

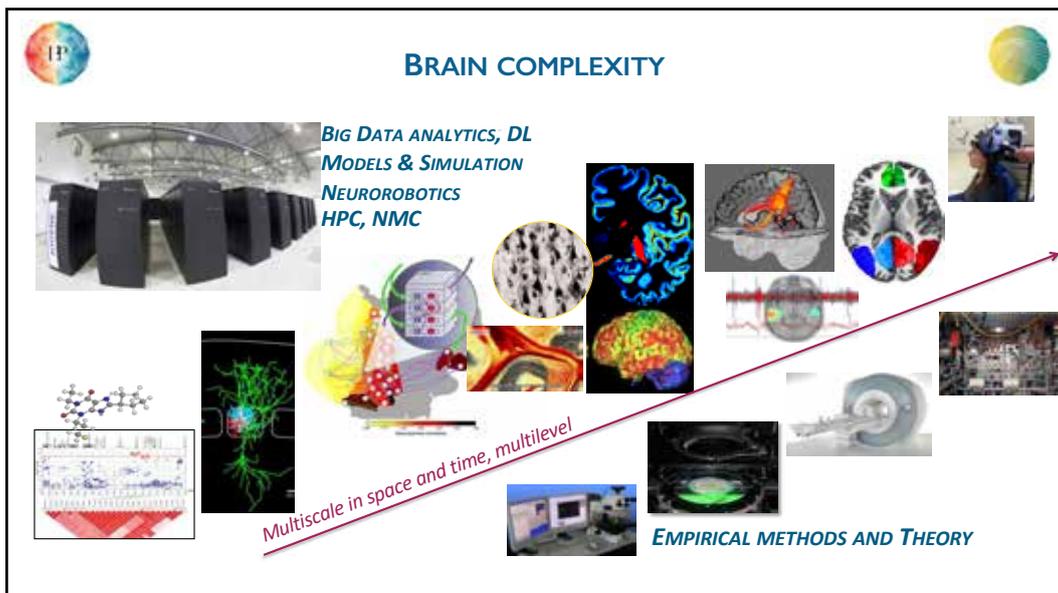
**Katrin Amunts**

**EBRAINS for YOUR research**

Institute of Neuroscience and Medicine, INM-1, Research Centre Jülich, Germany  
Cécile and Oskar Vogt-Institute for Brain Research, University Hospital, Heine University Düsseldorf, Germany  
The Human Brain Project

This slide features a vibrant, multi-colored background image of brain tissue. The text is overlaid on semi-transparent grey boxes. The top box contains the name 'Katrin Amunts'. The middle box contains the title 'EBRAINS for YOUR research'. The bottom box contains the affiliations: 'Institute of Neuroscience and Medicine, INM-1, Research Centre Jülich, Germany', 'Cécile and Oskar Vogt-Institute for Brain Research, University Hospital, Heine University Düsseldorf, Germany', and 'The Human Brain Project'.

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**BRAIN COMPLEXITY**

*BIG DATA ANALYTICS, DL  
MODELS & SIMULATION  
NEUROBOTICS  
HPC, NMC*

*Multiscale in space and time, multilevel*

*EMPIRICAL METHODS AND THEORY*

The diagram is titled 'BRAIN COMPLEXITY' and is enclosed in a black border. It features a central red arrow pointing from the bottom-left towards the top-right. Along this arrow, various images and text are arranged. At the top-left, there is a small globe icon with 'IP' on it. Below it, a photograph of server racks is shown. To the right of the server racks, the text 'BIG DATA ANALYTICS, DL MODELS & SIMULATION NEUROBOTICS HPC, NMC' is written in blue. The central part of the diagram contains several smaller images: a brain scan, a molecular structure, a neuron, a brain slice, and a person wearing a VR headset. At the bottom-right, there is another photograph of server racks and the text 'EMPIRICAL METHODS AND THEORY' in blue. A small globe icon is also present at the top-right corner of the diagram.

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## The HBP Flagship

**Vision:** To **deepen understanding of human brain structure and function**, by building a European research infrastructure that harnesses multiple disciplines and computing, and advances science, ICT and medicine, to the benefit of society

**Research Focus:** the **Connectome** with its variability, role for cognition & consciousness, and as adaptive architectures of cognitive functions

**Strategy: Co-design**

Start from neuroscientific questions → develop, together with engineers and informaticists **EBRAINS** → contribute high-quality data & tools → test it, use it, and help others to use it

- ➡ EBRAINS is openly accessible to the international research community. As an infrastructure on the ESFRI roadmap, EBRAINS will be available in the long term.
- ➡ As a international collaborative infrastructure, it is building links to other initiatives such as



**Co-design**

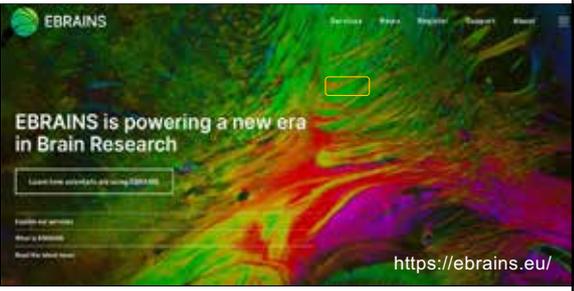




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## EBRAINS: tools & services to address brain complexity

-  **Data and Knowledge**  
Online solutions to facilitate sharing of and access to research data, computational models and software
-  **Atlases**  
Navigate, characterise and analyse information on the basis of anatomical location
-  **Simulation**  
Solutions for brain researchers to conduct sustainable simulation studies and share their results
-  **Brain-Inspired Technologies**  
Understand and leverage the computational capabilities of spiking neural networks
-  **Medical Data Analytics**  
The Medical Data Analytics service will provide two unique EBRAINS platforms, covering key areas in clinical neuroscience research



<https://ebrains.eu/>

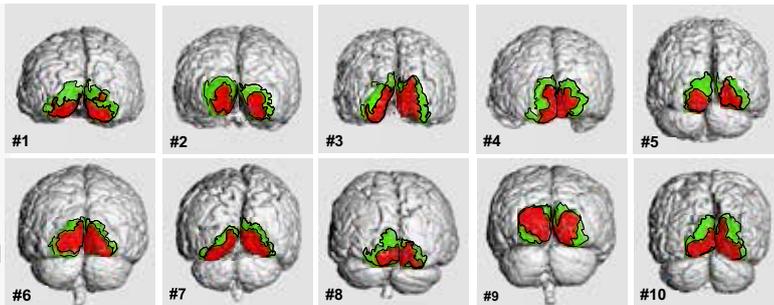





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### Challenge for human brain research: intersubject variability

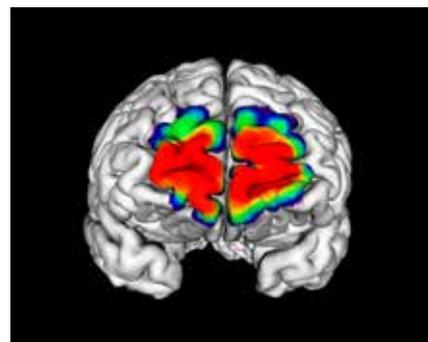
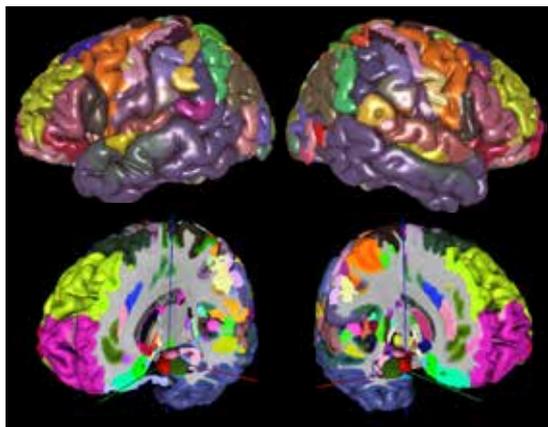
- Areas vary between brains in size and position
- Sulci vary between brains
- Sulcus-area relationship varies between brains and regions



Amunts et al., Neuroimage, 2000

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### Julich-Brain cytoarchitectonic maps



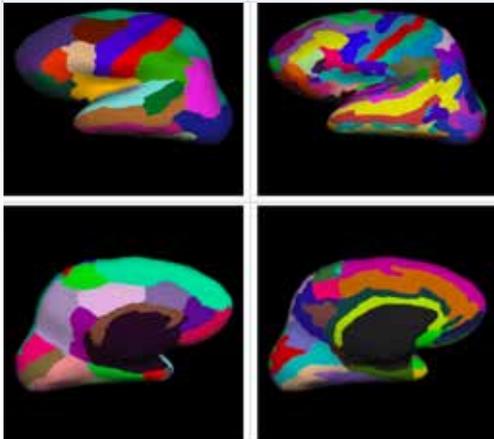
- Mapping is based on analysis of histological sections in ten postmortem brains
- Spatial resolution: 1 mm isotropic
- Intersubject variability integrated

Amunts et al., Science 2020 369(6506):988-992

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### Most parcellations are based on gyri and sulci, but not microstructure

Desikan-Killiany Atlas (7h.aparc.annot)	Destrieux Atlas (7h.aparc.a2009s.annot)
DKT Atlas (7h.aparc.DKTatlas40.annot)	

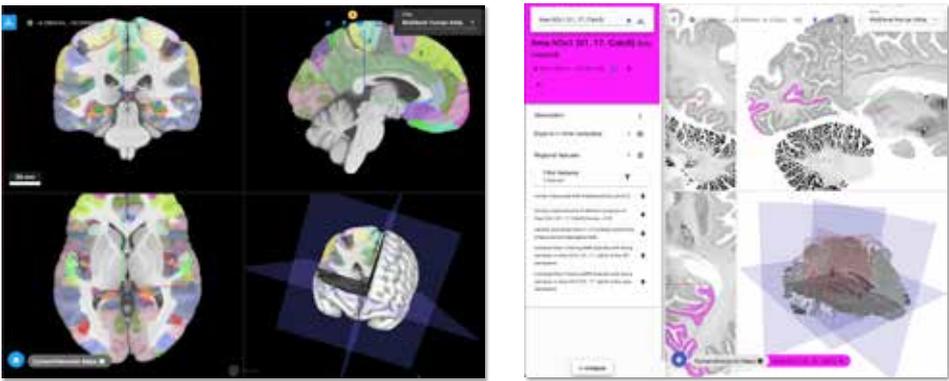


<https://surfer.nmr.mgh.harvard.edu/fswiki/CorticalParcellation>

Anatomical landmarks are poor indicators of microstructure

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### Multilevel human brain atlas: from micro to macro



siibra

open MIND

Human Brain Project

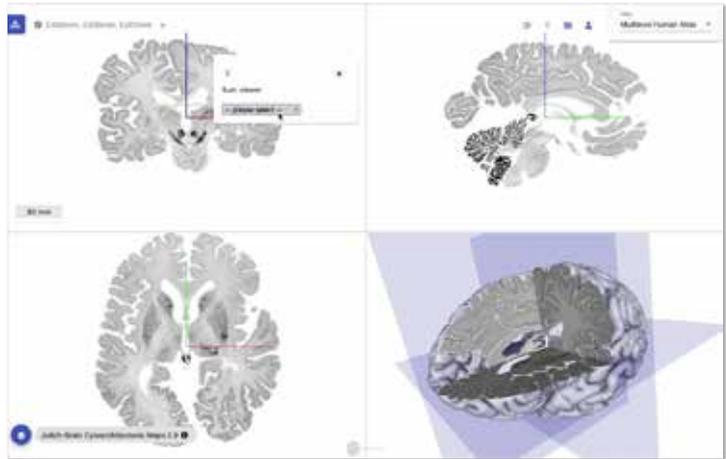
EBRAINS

HIBALL

Co-funded by the European Union

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### The BigBrain: template space and source of data @ micro-scale



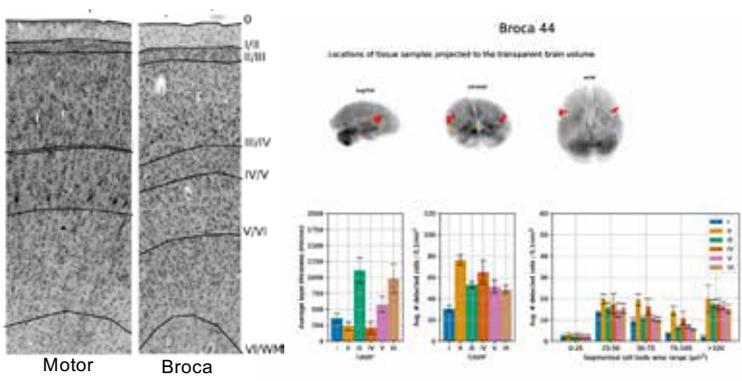
BigBrain data set  
20  $\mu\text{m}$  isotropic  
Section series @ 1  $\mu\text{m}$   
integrated and available

E BRAINS 

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### Cortical 1 $\mu\text{m}$ patches with cell detection and layer annotation released -> to inform modeling and simulation

- 120 patches across 12 cortical regions
- Precise cortical layer and cell segmentations
- At EBRAINS:  <https://search.kg.ebrains.eu/instances/Project/f06a2fd1-a9ca-42a3-b754-adaa025adb10>



Motor Broca

Broca 44

Locations of tissue samples projected to the transparent brain volume

Average layer thickness (mm)

Log<sub>10</sub> of detected cells (1/mm<sup>2</sup>)

Log<sub>10</sub> of detected cells (1/mm<sup>2</sup>)

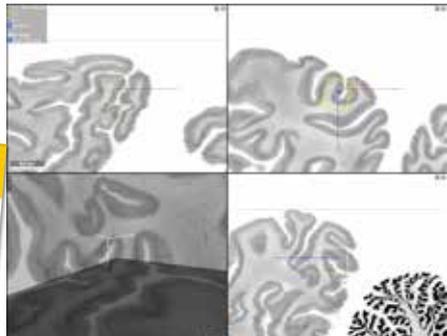
Normalized cell body area (mm<sup>2</sup>)

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## First two regions reconstructed at 1 $\mu\text{m}$ isotropic



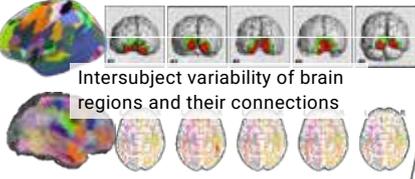
- Based on z-scanning with 29 virtual sections in each physical section
- Uses pairs of bisected cells of two neighboring sections
- Released on EBRAINS: <https://doi.org/10.25493/K8Q7-CG9>

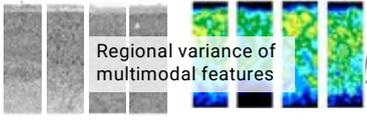


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## Atlas information available for other workflows at EBRAINS



Intersubject variability of brain regions and their connections



Regional variance of multimodal features

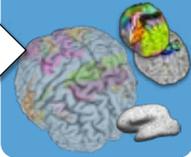
**EBRAINS data services**

Knowledge Graph

Cloud storage

EBRAINS curation services

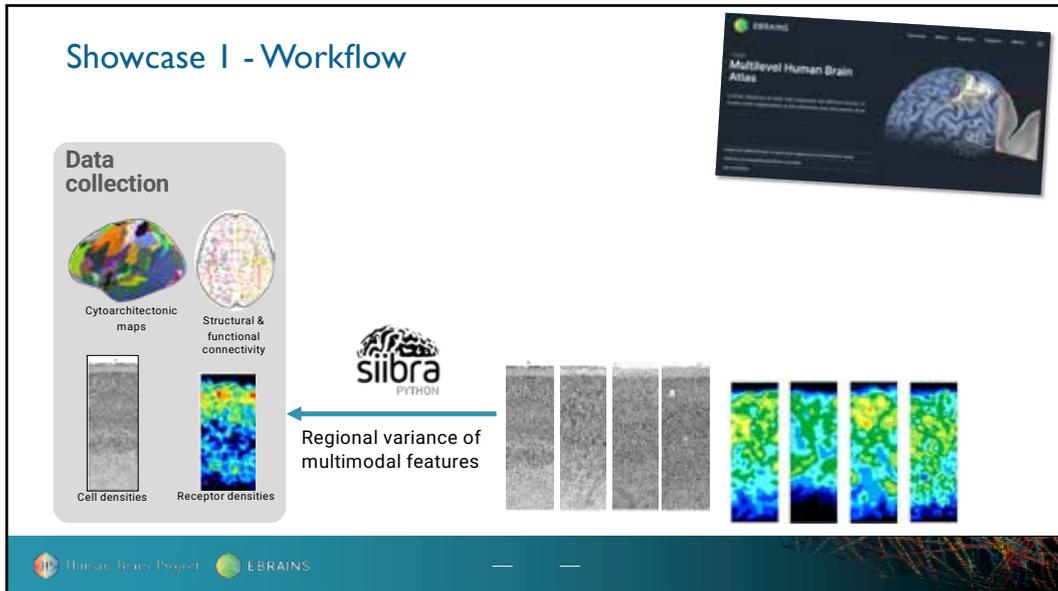
**EBRAINS atlas services**



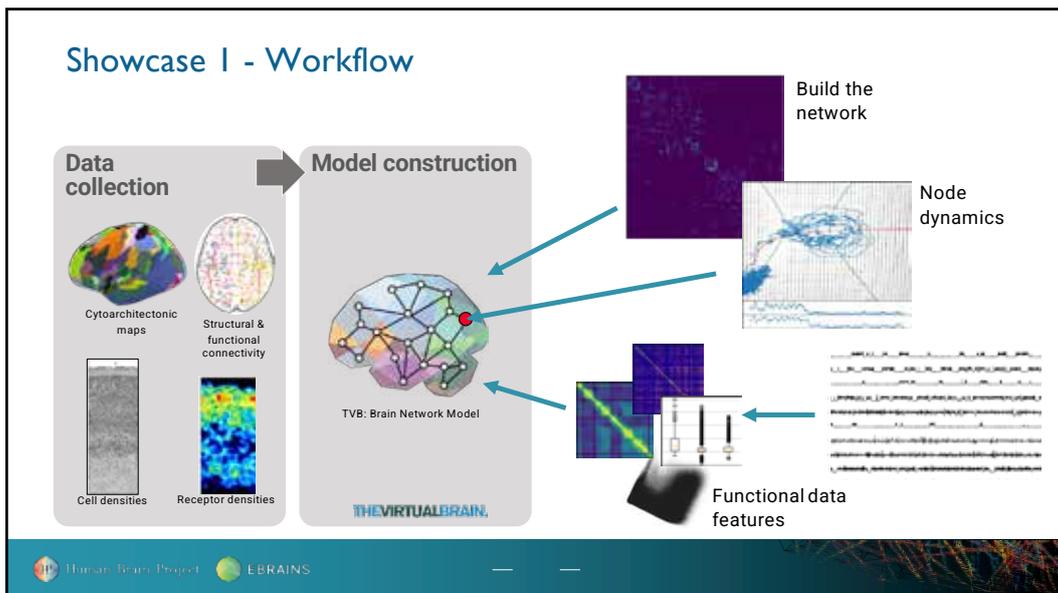
Software interface

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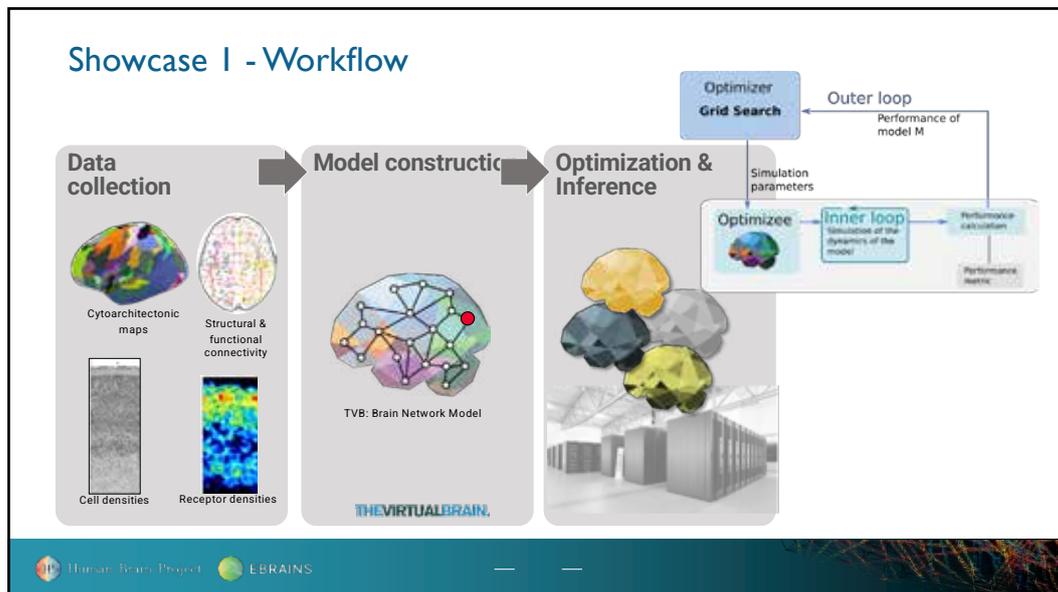




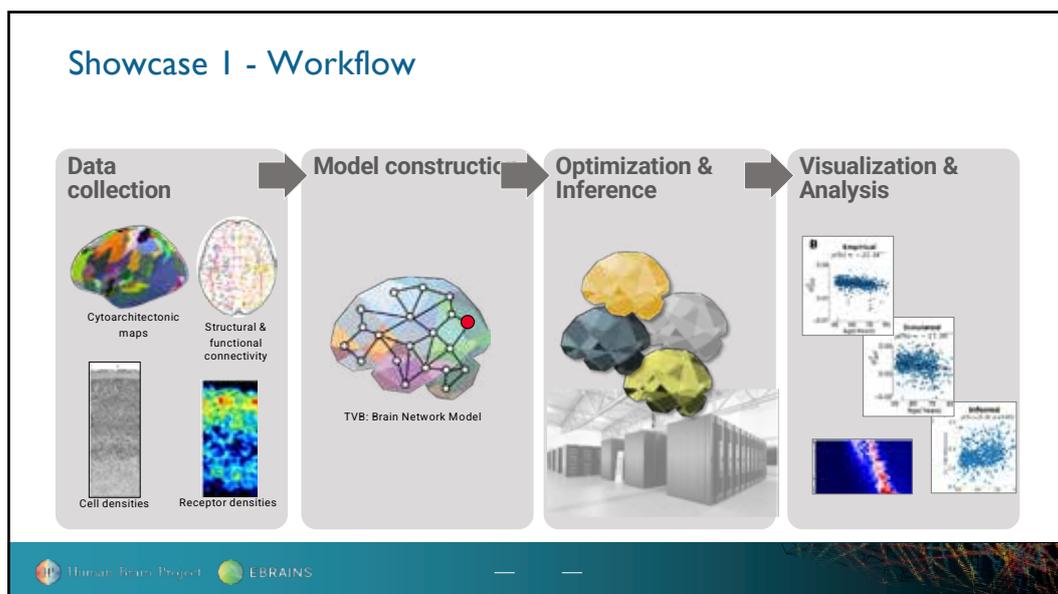
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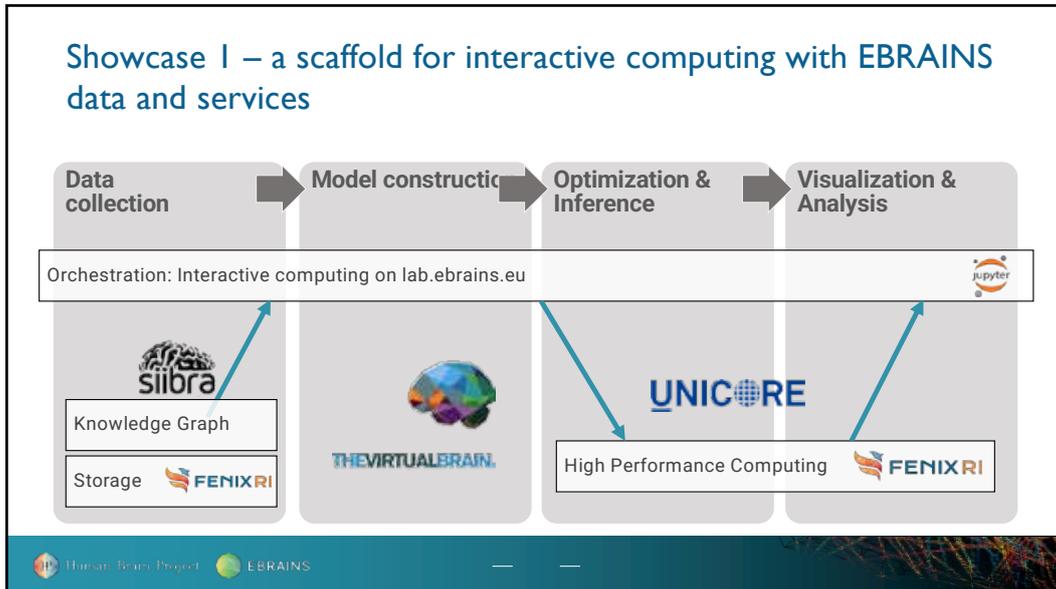
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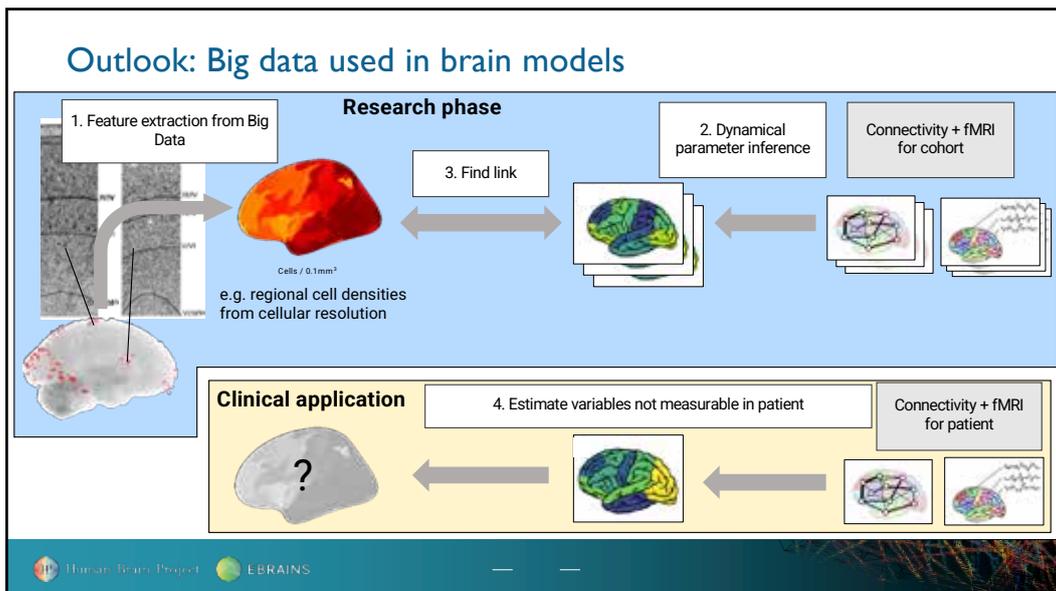
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**NEURO-TECHNOLOGY: fMRI → modeling → simulation → virtual robotics**

**FRONTOPARIETAL HAND ACTION NETWORK**

- REACH SUBNETWORK
- GRASP SUBNETWORK

**TOOL NETWORK**

**SUBSET OF PERCEPTION NETWORK**

*Gallivan et al. (2013), eLife, e00425.*

**Preparatory Decoding**

- Hand actions only
- Tool actions only
- Separate hand and tool actions
- Common hand and tool actions

**MODEL OF THE FRONTOPARIETAL NETWORK**

Human Brain Project | EBRAINS | Co-funded by the European Union

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**NEURO-TECHNOLOGY: fMRI → modeling → simulation → virtual robotics**

Union

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**Human Brain Project** **EBRAINS**

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