Summit 2020 posters

Posters marked with (YRE) in the table of contents will be considered for the best Summit poster award. Posters are sorted per SP number, CDPs are sorted according to their SP, not CDP number.

POSTER CODE	POSTER TITLE
CDP1-1	CDP1: Experimental and computational study on motor control and recovery after stroke neuroscience
CDP1-2	CDP1: Multiscale optical imaging and modeling of slow-wave activity
SP1-1	Experimental Measurements And Models Of The Cerebellar Network: Neurons And Synapses
SP1-2	Experimental Measurements And Models Of The Cerebellar Network: Local Microcircuit And Large-Scale Networks
SP1-3	High-Quality Multilevel Datasets at Molecular and Subcellular Level of Single Molecules, Single Synapses and Single Cells
SP1-4	Mouse Neocortex Multi-level Approach
SP1-5	Comparative Studies of Mouse and Human
SP1-6	WP1.3: Whole mouse brain - Functional and structural mapping to unveil large-scale organizational principles
CDP3-1	HBP's multilevel human brain atlas embedded in the EBRAINS infrastructure
CDP3-2	Spatial Anchoring of The Virtual Brain in the HBP Brain Atlas
CDP4-1	End-To-End Learning Saccades for Object Recognition
CDP4-2	Codesign Project 4: From Saccades to Dexterity
SP2-1	WP2.5 Cross-species comparisons of mouse, rat, monkey and human brains in visuo-motor areas and medial temporal lobe
SP2-2	The contribution of the superior colliculusin visuo-motor transformations during figure-ground segregation
SP2-3	WP2.1 Multimodal whole-brain mapping
SP2-4	Multi-modal, high-resolution model of the human hippocampus including cells, fibers, receptors, gene expressions for theory, modeling, simulation, and atlas
SP2-5	WP 2.4-Title: Inter-subject variability of the human brain and its relation to geno- and phenotype
SP3-1	Investigating the functional connectivity organisation of visual cortex using occluded movies during 3T fMRI
SP3-2	Multi-scale, multi-species, multi-methodology experiments, analysis tools and simulation models of Brain States and Complexity in SP3-UseCase002
SP3-3	A robot model of motivated behaviour to resolve conflicting drives
SP3-4	Learning and sleep in a thalamo-cortical multi-area model
SP3-5	A neurorobotic model of multi-sensory reconstruction and spatial memory incorporating real-time neuromorphic hardware in the loop
SP3-6	Neural mechanisms of cross-modal object memory
CDP7-1	The hippocampus-ventral striatum circuit model in the Neurorobotics Platform in navigation tasks
SP4-1	Multimodal Modeling of Neural Network Activity: Computing LFP, ECoG, EEG, and MEG Signals With LFPy 2.0
SP4-2	Implementing biologically informed mean-field models in The Virtual Brain
SP4-3	Multi-area model of macaque cortex as a scaffold model and workflow test case
SP4-4	The virtual epileptic patient (VEP): Taking neuroscience to clinical trials
SP4-5	Conductance-based dendrites perform reliability-weighted opinion pooling
SP4-6	Modeling astrocyte-neuron interactions on network signal transmission
CDP8-1	Multiscale brain simulation with TVB-NEST
CDP8-2	TVB brain model construction pipeline
SP5-1	SBA Composer: Web-based platform for interactive, multi-modal data visualization with Jupyter notebook control
SP5-2	New functionalities in the QUINT workflow for brain atlas-based image data analysis

SP5-3	Interactive anchoring of high-resolution volumes of interest to BigBrain using VoluBA
SP5-4	Integration of neuroscience data into the HBP KnowledgeGraph and interactive atlas viewers using MINDS and SAND metadata schemas
SP5-5	Designing generalizable, reproducible analysis workflows for experimental and simulated activty data using Elephant
SP5-6	DataLad: Management and transport logistics for scientific (meta)data
SP5-7	Ebrains architecture
SP5-8	HBP High Level Support Team (HLST)
CDP2-1	Cerebellar modular circuit into an adaptive control system
CDP2-2	Hackathon on Cerebellar Modeling 2020
SP6-1	The Brain Simulation Platform (BSP) - v2.0: building brain models in a collaborative environment
SP6-2	New Methods and Tools for Molecular level Simulations of Neuronal Processes
SP6-3	Cerebellum: advanced neuron and microcircuit models
SP6-4	Improving NEURON simulation performance for cellular simulation through more effective DSL translation and optimized computing engine
SP6-5	Scientific validation of data-driven neuroscience models despite complexity and sparse data
SP6-6	Graph-theoretical Derivation of Brain Structural Connectivity
SP7-1	Advanced plasticity rules in NEST
SP7-2	ICEI: HPC Centres Delivering Federated E-Infrastructure Services
SP7-3	NEST3 and NESTML: You'll love the new NEST user experience
SP7-4	Interactive Modeling and Visualization for Neuroscience
SP7-5	NEST Simulator: Documentation, Support, Community
SP7-6	Co-simulation of the multiscale brain with EBRAINS
CDP6-1	Molecular Dynamics of Regulatory Sites During the Glycine Receptor Gating and Desensitization
CDP6-2	The Glycine Receptor Allosteric Ligands Library (GRALL)
SP8-1	The Medical Informatics Platform (MIP): an innovative tool for leveraging patients' BIG data in clinical neuroscience across Europe
SP8-2	HIP: The human intracerebral EEG Platform
SP8-3	Data Factory: Data preparation and integration for the Medical Informatics Platform
SP8-4	Practical Application of Emulators instead of Simulators for UQ and Optimization in HBP
SP8-5	Asymmetrical effective connectivity in the mesial temporal network of the living human brain
SP8-6	Detection of single CCEPs and their correlation with seizure propagation networks
SP8-7	Virtual Dementia: The Virtual Brain improves pathophysiological understanding and diagnostics
SP8-8	Allosteric drug discovery for PIK3CA mutants
SP8-9	Open standards for deployment, storage and sharing of predictive models. PMML / PFA / ONNX in action.
SP8-10	Functional and structural connectivity of the human brain: synergy of results from direct electrical stimulation and diffusion magnetic resonance imaging
CDP5-1	Co-Design Project 5: Research highlights
CDP5-2	Co-Design Project 5: Research highlights
SP9-1	Hot Coffee: Associative Memory with Bump Attractor Cell Assemblies of Spiking Neurons
SP9-2	Realtime Cortical Simulation on SpiNNaker
SP9-3	Neuromorphic Computing Platform : Provide User Access
SP9-4	BrainScaleS-1 Near Future Upgrades
SP9-5	BrainScaleS-2 results
SP9-6	Silicon Brains booth poster
SP10-1	SP6-SP5-SP10: Knowledge Graph integration into the Neurorobotics Platform

SP10-2	Particle physics: the way to fluid dynamics in the Neurorobotics Platform
SP10-3	Neurorobotics Platform's new plotting framework
SP10-4	Strategic Experiment #7: duality between NRP and real-world robots under neurocomputing control
SP10-5	Learning event-based visual representations for grasping with e-prop on SpiNNaker
SP10-6	Large-scale NEST simulation on NRP running on HPC infrastructure (TBC)
SP12-1	Ethics Support
SP12-2	Responsible Dual Use in Neuroscience and Neurotechnology
SP12-3	Neuroethics, Philosophy and RRI in the HBP
SP12-4	Ethics and Society in HBP
SP12-5	Citizen And Stakeholder Engagement and EBRAINS Community Building
SP12-6	Foresight Lab
SP11-P1	Multiscale Model of Hippocampal Synaptic Plasticity: Integration to the Brain Simulation Platform
SP11-P2	Integration of CxSystem2 and Neuronal Dynamics Library to the Brain Simulation Platform
SP11-P3	Anomalies of directed and dynamic connectivity in stroke
SP11-P4	SpiNNcer: a cerebellum advanced circuit into a SpiNNaker system
SP11-P5	Mapping Brain Circuits in Spatial Navigation (MAPS): the spacing effect
SP11-P6	Modeling body and peripersonal space representations on humanoid robots with electronic skin
SP11-P7	Traveling waves in monkey premotor cortex at the edge of synchronization
SP11-P8	Addressing brain health challenges with neuroscience grounded technologies: A case study in the treatment of stroke using the Rehabilitation Gaming System.
SP11-P9	EpiCARE, THE EUROPEAN REFERENCE NETWORK FOR RARE AND COMPLEX EPILEPSIES
SP11-P10	Shaping the ethical dimensions of information technologies – a European perspective (SHERPA)
SP11-P11	StillSuit: the endoskeletal robot suit for the biological human augmentation
SP11-P12	Partnering Environment
SP11-1	Innovation management in HBP
SP11-2	WE ARE HBP: Vision and Strategy, Guiding Questions and Examples
SP11-3	Participate & collaborate: The HBP Education Programme
SP11-4	European Brain Research Area

Table of Contents

(YRE)Poster code: CDP1-1; Title: CDP1: Experimental and computational study on motor control and recovery after stroke neuroscience

Authors: Anna Letizia Allegra Mascaro, Egidio Falotico, Spase Petkoski, Maria Pasquini, Lorenzo Vannucci, Nuria Tort-Colet, Emilia Conti, Francesco Resta, Cristina Spalletti, Shravan Tata Ramalingasetty, Axel Von Arnim, Emanuele Formento, Emmanouil Angelidis, Camilla Hagen Blixhavn, Trygve Brauns Leergaard, Matteo Caleo, Alain Destexe, Auke Ijspeert, Silvestro Micera, Cecilia Laschi, Viktor Jirsa, Marc-Oliver Gewaltig, Francesco S. Pavone
Main author/presenter is early-career researcher: yes
Poster abstract: Being able to replicate real experiments with computational simulations is a unique opportunity for a cultural paradigm shift in neuroscience towards experiments that are planned and built based on theoretical predictions. An iterative loop between experiments and simulations would allow researchers to both refine and validate models with experimental data and redesign their experiments based on simulations. However, since it is technically demanding to model all components of an experiment, traditional approaches to modeling reduce the experimental setups as much as possible. As a result, direct comparison between experimentally observed data and modeling data is only possible for a small subset of the recorded data. We here present an approach that allows continuous integration of new experimental data into a computational modelling framework that aims at replicating all the relevant components in a study of motor control and motor rehabilitation after stroke. We demonstrate how experimental and computational techniques can be combined to study relevant features of the complete sensory-motor loop from brain activity to muscle contraction and object displacement. In detail, we show two successful examples of iterative closed-loop modeling. In the first, the simulation of brain activity by neural mass models allowed replicating the evolution of functional connectivity in mouse brain after stroke and under rehabilitation. The second pipeline, by feeding a spinal cord model with experimental registration of cortical activity could accurately reproduce experimental object displacement via the simulated embodiment in the virtual world. Our approach with iterative refinement of brain models with a closed loop of experiments and simulations will be extended to integrate multi-level brain models. We envision that this unique strategy will allow to achieve continuously improved experimental design. Finally, the models built and validated here could represent a remarkable prognostic tool in the hands of clinicians for the personalized treatment of stroke patients, that can be generalized to many neuropathologies.

Poster code: CDP1-2; Title: CDP1: Multiscale optical imaging and modeling of slow-wave activity

Authors: Anna Letizia Allegra Mascaro, Francesco Resta, Núria Tort-Colet, Marco Celotto4, Chiara De Luca4,Paolo Muratore4, Giulia De Bonis4, Pier Stanislao Paolucci4, Alain Destexhe3, Francesco S. Pavone
Main author/presenter is early-career researcher: no
Poster abstract: Slow-wave (SW) oscillations activity is critical for several fundamental processes from general brain homeostasis to memory consolidation. In this project, we aimed to study the main features of slow-wave propagation on different scales by developing in silico models and validating them on real multi-scale data. We took advantage of advanced optical imaging techniques coupled with genetically-encoded fluorescence calcium indicator (GCaMP6f) to collect information on neuronal activity both on large scale (wide-field microscopy) and single-cell resolution (two-photon microscopy). In collaboration

with SP3 and SP4 we started from experimental data in anesthetized mice to develop different analysis pipelines and models, to run SW activity simulations at large- and small-network levels. In collaboration with SP3, we developed a pipeline of analysis of slow wave propagation at a large scale. By adapting a well-characterized pipeline for electrophysiological recordings of (SWAP), to calcium imaging dataset we extracted some important features of wave propagation in deep-anesthetized mice. Moreover, we developed a toy model that successfully simulates SW activity on the large scale. In collaboration with SP4 we are analyzing the small network activity with cellular resolution recorded through two-photon fluorescence microscopy under different anesthesia levels. We found increasing levels of neuronal activity correlation at increasing level of anesthesia. These results were simulated with the Adex model by changing the adaptation level of the simulated excitatory neurons. This close-loop approach between experimental data and model simulation is a powerful tool to reveal mechanistic insights of slow-wave activity.

Poster code: SP1-1; Title: Experimental Measurements And Models Of The Cerebellar Network: Neurons And Synapses

Authors: Prestori F., Mapelli L., Gagliano G., Locatelli F., Masoli S., Ottaviani A., Rizza M., Soda T., Tognolina M., Tritto S., D'Angelo E.
Main author/presenter is early-career researcher: no
Poster abstract: High-quality multi-level datasets at molecular and subcellular level of single molecules, single synapses and single cells: (i) Development of novel methods and exploitable tools (of specific antigens and for multiscale localisation of synaptic plasticity) for mapping and imaging; (ii) New software for automatic detection and clustering analysis; (iii) New protocols to study plasticity at molecular level.

Poster code: SP1-2; Title: Experimental Measurements And Models Of The Cerebellar Network: Local Microcircuit And Large-Scale Networks

Authors: Mapelli L., Prestori F., Casellato C., Casali S., Montagna I., Moscato L., Tognolina M., Tritto S., D'Angelo E.
Main author/presenter is early-career researcher: no
Poster abstract: Multi-level datasets generated by integrating neuroanatomical data with genetic, molecular and physiological data using advanced technologies. A new approach developed by combining advanced technologies to perform recordings at different scales. A new framework including novel tools for integration, visualisation and analysis of anatomical and functional data implemented across different scales.

Poster code: SP1-3; Title: High-Quality Multilevel Datasets at Molecular and Subcellular Level of Single Molecules, Single Synapses and Single Cells

Authors: Cattaneo, A. Cherubini, E., Marinelli, S., Meli, G., Marchetti, C., Luján, R. and Sighemoto, R.
Main author/presenter is early-career researcher: no
Poster abstract: Key datasets on single neurons and circuits used in comparative studies on human and rodent for modelling. Ground-breaking techniques used to generate anatomical and functional datasets. New statistical models developed to perform comparative analysis.

(YRE)Poster code: SP1-4; Title: Mouse Neocortex Multi-level Approach

Authors: DeFelipe, J., Herreras, O., Olcese, U., Bosman, C., Armstrong, D., Sorokina, O., Sterratt, D., Pastor, L.., González de Quevedo, F., and García, M.

Main author/presenter is early-career researcher: yes
Poster abstract: To fully understand the complexity of the mouse brain, it is necessary to integrate sub-cellular, cellular and circuit-scale studies with brain-wide analysis of its structure and function. Here we present our activities on the reconstruction of the cytoarchitecture and of the vascular organization. Further, we show our results on functional imaging on awake mice and on the whole-brain activation mapping using immediate early genes. All these results were made possible by technological advancements in the field of imaging and image analysis, which are a core part of the activities of our WP.

Poster code: SP1-5; Title: Comparative Studies of Mouse and Human

Authors: Mansvelder, H., DeFelipe, J., Benavides-Piccione, R., Bielza, C., Larrañaga, P., and Mihaljevic, B.
Main author/presenter is early-career researcher: no
Poster abstract: N/A

Poster code: SP1-6; Title: WP1.3: Whole mouse brain - Functional and structural mapping to unveil large-scale organizational principles

Authors: Ludovico Silvestri, Anna Letizia Allegra Mascaro, Franca Schmid, Emilia Conti, Giacomo Mazzamuto, Francesco Resta, Irene Costantini, Elena Montagni, Alessandra Franceschini, Antonino Paolo Di Giovanna, Leonardo Sacconi, Bruno Weber, Francesco Saverio Pavone
Main author/presenter is early-career researcher: no
Poster abstract: N/A

Poster code: CDP3-1; Title: HBP's multilevel human brain atlas embedded in the EBRAINS infrastructure

Authors: Timo Dickscheid, Pavel Chervakov, Xiao Gui, Daviti Gogshelidze, Vadim Marcenko, Stefan Köhnen, Y. Leprince, J.-F. Mangin, V. Jirsa, K. Amunts
Main author/presenter is early-career researcher: no
Poster abstract: As part of the EBRAINS atlas services, the Human Brain Project develops a comprehensive multi-level atlas of the human brain. The atlas supports both the MNI ICBM 152 asymmetric and Colin 27 single-subject average templates at the macroscopic scale, where it captures brain variability in the form of probabilistic maps of cytoarchitecture derived from histology [1] and major fiber bundles derived from diffusion MRI [2]. The microscopic scale is represented by the BigBrain model [3], with maps of cortical layers [4] and a continuously growing set of high-resolution 3D cytoarchitectonic maps [5]. The scales are linked semantically by correspondence of the cytoarchitectonic area definitions, as well as through nonlinear spatial transformations, carefully regularized by sulcal patterns [6]. The human atlas reference framework is deeply integrated with EBRAINS' extensive neuroscience data repository, the Knowledge Graph. This way it provides the spatial organization of a constantly growing body of multimodal human brain data, that addresses intersubject variability, receptor architecture, cell densities, and other parameters. The multilevel human atlas can be accessed through a range of web-based services, which enable neuroscientists to discover, explore and access the different reference atlases and related multimodal data. The default interface is the EBRAINS interactive 3D viewer NeHuBA (https://interactive-viewer.apps.hbp.eu/) [7], which is built on top of the neuroglancer project (https://github.com/google/neuroglancer) and received a major update in 2019. It

allows visually supported navigation of 3D brain anatomy at microscopic resolution, browsing of region hierarchies, queries for data and metadata related to selected brain regions, and access to an extensible set of interactive analysis plugins. Among the most recent features is a browser for connectivity matrices. Through a plugin architecture, the online viewer also allows interactive analysis with tools such as JuGEx [8]. Since all actions performed in the atlas viewer are mapped to API calls, they can also be carried out in a programmatic fashion

Poster code: CDP3-2; Title: Spatial Anchoring of The Virtual Brain in the HBP Brain Atlas

Authors: Huifang Wang, Timo Dickscheid, Jan Fousek, Ananth Kashyap, Michael Marmaduke Woodman, Katrin Amunts, Viktor Jirsa
Main author/presenter is early-career researcher: no
Poster abstract: Large-scale brain network models are becoming a crucial tool to understand cognition and behavior. The Virtual Brain (TVB) provides a computational framework for modeling human neuroimaging data with neural mass models and biologically realistic connectivity. Typically, each node in the large-scale brain models uses identical models and parameters, whereas the empirical data demonstrates large spatial variation in exhibited dynamical repertoires across brain regions. Brain regions in the HBP human brain atlas are aggregate diverse experimental data that can provide important data features like cell density, properties of connectivity, receptor distribution among others. These novel data enable us to ask new scientific questions by building large-scale brain models with nonuniform local dynamics using the anatomical information on the brain regions. This scientific task will be one of the main topics in SGA3 WP1 and started to be addressed in CDP3 of SGA2. In this poster, we show some preliminary results. We first define brain regions and provide the mapping between BigBrain structural data with personalized functional data. We then present the examples of the structural and functional data features across the brain regions. The third result is a proof-of-concept where the region-specific data enable better sampling of model's parameter space.

Poster code: CDP4-1; Title: End-To-End Learning Saccades for Object Recognition

Authors: Danny da Costa, Mario Senden, Kurt Driessens & Rainer Goebel
Main author/presenter is early-career researcher: no
Poster abstract: "Object recognition operates in light of physical constraints imposed by the eye as well as functional requirements such as having high visual acuity while maintaining a large field of view. Physically, the organization of the retina meets these constraints by densely packing photoreceptors within a small central region, the fovea, and letting photoreceptor density decrease rapidly towards the periphery .
Functionally, this arrangement introduces a challenge
for the visual system since only the region of external space fixated by the eyes is resolved with high acuity. To overcome this, object recognition involves information integration across samples of external space obtained by continuously repositioning the eyes. Here we present an end-to-end reinforcement learning approach able to
effectively make saccades in order to recognize complex objects."

Poster code: CDP4-2; Title: Codesign Project 4: From Saccades to Dexterity

Authors: Mario Senden, Mahmoud Akl, Salil Bhat, Danny Da Costa, Benedikt Feldotto,

Alexander Kroner, Anno Kurth, Vaishnavi Narayanan, Raphael Stolpe, Tonio Weidler, Gorka Zamora-Lopez, Sacha van Albada & Rainer Goebel
Main author/presenter is early-career researcher: no
Poster abstract: "Codesign project 4 develops biologically inspired, embodied, cognitive architectures implementing visuomotor capacities. During SGA2, we developed a closed-loop system for scene understanding by visually exploring its environment via saccades. The system consists of four modules (object recognition, salience, target selection & saccade generation) implemented at varying levels of biological realism (deep learning, mean field & spiking neuron models). During SGA3 (within WP3), we will move to more complex visuomotor tasks including visually guided in-hand object manipulation. To that end we train a biologically inspired recurrent convolitional neural network (RCNN) to perform object manipulation on an anthropomophic robotic hand. The computational strategy developed by the agent (RCNN) will be closely examined to generate novel hypotheses as to how dexterity may be achieved in the human brain."

Poster code: SP2-1; Title: WP2.5 Cross-species comparisons of mouse, rat, monkey and human brains in visuo-motor areas and medial temporal lobe

Authors: Mansvelder H., Palomero-Gallagher N., Roelfsema P., Vanduffel W.
Main author/presenter is early-career researcher: no
Poster abstract: "In WP2.5 we identify features at multiple levels of organisation by analysing inter-species differences and
commonalities in mouse, rat, monkey and human brains in visuo-motor areas and the medial temporal lobe at different spatio-temporal scales. In Tasks 2.5.1-3, we will study the various types of inhibitory interneurons in different neocortical areas of the human brain, their function, morphology, connectivity, distribution, and compare those to monkey and rodent neocortical interneurons. In Task 2.5.4, we will study neurotransmitter and neuromodulator receptor distributions in visuo-motor systems in different species, while in Task 2.5.5 we will study how neuromodulators control learning and cortical representation in human and non-human primates. In Tasks 2.5.6 and 2.5.7, we will study how visual perception and attention are represented in human, monkey and rodent brain. The data generated in this WP will be used in SP6 for model simulations and will be integrated in the HBP Human Brain Atlas via the Neuroinformatics
Platform (SP5)."

Poster code: SP2-2; Title: The contribution of the superior colliculusin visuo-motor transformations during figure-ground segregation

Authors: Anne F. van Ham., Matthew W. Self, Pieter R. Roelfsema
Main author/presenter is early-career researcher: no
Poster abstract: "Background:
An important task of the visual system is to segregate objects from their backgrounds to guide behavior, a process called figure-ground segregation. Previous studies showed that neuronal activity in macaque primary visual cortex (V1) was modulated when the receptive field (RF) of a neuron fell on a figure compared to the background, a process referred to as figure-ground modulation (FGM). FGM correlated with the percept of the animal and was modulated by behavioral relevance. We recently showed that the pattern of FGM in V1 also impacted on the onset and end position of saccades that were planned towards figures. It is unknown, however, how and through which pathways activity patterns in V1 can influence

saccades. The goal of our study was to expand our knowledge of visuo-motor transformations that occur in the brain, in particular the transformations of this visual object information in V1 into saccades towards these objects. The superior colliculus (SC) is a good candidate to perform these visuo-motor transformations, as this subcortical multi-layer structure receives visual input from V1 and is connected to motor-related structures. Therefore, we studied the role of the SC in the planning of saccades towards figure-ground stimuli. We investigated 1) whether FGM occurred in the SC, 2) whether the figure size affected FGM, 3) how the superficial, intermediate and deep layers of the SC interacted to perform visuo-motor transformations and accomplish a FGM read-out.

Methods:
Using Tungsten glass electrodes, single and multi-unit activity was recorded from the different layers of the SC of 2 monkeys, while the animals performed a figure-detection task in which they had to make saccades towards the center of figures. Stimuli were textured figures on a textured background. There were 16 possible figure positions in and around the RF. The RF of a neuron could either fall on the background or on the figure (for instance, the center or the edge of the figure). Figure sizes were 0.5, 1, 2 or 4 times the RF size.

Results:
We found that FGM was present in SC, and that the presence of a figure was clearly signaled by the activity of single neurons. Compared to V1, FGM in SC was stronger and earlier and occurred for figure sizes that were much larger than the RF. The FGM profiles differed per layer. In the superficial layers we found a detailed representation of the entire figure (including the figure center and edges). However, the deep layers only represented the figure center, which was the target for the saccade. The intermediate layers showed an in-between response, as they represented both detailed visual information as well as the figure center. This suggests that within SC a transformation occurs from a detailed representation of the entire figure into a figure center only to represent the saccade.

Conclusions:
We conclude that the SC is involved in figure-ground segregation. The timing and the strength of FGM suggests that SC is involved early on. Furthermore, it appears that visuo-motor transformations during figure-ground segregation can occur within SC itself. Later in time, SC probably interacts with the visual cortex to accomplish more sophisticated FGM quickly after the appearance of a figure.
Key words: Figure-ground segregation, saccades, superior colliculus, visuo-motor transformations"

(YRE)Poster code: SP2-3; Title: WP2.1 Multimodal whole-brain mapping

Authors: Ana Luísa Pinho, Juan Jesús Torre, Swetha Shankar, Bertrand Thirion
Main author/presenter is early-career researcher: yes
Poster abstract: "The main outcomes of WP2.1 feature the latest advancements of the Individual Brain Charting (IBC) project. IBC is developing a multimodal neuroimaging dataset with a strong emphasis on individual, high-resolution (1.5mm) and multi-task fMRI-data. It intends to provide an objective basis to build a comprehensive functional atlas of the human brain.

Firstly, we present herein the quality-data assessment of the upcoming IBC-dataset releases. The second release –ongoing at the end of SGA2-- refers to tasks predominantly focused on higherorder cognition, like mental-time travel, reward, theory-of-mind, self-reference effect and speech recognition. The third release, also planned for the end of SGA2, is fully dedicated to the visual system, including tasks on retinotopy, movie watching and visualization of naturalistic scenes. The fourth release will be dedicated not only to the auditory system, integrating tasks on tonotopy, auditory language comprehension and listening of naturalistic sounds, but also to other perceptual and cognitive systems, addressed by tasks on decision making, motor inhibition, planning and vigilance.
Secondly, we report results deriving from our investigation on the feasibility of individual functional atlasing, by leveraging the complete collection of individual and statistical contrast-maps (n=13) from the first release of the IBC dataset. These contrasts refer particularly to twelve tasks addressing many cognitive systems. We demonstrate that elementary cognitive components -- extracted from all the contrasts-- are consistently mapped within and, to a lesser extent, across participants. We also show the relevance of the topographic information underlying these individual contrasts in a cross-validation experiment that reconstructs contrasts of one task from the contrasts of all other tasks. Each task is well predicted by other tasks when subject identity is preserved. Yet, results show a clear decrease of the proportion of the predicted voxels when subject identity is shuffled, confirming once again that topographies are subject to individual variability. Besides, we showcase the benefit of contrast accumulation for the fine functional characterization of brain regions within a pre-specified network. To this end, we delineate the cognitive profile of functional territories pertaining to the language network and prove that these profiles generalize across
participants."

(YRE)Poster code: SP2-4; Title: Multi-modal, high-resolution model of the human hippocampus including cells, fibers, receptors, gene expressions for theory, modeling, simulation, and atlas

Authors: Irene Costantini, Giacomo Mazzamuto, Luca Pesce, Marina Scardigli, Vladislav Gavryusev, Leonardo Sacconi, Ludovico Silvestri, Francesco Pavone, Karl Zilles, Nicola Palomero-Gallagher, Olga Kedo, Hartmut Mohlberg, Rui Pedro Fernandes, Jonas Gossen, Paolo Carloni, Giulia Rossetti, Alejandro Giorgetti
Main author/presenter is early-career researcher: yes
Poster abstract: "The human hippocampal complex is described using a multi-modal and multi-scales approach in order to expand the knowledge
of this area of the brain. The architecture of the tissue is exploited with different resolution: MRI and 3D-Polarized Light Imaging are used for high-resolution fiber tract imaging and Two-Photon fluorescence microscopy in combination with clearing techniques for cellular morphological reconstruction. Receptor autoradiography and Nissl staining are used for layer-specific localization of receptor binding site densities. Finally, genome-wide data on DNA methylation and gene expression in the hippocampus are studied and compared with the receptor fingerprints to create a complete scenario from the gene to the
protein level."

(YRE)Poster code: SP2-5; Title: WP 2.4-Title: Inter-subject variability of the human brain and its relation to geno- and phenotype

Authors: Sofie Valk, Thomas W. Mühleisen, Sarah Genon, NN, Svenja Caspers, Sven Cichon,

Simon Eickhoff
Main author/presenter is early-career researcher: yes
Poster abstract: "Panel, top left, Mühleisen:
Brain mapping studies suggest that the human cerebral cortex is functionally and structurally highly segregated. This is supported by autoradiography fingerprints of neurotransmitter receptors indicating regional activities of neurotransmitter systems in functionally different cortical areas. Other studies suggest inter-individual differences of gene activity (RNA expression) between these areas. However, it is largely unknown to what extent epigenetic factors (DNA methlyation) influence the expression regulation. Hence, we integrated genomic, transcriptomic, and cytoarchitectonic data in a discovery-replication design and found motor, somatosensory, and visual-specific expression signatures of receptor genes. The results may form a proper basis for the upcoming methylation analyses in postmortem tissue.
Panel, top right, Valk:
The project presented centers around understanding the large-scale organization of structural covariance and genetic correlation. We measured structural covariance and genetic correlation of thickness in humans in the HCP dataset (S900), as well as macaques, based on the primate image exchange (prime). Following, we performed a non-linear dimension reduction on structural covariance / genetic correlation matrices to evaluate large-scale topologies. In both humans and macaques we could uncover two major organizational axes, stretching from posterior-to-anterior regions, and inferior-to-superior regions, these axes aligned with organization of genetic correlation in humans, with regions at similar positions along these axes showing high genetic correlation among themselves. Further understanding of these axes can help evaluate disease progression, and possibly aid in uncovering associations between structure and function.
Panel, bottom left, Genon:
The recent availability of population-based studies with standard neuroimaging measurements and extensive psychometric characterization opens promising perspectives to investigate the relationships between interindividual variability in brain regions' connectivity and behavioral phenotypes. However, the multivariate nature of the prediction model based on connectivity within a network of brain regions severely limits the interpretation of the brain-behavior patterns from a cognitive neuroscience perspective. To address this issue, we here propose a connectivity-based psychometric prediction (CBPP) framework based on individual region's connectivity profile. Preliminary to the development of this region-wise machine learning approach, we performed an extensive assessment of the general CBPP framework based on whole-brain connectivity information. Because a systematic evaluation of different parameters was lacking from previous literature, we evaluated several approaches pertaining to the different steps of a CBPP study. We hence tested 72 different approach combinations in a cohort of over 900 healthy adults across 98 psychometric variables. Overall, our extensive evaluation combined to an innovative region-wise machine learning approach, offers a framework that optimizes both, prediction performance and neurobiological validity (and hence interpretability) to study brain-behavior relationships. "

(YRE)Poster code: SP3-1; Title: Investigating the functional connectivity organisation of visual cortex using occluded movies during 3T fMRI

Authors: Michele Svanera, Andrew Morgan, Lucy Petro, and Lars Muckli
Main author/presenter is early-career researcher: Yes

Poster abstract: Spatial and temporal processing hierarchies both exist in the brain's visual stream (Lerner et al., 2011). In parallel, foveal and peripheral vision are specialised for different functions (Gris et al., 2017). However, the interactions of these functional processes are not fully understood (Lu et al., 2017). Studies conducted so far have relied on resting state conditions (Gris et al., 2017), real-life audio stories (Lerner et al., 2011), or movies (but only as comparison to resting conditions (Wilf et al., 2015)) and have analysed these processes individually. Additionally, many studies neglect the contributions of cortical feedback (and lateral interactions). Our hypothesis is that by examining brain activity associated with complex stimuli such as natural movies, it is possible to better characterise functional connectivity while relating connectivity measures to movie features. The main goal of this work is therefore to investigate the functional connectivity of visual cortex by employing fMRI to characterise visual processing hierarchies. Importantly, correlation analyses will be performed between subjects rather than within, making it possible to avoid the inflation of correlation values due to spontaneous brain fluctuations (Simony et al., 2016). In this way, we can identify functionally relevant correlations across subjects driven by the audio/visual stimulation only. Furthermore, by utilising an Occlusion paradigm (Smith and Muckli, 2010) combined with suficiently large movie and subject datasets, we will localise functionally-relevant cortical feedback (and lateral connections) in the visual stream. A further goal is to be able to functionally correlate different V1 layers (for example characterising them as deep, middle, and superficial layers), in the occluded region, with other visual regions in order to their interconnectivity and the visual processing hierarchies.

Poster code: SP3-2; Title: Multi-scale, multi-species, multi-methodology experiments, analysis tools and simulation models of Brain States and Complexity in SP3-UseCase002

Authors: Giulia De Bonis1, Elena Pastorelli1, Cristiano Capone1, Robin Gutzen2, Alessandra Camassa3, Arnau Manasanch Berengué3, Francesco Resta4, Anna Letizia Allegra Mascaro4, Antonio Pazienti5, Andrea Pigorini6, Thierry Nieus6, Alessandro Arena7, Johan Frederik Storm7, Marcello Massimini6, Francesco Pavone4, Maria V. Sanchez-Vives3, Maurizio Mattia5, Andrew Davison8, Michael Denker2, Pier Stanislao Paolucci1.
Main author/presenter is early-career researcher: No
Poster abstract: "The general goal of SP3-UseCase002 is to offer to external users, through EBRAINS Knowledge Graph, an integrated environment, dedicated to the topic of cortical slow wave activity (SWA) [1,2] in spontaneous and perturbed mode, and to sleep/awake transitions, measures of complexity (like PCI, perturbational complexity index) and the cognitive effects of sleep in thalamo-cortical systems. The offering includes multi-scale multi-species experimental data, simulation models, simulation results, and analysis tools. The analysis tools are designed to be applicable to both experimental data and simulation results since, for a fair comparison and accurate validation of the models, the outcome of data-driven biologically-plausible simulations [3] should be subjected to the same analysis tools used for the data. We note that the variety of the experimental techniques for data acquisition and the diversity of subjects and species involved (due to large biological variability, but also to brain states, physiological/pathological conditions, drug doses and data taking setups) make challenging the building of reliable and generalizable data analysis tools aimed at identifying common observables when comparing the outcome of different experiments acquired with different experimental modalities, and at obtaining reproducible results. SP3-UseCase002 integrates the results of WP3.2 (aka WaveScalES, focusing on sleep,

anaesthesia and transition to wakefulness, KR3.2) and WP3.4 (aka ConsciousBrain, focusing on neural correlates and measure of consciousness in physiological and pathological brains, KR3.4).The analysis pipeline developed by WaveScalES [4,5], when applied to experimental data, enables the extraction of key spatio-temporal characteristics from slow waves acquired with multiple experimental methodologies (using micro-ECoG arrays and wide-field Calcium imaging techniques, to be extended to hd-EEG and stereo-EEG), at local and multi-areal spatial resolution. The platform also includes simulation models of SWA and AW-like cortical activity at biologically-plausible neural and synaptic densities [6] and simulation models demonstrating the effects of interactions among sleep and memories and the changes in cognitive performances of thalamo-cortical models passing through wakefulness-sleep-wakefulness cycles [7]. When applied to simulation results, similar features should be extracted, to enable a quantitative comparison between simulation and experimental data, fostering a better calibration of simulations.Concerning the ConsciousBrain research, the measure is based on a perturbational approach (i.e. perturbing the brain with an exogenous input and gauging the derived spatiotemporal dynamics). The proposed analysis pipeline calculates several complexity indices on multi-scale experimental data that includes TMS-EEG data in healthy humans and patients with disorder of consciousness, intracerebral recordings in epileptic patients undergoing presurgical evaluation as well as spikes and LFP signals in rats/mice. The Perturbational Complexity Index based on Lempel and Ziv algorithm (PCIlz)[8] correlates with the level of consciousness and has been validated using TMS-EEG data collected from a large cohort of healthy subjects and patients affected by disorder of consciousness [9]; the Perturbational Complexity Index based on State Transitions (PCIst)[10] is faster than PCIlz, it does not depend on source modelling algorithms and can be applied on data different from scalp EEG. In addition, a revisited version of PCIlz, calibrated on TMS/EEG and extracellular signals from cerebellar brain slices, will also be included. Here, we present the status of the implementation of the Use Case, with some preliminary results and conclusions.

(YRE)Poster code: SP3-3; Title: A robot model of motivated behaviour to resolve conflicting drives

Authors: Alejandro Jiménez-Rodríguez, David R. Buxton, Tony J. Prescott
Main author/presenter is early-career researcher: Yes
Poster abstract: Motivations — the factors responsible for initiation, maintenance, and termination of behaviors — are usually understood in terms of extrinsic and intrinsic drives (Bolhuis & Giraldeau, 2005). In animals, such drives are sometimes in conflict. For example, causal factors for thermophilic behaviour may directly conflict with the homeostatic drives for food in a given situation; yet all these drives must be acted upon if an animal is to survive. Therefore, the problem of action selection, activity switching, or “what to do next” (Franklin, 1997) in order to resolve those conflicts is a fundamental one that must be solved by every intelligent agent. In the mammalian brain, the basal ganglia and hypothalamic motivational system are essential for the expression of motivated behaviour. On one hand, there is significant evidence to suggest that the basal ganglia are the main nuclei for action selection in vertebrates (Redgrave et al., 1999). On the other hand, intrinsic and extrinsic drives contribute in varying degrees to specific behavioural systems in the hypothalamus; moreover homeostatic mechanisms are orchestrated in this region to complement or modulate overt behaviour (Swanson, 2000). In this work, firstly, we propose a model of motivated behaviour that includes homeostatic drives, external cues, and autonomic

mechanisms. Behavioural boundaries, initiation, and termination are directly driven by a dynamical mechanism. Such a model can reproduce different aspects of motivational conflict in simulations such as inhibition, ambivalence, and potentially displacement. Secondly, the model is implemented in the biomimetic MiRo robot platform in which we modify its existing brain-based control architecture (Mitchinson & Prescott, 2016) to include a dynamical basal ganglia model that replaces the previous winner-take-all selection model, and a hypothalamus model that modulates salience in response to extrinsic and intrinsic drives. Aspects of the interaction between the two control systems are studied and potential neural implementations investigated. Finally, an experimental situation with two competing drives is used as a live demonstration using MiRo. In it, external stimuli interact with internal drives to generate behaviour in a naturalistic way. We conclude that the model is capable of generating a diversity of motivated behaviours and is robust enough for a biomimetic implementation.

(YRE)Poster code: SP3-4; Title: Learning and sleep in a thalamo-cortical multi-area model

Authors: Chiara De Luca, Cristiano Capone, Elena Pastorelli, Giulia De Bonis, Pier Stanislao Paolucci

Main author/presenter is early-career researcher: Yes

Poster abstract: Wakefulness and sleep are brain-states that are essential for cognitive performances. During wakefulness, our perceptual system is continuously subjected to sensory inputs from different sources and modalities. The involved brain areas process the input in a framework set by previous knowledge (acquired through individual and evolutionary experience) with a crucial role played by the exchange of signals with other brain areas. The ability of the brain to integrate and segregate this information by building a coherent and complete representation of the environment is impressive. Despite there is plenty of empirical evidence suggesting that the nervous system uses a statistically optimal approach in combining external information, little is known about how the brain implements these strategies. Moreover, recent studies have shown that sleep plays a central role in storing and reorganizing information gained while awake and in the optimization of the energetic post-sleeping rates. Our work focuses on two main issues: first, we aim to simulate the ability of the awake brain to combine different kinds of information, throughout multisensory perception, with contextual information starting from the case of the integration of the two visual hemicampi that in the brain are processed by areas placed in two different hemispheres. Second, we study the beneficial effects of a deep-sleep-like biologically plausible slow oscillation activity on the classification accuracy. In summary, in this work, we create a simplified thalamo-cortical multi-area simulation model trained to learn, sleep and perform a classification task on handwritten digits. Moreover, we compared the network behaviour and performances in a single area versus a multi-area model within a noisy environment showing a higher resilience to noise in the multi-area model. Also, we explored the formation of groups of neurons with a precise temporal order whenever dynamic examples are presented to the network during both the training and the testing phases demonstrating easier learning over moving inputs rather than static ones. We demonstrated better performances when learning moving inputs (either vibrating or sliding) rather than static inputs. Finally, we observed that the novel two-hemicampi model exhibits superior improvement in the classification accuracy induced

by deep-sleep-like slow oscillation activity compared with that observed in the single area model.

Poster code: SP3-5; Title: A neurorobotic model of multi-sensory reconstruction and spatial memory incorporating real-time neuromorphic hardware in the loop

Authors: Martin J. Pearson1, Oliver Struckmeier2, Shrin Dora3, Cyriel M.A. Pennartz3, Nikhil Dhamne1 Julien P.N. Fiorilli3, Ben Mitchinson4
Main author/presenter is early-career researcher: No
Poster abstract: "All animals (including humans) must move through the world to find nutrients, avoid threats and breed. These behavioural goals are more efficiently met if prior knowledge of the structure of the world is represented internally. Associating the current sensory ""view"" of the world with past experiences enables us to locate ourselves in the environment and use our internal representation of the world to navigate. Humans predominantly use vision to navigate, however, other sensory modalities such as touch, sound and smell provide additional cues to supplement or replace vision and maintain a robust estimate of location. How these sensory cues are associated and recalled by the mammalian brain during spatial navigation remains an area of active research in neuroscience and could provide valuable insights for future autonomous navigation algorithms.
We use a neurorobotics approach, adopting the rodent as our biological analogue due to the availability of past data and ongoing behavioural and electro-physiological work. A robotic agent, called WhiskEye, has been built that combines both whisker tactile and vision sensing onto a non-holonomically constrained mobile platform which is situated in a visually sparse environment consisting of simple objects and boundary walls. WhiskEye's control architecture is based on an integrated systems neuroscience model of sub-cortical structures in the the rodent brain to coordinate movement of the body and whiskers, select between actions, attend to salient tactile stimuli, and compensate for self-generated sensory noise. WhiskEye's emergent behaviour is to interact with objects using its whiskers, and move into novel regions of space. Visual and tactile data are sampled at regular intervals in addition to the motor commands issued from the control architecture to the robot platform. A simulated model of the physical WhiskEye has been ported into the HBP NeuroRobotics Platform to enable virtual experiments to be conducted using the same control architecture and to generate simulated sensory data sets. These data are passed into the spatial memory model which is an extension to the RatSLAM algorithm developed outside of the HBP. The visual tactile sensory data is transformed into a joint latent space using a cross-modal deep predictive coding network to uniquely encode representations of features in the environment. These representations correct pose estimates made by WhiskEye as it integrates its self motion by way of a continuous attractor network of leaky integrate and fire neurons, phenomenologically representing the grid cells of entorhinal cortex. this spiking neural network has been ported into the SPINNAKER neuromorphic compute media and coupled into the real-time control architecture of the WhiskEye to enable performance evaluation and future extension.
"

(YRE)Poster code: SP3-6; Title: Neural mechanisms of cross-modal object memory

Authors: J.P.N. Fiorilli1, T. Ruikes1, G.Huis in ’t Veld1, M.E. Pearson, P. Marchesi, S. Dora1, M.E. Pearson2, C.M.A. Pennartz1
Main author/presenter is early-career researcher: Yes

Poster abstract: "Knowledge of our world is stored in our brains as rich, multimodal representations: When imagining an apple, one can think if its greenness, but also of its taste or its texture. A major outstanding question in the cognitive neurosciences is how different unimodal (sensory) object features get integrated into coherent, multimodal object representations. This is not trivial because the neural pathways that process this diverse sensory information are largely anatomically distinct. While the visual and tactile cortical systems may form their own, sensory-specific representations of objects as they are perceived and retrieved from memory, we hypothesize that medial temporal lobe structures such as perirhinal cortex, and the hippocampus, form more abstract object representations that can be accessed via multiple sensory modalities.
To test this hypothesis, we are performing a series of parallel experiments. To gain empirical-based insights in cross-modal recognition mechanisms, we recorded activity of multiple single neurons in different areas across the cortico-hippocampal hierarchy (Barrel cortex, Visual cortex, Perirhinal cortex and Hippocampus) of rats performing a multisensory object recognition task. In parallel, we developed a deep predictive coding network which can be used to reproduce cross-modal recall. Lastly, we developed a robot model (the WhiskEye, with artificial Whiskers and Eyes) which is able to sample its environment using touch and vision, and to navigate in it. One of our future aims is to use the electrophysiological data to restrain the deep predictive coding network to make it more biologically plausible, and to test the model by using real-world physical visual and tactile features sampled by the WhiskEye robot. In the near-future, this multi-disciplinary approach could validate new neuroscientific hypothesis by testing them in models and inspire artificial intelligence to solve hard tasks by copying principles from biology.
"

Poster code: CDP7-1; Title: The hippocampus-ventral striatum circuit model in the Neurorobotics Platform in navigation tasks

Authors: M. Priorelli, M. Kirtay, I. P. Stoianov, G. Pezzulo, E. Falotico
Main author/presenter is early-career researcher: No
Poster abstract: Studies in neuroscience suggest that the hippocampus, along with the corticostriatal circuit, is implicated in goal-directed learning and planning during spatial navigation. Stoianov et al. proposed a computational model of this circuit that combines Bayesian nonparametric and model-based reinforcement learning (MB-RL), and tested the model on a cue- and context-conditioning task, in a Y-maze environment. In order to find out how the computational model would perform in a realistic scenario, we integrated it within the Neurorobotics Platform (NRP): an infrastructure that aims to bridge the gap between neuroscience and robotics by providing biologically realistic brain models to virtually embodied agents. For these simulations we employed the Husky robot, an unmanned ground vehicle (UGV) with four wheels and realistic sensors. In order to assess the model performance in a robotic scenario, we relied on the four metrics used on the original work: (i) accuracy (number of trials during which the rodent finds a reward location over the number of trials); (ii) path length of each trial (a lower path length means that the rodent found the reward location in few steps); (iii) sweep depth for each trial; (iv) decision certainty of the rodent. The Husky robot is able to learn the first two tasks, while the decision certainty decreases. However, it has more difficulties learning the third task, due to the increased complexity of the environment – suggesting that extensions of the model may

be required to handle increasingly complex environments; for example, hierarchical extensions, as targeted in CDP7.

(YRE)Poster code: SP4-1; Title: Multimodal Modeling of Neural Network Activity: Computing LFP, ECoG, EEG, and MEG Signals With LFPy 2.0

Authors: Espen Hagen, Solveig Næss , Torbjørn V. Ness and Gaute T. Einevoll
Main author/presenter is early-career researcher: Yes
Poster abstract: " Recordings of extracellular electrical, and later also magnetic, brain signals have been the dominant technique for measuring brain activity for decades. The interpretation of such signals is however non-trivial, as the measured signals result from both local and distant neuronal activity. In volume-conductor theory the extracellular potentials can be calculated from a distance-weighted sum of contributions from transmembrane currents of neurons. Given the same transmembrane currents, the contributions to the magnetic field recorded both inside and outside the brain can also be computed. This allows for the development of computational tools implementing forward models grounded in the biophysics underlying electrical and magnetic measurement modalities. LFPy (LFPy.readthedocs.io) incorporates a well-established scheme for predicting extracellular potentials of individual neurons with arbitrary levels of biological detail. It relies on NEURON (neuron.yale.edu) to compute transmembrane currents of multicompartment neurons which is then used in combination with an electrostatic forward model. Its functionality is now extended to allow for modeling of networks of multicompartment neurons with concurrent calculations of extracellular potentials and current dipole moments. The current dipole moments are then, in combination with suitable volume-conductor head models, used to compute non-invasive measures of neuronal activity, like scalp potentials (electroencephalographic recordings; EEG) and magnetic fields outside the head (magnetoencephalographic recordings; MEG). One such built-in head model is the four-sphere head model incorporating the different electric conductivities of brain, cerebrospinal fluid, skull and scalp. We demonstrate the new functionality of the software by constructing a network of biophysically detailed multicompartment neuron models from the Neocortical Microcircuit Collaboration (NMC) Portal (bbp.epfl.ch/nmc-portal) with corresponding statistics of connections and synapses, and compute in vivo-like extracellular potentials (local field potentials, LFP; electrocorticographical signals, ECoG) and corresponding current dipole moments. From the current dipole moments we estimate corresponding EEG and MEG signals using the four-sphere head model. The open-source software LFPy is equally suitable for execution on laptops and in parallel on high-performance computing (HPC) facilities and is publicly available on GitHub.com.

Poster code: SP4-2; Title: Implementing biologically informed mean-field models in The Virtual Brain

Authors: Jennifer S Goldman, Lionel Kusch, Viktor Jirsa, Alain Destexhe
Main author/presenter is early-career researcher: no
Poster abstract: Hallmarks of consciousness span spatio-temporal scales, from neuromodulators acting on single neuron ion channels to changes in coupling and communication between macroscopic brain regions. However, incorporating all relevant scales into biologically informed computational models to develop a more complete knowledge of differing neural computations between brain states remains challenging.

Conscious and unconscious brain states differ both at baseline and in response to stimuli. During conscious states, neural activity is known to be more complex and responsiveness is increased compared to unconscious states. Strong evidence supports a role for neuromodulation-induced transisitions between brain states, with increasing levels of acetylcholine, among other neuromodulators, sustaining dynamics of high dimensional states supporting neural coding. In models of biological neuronal networks, neuromodulation can be simulated by numerically modulating neuronal conductances resulting in activity regimes that qualitatively resemble neural signals recorded during conscious and unconscious states. Conductance-based, mean-field models of neural networks developed in the HBP, in which activity displays biologically-realistic nonlinear dependence on membrane voltage (di Volo et al., Neural Computation 2019), are used. Specifically, second order mean-field approximations - taking into account the rate and variance of neural population activity - are scaled up to simulate full human brains, constrained and connected by subject-specific human neuroimaging data using The Virtual Brain (TVB). Quantitative comparison of full-brain simulations to previously reported data from conscious and unconscious brain states shows that microscopic-scale shifts in spike-frequency adaptation induced by neuromodulation can explain global changes in brain dynamics observed between conscious and unconscious states both at baseline and in response to perturbations. These scale-integrated results bind knowledge across spatio-temporal scales and support the hypothesis that macroscopic dynamics observed during conscious states emerge from microscopic phenomena to support neural coding.

(YRE)Poster code: SP4-3; Title: Multi-area model of macaque cortex as a scaffold model and workflow test case

Authors: Anno Kurth, Alexander van Meegen, Aitor Morales-Gregorio, Jari Pronold, Agnes Korcsak-Gorzo, Hannah Vollenbröker, Rembrandt Bakker, Markus Diesmann, Sacha van Albada

Main author/presenter is early-career researcher: Yes

Poster abstract: "There are many open questions on the relationships between the structure, dynamics and function of the brain, especially from a multi-modal perspective bridging micro-, meso- and macroscopic scales. Large-scale point neuron network models of cortical areas and their interconnections, integrating vast bodies of anatomical data, provide researchers with tools to investigate these issues. In order to make reliable steps in understanding, we need to take an incremental approach to the design of the models, and ensure that they can be built on by others.

Here we present a multi-area model (MAM) describing all 32 areas of the macaque vision-related cortex [1] that serves as a scaffold for relating brain structure to its dynamics and function on multiple scales. The model connectivity is determined by processing available anatomical data into a layer-resolved connectome [2] of macaque vision-related cortex. A spiking neural network with the specified connectivity is constructed using NEST [3] and simulated on a supercomputer to study resting-state activity.

The model is being extended and refined in various directions: In one project, the motor-related cortical areas are being added, thereby enabling the study of visuo-motor integration in a unified, biologically realistic framework. Mechanisms of spatial attention are being implemented as a first step towards modeling visual processing. Moreover, ongoing work explores the possibility of endowing the anatomically based model with information processing capabilities through learning methods for spiking neural networks [4]. The

methods devised to create the macaque model are further generalized to construct a model of the human visual cortex taking into account different neuron characteristics [5] and different anatomical constraints obtained via diffusion imaging [6].
Finally, a fully digitized illustrative workflow is provided alongside the MAM to ensure reproducibility and enable re-use by the community. All code is available on GitHub. The tool Snakemake [7] provides a reproducible and user-friendly framework for the execution of the model. The workflow from the anatomical data to the simulation code, analysis and visualization can serve as an example for similar data-driven brain models.
[1] Schmidt, M., Bakker, R., Shen, K., Bezgin, G., Diesmann, M., & van Albada, S. J. (2018). A multi-scale layer-resolved spiking network model of resting-state dynamics in macaque visual cortical areas. PLOS Computational Biology, 14(10).
[2] Schmidt, M., Bakker, R., Hilgetag, C. C., Diesmann, M., & van Albada, S. J. (2018). Multi-scale account of the network structure of macaque visual cortex. Brain Structure and Function, 223(3), 1409-1435.
[3] Peyser, A. et al. (2017). NEST 2.14.0. Zenodo. 10.5281/zenodo.882971.
[4] Bellec, G., Salaj, D., Subramoney, A., Legenstein, R., Maass, W. (2018). Long short-term memory and learning-to-learn in networks of spiking neurons. Advances in Neural Information Processing Systems, 787-797.
[5] Teeter, C., et al. (2018). Generalized leaky integrate-and-fire models classify multiple neuron types. Nature Communications, 9, 709.
[6] Van Essen, D. C., et al. (2013). The WU-Minn human connectome project: an overview. Neuroimage, 80, 62-79.
[7] Köster, J., & Rahmann, S. (2012). Snakemake—a scalable bioinformatics workflow engine. Bioinformatics, 28(19), 2520-2522.

Poster code: SP4-4; Title: The virtual epileptic patient (VEP): Taking neuroscience to clinical trials

Authors: Huifang Wang, Meysam Hashemi, Anirudh Vattikonda, Marmaduke Woodman, Fabrice Bartolomei, Viktor Jirsa
Main author/presenter is early-career researcher: No
Poster abstract: Drug-resistant epilepsy affects a significant percentage of the population worldwide. Despite many decades of experience, clinics still see failures and welcome advanced data processing techniques to improve outcome rates. We combine a neural mass model describing seizure dynamics, probabilistic tractography, an clinical brain atlas and inference over intracranial EEG data to build a personalized model of pathology, referred to as Virtual Epileptic Patient (VEP). VEP has been validated on a restrospective cohort of 50 patients, with half having post-surgical outcomes, and it is currently undergoing a clinical trial in 10+ centers across France, over a period of 3 years.

(YRE)Poster code: SP4-5; Title: Conductance-based dendrites perform reliability-weighted opinion pooling

Authors: Jakob Jordan, João Sacramento, Mihai A. Petrovici, Walter Senn
Main author/presenter is early-career researcher: Yes
Poster abstract: Cue integration, the combination of different sources of information to reduce uncertainty, is a fundamental computational principle of brain function. Starting from a normative model we show that the dynamics of multi-compartment neurons with conductance-based dendrites naturally implement the required probabilistic computations.

The associated error-driven plasticity rule allows neurons to learn the relative reliability of different pathways from data samples, approximating Bayes-optimal observers in multisensory integration tasks. Additionally, the model provides a functional interpretation of neural recordings from multisensory integration experiments and makes specific predictions for membrane potential and conductance dynamics of individual neurons.

Poster code: SP4-6; Title: Modeling astrocyte-neuron interactions on network signal transmission

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Main author/presenter is early-career researcher: no
Poster abstract: "Astrocytes, the largest group of non-neuronal cells in the mammalian brain, are recognized as important homeostatic, metabolic and neuromodulatory elements in the brain. They also couple with the neurovascular system. In many brain areas, astrocytes have intimate connections with adjacent neurons. They participate in neuronal network formation and act as metabolic support for intensive energy-demanding neuronal activity. Notably, some lines of evidence suggest that astrocytes actively participate in synaptic signaling by modulating the signals transmitted by neurons. Based on the experimental literature, the mechanisms involved seem to depend not only on the developmental stage of an animal but also on the brain area, neural circuitry, as well as on the experimental technique used to characterize the phenomena. Moreover, dysfunctioning of astrocytes is a possible contributing factor in pathologies of the central nervous system. Understanding the influence of glial cells on brain functions is of fundamental interest for neuroscience. A number of computational efforts have been presented to explore selected biophysical mechanisms of astrocytes and their roles in various neurophysiological phenomena. Models focusing on astrocytic regulation of synaptic transmission are however scarce. Further efforts are needed to extend these models with other relevant biophysical mechanisms. In addition, simple yet dynamically correct models suitable for addressing the role of neuron-astrocyte interactions in larger systems, such as spiking neural networks and brain circuit models, are rare. While the experimental evidence of astrocytes' roles in neural activity regulation accumulate, adequate network-level models could help to explore the role of neuron-astrocyte interactions in cognition. Here we focus on one specific mechanism of neuron-astrocyte regulation that, according to the experimental evidence, supports network synchrony. In short, glutamate released from astrocytes has been shown to activate extrasynaptic N-methyl-D-aspartate receptors in neighboring neurons, causing slow inward currents and increased capacity for synchronization at the circuit level. This experimental finding is here first explored in combination with our previous work [1] that focused on impact of ionotropic glutamatergic and gabaergic receptors to synaptic transmission and activity in cortical networks. Using a data-driven modeling framework, we integrated the model with the experimental data and quantified accuracy of data representation. We here extend this previous work by equipping the model with the minimal description for the extrasynaptic N-methyl-D-aspartate receptors and the related

cellular and synaptic mechanisms. The proposed work provides a step towards developing of theoretical methods for describing neuron-astrocyte interactions and more generally glial contributions in activity regulation, information transfer, synchronization, and learning in neuron-glia circuits. Furthermore, it will establish guiding principles for implementation of simplified, generic astrocyte models in neuromorphic technologies for engineering applications.
[1] H. Teppola, J. Aćimović, M.-L. Linne. Unique features of networks bursts emerge from the complex interplay of the excitatory and inhibitory receptors in rat neocortical networks. Frontiers in Cellular Neuroscience 13:377, 2019."

Poster code: CDP8-1; Title: Multiscale brain simulation with TVB-NEST

Authors: Perdikis, Schirner , Domide, Mersmann, Ritter
Main author/presenter is early-career researcher: no
Poster abstract: "NEST simulates neural activity at the microscopic spatial scale of single neurons or neuron networks. On the other hand, The Virtual brain simulates at the mesoscopic or macroscopic scales of large neural populations or brain regions. Here, both are brought together to enable neuroscientists to study how these different scales interact and how different scales inform activity ""from the bottom up"" and ""down from the top"". A generic Python interface allows users to quickly and conveniently set up a parallel simulation in TVB and in NEST and automatically handles the exchange of currents, spikes, voltages, etc. between the different scales. Although the technical aspect of this tool is realized, the scientific part is a work in progress and we are continuously enriching the coupling between scales such that biophysical plausibility is maintained. The TVB+NEST bundle software package -- available as an easy-to-use Docker image container -- combines the sophistication and flexibility of NEST's spiking neuron simulation infrastructure with TVB's whole-brain simulation, processing, analyses and visualisation capabilities.
While spiking neurons are often driven by noise (e.g. Poisson processes), this software enables to inform spiking neurons with input from more plausible large-scale brain network activity instead of plain noise. On the other hand, the activity of brain regions can be enriched by plausible, small-scale neuron network activity. The package allows simulation of common neural signals like Local Field Potentials (LFP), firing rates, membrane voltages, EEG, MEG or fMRI BOLD.
The Virtual Brain contributes all means necessary to generate, manipulate and visualize large-scale connectivity and network dynamics. In addition, it comprises a set of classical time series analysis tools, structural and functional connectivity analysis tools, as well as parameter exploration facilities by launching parallel simulations on a cluster.

Poster code: CDP8-2; Title: TVB brain model construction pipeline

Authors: Triebkorn, Schirner, Ritter
Main author/presenter is early-career researcher: no
Poster abstract: "The TVB pipeline allows neuroscientists to automatically extract structural connectomes from diffusion-weighted MRI data and functional connectomes from fMRI data based on a number of state-of-the-art methods for image processing, tractography reconstruction and connectome generation. Pipeline output can be directly uploaded to The Virtual Brain neuroinformatics platform for large-scale brain simulation. Further pipeline outputs include: raw tractography output (track streamlines), structural (coupling weights and distances) and functional connectomes, region-wise fMRI time series, M/EEG region-

wise source activity time series. The pipeline supports the following atlasses: AAL, AAL2, Craddock200, Craddock400, Desikan Killiany, Destrieux, Human Connectome Project Multimodal Parcellation and Perry512.
The pipeline is available as a Docker container based on the BIDS MRtrix3 App containing environment and software for connectome extraction (e.g. FreeSurfer, FSL, MRtrix). The container makes use of parallelized software that can be run with multiple threads locally or on supercomputers. Input data must be provided in BIDS format. As a minimum, dwMRI and strucutral MRI scans need to be provided. In addition, the pipeline can process fMRI (region-wise fMRI time courses and functional connectomes), EEG and MEG data (region-wise source activity time courses).

Poster code: SP5-1; Title: SBA Composer: Web-based platform for interactive, multi-modal data visualization with Jupyter notebook control

Authors: Rembrandt Bakker, Nestor Timonidis, Paul Tiesinga
Main author/presenter is early-career researcher: no
Poster abstract: "We present SBA Composer, an interactive online platform for visualizing brain volumes, tissue sections, region meshes, neuron morphologies and other 3d geometries inside a brain atlas. The platform uses brain atlases from the set collected by the Scalable Brain Atlas [Bakker et al (2015) Neuroinformatics, 13, 353-366]. They minimally consist of a brain region hierarchy, meshes for each brain area, one or more reference data volumes and a definition of the template space. Data can be imported into Composer either interactively by the user or programmatically from within a Jupyter notebook or via 3rd party websites, which can open SBA Composer as a separate tab in the browser and send data/receive messages from it.
A key challenge of multi-modal integration is the alignment of the various data sources. If they are pre-aligned to the selected atlas, they may still differ in the choice of units, orientation and origin. Composer offers a data import wizard to correct these settings, and uses the brain addressing system (brainaddress.org) to refer to location in the brain. For unregistered data, interactive tools for scaling, translation and rotation are available, as well as point-pair based registration. A first use case is the Connectomic Composition Predictor (CCP), a service developed for the Human Brain Project (HBP) which predicts a mouse connectivity matrix on the basis of gene expression data. The service runs in the HBP Collaboratory (https://collab.humanbrainproject.eu/#/collab/8650/nav/65518) which provides Jupyter notebook environment in which python scripts can be run interactively. The CCP visualization module opens an SBA Composer window and loads the predicted connectivity as a volume, which is displayed as one or more section planes at arbitrary angles. A second use case is the inspection of connectivity experiments from the Allen Institute. These experiments result in projection densities, which can be displayed as 'streamlines' and represent efferent connectivity from the injected area. In the figure, we inspect whether injections in the Anterior Cingulate Area are connected to the Basolateral Amygdalar nucleus. Future development of SBA Composer is use-case driven and focuses on the improvement of data-alignment services and the inclusion of high quality atlas templates.
Parts of this research have received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement No 785907 (Human Brain Project SGA2) and the FLAG ERA project FIIND (NWO054-15-104)"

(YRE)Poster code: SP5-2; Title: New functionalities in the QUINT workflow for brain atlas-based image data analysis

Authors: Sharon Yates, Nicolaas Groeneboom, Gergely Cscus, Anna Kreshuk, Dominik Kutra, Trygve Leergaard, Maja Puchades and Jan Bjaalie
Main author/presenter is early-career researcher: yes
Poster abstract: "The QUINT workflow enables the quantification and spatial analysis of histological features in rodent brains based on the segmentation of 2D brain section images and registration to a reference atlas. The workflow utilizes several open source software developed with support from the Human Brain Project. Here we present new software functionalities: an improved Nutil graphical user interface, a new feature for using masks during segmentation with ilastik and a tool for nonlinear registration of 2D images to the reference atlas.

(YRE)Poster code: SP5-3; Title: Interactive anchoring of high-resolution volumes of interest to BigBrain using VoluBA

Authors: "Xiao Gui, Yann Leprince, Pavel Chervakov, Stefan Köhnen, Katrin Amunts and Timo Dickscheid
Main author/presenter is early-career researcher: yes
Poster abstract: A common problem in high-resolution brain atlasing is spatial anchoring of high-resolution volumes of interest (VOIs) from specific imaging experiments into the detailed anatomical context of a high-resolution reference model like BigBrain (Amunts et al., 2013), to allow integration of partial volumetric data at the level of cortical areas, individual cortical layers or subcortical structures. Downloading and interacting with reference templates of whole human brains at microscopic resolution is out of reach for many neuroscientists due to the sheer size of such data, as well as the lack of practical tools. EBRAINS atlas services now provide a first version of a novel interactive volumetric alignment tool - VoluBA - which allows anchoring of such VOIs to very large reference volumes. VoluBA is implemented as a web service that allows users to upload a VOI from their own imaging experiment and perform interactive anchoring by direct manipulation of its position and rotation using the mouse pointer, flipping of 3D coordinate axes, as well as entering of point landmarks for refined alignment with affine components. The resulting transformation parameters can be downloaded for reference and for submission to HBP data curation. The aligned image volume can be directly opened in EBRAINS' interactive atlas viewer to view the VOI in full anatomical context, compare it to atlas regions, and access data linked to the region of interest. As an experimental feature, we also developed functionality for nonlinear alignment of cortical VOIs, which exploits the equivolumetric model of cortical depth to optimize alignment of cortical layers across subjects

(YRE)Poster code: SP5-4; Title: Integration of neuroscience data into the HBP KnowledgeGraph and interactive atlas viewers using MINDS and SAND metadata schemas

Authors: Lyuba Zehl, Stefan Köhnen, Lionel Adrien Sambuc, Yann Leprince, Camilla Blixhavn, Oliver Schmid, Heidi Kleven, Tom Gillespie, Xiaoyun Gui, Sara Zafarnia, Anna Hilverling, Ida Aasebo, Maja Amedjkouh Puchades, Timo Dickscheid, Trygve Leergaard
Main author/presenter is early-career researcher: yes
Poster abstract: "Research data which are openly accessible via searchable resources promote scientific progress through data reuse and knowledge integration. Despite the

heterogeneity of acquisition methods and scales, neuroscience data have one common ground they can all relate to: the anatomical location from where they originate.
To support these principles, the EBRAINS curation services offer registration of neuroscience data into a public accessible database called KnowledgeGraph (KG), using a set of metadata defined by the open Metadata Initiative for Neuroscience Data Structures (openMINDS).
The metadata description of registered data can be further extended with information defined in the Spatial Anchoring of Neuroscience Data Structures (SANDS), in order to link the data to their anatomical location, and make them accessible via EBRAINS atlas services.
This poster shows the interplay of both metadata schema implementations for openMINDS and SANDS.
Extending openMINDS with SANDS for describing data empowers users to not only semantically search and retrieve registered neuroscience data, but also to visually explore them in well established brain atlases.

(YRE)Poster code: SP5-5; Title: Designing generalizable, reproducible analysis workflows for experimental and simulated activty data using Elephant

Authors: "Danylo Ulianych
Robin Gutzen
Julia Sprenger
Elena Pastorelli
Giulia De Bonis
Pier Stanislao Paolucci
Andrew Davison
Sonja Grün
Michael Denker
Main author/presenter is early-career researcher: yes
Poster abstract: "Neuroscientists have a diversified and constantly growing repertoire of methods to analyze neuronal activity data. Moreover, the availability of open data sets containing neuronal activity data puts modelers in a position to perform a more in-depth validation of their models (e.g., [1]) based on the statistical descriptions of the activity observed in experiments. However, the increased possibilities also come at the cost of higher complexity of such analysis and validation processes. Here, we showcase the state of HBP-enabled, tool-based workflow solutions that implement rigorous and well-defined data handling and analysis, as well as model validation schemes, for activity data such as spike trains or local field potentials. We demonstrate methods for data and metadata representation, and its analysis using multiple emerging open-source software tools (e.g., [2-4]). Analysis is performed using the Electrophysiology Analysis Toolkit (Elephant, http://neuralensemble.org/elephant/) as a community-centered analysis framework for parallel, multi-scale activity data developed within the HBP, while validation is carried out using the HBP validation framework, and in particular the NetworkUnit library [5-7]. The interplay between the tools is showcased by integrating them into a robust workflow solution. Concrete examples on how to utilize these tools for scientific discovery in conjunction with the Collaboratory and Knowledgegraph HBPinfrastructure components, as well as with the snakemake workflow tool, are given in the context of the use cases of SP3 [8,9]. References
1. van Albada, S.J. et al. (2018). Front Neuroinf 12, 291.2. Garcia, S. et al. (2014). Front Neuroinf 8, 10.3. Zehl, L. et al. (2016). Front Neuroinf 10, 26.4. Grewe, J. et al. (2011). Front

Neuroinf 5, 16.5. Gutzen, R. et al. (2018) Front Neuroinf 12, 90.6. Omar, C. et al. (2014). ICSE Companion 2014, 524–527.7. Sarma, G. P. et al. (2016). F1000 Research, 5:1946.8. Pastorelli, E. et al. (2019) Front. Syst. Neurosci 13, 339. De Bonis, G. et al. (2019) Front. Syst. Neurosci. doi: 10.3389/fnsys.2019.00070 (in press)

Poster code: SP5-6; Title: DataLad: Management and transport logistics for scientific (meta)data

Authors: "Benjamin Poldrack, Adina Wagner, Yaroslav O. Halchenko, Kyle A. Meyer, Michael Hanke
Main author/presenter is early-career researcher: no
Poster abstract: "DataLad is a free and open source software for managing scientific datasets. It relies on git and git-annex -- well established tools for version control and data transport. DataLad datasets can handle arbitrarily sized files. It's worth pointing out, that this claim does indeed scale to terabyte-sized files, that might pose a challenge to underlying infrastructure.
Thus, DataLad allows to track and bundle all components of a dataset (data, code, computational environments) in a single, infrastructure agnostic structure, that can be dealt with in a uniform fashion. Furthermore, this structure is lightweight, for it doesn't necessarily contain actual data, but tracks data availability information across multiple storage locations (i.e. interfacing file servers, AWS, EBRAINS, …) . These features enable building flexible, distributed data stores suitable for HTC analysis workflows. Datasets can reference each other, so that datasets hierarchies can be built to represent data catalogs, or to declare data dependencies like input (raw) datasets for a analysis dataset. Additionally, DataLad supports provenance capture of performed analyses steps (""datalad run""), and verification that an update of a component (e.g., an input dataset, or a computational environment image) results in reproducible results.
Datasets can carry multiple, arbitrary metadata descriptions at the dataset and file level in a separate layer that is independent of actual data availability and that can be exported to enable metadata queries with built-in or specialized solutions.
With data management procedures centered around DataLad datasets, researchers can employ reproducible, version-controlled, and FAIR scientific workflows on large-scale datasets with minimal technical overhead.
Its domain-agnostic data representation enables maintenance by technical personnel, for example, to allow remote data stores to be backed-up by system administrators and maintained by data curators.

(YRE)Poster code: SP5-7; Title: Ebrains architecture

Authors: Wouter Klijn, Spiros Athanasiou, Sandra Diaz, Evdokia Mailli, Jan Bjaalie, Thomas Lippert, Katrin Amunts, Yannis Ioannidis
Main author/presenter is early-career researcher: yes
Poster abstract: "Based on the science and use-cases collected during SGA1 and SGA2, the infrastructure team in collaboration with the science & software coordinators and software engineers, created the EBRAINS Infrastructure Architecture. Based on the concepts of modularity, re-usability and ease of use, the different services and tools as developed in the previous SGA phases have been placed in a coherent framework in support of the neurosciences.
The Work Packages are:

- WP4: EBRAINS Data Services
- WP5: EBRAINS Modelling Services
- WP6: EBRAINS Computing Services

The Service Categories (SCs) are:

- SC1: Curated and shared data: EBRAINS FAIR data services - neuroscience data publishing
- SC2: Brain atlas services: navigate the brain in 3D - find, contribute and analyse brain data, based on location
- SC3: Brain modelling and simulation workflows: integrated tools to create and investigate models of the brain
- SC4: Closed loop AI and robotics workflows: design, test and implement robotic and AI solutions
- SC5: Medical brain activity data platform: human intracerebral EEG database and analysis service
- SC6: Interactive workflows on HPC or NMC: Europe-wide access to scalable and interactive compute services"

Poster code: SP5-8; Title: HBP High Level Support Team (HLST)

Authors: HLST Team
Main author/presenter is early-career researcher: no
Poster abstract: HLST is supporting users and developers of the HBP/EBRAINS infrastructure. The poster provides and overview of HLST and statistics.

(YRE)Poster code: CDP2-1; Title: Cerebellar modular circuit into an adaptive control system

Authors: Alberto Antonietti, Alice Geminiani, Edoardo Negri, Robin De Schepper, Claudia Casellato, Egidio D'Angelo
Main author/presenter is early-career researcher: yes
Poster abstract: "Sensorimotor signals are integrated and processed by the cerebellar circuit to predict accurate control of actions. In order to investigate how single neuron dynamics and geometrical modular connectivity affect cerebellar processing, we have exploited an olivocerebellar Spiking Neural Network with advanced point neuron models capturing essential non-linear neuronal dynamics (refer to poster SP6 "Cerebellum: advanced neuron and microcircuit models").
Distributed long-term plasticity has been introduced; in the scaffold configuration, at multiple connection sites, the synaptic strengths are modulated through bidirectional (long-term potentiation and depression) ad hoc learning rules.
The cerebellar circuits have been inserted into loops and receive input signals coding both the system status information and sensory or motor attentional/error signals driving the plasticity. The architecture is modular, including the cerebellum working both as forward and inverse model. To interface the cerebellar spiking networks with other control blocks, encoding and decoding strategies have been designed. In particular, in closed-loop testing protocols, sensory feedback and intentional planning signals are converted into spike patterns and fed to the neural structures; while, the spiking network outputs are sent as actuation commands to a peripheral system (eventually a neurorobot). The scaffold model has been split to geometrically define adjacent microcomplexes, so as to topographically segregate information on matching sensory and motor signals (e.g. target overshooting and

agonist corrective commands, or target undershooting and antagonist corrective commands). The inputs to the network come through the mossy fibers, which branch into the granular layer. The connectivity principles let spontaneously emerge areas of consistent incoming signals.
Different protocol-dependent control systems have been designed: the learning is driven by the cerebellar activity evolving along task repetitions. The behaviour emerges from network dynamics. We emulate an eye-blinking classical conditioning, in which the burst/pause patterns are responsible for the generation of a predictive time-locked blink response. We emulate a Vestibular-Ocular reflex actuating a simulated physical plant through the NeuroRobotic Platform (iCub head-eye degrees of freedom). We emulate a pointing task perturbed by prismatic glasses, including into the control system abstract cerebral cortex modules and multiple instances of the cerebellar model. The latter allow to achieve complementary processing able to predict a sensory discrepancy and compensatory motor commands. Therefore, the cerebellum works as a general-purpose massive predictive machine in whole-brain modular systems."

(YRE)Poster code: CDP2-2; Title: Hackathon on Cerebellar Modeling 2020

Authors: Ottaviani A., Tritto S., Antonietti A., Casali S., De Shepper R., Geminiani A., Masoli S., Palesi F., Rizza M.F., Casellato C., D'Angelo E.
Main author/presenter is early-career researcher: yes
Poster abstract: "The Hackathon on Cerebellum Modelling (Pavia on 13-15 January 2020) illustrated cerebellum models and provided tutorials for their development and applications. The course was designed with selected presentations and large space for hands-on experience. The 63 attendees from all over the HBP and outside including those coming from Italy (39; UNIPV, CNR, SSSA, POLIMI, CINECA), Spain (5; UPM, UGR), Sweden (4; KI, KTH), Switzerland (4, EPFL, CSCS), Japan (3, University of electro-communication Tokyo), Germany (2, Juelich), Israel (2, HUJI, Tel-Aviv University), UK (2, Manchester University), France (1, AMU) and Holland (1, ERASMUS-MC) were introduced to the main themes of cerebellum modelling and to the use of the Human Brain Project research infrastructure, Brain Simulation Platform (BSP), Neurorobotic Platform (NRP), Virtual Brain (TVB) and future EBRAINS, addressing the principles of multiscale brain modelling.
The presentations and tutorials with hands-on experience were guided by an outstanding staff of scientists illustrating multiscale modelling techniques and applications. These included the use of pyNEST, pyNEURON and TVB with illustration of examples running on the BSP and on the NRP. All the software programs have been made available through a convenient Virtual Machine (VM) container that was uploaded on the BSP/CSCS repository and preinstalled on the participants' notebooks. The venue in Pavia proved quite convenient in offering the halls for talks and the open spaces needed for discussion and socialization.
The event promoted the creation and consolidation of working groups forming the core of a scientific community working around the HBP aims demonstrating the maturity of the HBP and non HBP community built around the modelling system and infrastructure. The focus on the cerebellum allowed to illustrate specific use cases, from single cells to microcircuits, but also to extend them to a general modelling scheme applicable to other brain structures including the hippocampus, basal ganglia and cerebral cortex and to the whole brain.
The event has made the point on the ongoing works, from cellular level up to whole brain models, with identification of problems and elaboration of possible solutions to run them on BSP, NRP and TVB.

The Hackathon was in streaming and has been recorded in full in digital format and is available into a Collab called ""Hackathon on cerebellar modelling 2020"". This recorded version is going to be uploaded on the Brain Simulation Platform and on the Online Library of Public Education Training for further access and exploitation.

Poster code: SP6-1; Title: The Brain Simulation Platform (BSP) - v2.0: building brain models in a collaborative environment

Authors: Luca L. Bologna, Carmen A. Lupascu, Rosanna Migliore, Jean-Denis Courcol, Felix Schuermann, Andrew P. Davison, Michele Migliore
Main author/presenter is early-career researcher: no
Poster abstract: "The Brain Simulation Platform (BSP) of the Human Brain Project (HBP) offers the scientific community a set of tools and services for the formalization, reconstruction, simulation and analysis of data-driven brain models. The Platform leverages the HBP Collaboratory's framework that allows the creation and organization of common workspaces (known as Collabs) where collaborators can share data, results, methods and algorithms. Version 2.0 of the Platform is designed in a modular way and features mature functionality for the creation of single cell models, for in silico experimentation with single cells, scaffold microcircuit, brain region models, and a framework to validate models against a growing set of experimental data in an automated and repeatable manner. The seamless integration with the Neuroinformatics Platform, through the open source Blue Brain Nexus technology, and the tight integration with the HBP's High Performance Analytics and Computing Platform (HPAC) makes the BSP a unique tool in the field.

Poster code: SP6-2; Title: New Methods and Tools for Molecular level Simulations of Neuronal Processes

Authors: Daria Kokh, RiccardoCapelli, Juliette Martin,WenpingLyu, Michele Parrinello, NuriaCirauqui, Elisa Frezza, Paolo Carloni,,RebeccaWade
Main author/presenter is early-career researcher: no
Poster abstract: Molecular simulations allow computation of biomolecular binding properties and kinetic parameters for molecular processes that occur in brain cells. They can be used to constrain and parameterize kinetic models at the subcellular/cellular level, to aid molecular design (e.g. target validation, chemical probe design), to understand effects of molecular variation (disease mutations, posttranslational modifications, epigenetics) and molecular recognition, and to assist design of new drug compounds for treating neurological diseases. Molecular simulations exploit detailed information on bio-molecular structure and function, and make use of numerous computational techniques, such as molecular dynamics simulations. Specialized molecular simulation engines developed by HBP researchers include:SDA- a software for simulating the diffusionalassociation of biomolecules, ArDock - webserver for predicting protein binding sites, CNS and CNS_MoDeL - databases of small molecules, MoDeL - database of molecular simulation trajectories,tRAMD- a protocol for prediction of drug-protein residence times. This poster presents three molecular studies:(i) Simulation of mechanism and kinetics of ligand unbinding from GPCRs using tRAMD approach,(ii) Modeling dissociation kinetics of iperoxo from M2 muscarinic receptor using metadynamics methods, (iii) Modeling of protein-protein interactions taking protein flexibility into account.

(YRE)Poster code: SP6-3; Title: Cerebellum: advanced neuron and microcircuit models

Authors: Robin De Schepper, Stefano Masoli, Alice Geminiani, Dimitri Rodarie, Stefano Casali, Martina Rizza, Alessandra Ottaviani, Claudia Casellato, Egidio D'Angelo
Main author/presenter is early-career researcher: yes
Poster abstract: "Advanced detailed neuron models have been built, optimized and validated, exploiting variegate morphological data and peculiar electrical properties (refer to poster SP1 on Cerebellar experimental data): the main interneurons (Golgi cell, stellate and basket cells), the granule cell, and the Purkinje cell. Dendritic and axonal arborisations are endowed with voltage dependent ionic channels. This way cell-specific critical aspects are reproduced, for instance the role of the axon initial segment, the spontaneous firing and the synaptic burst/pause behaviour.
In parallel, customized point-neuron versions have been developed (Extended-Generalized Leaky Integrate and Fire model) in order to reproduce complex electro-responsive properties of olivo-cerebellar neurons even in mono-compartmental models, such as pacemaking, adaptation, bursting, post-inhibitory rebound excitation, subthreshold oscillations, resonance, and phase reset. These cell-specific phenotypes play a fundamental role for network entraining, plasticity induction, signal processing, and noise filtering.
A scaffolding procedure has been finalized, able to generate a scalable cerebellar structure, embedding specific 3D positions for each neuron and specific pair connections. Customized placement strategies allow to match layered density and encumbrance for each neuron type. Customized connection strategies allow to match anisotropic geometrical fields of intersection, and statistical convergence and divergence ratios; when morphologies are taken into account an optimized touch detection strategy allows synaptic localization. Full-scale atlas-mapped mouse cerebellar regions are under reconstruction, through voxel-based particle placement strategy and connectivity rules based on orientation vectors (voucher #49 VM-CerebNEST).
The scaffold can host different neuron models, from point-neurons in pyNEST to multi-compartmental neurons in pyNEURON. Several input stimulation patterns are used to investigate network complex dynamics, revealing the relationships between structural constraints and underlying neuron mechanisms with the cerebellar circuit functioning, over space and time."

Poster code: SP6-4; Title: Improving NEURON simulation performance for cellular simulation through more effective DSL translation and optimized computing engine

Authors: James King, Pramod Kumbhar, Omar Awile, Liam Keegan, Jorge Alonso, Ioannis Magkanaris, Felix Schuermann, Henry Markram, Michael Hines
Main author/presenter is early-career researcher: no
Poster abstract: The Blue Brain Project (BBP) seeks to build biologically detailed models of neuronal tissue and perform simulated experiments to help advance the understanding of the brain. Recent work has seen the realization of a tissue reconstruction consisting of 9 million neocortical neurons with 80 billion synapses. Such volume of data is a challenge to simulate and to aid in this endeavor, we participate to advance software capabilities for scalability and performance. From its inception, BBP has used NEURON since it has a rich feature set developed over the last thirty years. In recent years, CoreNEURON has been under development as a new compute engine for NEURON. CoreNEURON uses a better optimized memory layout which allows for simulations up to 7 times larger to run on the same compute infrastructure. The internal data structures are more easily adaptable to take

advantage of modern computing architecture capabilities. During this work to advance CoreNEURON, we also investigated better methods for translation of the domain-specific languages (DSLs) as used to describe biological models simulated in NEURON such as ion channels and synapses. This new NMODL translation allows for qualitative analysis of the user source code and restructures the final organization for better optimization of the final generated code, yielding more efficient execution in the built application. NMODL is capable to implement multiple SIMD and SPMD targets applicable to modern hardware. Benchmarks were executed on Intel Skylake, Intel KNL, and AMD Naples platforms, with individual compute kernels showing a speedup of up to 20x. In production simulations, overall performance gains of ~10x were measured. Further NMODL yields a 2x speed up when compared to a previously published SIMD optimized version that heavily relied on auto-vectorization by the compiler.

Poster code: SP6-5; Title: Scientific validation of data-driven neuroscience models despite complexity and sparse data

Authors: P. Garcia-Rodriguez, L. Sharma, S. Appukuttan, A. Kozlov, A. Romani, A. P. Davison
Main author/presenter is early-career researcher: no
Poster abstract: "Computational simulations are a valuable tool to gain insight into brain function, from the sub-cellular to the network scale. However, before a model can be used in research or medical applications, an assessment of its performance is required, including a validation with respect to experimental data. Validating a model concerns its generalization/predictive power, i.e. its ability to replicate observations obtained in experimental scenarios other than those used in constructing the model. To that end, a prediction error can be calculated to quantify the model's performance by the match between model prediction and experimental observation.
Model validation implies scientific challenges such as intensive data searching or meta-analysis, reconciling conflicting findings, and deciding the weighting of different validations. The application of traditional statistical hypothesis testing, to judge the relevance of the discrepancy between experiment and model, requires the specification of a probability distribution for the reference data. However, many studies report too few observations to accurately determine the statistical description needed. Such sparse experimental data also presents a serious handicap to accurately estimate prediction errors using bootstrap or cross-validation methods. An alternative to hypothesis testing in model assessment is model selection, where different alternatives are compared to choose the most appropriate model. Models often differ in terms of complexity, and prediction errors are known to follow a non-monotonic curve, showing a minimum at intermediate complexity (Hastie et al. 2001). This behavior is related to the bias-variance trade off and the well known under- and over-fitting compromise. It is caused by the opposite trends of these two quantities that determine the prediction error. Finally, each model can be assigned a score defined as the relative prediction error with respect to the uncertainty level present in the data and in the model. We are attempting to address the above challenges by developing test suites that automate comparison between different models, and allow tracking the performance of a model over time as it is refined. In these test suites, model and test definitions use the SciUnit interface (Gerkin & Omar, 2014), which supports model-agnostic validation suites by decoupling test and models. MorphoUnit is for validating morphologically-detailed cell models according to neurite features. eFELUnit is designed to validate the biophysical

behavior of single cell models. BasalUnit and CerebUnit provide validation tests specific to the basal ganglia and cerebellum, respectively."

(YRE)Poster code: SP6-6; Title: Graph-theoretical Derivation of Brain Structural Connectivity

Authors: G Giacopelli,M Migliore,D Tegolo
Main author/presenter is early-career researcher: yes
Poster abstract: Brain connectivity at the single neuron level can provide fundamental insights into how information is integrated and propagated within and between brain regions. However, it is almost impossible to adequately study this problem experimentally and, despite intense efforts in the field, no mathematical description has been obtained so far. Here, we present a mathematical framework based on a graph-theoretical approach that, starting from experimental data obtained from a few small subsets of neurons, can quantitatively explain and predict the corresponding full network properties. This model also changes the paradigm with which large-scale model networks can be built, from using probabilistic/empiric connections or limited data, to a process that can algorithmically generate neuronal networks connected as in the real system.

(YRE)Poster code: SP7-1; Title: Advanced plasticity rules in NEST

Authors: Jonas Stapmanns, Jan Hahne, David Dahmen, Moritz Helias, Matthias Bolten, Markus Diesmann
Main author/presenter is early-career researcher: yes
Poster abstract: Due to the point-like nature of neuronal spiking, efficient neural network simulators often employ event-based simulation schemes for synapses. Yet many types of synaptic plasticity rely on the membrane potential of the postsynaptic cell as a third factor in addition to pre- and postsynaptic spike times. In order to update their strength, synapses therefore require continuous information which a priori necessitates a continuous update in a time-driven manner. Simulations of networks with this type of plasticity are therefore restricted to small network sizes. Here, we show an efficient archiving of the history of postsynaptic membrane potentials to maintain an event-based update for synapses that minimizes the amount of stored data and communication between neurons.

Poster code: SP7-2; Title: ICEI: HPC Centres Delivering Federated E-Infrastructure Services

Authors: Dirk Pleiter, Anne Nahm
Main author/presenter is early-career researcher: no
Poster abstract: The ICEI (Interactive Computing E-Infrastructure for the Human Brain Project) project is funded by the European Commission under the Framework Partnership Agreement of the Human Brain Project (HBP). The five leading European Supercomputing Centres BSC (Spain), CEA (France), CINECA (Italy), ETHZ-CSCS (Switzerland) and JUELICH-JSC (Germany) are working together to develop a set of e-infrastructure services that will be federated to form the Fenix Infrastructure.

Poster code: SP7-3; Title: NEST3 and NESTML: You'll love the new NEST user experience

Authors: Jochen M. Eppler, Abigail Morrison, Håkon Mørk, Susanne Kunkel, Charl Linssen, Hans E. Plesser, Stine B. Vennemo

Main author/presenter is early-career researcher: no
Poster abstract: "NEST 3.0 is the next major version update of NEST. With it, big changes are made not only to the user interface, but also to the inner workings of NEST. In the PyNEST interface, new concepts are introduced, such as NodeCollections, SynapseCollections and Parameters. The PyNEST Topology module is integrated into the standard PyNEST package, and creation and connection of spatial networks are now performed by calling the standard functions. A new and improved infrastructure for handling recordings has been implemented, with built in backends to record to memory, ASCII files and screen. NEST 3.0 has been in the making for a long time, but now most of the planned features have been implemented, and are ready to be tested by users. Here we will present an overview of the new features and changes. NESTML is a domain-specific language for neurons and synapses: the network elements that are instantiated when using the PyNEST interface. It serves as a specification and exchange format, where dynamical systems are expressed in continuous time (using e.g. differential equations) and have the additional ability to receive and emit precisely timed events (representing action potentials). Feature highlights include a concise yet expressive syntax inspired by Python, direct entry of dynamical equations, and imperative programming-style specification of event handling and generation. NESTML comes with a powerful toolchain, written in Python, and released under the GNU GPL v2.0. It parses a given model and performs code generation ("transpiling"). The generated code targets a particular hardware and software platform (e.g. NEST running on a high-performance computing cluster) with highly optimised and performant code. The toolchain performs detailed analytical and numerical analysis to yield optimal solver recommendations, and precise solutions where possible. Target platforms can be added flexibly using Jinja2 templates."

Poster code: SP7-4; Title: Interactive Modeling and Visualization for Neuroscience

Authors: Benjamin Weyers
Main author/presenter is early-career researcher: no
Poster abstract: For interactive modeling and visualization of neural models, various tools were developed, deployed and supported in HBP. This poster presents tools for the expert user to analyses and inspect morphological as well as activity data emerging from models and simulations. Additionally, a web-based interactive tool is presented called "NEST Desktop", which brings NEST to the classroom via a graphical user interface. Finally, a framework has been developed to couple running simulations of various type to visualization front-ends for live inspection and analysis.

Poster code: SP7-5; Title: NEST Simulator: Documentation, Support, Community

Authors: Hans Ekkehard Plesser
Main author/presenter is early-career researcher: no
Poster abstract: We present important advances achieved in the quality of NEST documentation during SGA2, including an automated workflow for documentation generation, high-quality formatting using restructured text, comprehensive coverage of models, a wide range of examples and documentation delivery through the widely used Read The Docs platform. We also present NEST support channels and community building efforts such as NEST Hackathons and the NEST Conference.

(YRE)Poster code: SP7-6; Title: Co-simulation of the multiscale brain with EBRAINS

Authors: Wouter Klijn, Sandra Diaz, Kim Sontheimer, Alper Yegenoglu, Alexander Peyser,

Thorsten Hater, Lena Oden,Benjamin Weyers, Simon Oehrl, Dionysios Perdikis, Petra Ritter, Hans Ekkehard Plesser, Jochen Martin Eppler, Viktor Jirsa, Lionel Kusch, Abigail Morrison
Main author/presenter is early-career researcher: yes
Poster abstract: "The brain is an inherently multiscale system and the interplay between these scales remains an open question: Efficient simulation at each scale is critical, but not sufficient for understanding the whole system. SGA2 sees the completion of four interrelated proof of concepts providing fundamental insight into the requirements of co-simulation: NEST-TVB coupling, NEST-Arbor coupling, in transit analysis using Elephant, and in-situ visualization of NEST and Arbor. During SGA3, EBRAINS will deliver a modular framework for connecting models and simulation engines working at different or the same scales. It will include in situ analysis and communication infrastructure, and science workflows that will provide the neuroscience community with novel tools for researching the multiscale nature of the brain. Co-simulation in EBRAINS is designed for large-scale deployment on HPC, including the necessary transducing modules between simulators and integration with EBRAINS tools for parameter space exploration, analysis and visualization. This presentation will discuss the use cases and showcases guiding the work in SGA3."

Poster code: CDP6-1; Title: Molecular Dynamics of Regulatory Sites During the Glycine Receptor Gating and Desensitization

Authors: Adrien Cerdan, Alison Popp, Marion Sisquellas, Jean-Pierre Changeux, Marco Cecchini
Main author/presenter is early-career researcher: no
Poster abstract: N/A

Poster code: CDP6-2; Title: The Glycine Receptor Allosteric Ligands Library (GRALL)

Authors: Adrien Cerdan, Marion Sisquellas, Gilberto Pereira, Diego E. Barreto Gomes Jean-Pierre Changeux, Marco Cecchini
Main author/presenter is early-career researcher: no
Poster abstract: N/A

Poster code: SP8-1; Title: The Medical Informatics Platform (MIP): an innovative tool for leveraging patients' BIG data in clinical neuroscience across Europe

Authors: ThierryPhenix, Erika Borcel, Ludovic Claude, Mirco Nasuti, Stefano Cappa,FerathKherif, Olivier David, Christian-Jacques Dhondt, IoannisFoufoulas, Giovanni Frisoni,Florent Gaillard, Martin Hofmann-Apitius, Athanasios Michail Karampatsis, Kostis Karozos,Sofia Karvounari, Konstantinos Kechagias,MélanieLeroy,Evita Mailli, Mira Marcus,Flavio Nasuti, Evgenia Panagiotopoulou, Florence Pasquier,NorinePerrin,Barinjaka Rakotomiaramanana, Alberto Redolfi, PetraRitter, Jason Sakellariou, Sandra Schweighauser, Pegah Sarkheil, David Steinberg, Manuel Guy Spuhler, EleniZacharia, Jean-François Demonet,VasilisVassalos ,Yannis Ioannidis,PhilippeRyvlin.
Main author/presenter is early-career researcher: no
Poster abstract: Medical and research activities in clinical neuroscience produces a massive amount of patients' data that could leverage our knowledge and understanding of brain diseases. Unfortunately, despite growing incentives for open data, most of it remains currently locked in hospitals or labs, either for regulatory or cultural reasons. The Human Brain Project (HBP) has developed the MIP, an innovative tool to investigate, compare and analyze large patients' datasets distributed across centers without requiring the data to be

sent out from their site of origin. To achieve this goal, a MIP instance is installed in each participating hospital/lab, enabling harmonization of local data via pre-processing, data integration and anonymization techniques by the MIP data factory so as to be imported into the platform. The MIP central engine then enables federated web-based queries which will execute the same algorithm in each site in a coordinated way, to eventually provide aggregated findings. To this purpose, analytical tools are deployed in each MIP algorithm factory, from standard descriptive statistics to complex supervised and unsupervised machine learning tools. Beyond anonymization, data privacy is further ensured by only allowing end-users to query aggregated findings, while not being able to investigate the datasets at the individual level. Similarly, databases cannot be copied or uploaded. The MIP is currently installed in 24 hospitals, with a fast track development to reach 30 in the near future. Datasets from several thousand patients are available in the fields of dementia and traumatic brain injury, and soon in that of epilepsy and mental health. Public datasets are also available for comparisons (ADNI, PPMI, EDSD). Data types include clinical information and pre-processed MRI 3D-T1 images with regional brain volume for 120 pre-defined regions of interest. Human intracerebral EEG recording will be added soon. MIP will help neuroscientists and clinicians to investigate and compare harmonize scientific big-data from harmonized pre-processed neuroimaging, neurophysiological, -omics and medical records using a user-friendly interface to run data-driven statistical analysis and predictive models. The MIP will link brain-science research, clinical research and patient care into a unique and accessible space, providing the scientific and clinical community with the tools to improve knowledge, diagnosis, early prediction and innovative treatment of brain diseases.

Poster code: SP8-2; Title: HIP: The human intracerebral EEG Platform

Authors: Philippe Ryvlin*1, Olivier David*2, Viktor Jirsa3, Jean-Philippe Lachaux4, Erika Borcel1, Carolina Ciumas1
Main author/presenter is early-career researcher: no
Poster abstract: HIP is an open-source EBRAINS-integrated platform specifically designed to optimally collect, store, curate, share and analyse multiscale iEEG data within the framework of EBRAINS while ensuring full compliance with ethics and data privacy regulations. To achieve its endeavour, HIP will integrate a number of open-source IT tools and workflows previously developed within and outside HBP into a secured and well-controlled platform offering an optimal balance between data privacy and access for relevant end-users. HBP has already created an official partnership with the largest clinical consortia performing iEEG - the European Reference Network EpiCARE – that includes the installation of the Medical Informatics Platform (MIP) across the EpiCARE centres and their participation to an iEEG-based consortium. The primary objective of HIP is to leverage Human brain research based on direct intracerebral recording of Human brain neuronal activity at all available scales (single neurons, multi-unit, LFP) by providing the scientific community unprecedented access to such data."

Poster code: SP8-3; Title: Data Factory: Data preparation and integration for the Medical Informatics Platform

Authors: Vasilis Vassalos, Kostis Karozos, Iosif Spartalis, Admir Demiraj, Sotirios Nikoloutsopoulos
Main author/presenter is early-career researcher: no
Poster abstract: N/A

(YRE)Poster code: SP8-4; Title: Practical Application of Emulators instead of Simulators for UQ and Optimization in HBP

Authors: Ella Shaposhnik, Gilad Shapira, David Steinberg, Mira Marcus
Main author/presenter is early-career researcher: yes
Poster abstract: "This work demonstrates the use of emulator (statistical model) instead of simulator for uncertainty quantification and parameter optimization to save time and computational costs. An important task in neuroscience is to develop simulators that reproduce observations obtained at a variety of experimental conditions in the laboratory. The use of computer simulations of various types at both neuronal and cellular levels is very common in neuroscience and plays a prominent role in HBP . Running a simulator may be both slow and expensive to perform major tasks, like Uncertainty Quantification (UQ) or Optimization . We illustrate the advantages in moving from simulator to emulator, an empirical approximation to the simulator. Our ideas thus provide an alternative, and potentially more efficient scheme for carrying out UQ or Optimization in neuroscience. Methods: In the first step we define a simulator likelihood function and optimize on MLE. In the second stage we find viable space by applying MCMC algorithm . Then, emulator is fitted for each simulator configuration in viable space using PCA and Linear regression . In final step, an ensemble model is fitted, consisting of Random Forest and Gaussian Process models. Finally , we use this emulator to perform UQ and compare the results to those from the simulator. For UQ we used Bayesian Computation Using Design of Experiments Based Interpolation Technique (DoIt) Goals: Save time for Optimization/UQ Processes involving simulator runs in HBP, Find efficient statistical methods, Explore emulator usage as a companion to a simulator Results:We show that MLE can be used for optimizing the simulator , supplying the initial parameter settings for the next laboratory experiment . Also we were able to build an emulator by modeling the simulator function shape with an ensemble model using Gaussian Process and Random Forest. Finally, we demonstrate that the emulator can effectively replace the simulator for Uncertainty Quantification, giving similar results faster and at less expense. When acting in viable space, the emulator and simulator lead to very similar conclusions about the posterior distribution of parameters."

Poster code: SP8-5; Title: Asymmetricaleffectiveconnectivity in themesialtemporal networkofthelivinghuman brain

Authors: Yulia Novitskaya, Matthias Dümpelmann, Andreas Vlachos, Peter Christoph Reinacher, Andreas Schulze-Bonhage
Main author/presenter is early-career researcher: no
Poster abstract: "The human temporal lobe is a multimodal association area which plays a key role in various aspects of cognition, particularly in memory formation and spatial navigation. Functional and anatomical connectivity of temporal structures is thus a subject of intense research, yet by far underexplored in humans due to ethical and technical limitations. We assessed intratemporal cortico-cortical interactions in the living human brain by means of single pulse electrical stimulation (SPES), an invasive method allowing mapping functional intracortical connectivity with a high spatiotemporal resolution.
18 subjects with normal anterior-mesial temporal MR imaging undergoing intracranial presurgical epilepsy diagnostics with multiple depth electrodes were included. The investigated structures were temporal pole, hippocampus, amygdala and parahippocampal gyrus. Intratemporal cortical connectivity was assessed as a function of amplitude of the

early component of the SPES-evoked potentials. While the analysis revealed robust interconnectivity between all explored structures, a clear asymmetry in bidirectional connectivity was detected for the hippocampal network and for the connections between the temporal pole and parahippocampal gyrus. The amygdala showed bidirectional asymmetry only to the hippocampus.
These results provide an evidence of asymmetrically weighed reciprocal connectivity between the structures of the mesial temporal network in humans in vivo. The findings are in exact accord with the anatomical tracing studies in non-human primates and open a translational route for interventions employing modulation of temporal lobe function."

Poster code: SP8-6; Title: Detection of single CCEPs and their correlation with seizure propagation networks

Authors: Daniel Lachner-Piza; Yulia Novitskaya; Matthias Dümpelmann;AndreasSchulze-Bonhage
Main author/presenter is early-career researcher: no
Poster abstract: N/A

Poster code: SP8-7; Title: Virtual Dementia: The Virtual Brain improves pathophysiological understanding and diagnostics

Authors: P. TRIEBKORN,L. STEFANOVSKI, A. SPIEGLER, M. DIAZ-CORTES, D. PERDIKIS, K DHINDSA, R. PAI, A. SOLODKIN, V.K. JIRSA, A.R. MCINTOSH, P. RITTER
Main author/presenter is early-career researcher: no
Poster abstract: Alzheimer'sdisease(AD) is the most common cause of dementia and the most common neurodegenerative in general. In order to improve prediction of disease development we implementa new approach combining clinical data, molecular biology and dynamical systems theory. We use neuroimaging data to construct individual brain network models and simulate those in The Virtual Brain (TVB). TVB is a brain simulation platform that integrates local neural mass models with long range structural connectivity (SC) creating a brain network model.

(YRE)Poster code: SP8-8; Title: Allosteric drug discovery for PIK3CA mutants

Authors: Ioannis Galdadas, Francesco L. Gervasio, Zoe Cournia
Main author/presenter is early-career researcher: yes
Poster abstract: Innovative neuromedicine approaches require a detailed understanding of the molecular and systems-level organisation of the human brain. Because of the high complexity of the nervous system and the inter-subject variability, there is currently no cure for most neurodegenerative disorders. CDP6 aims to develop new strategies for more effective drug treatments based on the allosteric interaction paradigm. The project relies on a broad expertise involving the Institut Pasteur (France), Forschungszentrum Jülich (Germany), University of Strasbourg, Academy of Athens (Greece), and University College London (UK). In this poster, using molecular simulations, compounds with enhanced selectivity and reduced off-target effects against mutant forms H1047R and E545K of PI3Kα, which are prevalent in glioblastoma have been designed.

Poster code: SP8-9; Title: Open standards for deployment, storage and sharing of predictive models. PMML / PFA / ONNX in action.

Authors: Svetlana Levitan, IBM CODAIT and DMG, Nick Pentreath, IBM CODAIT, Ludovic Claude, CHUV

Poster abstract: Machine learning pipelines span organizational teams and tools. Challenges include:

- Bridge various languages, frameworks, versions
- Friction between teams – data science vs production vs business
- Proliferation of formats – lack of standardization leads to custom solutions.

Open standards for model serailization provide ways to easily deploy or exchange models between different products or systems regardless of programming languages, operating systems, file systems.

The Data Mining Group (DMG) was created in 1990's to work on such open standards.

Mainstream open standards for model serialization and deployment include:

- Predictive Model Markup Language (PMML)
- Portable Format for Analytics (PFA)
- Open Neural Network Exchange (ONNX)

Application: PFA models in Brain Research

The Medical Informatics Platform (MIP) of Human Brain Project is deployed in 30 hospitals in EU and provides privacy-preserving machine learning and analytics services.

Usage and benefits of PFA for the platform:

- Scientist with machine learning algorithms in any language. Algorithms are packaged in Docker, adapted to export models as PFA and deployed in hospitals
- PFA models can be shared between hospitals; a hospital can build models from its data then test the model onto another hospital without revealing or exchanging any of its patient data.
- PFA models can be stored on a repository for sharing and reuse.

Poster code: SP8-10; Title: Functional and structural connectivity of the human brain: synergy of results from direct electrical stimulation and diffusion magnetic resonance imaging

Authors: M. Jedynak 1 , L. Trebaul 1 , J.-D. Lemarechal 2 , N. Labra 3 , P. Deman 1 , V. Tuyisenge 1 , F. Tadel 1 , B. Chanteloup-Forêt 1 , C. Saubat 1 , G. Reyes Mejia 1 , C. Poupon 3 , J.-F. Mangin 3 , O. David 1 , F-Tract Consortium

Poster abstract: Functional tractography by means of Direct Electrical Stimulation (DES) provides information about functional connections between remote brain areas. Here, we perform group analysis of DES data and corroborate results obtained by multi-subject clustering of diffusion MRI High Angular Resolution Diffusion Imaging (dMRI HARDI)-derived fibers. The structural and functional data sets are complementary: fiber geometry that can be determined in the structural study cannot be found in the functional approach, which, in turn, provides information about the direction of signal transmission and propagation latency. We combine these two data sets to tests their mutual consistency and to find results inaccessible from within either method alone, namely signal propagation velocity. First, we analyzed the HARDI data in order to derive the organization of fibers into bundles repetitive between individuals. We used data of 77 healthy human subjects from HARDI database called CONNECT/Archi that is distributed by the Human Brain Project. Second, in order to determine functional connectivity between remote brain areas we applied the

procedure developed in the F-Tract project, i.e. we analyzed signals recorded with intracerebral (stereo-electroencephalographic) electrodes from nearly 300 drug-resistant epilepsy patients. Electrical stimulation in certain brain areas and simultaneous recordings in other areas allowed us to assess the existence of functional connectivity between these areas and characteristics (such as latency) of cortico-cortical potentials evoked by DES. Finally, we superimposed the obtained structural and functional data sets and tested how the geometry of the HARDI-derived fibers correlates with the spacial distribution of functional connectivity. We estimated the probability of signal transmission and its propagation latency along each fiber in both directions. Signal propagation speed was obtained as a ratio of distance (length of a fiber) and propagation time (latency from the DES procedure).
In summary, we present an integration of structural and functional data obtained from two distinct but complementary brain mapping methods, namely diffusion MRI and Direct Electrical Stimulation. This integrative approach allowed us to examine consistency between the two methods and to find speed of the signal propagation that could not be measured in either of these methods alone.

(YRE)Poster code: CDP5-1; Title: Co-Design Project 5: Research highlights

Authors: CDP5
Main author/presenter is early-career researcher: yes (Andreas Baumbach)
Poster abstract: N/A

(YRE)Poster code: CDP5-2; Title: Co-Design Project 5: Research highlights

Authors: CDP5
Main author/presenter is early-career researcher: yes (Andreas Baumbach)
Poster abstract: N/A

Poster code: SP9-1; Title: Hot Coffee: Associative Memory with Bump Attractor Cell Assemblies of Spiking Neurons

Authors: Christian Huyck, Alberto Vergani
Main author/presenter is early-career researcher: no
Poster abstract: "Networks of spiking neurons can have persistently firing stable bump attractors, to represent large number spaces (like temperature). This can be done with a topology that has local excitatory synapses, with surround inhibition, but with any particular topology there are critical points in the weight space. Activating large ranges in the bump can lead to streams, that show repeller attractor dynamics, however, these streams can be merged by overcoming these repeller dynamics. A simple associative memory can include these bump attractors, allowing the use of continuous variables in these memories. This is a step toward a more complete cognitive associative memory.

(YRE)Poster code: SP9-2; Title: Realtime Cortical Simulation on SpiNNaker

Authors: Luca Peres, Oliver Rhodes
Main author/presenter is early-career researcher: Yes (Luca Peres)
Poster abstract: Execution of SNN models is a complex process on traditional computing machinery, particularly at scale. Traditional communication mechanisms are inefficient

because of long-range connectivity and sparse temporal signals. This problem scales nonlinearly with neural network size. This work presents a solution to the problem through the use of the SpiNNaker neuromorphic platform, together with software development optimizing the use of the hardware. The target network is a cortical microcircuit network, containing biologically representative numbers of neurons (77 * 103 neurons and 0.3 * 109 synapses), connection topology and spiking activity. This work provides an implementation capable of simulating the model at biological real time, a result not currently achievable using conventional HPC or GPU hardware.

Poster code: SP9-3; Title: Neuromorphic Computing Platform : Provide User Access

Authors: "M. Sénoville, O. Ates, J. Duperrier, D. Guarino, B. Lungsi Sharma, A.P. Davison and the HBP-SP9 Neuromorphic Computing Collaboration
Paris-Saclay Institute of Neuroscience, UMR 9197, Centre National de la Recherche Scientifique/Université Paris-Saclay, France"
Main author/presenter is early-career researcher: No
Poster abstract: The Neuromorphic Computing Platform offers access to two large-scale facilities, the BrainScaleS 20-wafer system in Heidelberg and the SpiNNaker 1,000,000 core machine in Manchester. With the goal to make the use of these machines as easy as possible, the platform provides (i) a remote access through both a graphical interface on the HBP Collaboratory (for result visualisation and integration with HPAC facilities) and a scriptable interface (locally from a terminal), and (ii) an easy-to-learn, flexible and powerful programming interface (PyNN). This poster will discuss the current status of the platform, in particular a new Collaboratory app, which allows users to create models of point spiking neurons using a graphical interface, without any programming, and then run simulations directly on the neuromorphic computing systems, as well as new features added to the command-line interface with the aim to mimic batch job submission from remote terminals.

Poster code: SP9-4; Title: BrainScaleS-1 Near Future Upgrades

Authors: Tobias Thommes, Joscha Ilmberger, Hartmut Schmidt, Simon Rosenkranz, Sebastian Schmitt; Ulrich Brüning, Johannes Schemmel
Main author/presenter is early-career researcher: no
Poster abstract: BrainScaleS-1 consists of 20 wafer modules. Each comprising, amongst others, of a silicon wafer and 48 FPGA boards. One such wafer consists of 384 HICANN chips, each providing 512 analog neuron circuits. A digital on-chip bus network transports spikes to analog synapses. Analog readout of, e.g. membrane traces, is possible from two outgoing sources per 8 HICANNs, totalling in 96 signals. In this poster, a new readout system -- ANANAS -- is presented that allows to digitize all 96 analog signals in parallel. Two analog-to-digital converters are selectable for each input, offering different conversion rates, accuracies and signal terminations. Inter-wafer spike communication is planned, utilizing the high-performance networking technology EXTOLL, which provides bandwidths of up to 100.8 Gbit/s and latencies of approximately 70 ns per switching hop. The Network Interface Cards (NICs) provide connectivity through 7 links, directly connecting to other NICs and suggesting a 3D-Torus as network topology. Spike-events will be aggregated to larger packets, according to their arrival deadline timestamp, in order to minimize the header overhead. With this communication network, it will be possible to map large SNN models across several wafers. It will also be easily adaptable to a future large scale BrainScaleS-2 system. Progress on bringing a cortical microcircuit network to BrainScaleS-1 is presented as

well focusing on the one hand on theoretical studies scaling the network down and converting from current- to conductance-based synapses, as on the other hand on the mapping and routing workflow that needs to account for hardware constraints.

Poster code: SP9-5; Title: BrainScaleS-2 results

Authors: N/A
Main author/presenter is early-career researcher: no
Poster abstract: N/A

Poster code: SP9-6; Title: Silicon Brains booth poster

Authors: N/A
Main author/presenter is early-career researcher: no
Poster abstract: N/A

Poster code: SP10-1; Title: SP6-SP5-SP10: Knowledge Graph integration into the Neurorobotics Platform

Authors: Axel VON ARNIM (fortiss), Stefano NARDO (SSSA), Oliver SCHMID (EPFL)
Main author/presenter is early-career researcher: no
Poster abstract: "The SP5 Knowledge Graph has been integrated in the Neurorobotics Platform. This is a highlight in SGA2 and paves the way for the EBRAINS architecture and a full integrated toolchain between the Brain Simulation and the Neurorobotics Platform. This use case shows the how the SP6 Cerebellum brain can be loaded into the NRP through the Knowledge Graph and how simulation results are fed back, enabling users to enrich the brain database with experimental data.
This work will be continued in SGA3 and merged with the efforts to run the NRP on SP7 HPAC systems."

Poster code: SP10-2; Title: Particle physics: the way to fluid dynamics in the Neurorobotics Platform

Authors: Manos ANGELIDIS (fortiss), Axel VON ARNIM (fortiss)
Main author/presenter is early-career researcher: no
Poster abstract: Simulating fluids in the Neurorobotics Platform is a huge asset over other robotic simulators, as it enables for the experimentation on swimming behaviours and gaits on soft terrains. Particle physics combine a faster computation time than hardcore mechanics with an acceptable physical accuracy. The use case shown here implements a spiking swimming controller in simulated water on an animal model.

Poster code: SP10-3; Title: Neurorobotics Platform's new plotting framework

Authors: Axel VON ARNIM (fortiss), Yves DORNBIERER-SCHMID (Plexus Games)
Main author/presenter is early-career researcher: no
Poster abstract: Users of the Neurorobotics Platform have requested more plotting capabilities that we are proud to showcase here.

Poster code: SP10-4; Title: Strategic Experiment #7: duality between NRP and real-world robots under neurocomputing control

Authors: "Juan Pablo Romero Bermudez (KTH), Jens Egholm Pedersen (KTH),

more-to-be-confirmed (TUM? SSSA?), Jorg Conradt (KTH)"
Main author/presenter is early-career researcher: no
Poster abstract: "Here we present the duality between robotic experiments in simulation (NRP) and real-world robotics in a task that employs a compliant
robot arm (myoRobotics) for pickup and exploration of an a-priori unkonwn object, followed by adapted motor control to handle the
object within a high-speed, high-precision task."

Poster code: SP10-5; Title: Learning event-based visual representations for grasping with e-prop on SpiNNaker

Authors: Jacques Kaiser (FZI), J. Camilo Vasquez Tieck (FZI)
Main author/presenter is early-career researcher: no
Poster abstract: We rely on the e-prop's SpiNNaker implementation provided jointly by TU Graz and the University of Manchester to learn representations from an event-based vision sensor to classifiy different grasp types in a real-world robot setup.

Poster code: SP10-6; Title: Large-scale NEST simulation on NRP running on HPC infrastructure (TBC)

Authors: Eloy Retamino (UGR), Hossain Mahmud (Fortiss), Kepa Cantero (Fortiss), Susie murphy (EPFL), Colin McMurtrie (CSCS), Felipe Cruz Villaroel (CSCS), Alex Upton (CSCS), Jochen Eppler (FZ Julich), Michael Zechmair (TUM)
Main author/presenter is early-career researcher: no
Poster abstract: In this poster are presented the results of a SP7/SP10 collaboration for deploying the Neurorobotics Platform (NRP) on the High-Performance Computing infrastructure at CSCS. It overviews the technical challenges for distributing neurorobotic simulations in NRP and the final setup for deploying the platform on the supercomputer.

Poster code: SP12-1; Title: Ethics Support

Authors: Ethics Support (Work package 12.4)
Main author/presenter is early-career researcher: no
Poster abstract: "This poster presents aims and activities of the Ethics Support 12.4 work-package in the Human Brain Project. We aim to
facilitate research-based ethics dialogues with HBP members, Ethics Rapporteurs and the Ethics Advisory Board to support reflection, good practice and compliance.
develop good practices for ethics support processes, combining empirical research and practice as part of the Human Brain Project's approach to Responsible Research and Innovation.
We implement the following tasks:
Ethics Support in the HBP: We contribute to ethical aspects of HBP governance.
Compliance Management: We aim to ensure that research conducted in the HBP meets the ethical standards required for Horizon 2020 projects.
We support:
The Ethics Advisory Board (EAB): An independent body that advises the HBP governing bodies on ethical, regulatory, social and philosophical issues encountered within the HBP
The POint of REgistration of ethical concerns (PORE): A public open portal for requests to address ethical, regulatory and social issues in HBP research

The Ethics Rapporteur Programme: An HBP crossover ethics governance structure, which deepens understanding of potential ethical and social implications of research and other work by the academics, scientists and engineers in all the HBP SubProjects.
Ethics Support Outreach and Dissemination: We communicate our good practices and research results to diverse audiences in the scientific community, policy-making and general public. We closely collaborate with the Foresight Lab on researcher awareness activities.
Ethics-Related Data Governance: We contribute our expertise in ethics to ensure responsible data governance in the HBP.
Data Protection Officer: We ensure that any potentially privacy-relevant data in the HBP are dealt with in accordance with data protection principles, in particular, the General Data Protection Regulation. "

Poster code: SP12-2; Title: Responsible Dual Use in Neuroscience and Neurotechnology

Authors: Ethics and Society (SP12)
Main author/presenter is early-career researcher: no
Poster abstract: "Responsible Dual Use in Neuroscience and Neurotechnology
While brain research aims at advancing neuroscience, brain related medicine and brain inspired computing, its results can also be used for political, military, security and intelligence purposes. Technologies developed for civilian use that also can have military use are known as 'dual use' technologies. When should researchers, society and policy-makers be concerned about potential uses of neuro-ICT research? And what can they do to avoid 'dual use of concern'? To answer these questions, the Ethics and Society Subproject (SP12) of the Human Brain Project has undertaken a number of research, outreach and engagement activities that have resulted in our 'Opinion on Responsible Dual Use. Political, Security, Intelligence and Military Research of Concern in Neuroscience and Neurotechnology'.
In preparation of the Opinion, we have consulted and surveyed citizens, organized expert webinars and policy workshops, and reached out to neuroscientists and engineers. Insights from these activities have led to a number of scoping reports and recommendations. We suggest to apply principles of Responsible Research and Innovation (RRI) to identify 'dual use of concern' that can threaten the peace, health, safety, security and well-being of citizens. Furthermore, we have developed a number of recommendations that can help to ensure 'responsible dual use'. These include recommendations to policy-makers to extend policies on dual use to consider and mitigate potential risks, to universities to provide appropriate training and to businesses to ensure self-regulation. The HBP Dual Use Working Group in collaboration with the Ethics Rapporteur Programme, HBP Education Programme and other internal and external stakeholders implements these recommendations."

Poster code: SP12-3; Title: Neuroethics, Philosophy and RRI in the HBP

Authors: Neuroethics and Philosophy (SP12)
Main author/presenter is early-career researcher: no
Poster abstract: "Responsible Research and Innovation (RRI). Responsible Research and Innovation is an interactive process that engages social actors, researchers, and innovators who must be mutually responsive and work towards the ethical adequacy and accountability of the relevant research promoting an ethically and socially sustainable infrastructure.

Philosophical and conceptual analysis (i e fundamental neuroethics theoretically and ethically broadens research and innovation within the HBP:
1. Bringing to the forefront dimensions typically unacknowledged thus stifling tendencies to interpret neuroscientific results in a simplistic fashion,
2. Offering different and possibly complementary approaches to the issues investigated by empirical science
3. Providing the necessary background for examining the potential impact of neuroscience on topics such as the mind/brain relationship, criteria for consciousness, the question of human identity, personal responsibility, and freedom
Focus on AI ethics
Practical ethical analysis of AI is complemented by conceptual reflection on the relevant concepts and notions (e.g., intelligence, trust, transparency, anthropomorphism, etc.). This provides needed clarification and avoids misplaced or disproportionate concerns thus promoting a more productive discussion of the issues raised by AI."

Poster code: SP12-4; Title: Ethics and Society in HBP

Authors: SP12
Main author/presenter is early-career researcher: no
Poster abstract: "Ethics and Society is part of the Human Brain Project's (HBP) research Through research and ethics management it promotes Responsible Research and Innovation (RRI) practices within the HBP and helps shape the direction of the HBP in ethically sound ways that serve the public.
Ethics and Society are composed of:
•The HBP Foresight Lab focuses on identifying and evaluating the future impact of new knowledge and technologies generated by the HBP using a range of methods including action research, interviews, participant observation, literature reviews, surveys and expert workshops.
•Neuroethics and Philosophy focuses on neuroscientific research and emerging neuro technologies afford several conceptual, social, ethical, and regulatory issues, from potential privacy threats to understanding consciousness and the meaning of human and personal identity.
•Public Dialoque and Engagement organise and facilitate dialogues with the public on potentially controversial issues and those of immediate relevance to the HBP Our vision is to engage European
•society in setting the direction for HBP research and innovation and broaden the debate on the ethical, legal and societal issues arising from the project
•Ethics Support facilitate research based ethics dialogues with HBP members, Ethics Rapporteurs and the Ethics Advisory Board to support reflection, good practice and compliance
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Poster code: SP12-5; Title: Citizen And Stakeholder Engagement and EBRAINS Community Building

Authors: SP12
Main author/presenter is early-career researcher: no
Poster abstract: "Citizen and Stakeholder Engagement

HBP engagement activities aim to break barriers and provide the society that surrounds HBP with a voice that is heard inside the project. It is an opportunity to discuss the project, its research and its implications with people who directly or indirectly has a stake in these. These activities explore the broader social, political, ethical, practical and legal implications of HBP research by consulting people who are experts in their profession and people who are experts in their own lives as citizens of the European Union. All of this, to create and maintain a constructive exchange between the HBP, the research community outside the project and the society in which it is embedded.
EBRAINS inclusive Community Building
The EBRAINS Community will build bridges between the groups of EBRAINS supporters, users and collaborators, who will contribute to and benefit from EBRAINS services and research. Excellent science of benefit to society will happen when these three types of community members pool their competences and work together. Furthermore, an inclusive community will foster close collaboration across disciplinary and professional practices, institutes, nations, stakeholders, funders, policy-makers and societal actors, in order to expand the scale of use."

Poster code: SP12-6; Title: Foresight Lab

Authors: SP12
Main author/presenter is early-career researcher: no
Poster abstract: "The Foresight Lab at King's College London is a part of the HBP's Subproject12 and focuses on identifying and evaluating the future impact of new knowledge and technologies generated by the HBP using a range of methods including action research, interviews, participant observation, literature reviews, questionnaire surveys and expert workshops.

Key Objectives
A key objective is to develop 'foresight', which is the practice of making ‘forward looks,’ of anticipating change, and studying future possibilities. To do this, scenarios are developed which serve as frameworks and stimuli for evaluating the HBP’s possible consequences on society. These are then discussed with key informants from a range of communities to generate a series of best practice recommendations directed towards researchers and HBP managers. This simultaneously enables the adoption of strategies that optimise scientific and social benefits while enhancing preparedness for possible ethical concerns and dilemmas.

Poster code: SP11-P1; Title: Multiscale Model of Hippocampal Synaptic Plasticity: Integration to the Brain Simulation Platform

Authors: J. Dainauskas1, A. Kramer2, J. Hellgren-Kotaleski2,3, M. Migliore4, P. Jedlicka5, B. Graham6, A. Saudargiene1,7
Main author/presenter is early-career researcher: no
Poster abstract: "A variety of different programming languages and platforms is used to build, validate and simulate computational models of biochemical and electrophysiological processes of neuronal circuits in Systems Biology and Computational Neuroscience fields. The goal of the project is to integrate and test the model of neuronal electrical activity and chemical intracellular cascades of hippocampal synaptic plasticity using a standardized workflow for building, validation, optimization, sensitivity and stability analysis.

The standardized workflow is based on the model definition in SBtab format (Systems Biology Syntax rules), conversion to the Vector Field File generator (VFgen) compatible XML file and generation of programming code in a preferred programming language including C, Python, NEURON. Stability and sensitivity analysis of models is done using MCMC_lib program.
We applied a standardized workflow to translate a complex computational model of synaptic learning in hippocampal CA1 pyramidal neurons (Saudargiene and Graham, 2015) from C++ code to NEURON file using SBtab and VFgen formats. It enabled performing stability and sensitivity analysis of the model and running simulations in NEURON simulator used by the Human Brain Project Brain Simulation Platform. The model was integrated into the Human Brain Project Collaboratory Platform.
A standardized workflow has been proposed and implemented to enhance computational model analysis, sharing, and reproducibility. Standardization of the modeling process is important in Systems Biology and Computational Neuroscience as models are becoming increasingly complex, more detailed and multiscaled.
Acknowledgements: This project was supported by the Human Brain Project Voucher Programme 2019-2020."

(YRE)Poster code: SP11-P2; Title: Integration of CxSystem2 and Neuronal Dynamics Library to the Brain Simulation Platform

Authors: Henri HOKKANEN, Vafa ANDALIBI , Simo VANNI
Main author/presenter is early-career researcher: yes
Poster abstract: Complex models of cortical networks are difficult to manage due to the large number of biological details. We have previously built CxSystem, an open-source simulation framework for cortical networks, enabling simulations locally and on computing clusters. It is implemented in Python3 on top of the popular Brian2 simulator and embraces the main goal of Brian – minimizing development time – by providing the user with a simplified interface. We have now extended our software, CxSystem2, to make it even more accessible. First, we have extended the code base accompanied by the book Neuronal Dynamics (Gerstner et al., 2014, Cambridge University Press) to construct the Neuronal Dynamics Library (neurodynlib) and integrated it with CxSystem2. This allows users to explore neuron models and build prototype networks in the familiar Jupyter Notebook environment. Second, we have designed a browser-based user interface to CxSystem2 that can be run locally or accessed via the Brain Simulation Platform. Our software provides a way for the novice to advance from knowledge of neuron models to applications in complex networks. We will continue developing CxSystem2 with the aim of understanding the early stages of cortical processing of vision in primates.

(YRE)Poster code: SP11-P3; Title: Anomalies of directed and dynamic connectivity in stroke

Authors: Chiara Favaretto1, Michele Allegra2, Andrea Brovelli2 and Maurizio Corbetta1,3,4
Main author/presenter is early-career researcher: yes
Poster abstract: Neuroimaging has considerably deepened our understanding of stroke, revealing that focal lesions induce severe disruptions of structural connectivity and consequently perturb the global functional organization of the brain. Compared to healthy subjects, stroke patients commonly exhibit a higher segregation between the opposite hemispheres, and a higher integration within each one separately. Such anomalies, that

were observed in the analysis of static (i.e., average) resting-state functional connectivity, must be the resultant of alterations in the underlying dynamics. Identifying the dynamical effects at play would not only help to clarify the relation between structural damage and behavioral deficits, but also inspire the design of more effective therapies, including stimulation aimed at restoring the normal functional balance. We probed resting-state dynamics in stroke patients with two complementary approaches. First, we used transfer entropy to investigate how the lesions may affect directed interactions between brain areas. Second, we used a combination of PCA and clustering to analyze the impact of stroke on the transient connectivity states, which jointly determine static connectivity. The transfer entropy analysis showed that the healthy hemisphere tends to have a stronger influence on the lesioned one than the other way around. Furthermore, influences within the lesioned hemisphere were suppressed in stroke patients in comparison to healthy controls. This finding suggests the lesioned hemisphere as a preferential target for neurorehabilitation approaches. The analysis of dynamical states showed that the increased intra-hemispheric integration seen in stroke patients, which jeopardizes the usual segregation between the task-positive and task-negative network, is characteristic of a dynamical connectivity state, which occurs with anomalous frequency in stroke patients. Recovery of normal function 1 year after stroke was associated with a restoration of the normal frequency of occurrence for this state. Overall, our results demonstrate key changes in resting state dynamics in a major pathology.

(YRE)Poster code: SP11-P4; Title: SpiNNcer: a cerebellum advanced circuit into a SpiNNaker system

Authors: Beatrice Marcinno, Petrut Bogdan, Stefano Casali, Francesco Leporati, Claudia Casellato, Oliver Rhodes, Egidio D'Angelo [UNIPV, Manchester Univ]
Main author/presenter is early-career researcher: yes
Poster abstract: "The digital neuromorphic hardware SpiNNaker has been developed with the aim of enabling large-scale neural
network simulations in real time and with low power consumption. We here describe the first simulations of a
biological cerebellar microcircuit on SpiNNaker.
We have exploited an olivocerebellar scaffold model with advanced point neurons capturing essential nonlinear neuronal dynamics (refer to poster SP6 "Cerebellum: advanced neuron and microcircuit models"). We use a reconstructed cerebellar cortical volume of about 0.014 mm3 and a corresponding volume of Deep Cerebellar Nuclei. We port the model to the PyNN language for SpiNNaker. We simulate the model in pyNEST and in SpiNNaker, by setting a stimulation pattern on mossy fiber bundles around 40 Hz superimposed on background noise. Comparison with simulation outcomes using pyNEST on a high-performance cluster shows that both simulators can reach a similar accuracy, in terms of neuronal population activity (PSTHs), demonstrating the reliability of the cerebellar functioning on SpiNNaker.
The main bottleneck for the real time is related to the high convergence ratio for some connection types, especially the one from parallel fibers to Purkinje cells, which yields to a lot of simultaneous incoming spikes mainly when a highly synchronized input burst is imposed as stimulation pattern. We are designing a cortical-cerebellum system, running on SpiNNaker. Next step will be to embed long-term plasticity into the networks, translating customized modules of learning rules into PyNN for SpiNNaker.

This project demonstrates and exploits the potential of neuromorphic hardware as a neuroscience research tool for studying complex spiking neural networks over extended time periods, mainly crucial for generating and investigating learning mechanisms.

Poster code: SP11-P5; Title: Mapping Brain Circuits in Spatial Navigation (MAPS): the spacing effect

Authors: E. Centofante, L. Fralleoni, V. Mastrorilli, A. Rinaldi, A. Mele
Main author/presenter is early-career researcher: no
Poster abstract: "It is well established that the hippocampus (HPC) plays a crucial role in the early stages of the encoding and consolidation of spatial memories. This view has recently evolved with the suggestion that spatial memory formation might be rather sustained by the coordinated activity of a more integrated circuit, including cortical and subcortical regions. In particular, although striatal circuits have been mostly investigated for their involvement in locomotor activity, motivation, addiction and stimulus-response associations, in the past decade the striatal complex and hippocampus-striatal connections have been strongly implicated in spatial learning and memory, suggesting that a comprehensive understanding of spatial memory processing should be viewed in the context of a wider neural circuit.
It has long been known that information presented using spaced repetitions is better remembered than information presented via massed repetitions, a phenomenon called spacing effect. One of the most salient characteristics of the spacing effect is its uncommon generality over a great variety of learning tasks, materials, and organisms. However, very little is known about the neural networks dynamics that underlie this phenomenon.
In order to model the spacing effect during spatial learning, we compared the effect of distributed and massed training in the Morris Water maze in mice. Animals trained with the two protocols did not differ in their learning rate or in the ability to remember the platform 24 hours after the last training session, but interestingly only spaced-trained mice could locate the platform 14 days after training.
Neuronal immediate early genes (IEGs) play an important role in the neuroplastic mechanisms supporting memory formation, and represent an useful tool to identify the level of neuronal activation during different stages of the memorization process. We used IEGs expression as a marker of active neuronal ensambles, to investigate simultaneously in the same subject the pattern of activation of the dorsal hippocampus, the dorsomedial striatum and the dorsolateral striatum, in mice trained in the massed and distributed version of the Morris Water maze or home caged controls.
We plan to use these data to to carry out realistic simulations of the involved microcircuits, with the aim of developing a model of specific hippocampal activation in response to different navigational strategies and at different training stages, using the Brain Simulation Platform (BSP)."

Poster code: SP11-P6; Title: Modeling body and peripersonal space representations on humanoid robots with electronic skin

Authors: Zdenek Straka and Matej Hoffmann
Main author/presenter is early-career researcher: no
Poster abstract: "The mechanisms of how the brain represents the body and the space around it are not fully understood. We use the iCub humanoid robot equipped with a

whole-body artificial skin array to develop embodied computational models of the development and operation of these body representations.

Robot homunculus. First, we investigate how representations of the whole skin surface resembling those found in primate primary somatosensory cortex can be formed from local tactile stimulations traversing the body of a physical humanoid robot – the iCub. The "tactile homunculus" has a specific sequence and proportions of body parts – a result of genetic patterning (activity-independent factors) as well as experience (activity-dependent influence). Application of the standard self-organizing map (SOM) algorithm to the tactile stimulations is equivalent to experience only and does not guarantee convergence to a specific layout of the "cortical sheet". Therefore, we introduce a modification that makes it possible to restrict the maximum receptive field size of neuron groups at the output layer. The framework conveniently allows one to specify prior knowledge regarding the skin topology and thus to effectively seed a particular representation that training shapes further. This gives rise to the "iCub homunculus" which respects coarse somatotopy from the cortex.

Learning a peripersonal space representation. The space immediately surrounding the body (so-called peripersonal space - PPS) and its representation are essential for appropriate interaction of any agent with its environment. It constitutes a virtual margin-of-safety around individual body parts. In primates, this is mediated in particular by neurons with visuo-tactile receptive fields. We propose a computational model that addresses PPS learning as a visuo-tactile prediction task: a neural network composed of a Restricted Boltzmann Machine and a feedforward neural network. The former learns in an unsupervised manner to represent position and velocity features of the stimulus. The latter is trained in a supervised way to predict the position of touch (contact).
It considers: (i) stimulus position and velocity, (ii) uncertainty of all variables."

Poster code: SP11-P7; Title: Traveling waves in monkey premotor cortex at the edge of synchronization

Authors: Antonio Pazienti1, Andrea Galluzzi1, Pierpaolo Pani1, Stefano Ferraina1, Maurizio Mattia1
Main author/presenter is early-career researcher: no
Poster abstract: "The richness of brain dynamics is often associated to critical states close to boundaries separating different dynamical phases. This complexity has been argued to be the necessary ingredient to optimally perform cognitive functions like sensory-motor control and information processing. Boundaries like these are expected to be crossed in the universal sleep-wake cycle, when brain activity transitions from asynchronous, strongly irregular, to highly stereotyped spatiotemporal patterns occur. In the latter cell assemblies oscillate synchronously in so-called slow waves of activity (SWA).
Here, by measuring intracortical multi-unit activity (MUA) and local field potential (LFP) with multi-electrode arrays chronically implanted in the premotor cortex of two macaque monkeys, we found a rich repertoire of spatiotemporal patterns spontaneously emerging during the execution of a delayed reaching task. Intriguingly, these patterns i) emerged during MUA minima, ii) co-occurred with global negative LFP deflections (nLFP), and iii) consisted of MUA Down-to-Up transitions coordinated in space as traveling waves. Furthermore, the 12-14 Hz component of MUA displayed modulations locked to the nLFPs. As these patterns were reminiscent of the SWA reported under sleep and anesthesia, in the

same monkeys we induced deep anesthesia. As expected, we found similar activation waves locked to both nLFP and spindles-like waxing-and-waning oscillations.
We reproduced this dynamics using a spiking network model set to work close to the bifurcation between the synchronous and asynchronous states. When in simulations global firing rates were lowered, the critical point was approached, eventually increasing the probability of SWA. Overall, these findings provide compelling evidence that the premotor cortex, while performing reaching tasks, works close to the edge of synchronization, taking the brain closer to the sleep-wake bifurcation point."

Poster code: SP11-P8; Title: Addressing brain health challenges with neuroscience grounded technologies: A case study in the treatment of stroke using the Rehabilitation Gaming System.

Authors: Belen Rubio, Martina Meier, Klaudia Grechuta, Paul Verschure
Main author/presenter is early-career researcher: no
Poster abstract: Stroke is the leading burden of disease for neurological disorders accounting for about 5% of global disability adjusted life years [1]. It is predicted that by 2025, 1.5 million European people will suffer a stroke annually. In addition to primary effects, these patients face additional poor outcomes including re-hospitalisation (33%), recurrent events (7 to 13%), dementia (7 to 23%) mild cognitive disorder (35 to 47%), depression (30 to 50%), and fatigue (35% to 92%) [2]. This rapid growth in the number of patients needing care and rehabilitation requires an urgent response that is both scientifically grounded and scalable. We have realized such a solution called the Rehabilitation Gaming System (RGS) which combines theoretical neuroscience grounded, Virtual Reality based, and AI enhanced intervention protocols with which to date over 3000 patients across Europe have been successfully treated for deficits post stroke. RGS has shown impact in a range of domains including: motor, affective, cognitive3 [3] and language [4]. One important question in the domain of neurorehabilitation is when the optimal period is to deliver interventions. Indeed, the impact of rehabilitation on post-stroke recovery and its dependency on the patient's chronicity remain unclear. The field has widely accepted the notion of a proportional recovery rule with a "critical window for recovery" within the first 3–6 mo poststroke. This hypothesis justifies the general cessation of therapy at chronic stages. However, the limits of this critical window have, so far, been poorly defined. In this analysis, we address this question, and we explore the temporal structure of recovery using individual patient data from a homogeneous sample of 219 individuals with mild to moderate upper-limb hemiparesis treated with RGS [5]. We observed that improvement in function was possible even at late chronic stages. A bootstrapping analysis revealed a gradient of enhanced sensitivity to treatment that extended beyond 12 mo post-stroke refuting the critical time window hypothesis. in response to this observation, we have embarked on realizing an ecosystem of technologies that support the patient throughout their journey from the acute phase to treatment in late chronic stages at home. This RGS@HOME system combines RGS with wearables and mobile apps and is now deployed in a large Europe wide trial. Hence, RGS shows how basic neuroscience research can be successfully translated to clinical applications in the service of society.

Poster code: SP11-P9; Title: EpiCARE, THE EUROPEAN REFERENCE NETWORK FOR RARE AND COMPLEX EPILEPSIES

Authors: A. Schulze-Bonhage, H. Cross, A. Arzimaoglou on behalf of the EpiCare consortium.

Main author/presenter is early-career researcher: no
Poster abstract: The European Reference Networks (ERNs) connect highly specialized expert centres across Europe to improve access to diagnosis and treatment of all patients with rare diseases by providing accessible cross border healthcare. EpiCARE is the European Reference Network for Rare and Complex Epilepsies.

Poster code: SP11-P10; Title: Shaping the ethical dimensions of information technologies – a European perspective (SHERPA)

Authors: Laurence Brooks, Bernd Stahl on behalf of the SHERPA consortium
Main author/presenter is early-career researcher: no
Poster abstract: In collaboration with a broad range of stakeholders, the SHERPA project will investigate, analyse and synthesise our understanding of the ways in which smart information systems (SIS; the combination of artificial intelligence and big data analytics) impact ethics and human rights issues. It will develop novel ways of understanding and addressing SIS challenges, evaluate with stakeholders, and advocate the most desirable and sustainable solutions. SHERPA will: (1) represent and visualise the ethical and human rights challenges of SIS through case studies, scenarios and artistic representations, (2) work with a range of stakeholders to identify their concerns and preferred solutions (via interviews, a large-scale online survey, a Delphi study, a stakeholder board), (3) develop and publish a workbook on responsible development of SIS, (4) present technical and regulatory options (e.g., terms of reference for a regulator), (5) validate and prioritise the proposals through multi-stakeholder focus groups, and (6) advocate, promote and implement the most promising solutions through targeted dissemination and communication activities. The SHERPA consortium has 11 partners from six European countries (representing academia, industry, civil society, standards bodies, ethics committees, art).

Poster code: SP11-P11; Title: StillSuit: the endoskeletal robot suit for the biological human augmentation

Authors: Satoshi Oota, Yoshihiko Nakamura, Akihiko Murai, Ko Ayusawa, Eiichi Yoshida, Hidekazu Kaneko, Nobuo Kunori, Noriyuki Higo, Oleg Gusev, Shigeho Noda, Ryutaro Himeno, Shingo Shimoda, Shintaro Oyama, Hideo Yokota, Takayuki Michikawa, Martin, Fischer, Rüdiger Dillmann, Peer Lucas, Hirohisa Hirukawa, Knoll Alois, Masaaki Mochimaru
Main author/presenter is early-career researcher: no
Poster abstract: We have been developing an endoskeletal robot suit (StillSuit) to support the aging society. The StillSuit is primarily for human augmentation, not only for the physical assistance of elderly people. Usually, human augmentation refers to the cognitive-physical enhancement of human functions by using exogenous means: e.g., microscopes for vision, stethoscopes for auditory perception, and exoskeletal robots for physical strength. However, our StillSuit is primarily designed for cognitive and physical interventions on the human mind and body by taking advantage of endogenous flexibility, namely, remodeling. From a modern biological view, the biological system is an integrated molecular machine that can remodel itself by responding to internal and external stimuli in both positive and negative ways. For example, mammals (including humans) have around 20,000 genes, which are spatiotemporally regulated through internal and external interactions. StillSuit intervenes in the network by noninvasive manners and attempts to induce positive remodeling. To develop StillSuit, an accurate yet feasible computational brain model is necessary to evaluate the effects of the cognitive and physical interventions. The HBP

neurorobotics platform (NRP) is an ideal tool for the comprehensive analysis, in which we can conduct virtual experiments by using human and non-human animal subjects. StillSuit has yet another feature as a communication tool. Since the StillSuit is a bidirectional data logger, plural StillSuits have the potential to exchange wearers' cognitive-physical information (e.g., joint angles, haptic sensations, and visual-audio information). Through virtual reality (VR) and/or augmented reality (AR) spaces, wearers can share non-verbal experiences, which can be a new type of social network.

Poster code: SP11-P12; Title: Partnering Environment

Authors: Martin Telefont, Evan Hancock, Je-ok Presser
Main author/presenter is early-career researcher: no
Poster abstract: Partnering Projects are Research bodies which enter into a formal agreement to work with the HBP, using HBP infrastructure and/or contributing to its development.PPs bring new knowledge, competencies, ideas and resources to help advance the HBP Flagship's scientific and technological agenda by performing research and innovation activities in cooperation with the HBP Consortium. Join and contribute to the HBP via the Partnering Project mechanism if your project has its own funding and is using/and or contributing to the development of the HBP Infrastructure. Applications are accepted on a continuous basis, will get scientifically and ethically reviews, approved/rejected by the Science and Infrastructure Board (SIB) and collaborations formalized by signing a MoU.

Poster code: SP11-1; Title: Innovation management in HBP

Authors: Guillermo Velasco, Bárbara Gasset
Main author/presenter is early-career researcher: No
Poster abstract: The INNOVATION AND TECHNOLOGY TRANSFER NODE helps to introduce HBP mature technologies and services into the Neuroscience, Computing and Brain medicine users´ markets. We support HBP partners in assessing the exploitation potential of their technology developments and matching them with the scientific and industrial needs.

Poster code: SP11-2; Title: WE ARE HBP: Vision and Strategy, Guiding Questions and Examples

Authors: Karin Grasenick
Main author/presenter is early-career researcher: no
Poster abstract: The HBP (T11.2.5) has developed a vision and an action plan on how to enhance equal opportunities in a complex science partnership. It is based on a inclusive and holistic approach, considering gender and diversity as cross cutting issues not only on an individual level (training, workshops, mentoring) but as crucial in the design of structurs and processes as well as research and lectures. One of the indicators most widely used to measure equal opportunities is the percentage of women in leadership position. This indicator is reflected in the context of different scientific disciplines.

Poster code: SP11-3; Title: Participate & collaborate: The HBP Education Programme

Authors: Alois Saria, Tina Kokan, Laura Saxer, Judith Kathrein, Sylvia Aßlaber, Manuel Gran, Bettina Eibl, Martina Schmalholz, Theresa Rass
Main author/presenter is early-career researcher: no
Poster abstract: The HBP Education Programme has defined a teaching and training

strategy tailored to the needs of the Human Brain Project. The programme consists of various formats targeted at early-career researchers working in the main research areas of neuroscience, medicine and ICT. On the one hand, advanced schools are offered to tackle specific problems and questions of the various research fields. Once a year, a transdisciplinary Student Conference is organised to bring together young researchers from different disciplines, foster scientific exchange and provide a fertile soil for new, innovative ideas. In order to also target scientists outside their area of specialisation, a special HBP Curriculum has been developed. It combines online courses and face-to-face workshops offering basic lessons in the key disciplines as well as modules dealing with complementary subjects like research ethics, intellectual property rights or the translation and exploitation of research results.

Poster code: SP11-4; Title: European Brain Research Area

Authors: Giovanni Esposito, Kristien Aarts, Elke De Witte, Stephanie Kramer, Marie-Elisabeth Colin

Main author/presenter is early-career researcher: no

Poster abstract: EBRA was created as a catalyzing platform for brain research stakeholders (researchers, clinicians, patients, governments, funders and public institutions) to avoid duplication, fragmentation and streamline and better co-ordinate brain research across Europe while fostering global initiatives. EBRA's coordination is done at the strategic level (e.g. developing a Shared European Research Agenda) and operational level (e.g. call for clusters open til 2021). The Human Brain Project is one of the partners of the H2020 project, which was launched in November 2018 and is coordinated by the European Brain Council.