of HRVLFHF supporting even more our hypothesis about similarity between HR and ICP behaviours. Figures 3A–D: (a) Wavelet Coherence (b) Wavelet clustering (d) Example of wavelet correlation (c) Example of a cross correlation function plot of ICP and HR of a given patient 3.

Peaks Detection Algorithm: In addition to these analyses, we implemented a peak detection algorithm, following the first algorithm suggested in Palshikar (2009). In this way, we could try to find correlations between peaks happening in the ICP and in the HR series, seeing the possible temporal correlation between them. This is the first step for a further implementation of peaks prediction algorithm that will be the next step in our study. In the Figure 4, we can see the result of the peaks detection algorithm in the ICP series. Figures 4A,B: example of the application of the peaks algorithm detection we implemented to the ICP time series and to the HR time series. We performed preliminary analysis on peaks detection in HR and ICP and we obtained a significant overlap in the peaks detected in the ICP and HR, suggesting the validation of our initial intuition regarding the possibility of crosstalks events between ICP and HR as well as the possibility for a future utilization of HR information to predict ICP peaks and trends.

Granger Causality Test: A further statistical analysis we are currently performing is the Granger Causality test. Such test (Berzuini et al., 2012) check whether it is possible to infer a cause effect relationship given two time series considering the concept of Ganger Causality (Granger, 1969). We performed preliminary granger test causality



on the HR and ICP time series, and first preliminary results on some samples show a significant p -value (0.012) of an existing causal relationship between HR and ICP. Such approach has been widely used also in brain data processing (Ge et al., 2009; Kim et al., 2011; Tang et al., 2012).

Results and Conclusion: The preliminary analysis performed on a subset of 3 patients from the cohort of 38 patients, suggests that our initial visual intuition is confirmed from a preliminary statistical analysis of the dataset. The Wavelet Coherence, as well as the peaks detection algorithm and the recurrence plots, confirmed our preliminary hypothesis. We are now further analysing the time series using the Granger Causality method, trying to understand the causality correlations existing between the various time series as well as further develop our methodology to implement an online ICP peaks detection algorithm.

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