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Opening perspective: A user-friendly web portal for neuro-imaging research

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CEREBRO GmbH presentation and focus on the user-friendly web portal for neuroimaging developed in the neuGRID EU Project. CEREBRO offers a complete research support and consultancy service within an online infrastructure and its market place dedicated to neuroscientist and neuroimaging researchers.

- CEREBRO Value Offering
- CEREBRO A New Service for Big Data Neuroimaging Analysis
- CEREBRO User cases and research support service
- neuGRID Infrastructure Example &Computational Resources in Tier 1
- Service Access and Contact

CEREBRO Value Offering (for Neuroscientists)

CEREBRO is a brain data scientist. More specifically, it is a consultancy service offering world class scientific, ICT, and clinical expertise in the field of brain imaging with specific focus on cognitive disorders of adult and late life. Whether you are a clinical doctor, a neuroscientist, a developer of image analysis tools, or a pharmaceutical industry, CEREBRO can help you analyze your problem, discuss how to address it, design state-f-the-art scientific experiments, carry them out for you, discuss results and accompanying presentation strategy, or any combination of the above, as is illustrated in the following figure.

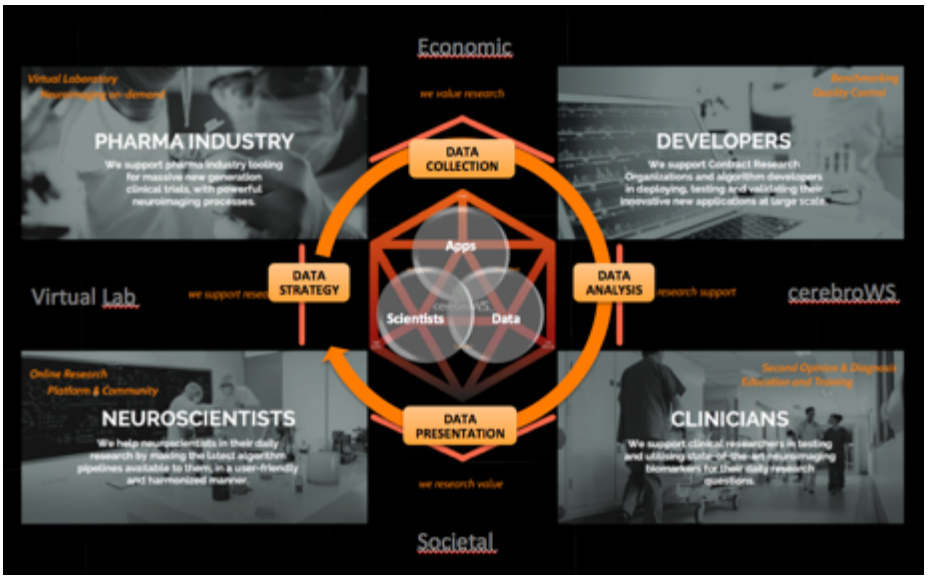
CEREBRO is not an imaging CRO. At its very core, it leverages on the neuGRID Infrastructure and more specifically on its market place, thus offering integrated and easy access to significant neuroscientific resources. CEREBRO and its services can be utilized with a simple Internet connection through neuGRID. Our team consists of leading experts in complementary areas such as: medical imaging, neuroscience, predictive analytics and machine learning, big data analysis, grid/hpc/cloud computing.

CEREBRO develops optimized approaches to the data stratification, pre and post quality control, and analysis of image data to maximize the interpretability of results. CEREBRO offers imaging diagnostics with maximum sensitivity and reliability of the results by applying proprietary software tools to differentiate between dementias, and across dementia stages.

CEREBRO is dedicated to providing the highest quality, technology and operational efficiency to its customers. Analyses can thus be rapidly performed, using well-established standard tools like: AFNI, FSL, ITK-VTK, MNI, and other state-of-the-art libraries that yield highly sensitive measurements of the brain. Finally, CEREBRO can be used to generate results that can be used to form critical hypotheses.

CEREBRO, A NEW SERVICE FOR BIG DATA NEUROIMAGING ANALYSIS

At CEREBRO, We Support & Value research.



We offer professional Big Data Analysis consultancy service based on 4 steps value chain process:

DATA*STRATEGY* Our data scientists will assist you in devising new strategies to make the best out of your data, from a simple diagnostic, to a complete feasibility study.

- **Audit, diagnostic**
- **Feasibility study**
- **Data Scientist consulting**

DATA*COLLECTION* Our data experts will help you with sourcing, preparing optimally your data, enriching and curating it for your particular analyses.

- **Sourcing**
- **Quality Control**
- **Enrichment**
- **Curation**

DATA*ANALYSIS* Utilising the most powerful computing platform in the field, our data scientists will support you in selecting feature extraction and processing algorithms to solve your pressing scientific questions.

- **Analytics strategy**
- **Quality Control**
- **Processing**
- **Benchmarking**
- **Data Scientist support**

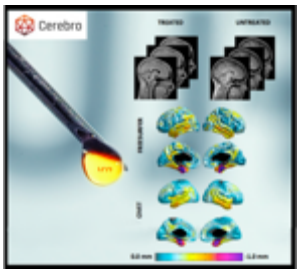
DATA*PRESENTATION* Our data scientists will simplify, illustrate your analysis outcomes with powerful visualisation and reporting techniques.

- **Interpretation**
- **Visualization**
- **Reporting**

CEREBRO USER CASES & RESEARCH SUPPORT SERVICE

PHARMA INDUSTRY

We support pharma industry tooling for massive new generation clinical trials, with powerful neuroimaging processes.



- A Pharmaceutical company has historical data from a failed clinical trial of a monoclonal antibody in Alzheimer's disease whose post-hoc analyses might provide precious information on the mechanism of action of the class of drugs.
- CEREBRO personnel develop design an experiment on 2.500 high-resolution MR scans and 1.000 amyloid PET scans of treated and placebo patients scanned at baseline and 3 time points over the duration of the trial.
- The cortical thickness is extracted in the neuGRID environment with the CIVET and FREESURFER pipelines. Statistical analysis shows that the paradoxical greater cortical thinning in treated patients map in the regions of greater amyloid load, confirming that the previously unexplained finding is due to energetic amyloid removal rather than aspecific mechanisms (e.g. shift of water among compartments).
- Results are neatly presented by CEREBRO and used by the company to internally discuss the future of its €800M worth research line on monoclonal antibodies.

DEVELOPERS

We support Contract Research Organizations and algorithm developers in deploying, testing and validating their innovative new applications at large scale.

- A software developer has implemented a new algorithm for the assessment of hippocampal atrophy on T1-weighted MR scans.
- Thanks to CEREBRO's Web portal he can validate his algorithm on large datasets by exploiting the computational resources of the underlying platform.
- Once validated, the new algorithm can be exposed to other CEREBRO users to enhance visibility and spread its use in the scientific and clinical community.

CLINICIANS

We support clinical researchers in testing and utilising state-of-the-art neuroimaging biomarkers for their daily research questions.

- A clinician is interested in extracting imaging markers of Alzheimer's disease out of brain FDG-PET and structural MR scans (i.e. posterior cortical hypometabolism and hippocampal atrophy) and confirm or disprove the findings of the neurorardiologist's and nuclear medic's visual assessment reports.
- The clinician can log onto CEREBRO's web portal, easily upload the scans, run a number of specifically designed tools, and receive a report in his/her email account.

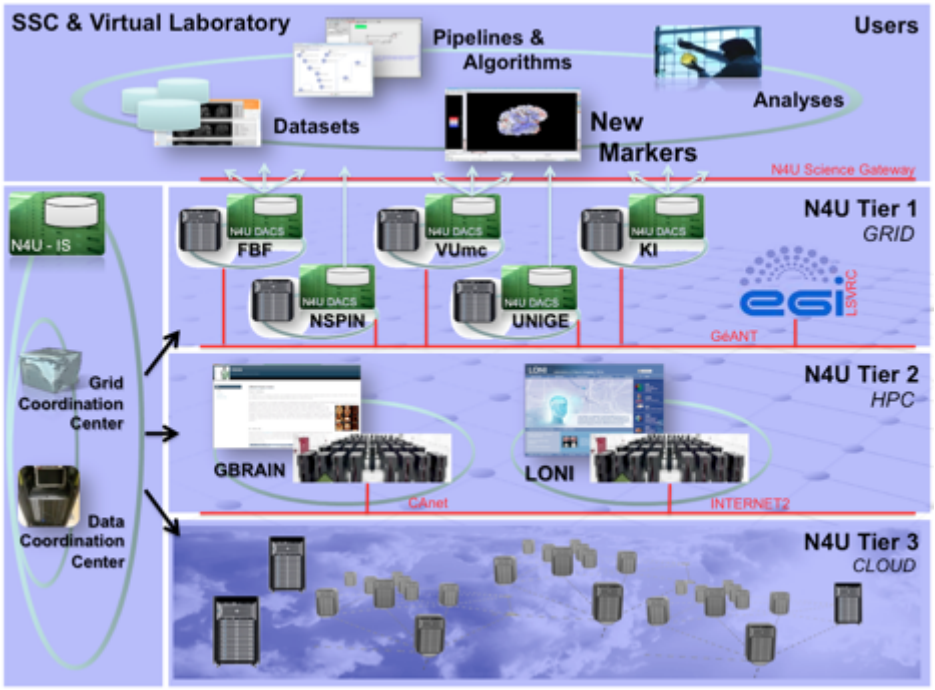
NEUROSCIENTISTS

We help neuroscientists in their daily research by making the latest algorithm pipelines available to them, in a user-friendly and harmonized manner.

- A Pharmaceutical company has historical data from a failed clinical trial on monoclonal antibody in Alzheimer's disease whose post-hoc analyses might provide precious information on the mechanism of action of the class of drugs.
- CEREBRO develops an experiment for extracting cortical thickness on 2.500 high-resolution MR scans and 1.000 amyloid PET scans of (treated and placebo) patients followed for the duration of the trial.
- Statistical analysis shows that the paradoxical greater cortical thinning in treated patients map in the regions of greater amyloid load, confirming that the previously unexplained finding is due to energetic amyloid removal rather than a specific mechanisms (e.g. shift of water among compartments)

neuGRID Infrastructure Example

The neuGRID infrastructure was made interoperable by design. It has been thought as an innovative integration middleware enabling the use of various types of computational resources at the same time. It is thus composed of 3 tiers, as shown in the following figure.



The Tier 1 is the Grid. It is a tier made of private and public grid computing resources. The private resources come from participating clinical centers and technical partners such as (IRCCS Fatebenefratelli in Brescia, HUG in Geneva, VUmc in Amsterdam, KI in Stockholm and NeuroSPIN in Paris), whereas the public resources come from the EGI grid infrastructure. **The private resources are fully dedicated to the neuGRID users, in order to guaranty a satisfactory quality of service**, while public ones can be used to externalize larger scale analyses.

The Tier 2 makes the link with HPC infrastructures. In the present version of the infrastructure, two external initiatives respectively LONI at USC in California and CBRAIN at McGill in Montreal, have been interconnected with neuGRID, thus bridging with their HPC resources.

Last but not least, the Tier 3 is an extension to the commercial Cloud. The objective of the latter is to make it possible to increase the computational power and storage capacity on demand for commercial purposes.

Overall the infrastructure covers two major use cases:

1. Planned resources allocation (Grid & HPC): e.g., a new project plans to use neuGRID within two weeks and needs a fixed amount of computational power. The neuGRID system administration team will negotiate access to and deploy newly obtained computational resources be it from the public grid, hpc or the cloud.

2. Punctual resources allocation (Cloud): e.g., a pharma industry wants to run a clinical study over the neuGRID infrastructure. The system increases the platform capacity automatically by extending to the commercial cloud.

neuGRID Computational Resources in Tier 1 (Grid)

NeuGRID has built a virtual research environment where neuroscientists, clinicians, algorithm developers and pharmaceuticals in Europe can securely upload, use and share brain feature extraction algorithms paired with access to computational power, large image datasets and specialized support & training.

NeuGRID participates to the developments of the EGI-Engage recently funded chapter of the European Grid Initiative. More specifically, GNUBILA and Fatebenefratelli partners, on behalf of neuGRID, are leading the setup of the so-called MoBRAIN competence center, which is witnessing the convergence of molecular biology and neurosciences into one dedicated point of access to scientific resources.

Bearing in mind ongoing discussions with HBP and the fact that neuGRID may contribute "in kind" to the HBP as one of the market places available to its users, neuGRID has proactively requested access to more computational resources from the public EGI grid infrastructure, as is summarised in the table below.

Resources	Actual	Future with EGI
Nbr of sites	4	> 10
CPU Cores	6 000	> 10 000

neuGRID Access

NeuGRID offers two types of accesses, based on a freemium business model.

New users register for free and are automatically equiped with a (robot) certificate allowing them to use a subset of the market place and public grid resources.

Users needing further support can request for a premium account, requiring a personal certificate from a national authority. In doing so, they gain access to dedicated resources, full resources as well as accompanying level 3 support.

neuGRID Market Place

Over the last decade, neuGRID has invested significant efforts at integrating neuroscientific resources into a single harmonised and secure place where scientists can appreciate a growing portfolio of pipelines, algorithms, image datasets and computing resources. This is what these figures report on.

The following tables exhaustively list the neuGRID present portfolio in terms of pipelines/algorithms and imaging databases which can be accessed, combined, analyzed or even further expanded.

PIPELINE STORE *(extracted from https://neugrid4you.eu/software)*					
Software	**Community**	**Clinical/Biological Phenomenon of study**	**Description**	**Resources Required**	**Status**
FREESURFER	NS-NDD NS-WMD	Study of cortical and subcortical anatomy	FreeSurfer is a set of automated tools for reconstruction of the brain's cortical surface and other brain structures from MRI data. A few key applications have been implemented as official scripts in ExpressLane, which as well as providing useful applications, also provide examples of how to implement many other FreeSurfer applications.		
FREESURFER ReconAll Cross Sectional	NS-NDD NS-WMD	Study of cortical and subcortical anatomy	For a single MRI scan, segments cortical and subcortical anatomy - including the hippocampus - and calculate areas and thickness.	2GB, 1 day, single core	
FREESURFER ReconAll Longitudinal	NS-NDD NS-WMD	Study of cortical and subcortical anatomy	For a pair of MRI scans, segments cortical and subcortical anatomy - including the hippocampus - and calculate areas, thickness and change in volumes	2GB, 3 to 5 days, single core	
FREESURFER Tracula	NS-NDD NS-WMD NS-PSY	Study of tractographic (DTI) anatomy of the brain	A tool for automatic reconstruction of a set of major white-matter pathways from diffusion-weighted MR images	2GB, 1 to 2 days, single core	

MAPS-HBSI	NS-NDD NS-WMD NS-PSY	Hippocampal and whole brain volume change over time - atrophy measures. Preliminary results show MAPS-HBSI to be 50% more reproducible than the standard in the field - FreeSurfer/ReconAll and manual. AAIC2014 Poster Neuroimage. **2010** Jul 15;51(4):1345-59.	Newly implemented algorithm. Restricted access - contact N4U.	4GB, 3 to 5 days, single core	
FSL	NS-NDD NS-WMD NS-PSY	Study of functional (fMRI), structural (MRI) and tractographic (DTI) anatomy of the brain	A library of image analysis for MRI, functional MRI and diffusion tensor imaging brain imaging data. A few key applications have been implemented as official scripts in ExpressLane, which as well as providing useful applications, also provide examples of how to implement many other FSL applications.		
FSL TBSS - N^2	NS-NDD NS-WMD NS-PSY	Track Based Spatial Statistic - Find the "typical" image volume among a set for factional anisotropy (FA).	Superior version of the widely used algorithm. neuGRID's multicore implementation reduces computation time by factor of 24 making the rarely used but superior N^2 implementation of TBSS practical.	N^2 time, 144 scans takes about 6 days, multicore	
FSL FIRST	NS-NDD NS-WMD	Study of structural (MRI)	Widely used FSL algorithm that segments the left and right hippocampi from MRI scans. Takes 20 to 30 minutes per scan.	2GB, under 1 hour, single core	

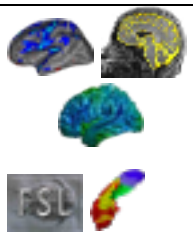
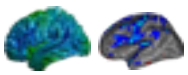
FSL SIENA	NS-NDD NS-WMD	Study of structural (MRI)	Widely used FSL algorithm that calculates the percentage change in brain volume between two MRI scans of the same person at different time points. Takes under 1 hour per pair of scans.	2GB, 1 to 3 hours, single core	Available for processing in neuGRID
FSL SIENAX	NS-NDD NS-WMD	Resting State fMRI	Widely used FSL algorithm that calculates the normalize brain volume of an MRI scan. Takes under 1 hour per scan.	2GB, 1 to 3 hours, single core	Available for processing in neuGRID
FSL Melodic	NS-NDD NS-WMD	Resting State fMRI	MELODIC (Multivariate Exploratory Linear Optimized Decomposition into Independent Components) 3.0 uses Independent Component Analysis to decompose a single or multiple 4D data sets into different spatial and temporal components.	2GB, 1 to 3 hours, single core	Available for processing in neuGRID
FSL fnirt	NS-NDD NS-WMD	Non-linear registration	Non-linear registration between two image volumes.	1GB, 20 minutes, single core	Available for processing in neuGRID
MIPAV	NS-NDD NS-WMD NS-PSY	Analysis and visualization of medical images of numerous modalities such as PET, MRI, CT, or microscopy	MIPAV enables quantitative analysis of medical images.		Available for processing in neuGRID
MNI LIBRARES	NS-NDD NS-WMD (NS-PSY)	Pre-processing of MR images for a better and refined imaging markers extraction.	These packages (e.g. dcm2mnc, dcm2nii, mincinfo, mincmath, mincresample, N3) are suited for MRI structural analysis. They allow the MANAGEMENT, conversion and visualization of different file formats.		Available for processing in neuGRID

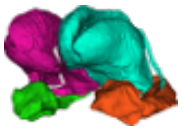
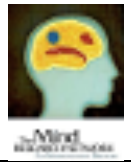
SPM-LST	NS-WMD	A fully automated software to segment White Matter Lesions and estimate brain tissue volumes using a combination of FLAIR and 3D T1 weighted images	Available on the internet	2GB, 1 to 3 hours, single core	
CASCADE	NS-WMD	A fully automated software to segment White Matter Lesions and estimate brain tissue volumes using any combination of FLAIR, T1, T2, and PD images	Newly developed algorithm	2GB, 1 to 3 hours, single core	
Lesion TOADS	NS-WMD	Automatic detection of white matter lesions	Widely distributed algorithm	12GB, 3 to 5 hours, single core	
AdaBoost	NS-NND	Cross sectional hippocampal volume	Newly developed algorithm for hippocampal volume based on training AdaBoost.	Uses LONI resources. Contact N4U	
CLASP-CIVET	NS-NDD NS-WMD	Cortical Thinning	CIVET is a fully automatic imaging- processing pipeline focused on extraction of cortical thickness in the human brain from MRI data	2GB, 2 to 3 days, single core	
SPHARM-PDM UNC Toolbox	NS-NDD	Statistical shape analysis of brain structures	A comprehensive set of tools for the computation of 3D structural statistical shape analysis. It has been applied in several studies on brain morphometry, but can potentially be employed in other 3D shape problems. Its main limitations is the necessity of spherical topology.	Under Consideration	Not Yet Available

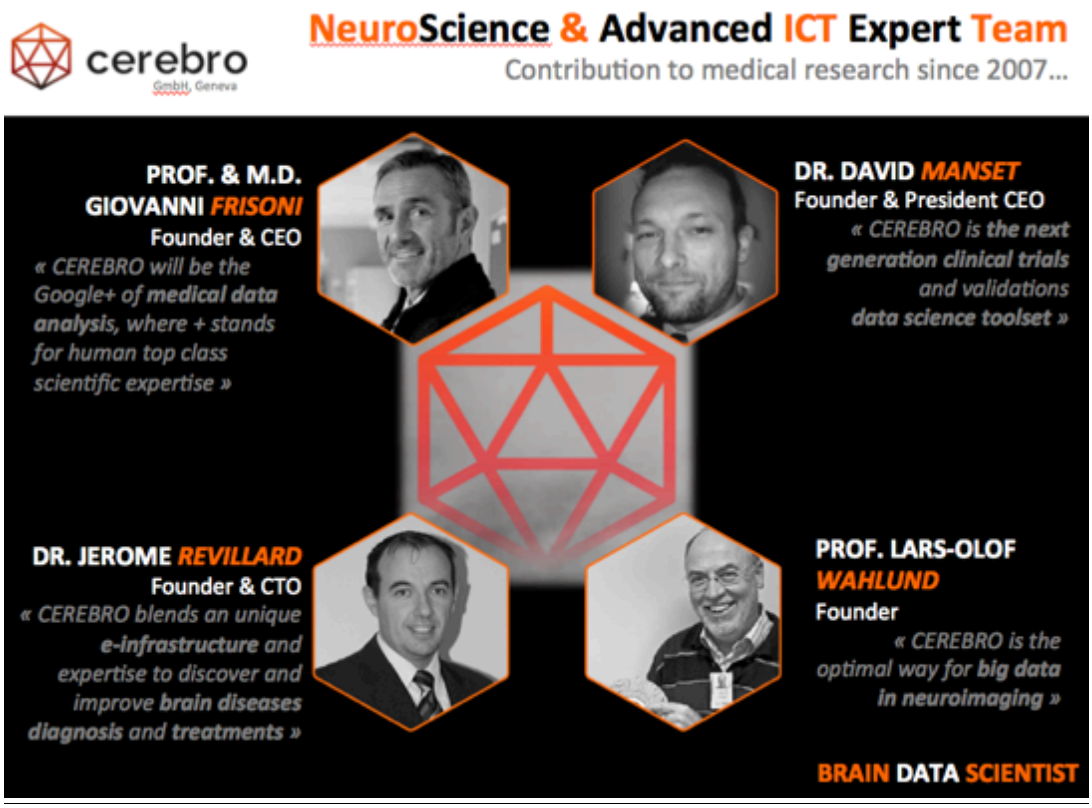
SDM (Signed Differential Mapping)	NS-NDD (NS-WMD) (NS-PSY)	Statistical technique for meta-analyzing studies	Signed Differential Mapping is a statistical technique for meta-analyzing studies on differences in brain activity or structure which used neuroimaging techniques such as fMRI, VBM or PET	Under Consideration	Not Yet Available
BRAINVISA	NS-NDD (NS-WMD) (NS-PSY)	Segmentation of T1-weighted MR images	A modular and customizable software platform that hosts heterogeneous tools. The main toolboxes are: T1 MRI, sulcal identification and morphometry, cortical surface analysis, diffusion imaging and tractography, functional MRI, nuclear imaging, EEG and magnetoencephalography, and transcranial magnetic stimulation	Under Consideration	Not Yet Available
R	NS-NDD NS-WMD (NS-PSY)	Tool that deals with the problem of interpretations of significant results from populations of analyzed subjects	A free software environment for statistical computing and graphics.	Available	
OCTAVE	NS-NDD NS-WMD (NS-PSY)	Tool that deals with the problem of interpretations of significant results from populations of analyzed subjects	GNU Octave is a high-level interpreted language, primarily intended for numerical computations. It provides capabilities for the numerical solution of linear and nonlinear problems, and for performing other numerical experiments. It also provides extensive graphics capabilities for data visualization and manipulation.	Available	

ITK - VTK	NS-NDD NS-WMD (NS-PSY)	Study of registration and correct segmentation of multidimensional imaging data and brain structures	Libraries with an extensive suite of software tools for image analysis	Available	Available for processing in
SPM-VBM	NS-NDD NS-WMD NS-PSY	Voxel Based Morphometry	SPM is a statistical technique for examining differences in brain activity recorded during functional neuroimaging experiments using neuroimaging technologies such as fMRI or PET. Furthermore, SPM can be used also to perform image pre-processing, statistical comparision and graphical representations.	Available Contact N4U	Soon Available
AFNI - SUMA	NS-NDD NS-WMD NS-PSY	Analysis of Functional NeuroImages and cortical outputs	AFNI is a used for processing, analyzing, and displaying functional MRI (FMRI) data - a technique for mapping human brain activity. SUMA is a program that adds cortical surface based functional imaging analysis to the AFNI suite of programs. It allows viewing 3D cortical surface models, and mapping volumetric data onto them.	Under Consideration	Not Yet Available
Image-J	NS-NDD NS-WMD NS-PSY	Subject image visualization and analysis	ImageJ can display, edit, analyze, process, save and print 8-bit, 16-bit and 32-bit images. It can read many image formats. It supports "stacks", a series of images that share a single window. It is multithreaded, so time-consuming operations can be performed in parallel with other operations.	Available	Available for processing in

ITK-SNAP	NS-NDD (NS-WMD) (NS-PSY)	ITK-SNAP is a software application for medical T13D image segmentation	ITK-SNAP primary use is for delineating anatomical structures and regions in MRI, CT and other 3D biomedical imaging data.	Under Consideration	Not Yet Available
GIFT	NS-NDD NS-WMD NS-PSY	Independent component analysis of group functional magnetic resonance imaging data	GIFT is widely used to determine ICA and blind source group and single subject separation analysing fMRI data through multiple algorithms.	Under Consideration	Not Yet Available
3D-Slicer	NS-NDD NS-WMD NS-PSY	Multi-modality Image analysis and visualization including: MRI, CT, DTI, fMRI, nuclear medicine.	3D-Slicer provides a graphical user interface to interact with the data. In addition to manual segmentation and the creation of 3D surface models from conventional MRI images, Slicer has also been used for non-rigid image registration and to incorporate models of the neurovascular bundle using image segmentation in MRI-guided interventions.	Available	
BrainVoyager (QX)	NS-NDD NS-WMD NS-PSY	Educational program about the human brain	The BrainVoyager Brain Tutor teaches knowledge about the human brain through interactive exploration of rotatable 3D models. The models have been computed using original data from magnetic resonance imaging (MRI) scans. The program contains information about the major lobes, gyri, sulci and Brodmann areas of the cerebral cortex.	Under Consideration	Not Yet Available

DATA STORE *(extracted from https://neugrid4you.eu/datasets)*					
Name	Website	Derived data	Tipology	Access Right	Availability
OASIS	OASIS	Not yet available	NS-NDD	OPEN ACCESS	Available for processing in neuGRID
MIRIAD	Minimal Interval Resonance Imaging in Alzheimer's Disease	Not yet available	NS- NDD	RESTRICTED ACCESS	Available for processing in neuGRID
ADNI-1 ADNI-GO ADNI-2	ADNI		NS-NDD	FACILITATED ACCESS	Available for processing in neuGRID
H2H Comparison Study	neuGRID N4U (neuGRID for you)		NS-NDD	OPEN ACCESS	Available for processing in neuGRID
ADHD-200	ADHD 200	Not yet available	NS-PSY	OPEN ACCESS	Available for processing in neuGRID
1000 Functional Connectomes Project	1000 FUNCTIONAL CONNECTOMES PROJECT	Not yet available	NS-PSY	OPEN ACCESS	Available for processing in neuGRID
PHARMACOG-Morphometry-Reproducibility	PharmaCog LV Advancing science and treatment of Alzheimer's Disease	Not yet available	NS-NDD	OPEN ACCESS	Available for processing in neuGRID
PHARMACOG-DTI-Reproducibility	PharmaCog LV Advancing science and treatment of Alzheimer's Disease	Not yet available	NS-NDD	OPEN ACCESS	Available for processing in neuGRID

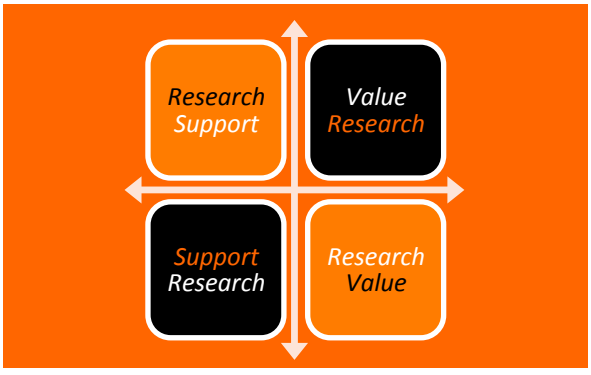
ARWIBO		Not yet available	NS-NDD	OPEN ACCESS	Available for processing in
EDSD	European diffusion tensor imaging study in dementia	Not yet available	NS-NDD	OPEN ACCESS	Available for processing in
MAGNIMS	Magnetic Resonance in Multiple Sclerosis		NS-WMD	RESTRICTED ACCESS	Available for processing in
fBIRN Phase I & II		Not yet available	NS-PSY	OPEN ACCESS	Available for processing in
NUSDAST	NU Schizophrenia Data and Software Tool Federation using BIRN Infrastructure		NS-PSY	OPEN ACCESS	Available for processing in
ABIDE		Not yet available	NS-PSY	OPEN ACCESS	Available for processing in
INDI		Not yet available	NS-PSY	OPEN ACCESS	Available for processing in
COBRE		Not yet available	NS-PSY	OPEN ACCESS	Available for processing in



CEREBRO GmbH

- We have **hacking mind-set** and **high quality data services** orientation.
- **We strongly believe** smart ICT's are made to **boost research** and to **contribute to patient health** improvement.
- We offer advanced toolkits **to save R&D time** and money, and **we support researchers action** with **tailored** expert **neuroscientists** and **data scientist's** teamwork and consulting **services**.

Visit our web site : www.cerebro.pro



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