EUDAT

Sean Hill
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International Neuroinformatics Coordinating Facility
www.incf.org





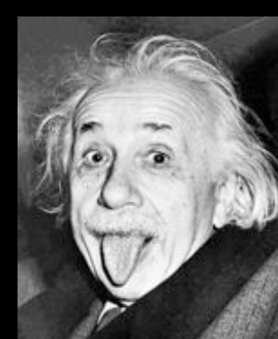


















Developmental Disorders

- Autism spectrum disorders
- ADHD
- Learning disorders, conduct disorders
- Strong genetic disorders (Fragile X, Down's etc)

Adolescent Disorders

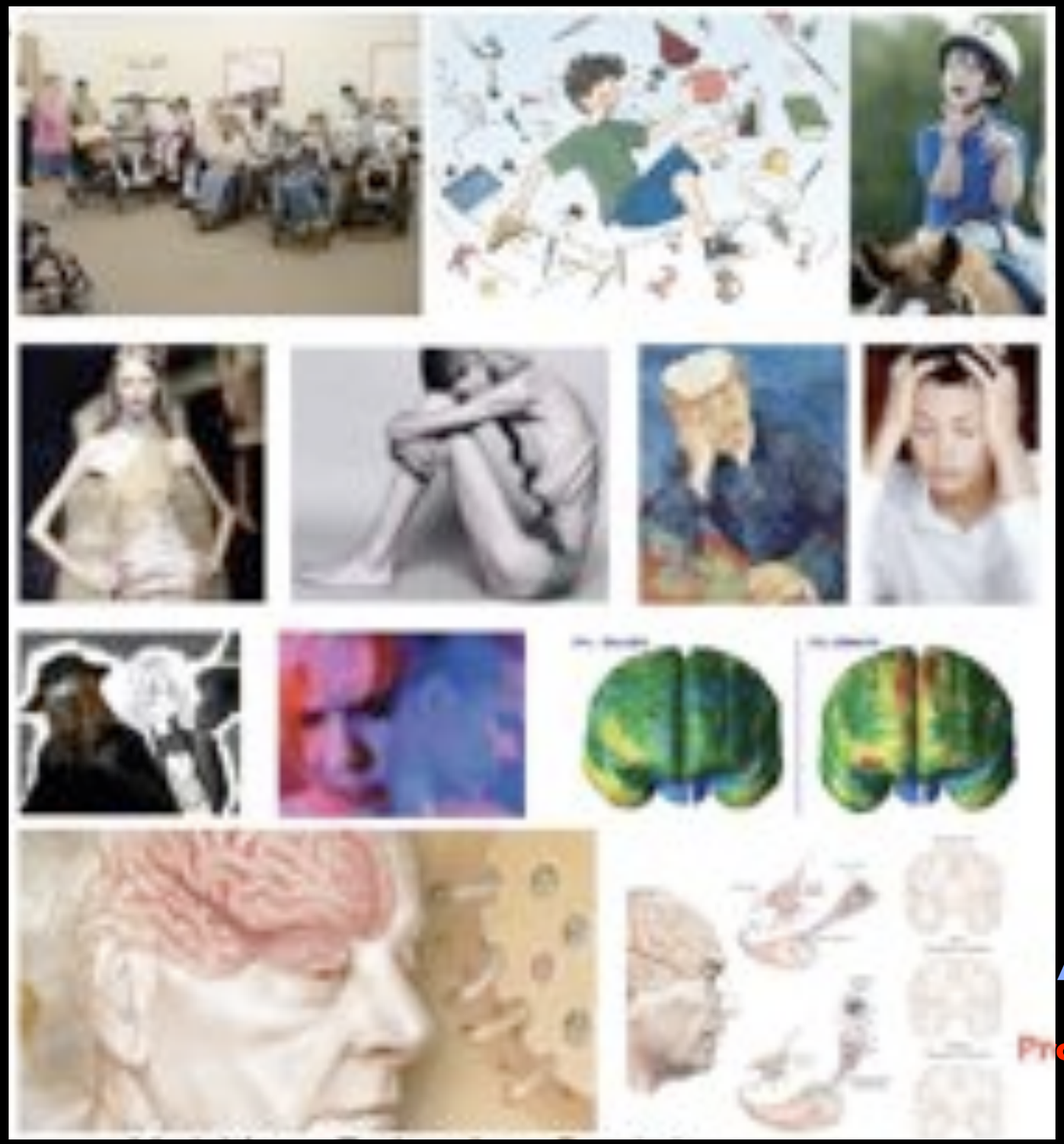
- Depression, Suicide
- Eating disorders
- Bipolar disorder
- Conduct disorders and violence
- Borderline syndrome
- Adjustment disorders
- Anxiety, phobias, suicide
- Tourette's syndrome
- Epilepsy

Adult Disorders

- Schizophrenia
- Epilepsy
- Mood disorders, hysterias, anxieties and phobias
- Obsessive compulsive disorders
- Eating disorders, sexual disorders
- Sleep disorders, stress disorders
- Impulse control disorders
- Substance abuse disorders

Aging Disorders

- Depression
- Dementia
- Neurodegenerative disorders
  - Alzheimer's
  - Parkinson's
  - Huntington's
- Memory disorders



Glutamate

Nutrition

Dopamine

Genes

Sugar

GABA

Myelin

Serotonin

Metals

Dopamine

Toxins

Acetylcholine

Protein misfolding

Transform Neuroscience into an eScience

Databases

Multiscale Integration

Tools

Models

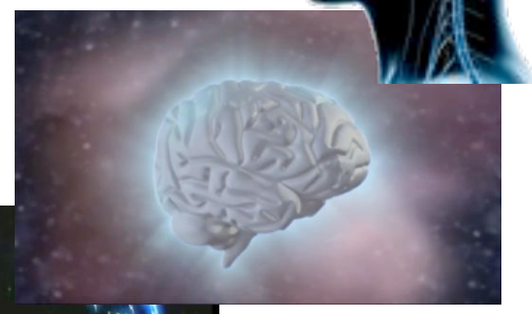
Supercomputing

Data intensive science

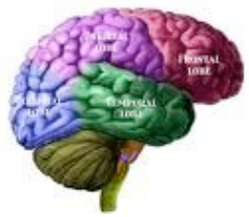
Clinical

Cognition

Whole brain

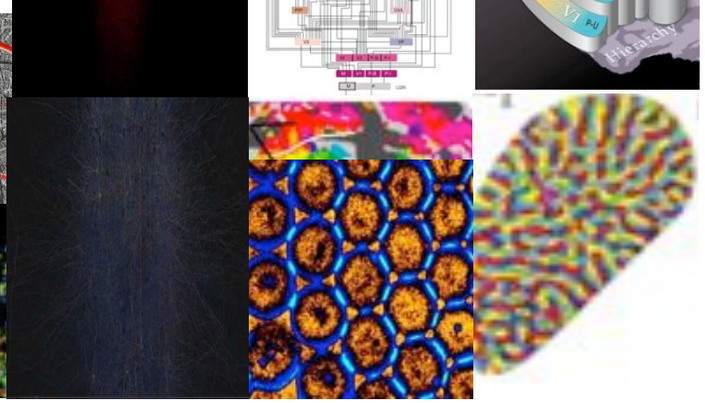


Macrocircuits



Mesocircuits

Microcircuits



Synapses

Neurons

Molecules

- ✓Databases
- ✓Genomics
- ✓Translational
- ✓Systems Biology…
- ✓Integrative Biology…
- ✓Informatics…
- ✓Neuroscience…
- ✓Mathematical Modeling…
- ✓Supercomputer Simulation …
- ✓Visualization…
- ✓Analysis…

The birth of INCF

- The Global Science Forum of OECD realized the need for a concerted action for developing Neuroinformatics on the international level.
- 2005 INCF plans endorsed by the ministers of research of OECD
- August 1st 2005 INCF formed with 7 members including Japan and the US

incf International Neuroinformatics Coordinating Facility

The mission of the INCF

Coordinate and foster international activities in neuroinformatics

Contribute to development and maintenance of database and computational infrastructure and support mechanisms for neuroscience applications

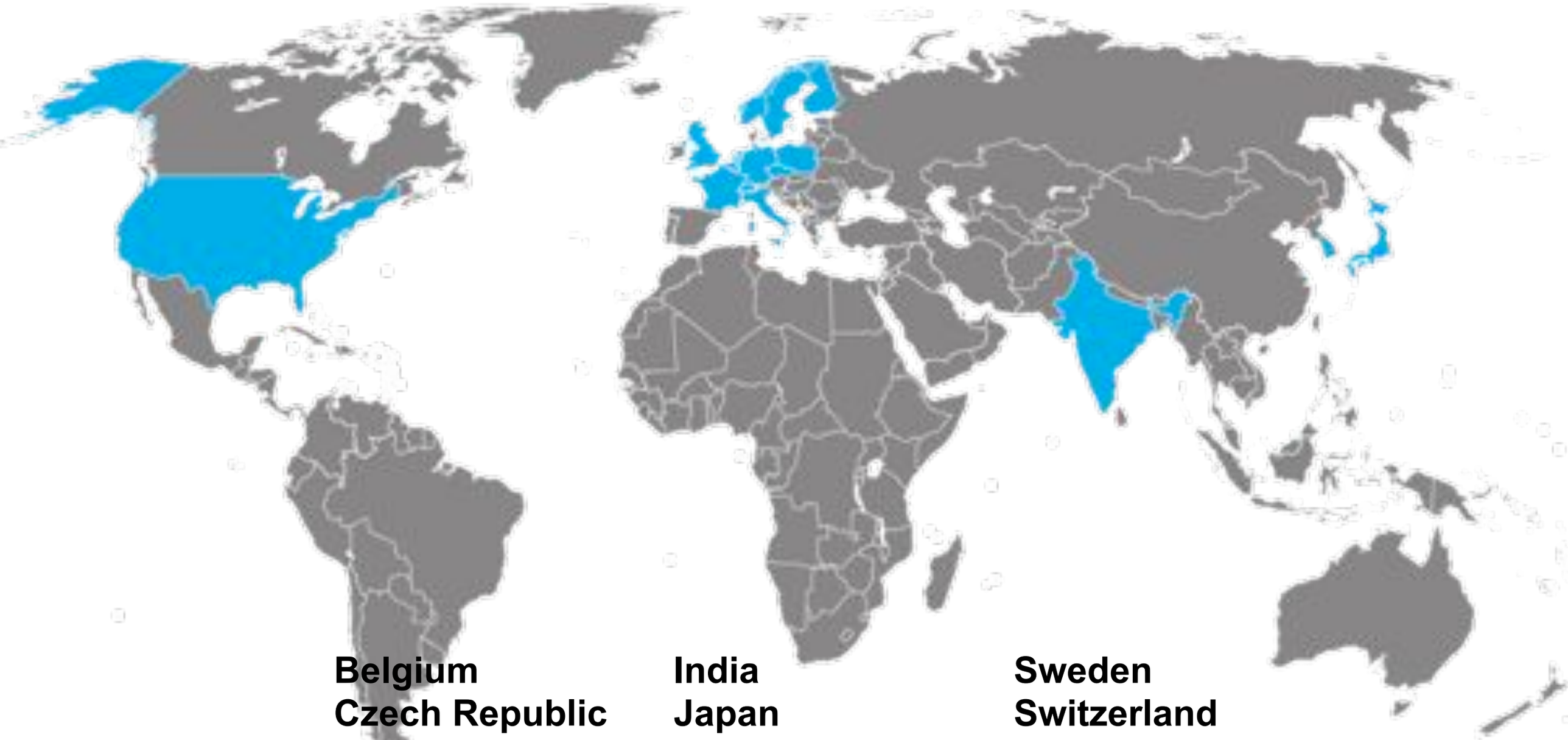
Enable access to all freely accessible data and analysis resources for human brain research to the international research community

Develop mechanisms for the seamless flow of information and knowledge between academia, private enterprises and the publication industry

INCF works for technological, cultural and policy changes

- Organize the community
- Advocate open access and data publication
- Work on scientific, technical and sociological issues surrounding data sharing and integration
- We talk to and bring together government policy makers, funders, publishers, scientists to address these issues

16 INCF Member Countries



Belgium
Czech Republic
Finland
France
Germany
Italy

India
Japan
Korea
Netherlands
Norway
Poland

Sweden
Switzerland
United Kingdom
United States

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"Just so are these preachers and scholars holding various views blind and unseeing.... In their ignorance they are by nature quarrelsome, wrangling, and disputatious, each maintaining reality is thus and thus".

- The Blind Men and the Elephant
13th century Buddhist writings

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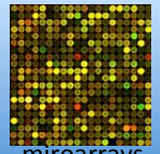
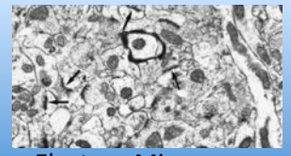
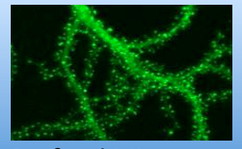
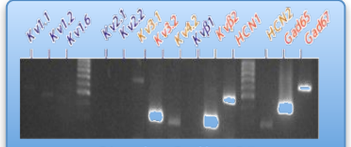
Multiomic Neuroscience Data

sub-cellular resolution


miroarrays

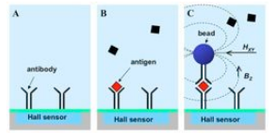

Electron Microscopy


Confocal Microscopy

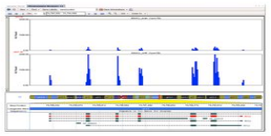


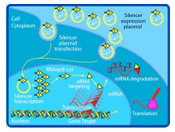
Single Cell PCR

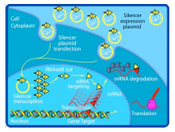

Protein quantification

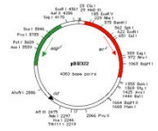


magnetic bead labeling


Gene sequencing


Gene silencing

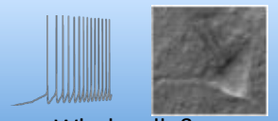

Gene over-expression

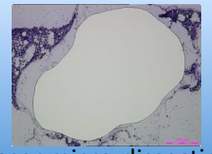

Genetic vectors

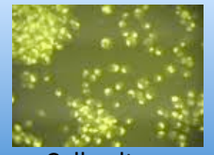

Two-hybrid system

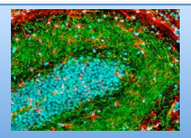

protein separation

cellular resolution

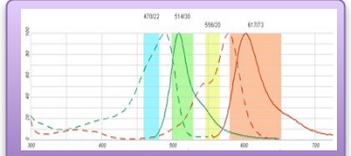

Wholecell &
Inside-Out Patch

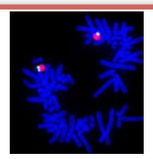

Laser micro-dissection

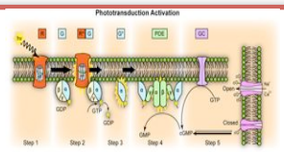

Cell culture


Fluorescence microscopy


Cellular tracing

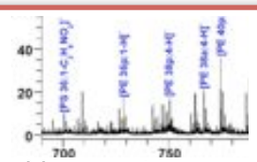

Cell sorting


In situ hybridization

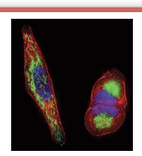


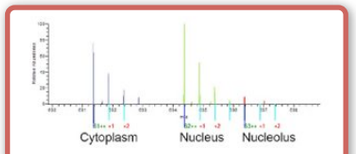
Rhodopsin vectors


immuno-detection amplified by T7



Mass-spectroscopy

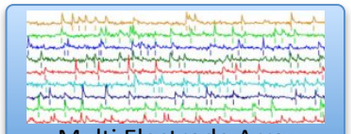

Organelle transfection

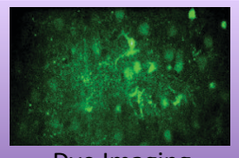


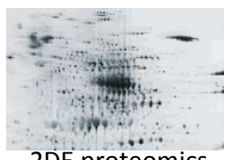
Spatial Proteomics

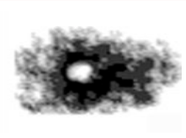
tissue resolution

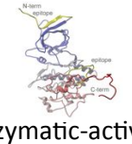

Immunostaining


Multi Electrode Array
Extracellular Recording


Dye Imaging


2DE proteomics

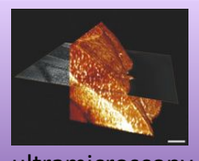

tissue transfection

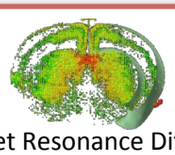


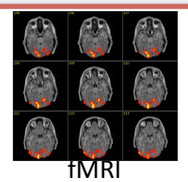
enzymatic-activity
measurement

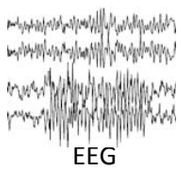
whole brain scale


Behavioral Studies


ultramicroscopy


Magnet Resonance Diffusion
Imaging


fMRI


EEG


Transgenic lines

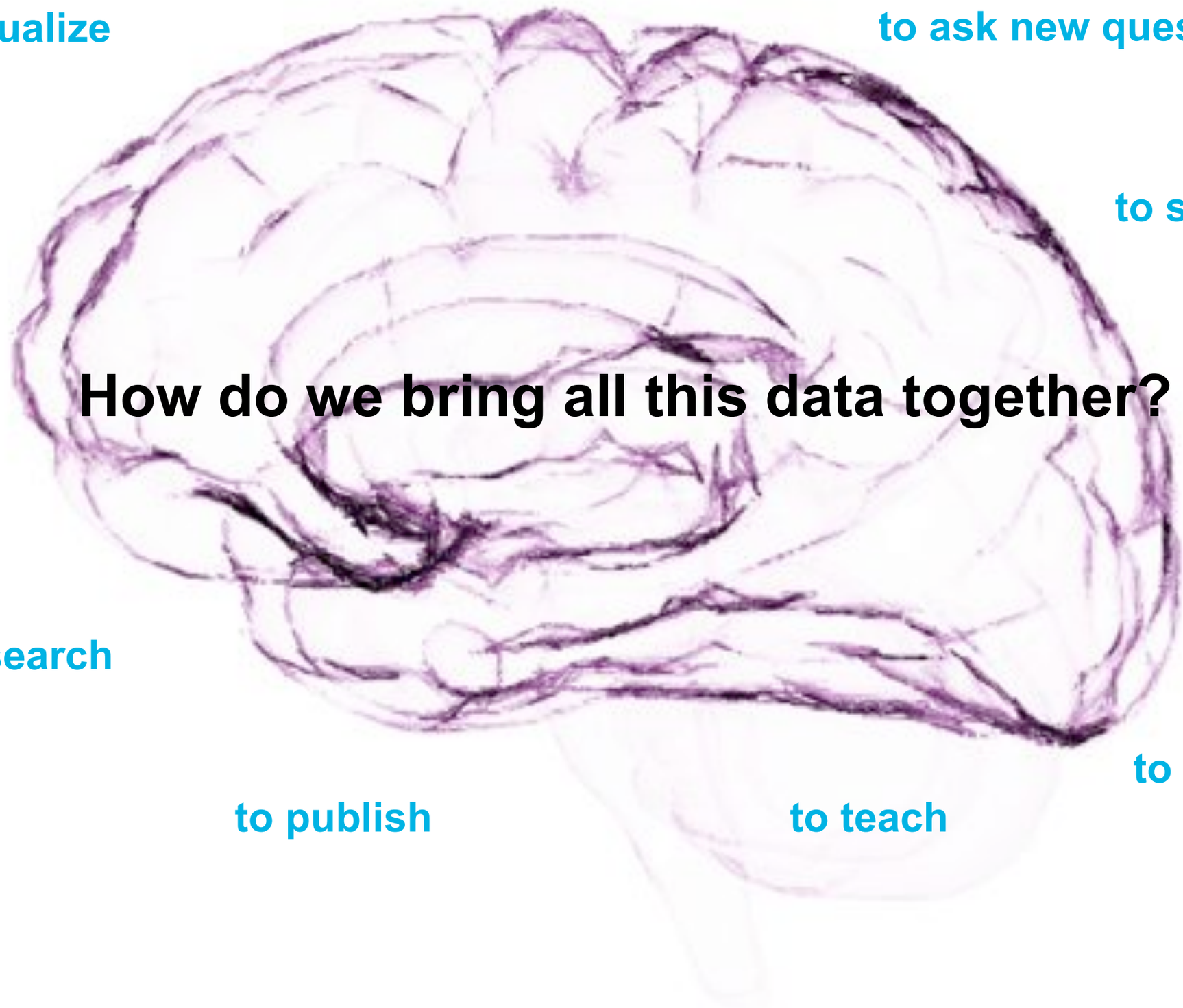
to replicate experiments

to visualize

to ask new questions

to simulate

to analyze



How do we bring all this data together?

to model

to search

to share

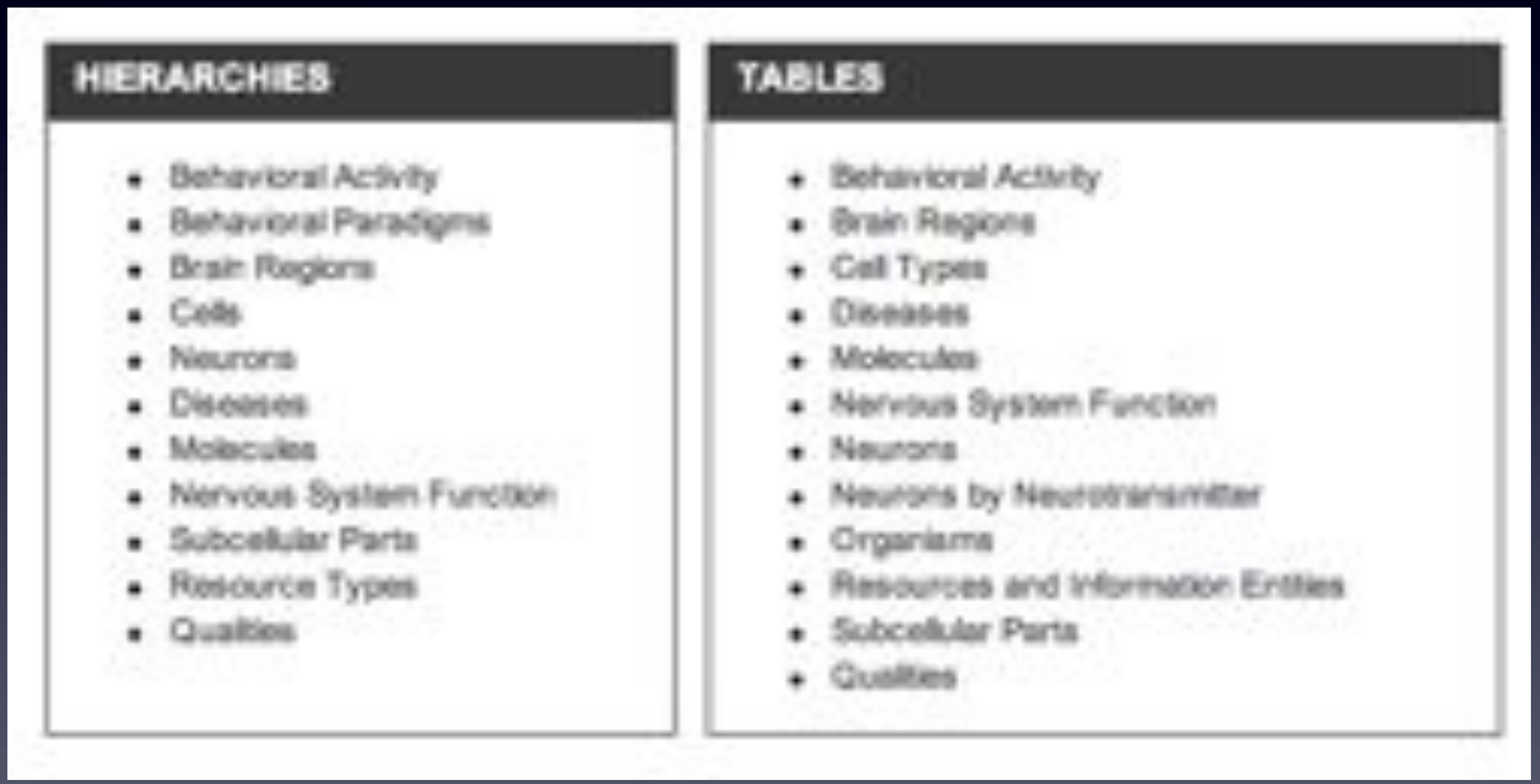
to publish

to teach

INCF Programs

- **Ontologies of Neural Structures**
- **Digital Brain Atlasing**
- **Multi-Scale Modeling**
- **Datasharing**

Program on Ontologies of Neural Structures (PONS)



Ontology Needs

- Not well defined for much of neuroscience
- Dynamic
- Easy to maintain
- Easy to review and curate
- Accessible through standard web service API

“Brainpedia” General concept

- Community wiki-based encyclopedia - built off of neurolex.org
- Semantic annotations - semantic media wiki
- Ontology, Vocabulary and CDE queries through web service - federate existing ontologies
- Rich multimedia wiki environment
- Technology assisted data mining and curation
- An interface to federated literature, data and models
- Partnership with Allen Institute, Blue Brain Project, One Mind, Vulcan Technologies

Structured Data

Neocortex basket cell

BASIC | DETAIL | ADVANCED | FACTBOX

Name:	Neocortex basket cell
Synonym(s):	cortical basket cell, basket cell, cortical basket neuron, Neocortical basket cell
Super-category:	Neuron
Id:	nifext_56
Organism:	Vertebrata
Link to OWL / RDF:	Download this content as OWL/RDF

Soma Specific Properties

Cell Soma Shape:	Multipolar
Soma Location:	Neocortex, Neocortex layer 2, Neocortex layer 3

Dendrite Specific Properties

Spine density on dendrites:	Smooth[4]
Branching type:	multipolar[4]

Axon Specific Properties

Axon myelination:	myelinated[4]
Axon projection laterality:	bilateral[4]
Origin of axon:	soma and sometimes dendrite

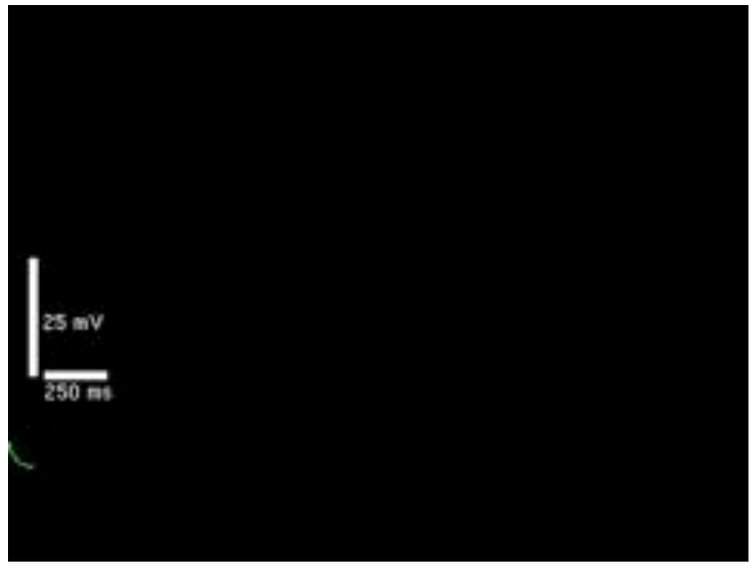
Neurotransmitter released:	GABA
Neurotransmitter receptors:	Glutamate-gated cationic channel, GABA-gated anionic channel, dopamine[3]
Molecular constituents:	parvalbumin
Spontaneous firing rate:	Rapid firing

and Wiki, Data, Models and Literature

Neocortical basket cells

Neo cortical Basket Cell is a neuron found in vertebrates

Contents [hide]



Neo cortical Basket cell

Basic Information

Basket Cells were first described by Cajal in the motor and visual cortex of the human brain. They are small, medium-sized, and large multipolar neurons, whose diameters vary from 12 to 30 μm and whose bodies are located in layers II–VI . BC terminals–basket plexuses and pericellular nesties contact with bodies, axonalhillock and proximal regions of pyramidal neurons dendrites and double-bouquet cells, forming reciprocal relations with them in accordance with domain-selection principle. BC establish ties between each other and interconnect by means of autapses

Neuronal Type: Local Interneuron.

Variety and Topographical characteristics

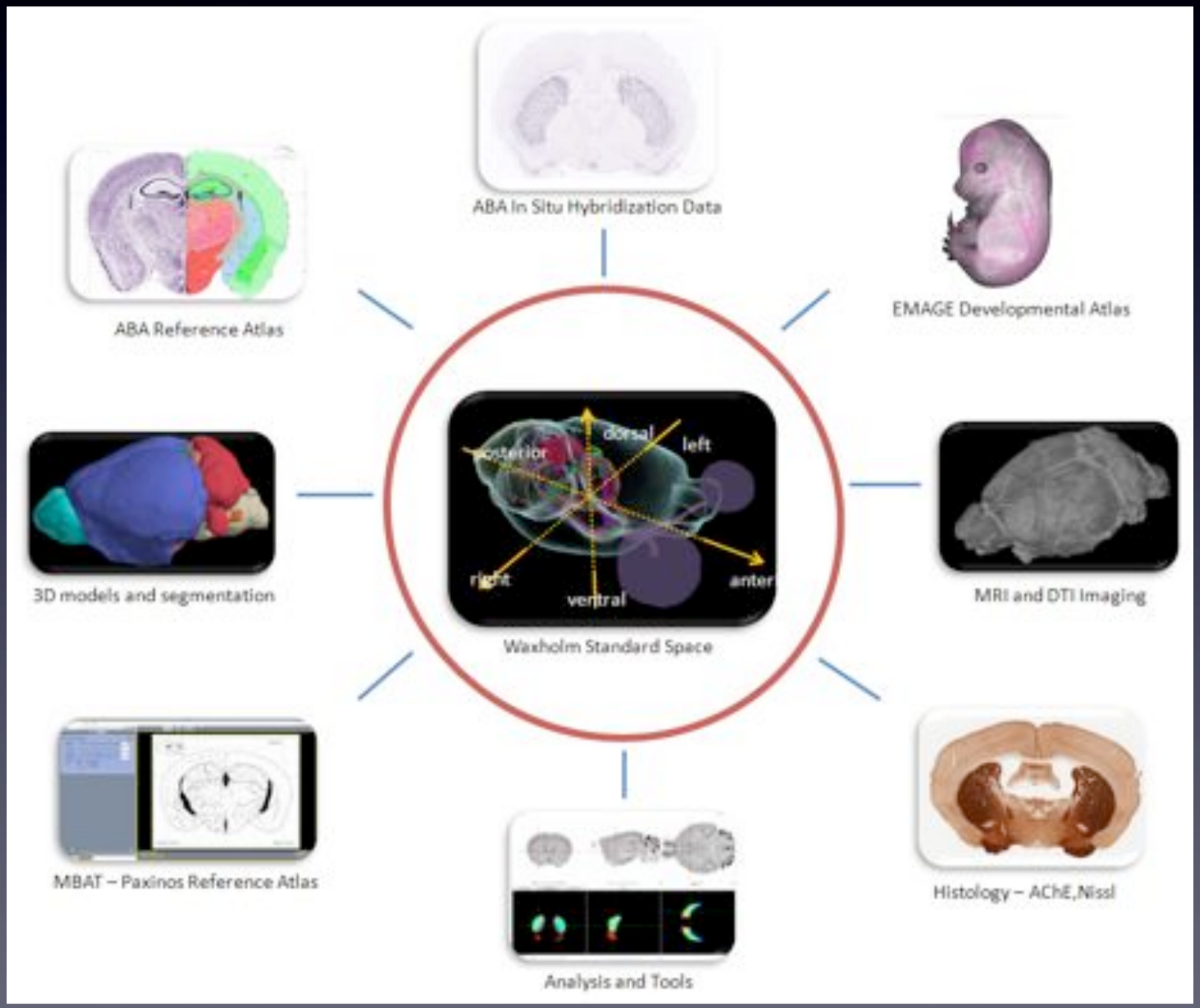
Neocortical basket cell somata are located in layers II-VI or the cortex. They have diameters that range from 12 to 30 μm. Their dendrites are either smooth or have very few spines and their axons mostly pass in the vertical and horizontal direction. Basket cells make up the largest population of inhibitory neurons.

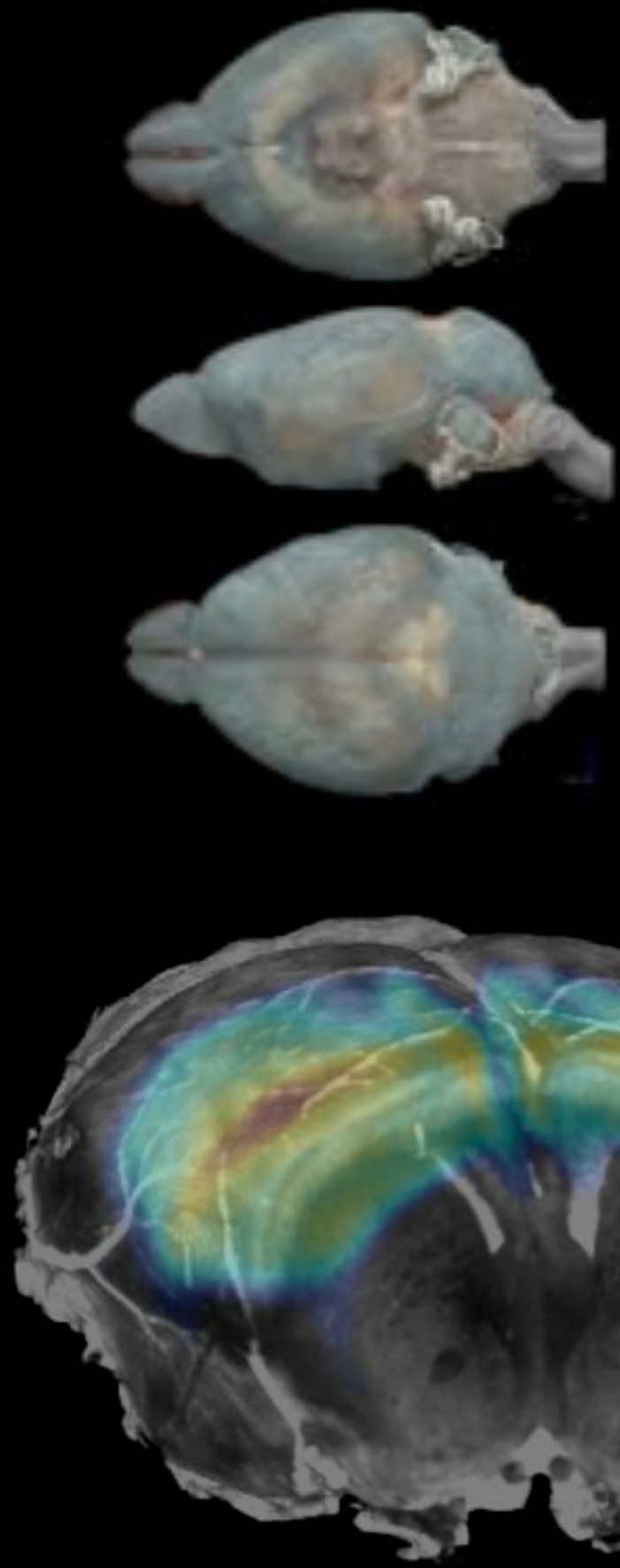
Basket neurons are distinguished from other cortical interneurons by their axons, which pass predominantly in the vertical and horizontal directions. They form long (up to300–700 μm), extensively arborized or straight branch rays in the horizontal, oblique, and vertical directions, covering large areas of the cortex with diameters of up to 1400 μm. A second morphological characteristic is provided by the axon terminals – vertically orientated filaments with large beads and basket-like plexuses or pericellular holes.

Image of Neocortical Basket cell

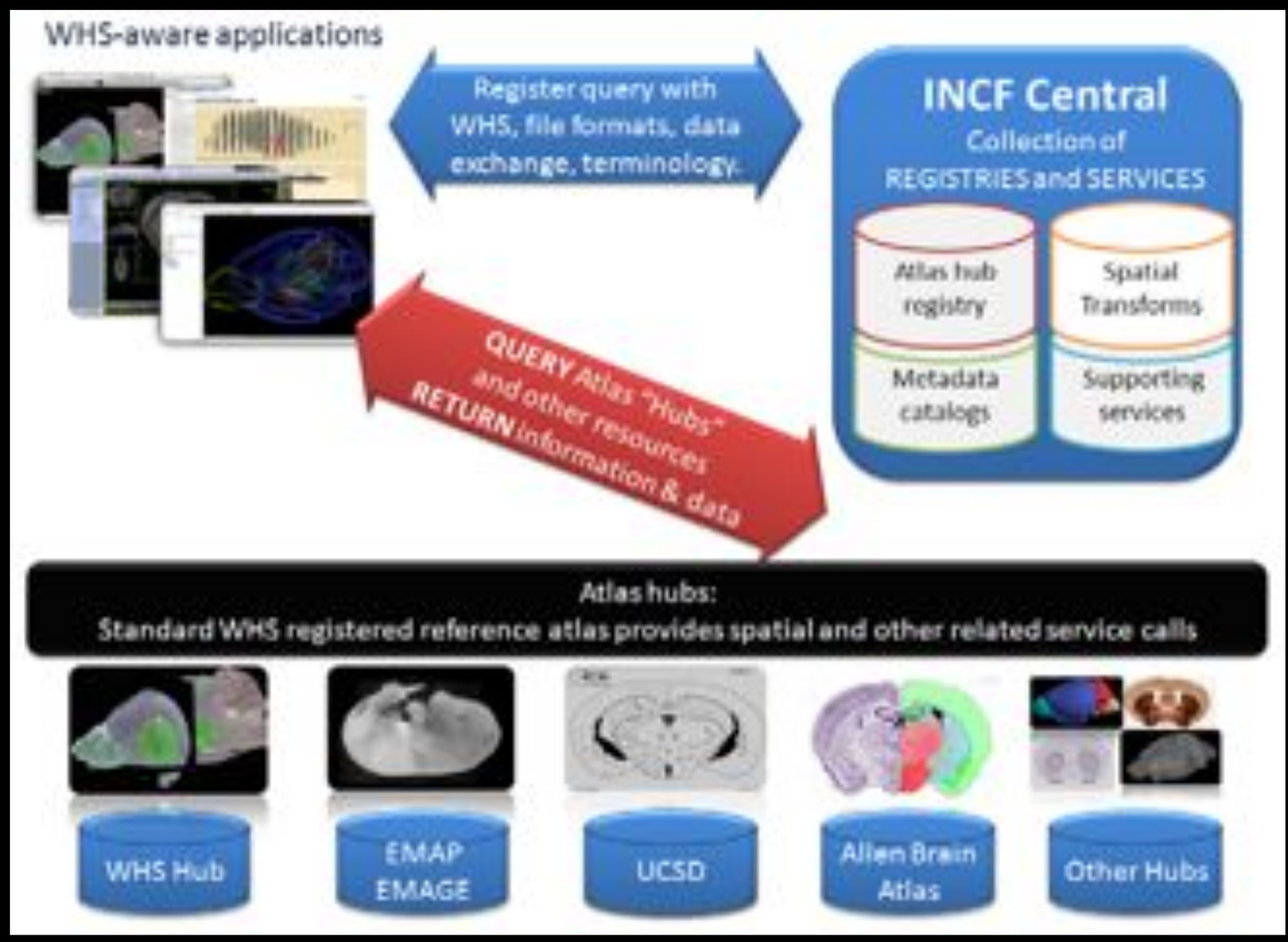
Program on Digital Brain Atlasing

Spatial Data Integration via
Waxholm Space and Digital Atlasing Infrastructure



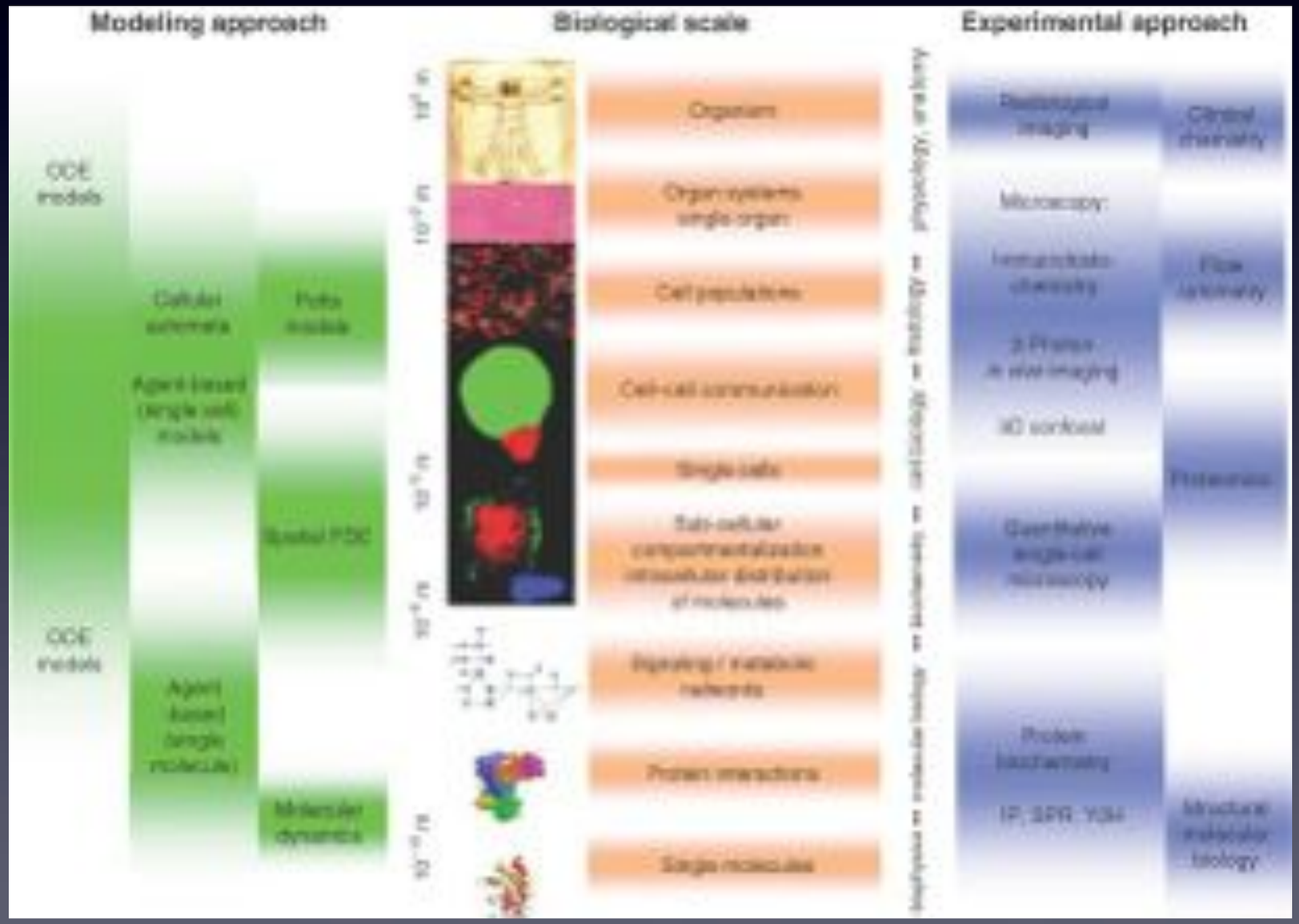


INCF Digital Atlasing Infrastructure Integrates spatial brain data



Program on Multi-Scale Modeling

NineML - simulator independent computational model description

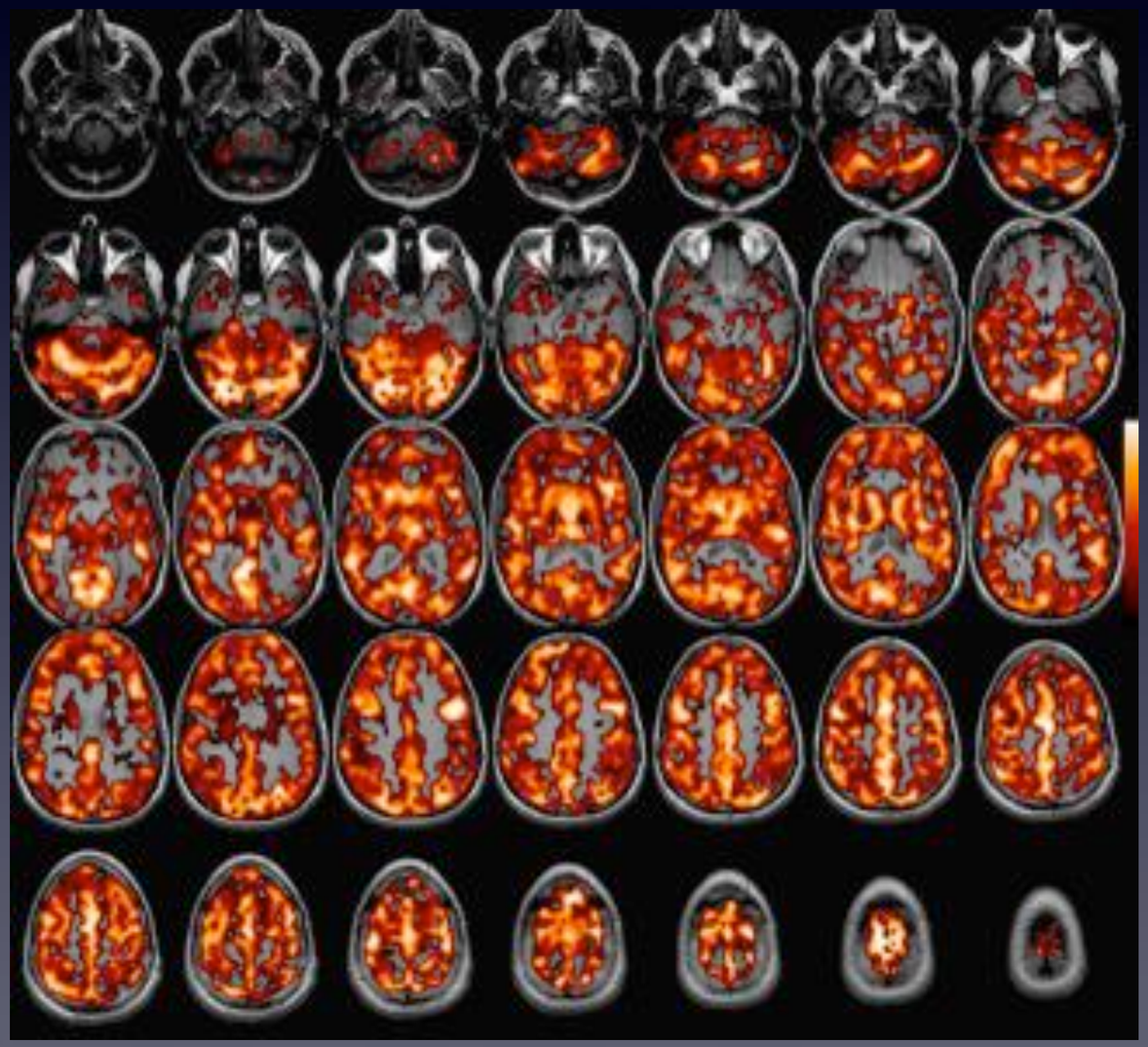


MEIER–SCHELLERSHEIM, et al. 2009

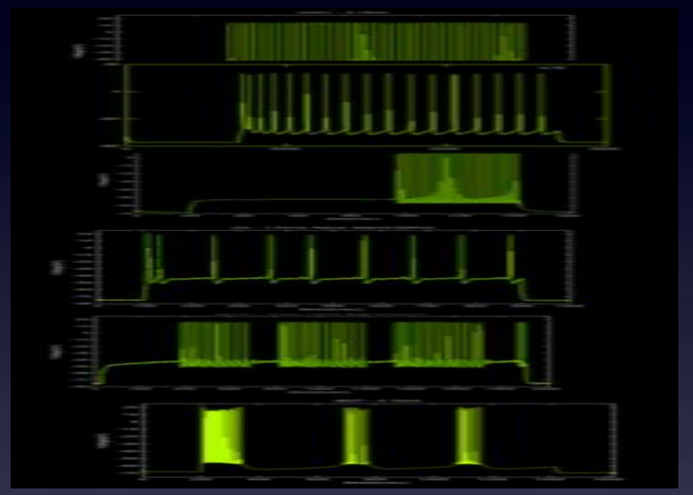
Program on Datasharing

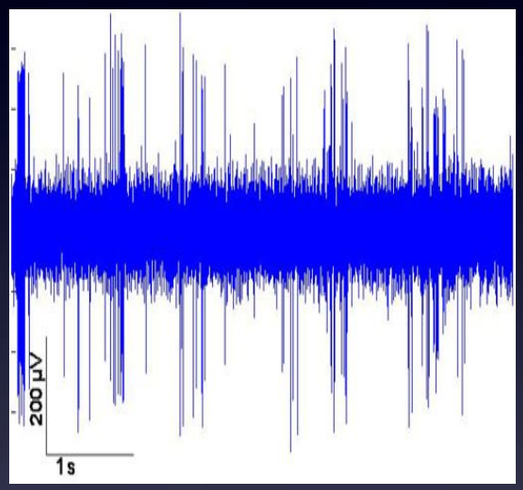
Data Object Models for:

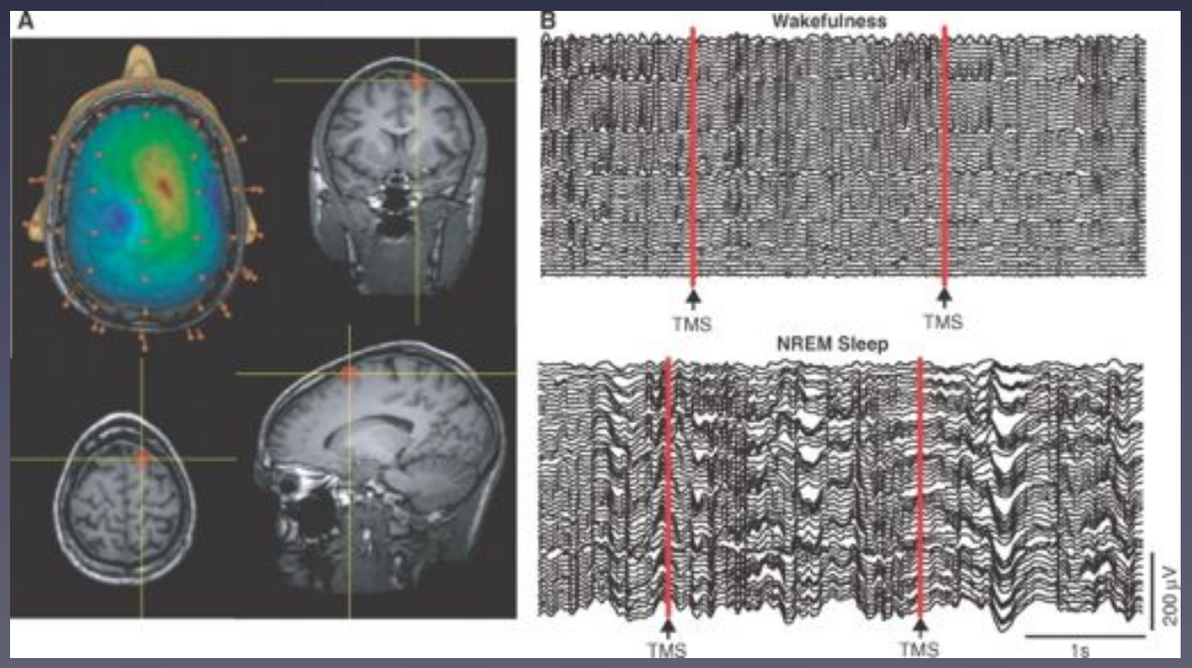
Brain Imaging



Electrophysiology



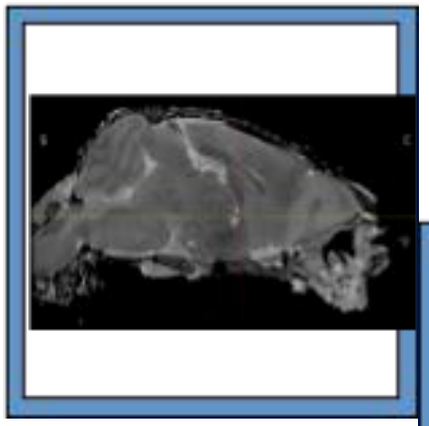




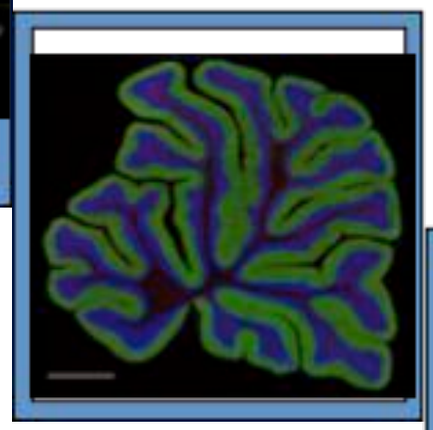
Non satis communicare

To share is not enough

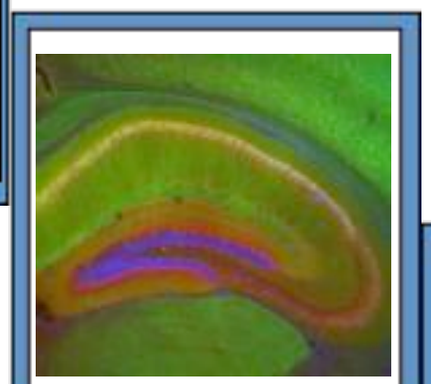
Neuroscience data integration: A multi-scale problem



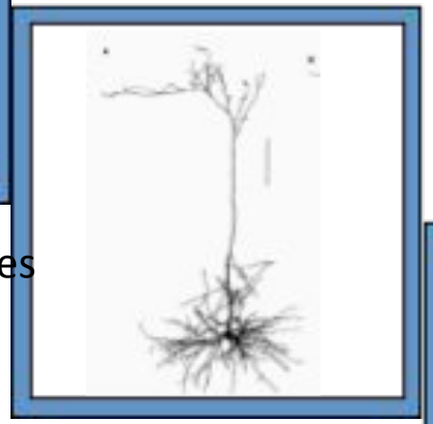
Whole brain data (20 um microscopic MRI)



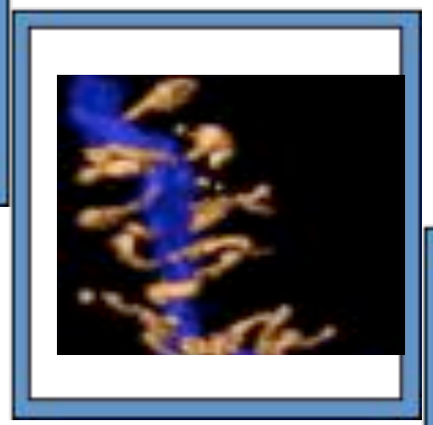
Mosiac LM images (1 GB+)



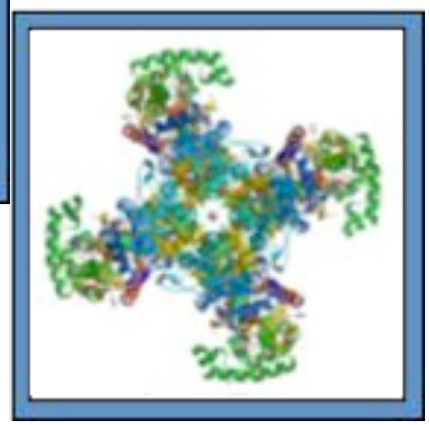
Conventional LM images



Individual cell morphologies



EM volumes & reconstructions



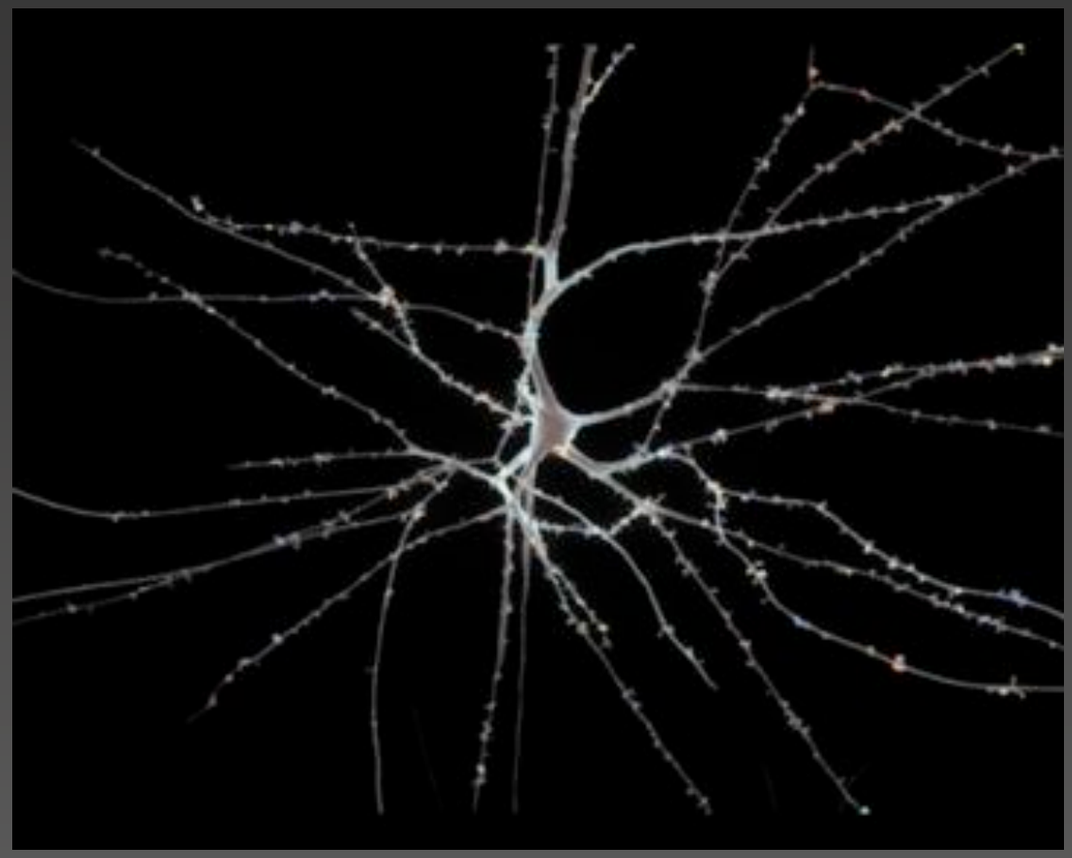
Solved molecular structures

Scale

Stephen Larson, UCSD

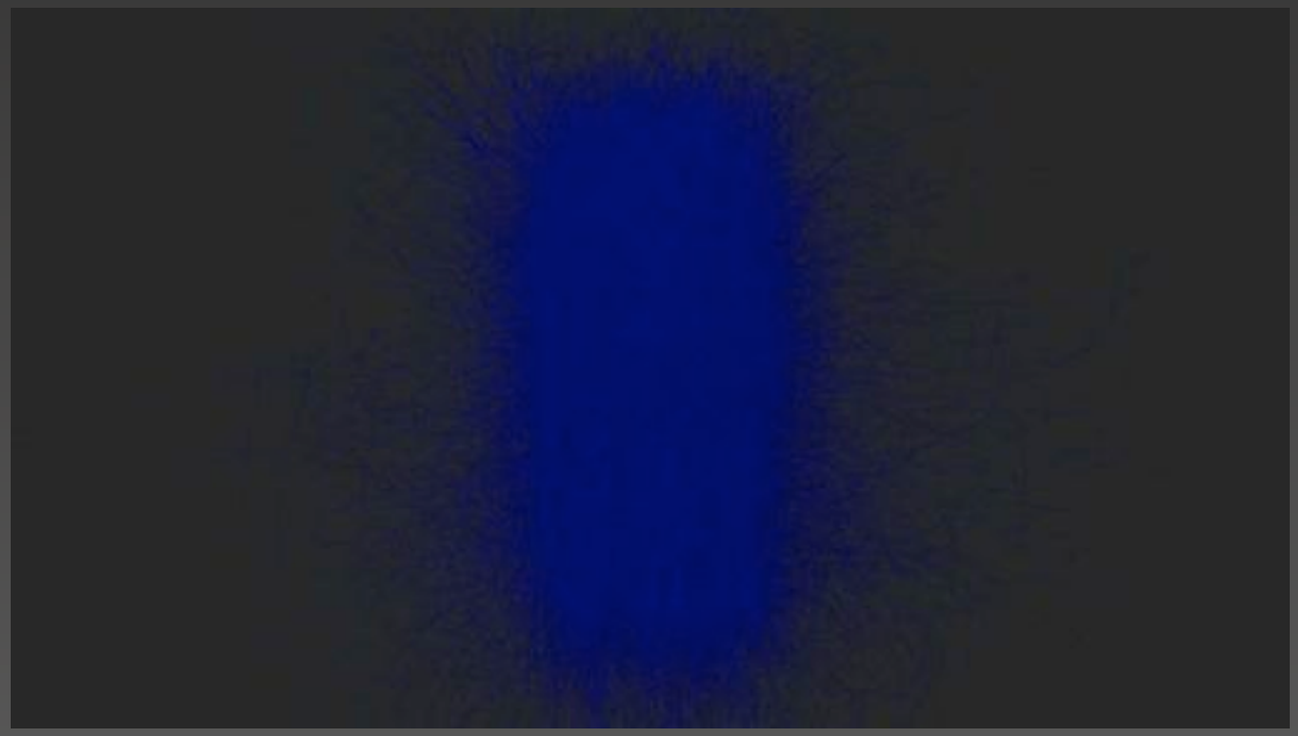
Use case I: Neuronal modeling

- Morphology
- Gene expression
- Electrophysiology
- Electrical model
- Simulations



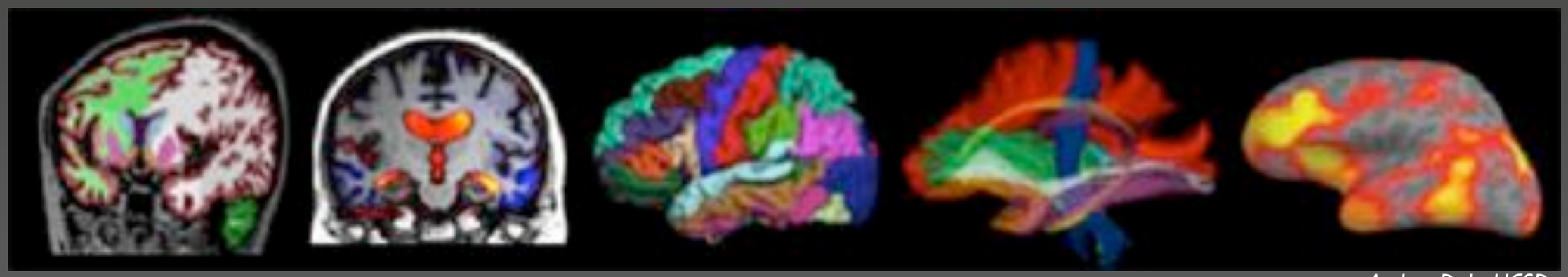
Use case II: Model neural microcircuits

- Cell types
- Cell distributions
- Electrophysiology
- Morphology
- Synaptic dynamics
- Connectivity
- Network dynamics



Use case III: Human Brain Atlasing

- Structural data
- Gene expression
- Cytoarchitectonics
- Receptor maps
- Fiber tracts
- Connectivity
- Resting state data
- Functional mapping



Anders Dale, UCSD

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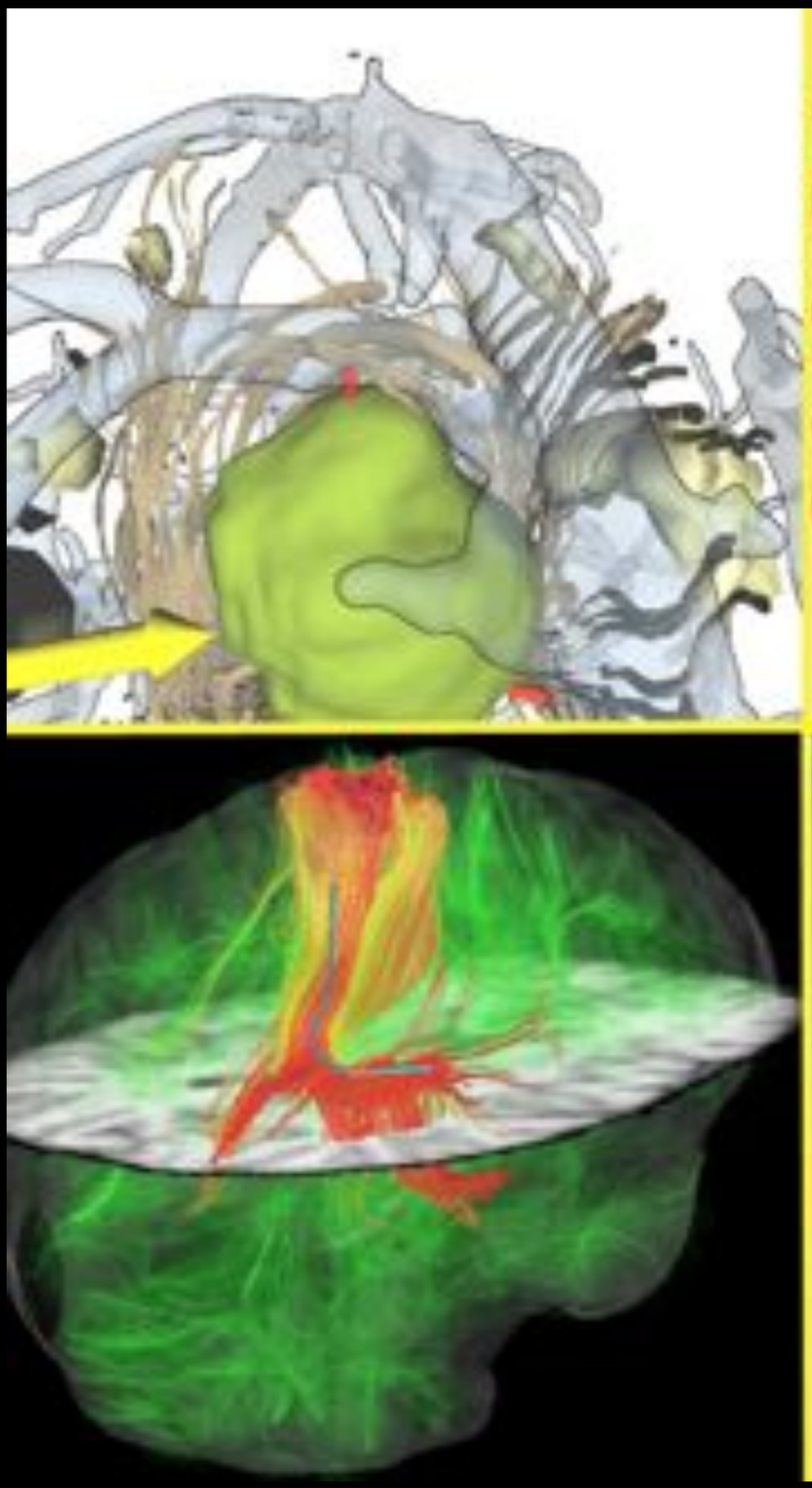
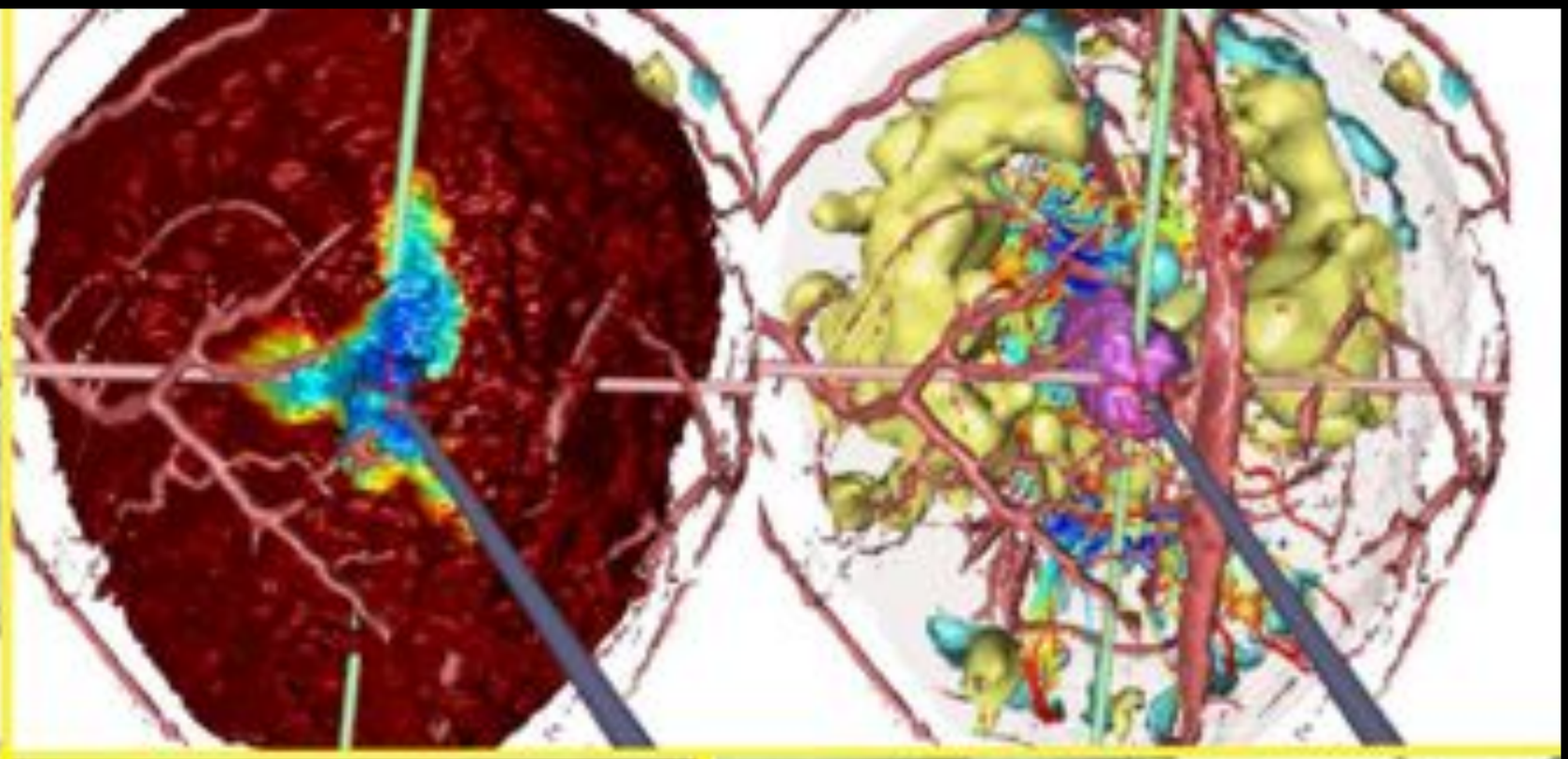
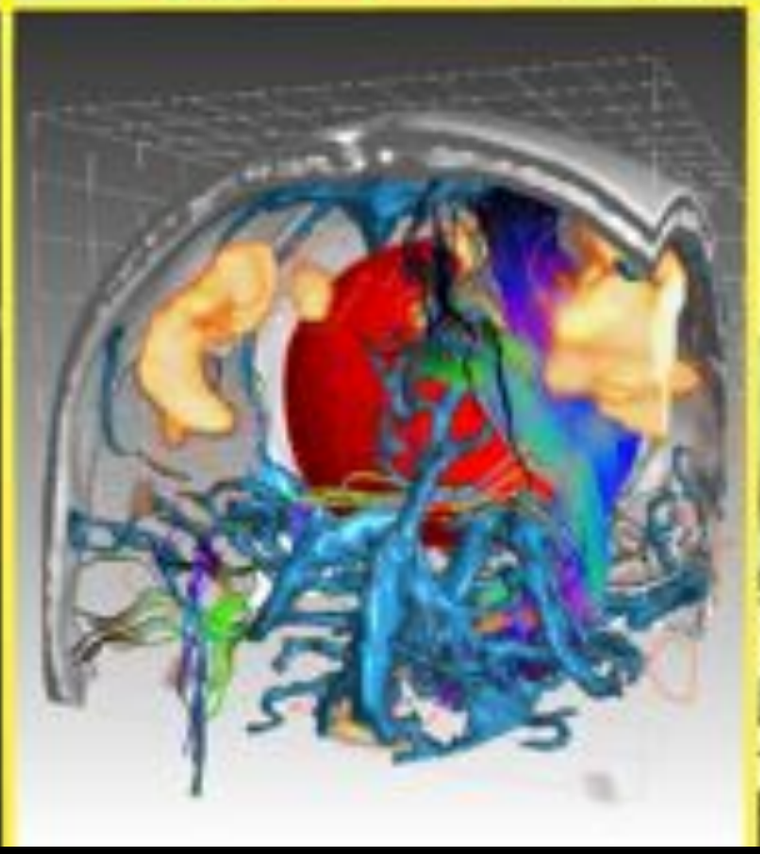
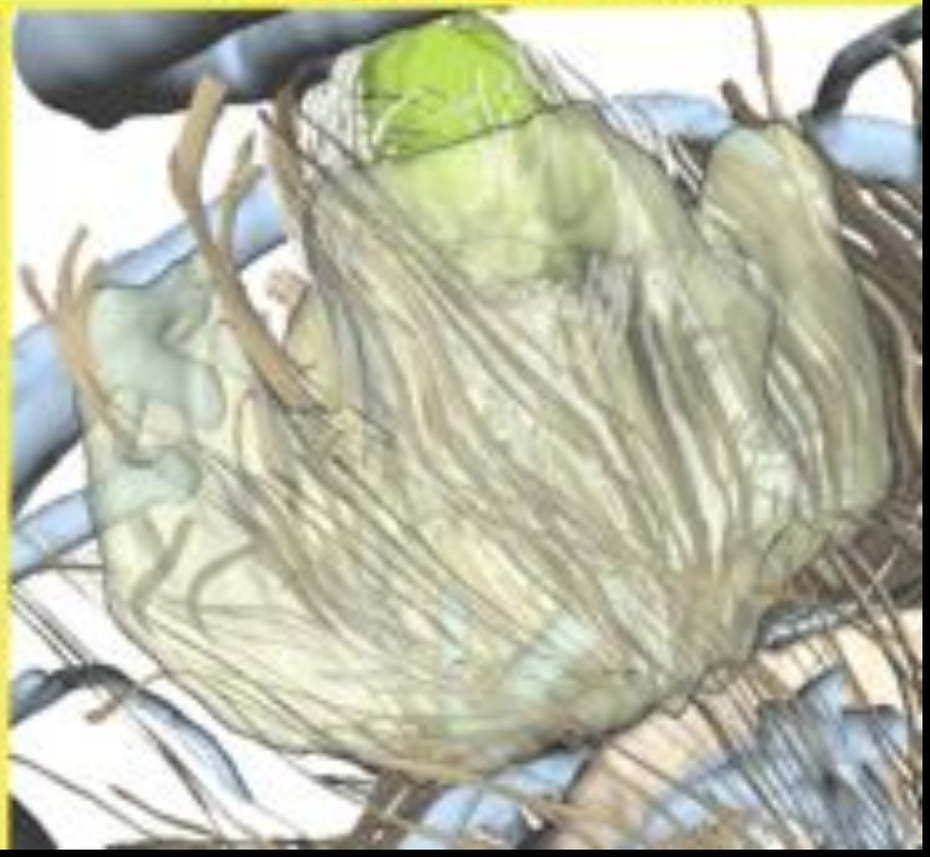
Multimodal brain atlases for research and medicine









IEEE Visualization 2010

Requirements: Neuroinformatics Cyberinfrastructure

- Share data: Secure access, authorization, collaborative
- Publish data: Data citation, community rating and reviews
- Preserve data: Versioning, archive, mirror, replicate
- Federate data: Tens to hundreds of thousands of members of the federation
- Federated search: Search over all data, free text, ontology-based or spatial search
- Ease of use: Lightweight! Dropbox-like functionality, easy metadata annotation, portal for search
- Access data: Object-based view of data, semantic annotations, data models, flexible metadata
- Analyze and integrate data: Support data analysis, workflow building, provenance tracking

Neuroinformatics Infrastructure

Phase III

Portal

Visualization Workflows

Analysis Workflows

Modeling Workflows

Simulation Workflows

Phase II

Object-based Data Integration Layer

Phase I

INCF Federated Dataspace

First step: Dropbox for Scientific Data

Decentralized, data publication

Authorization and authentication

Local file access

Global address space

Built on iRODS

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Launch INCF Cloud

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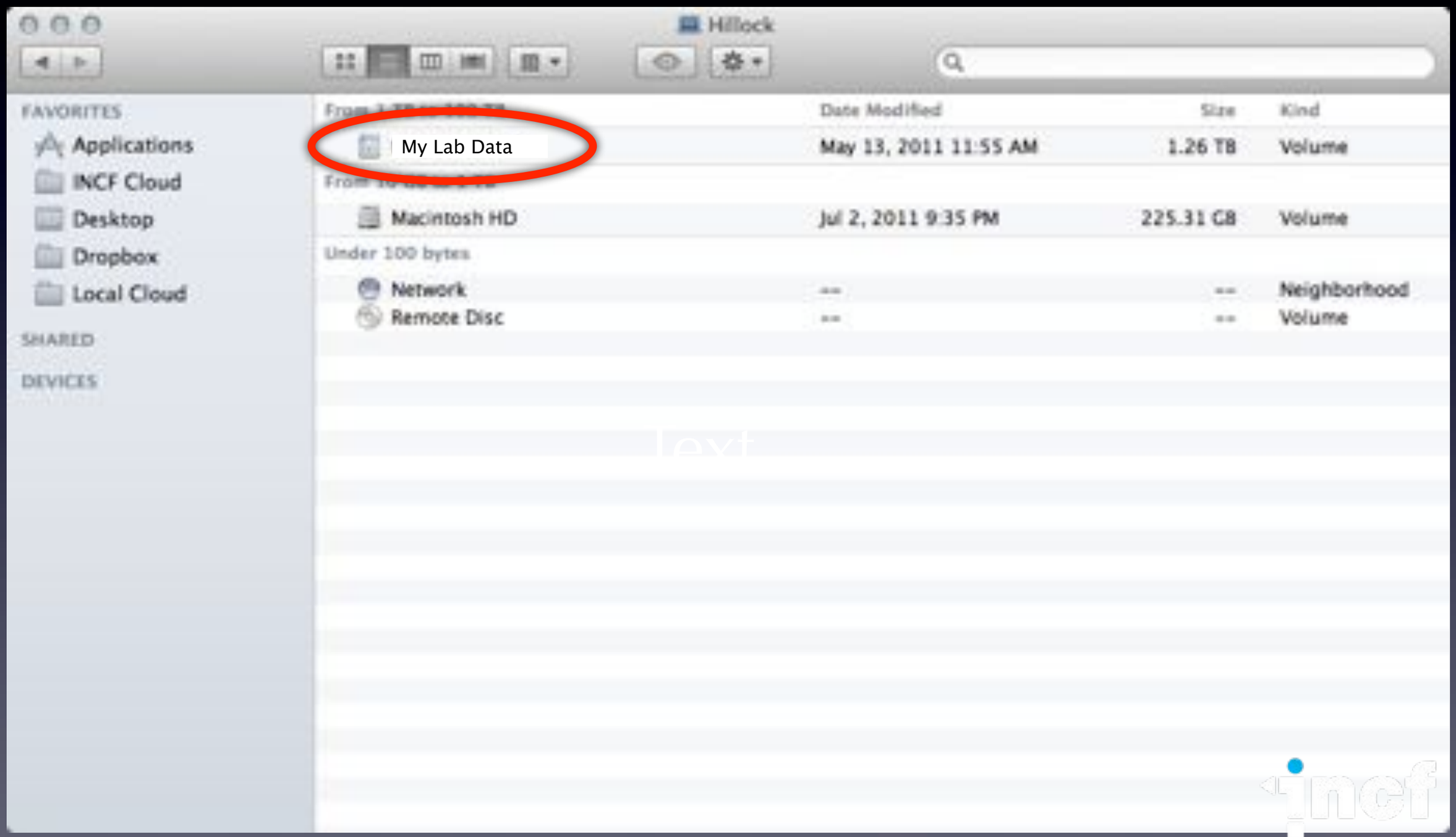
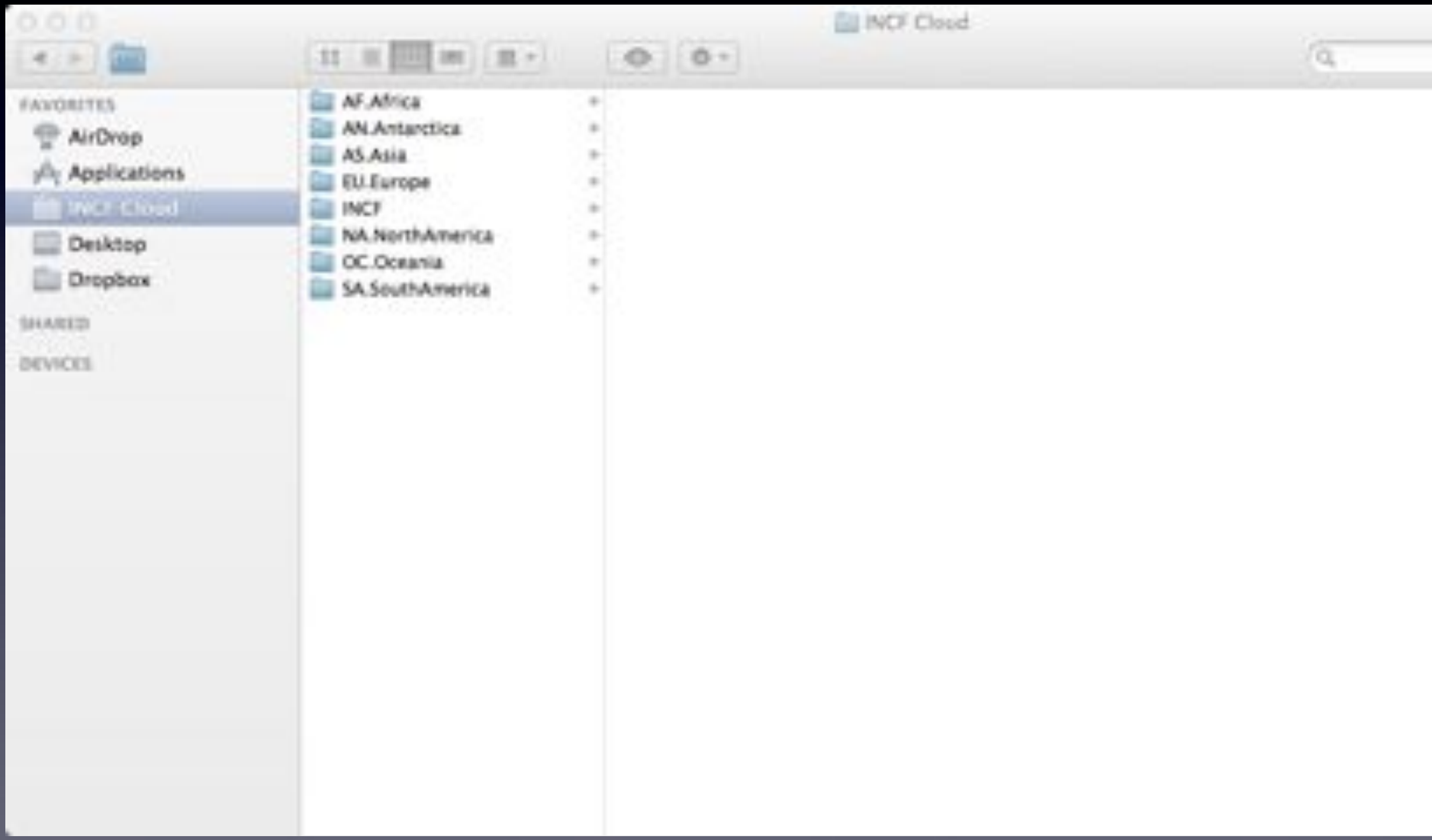
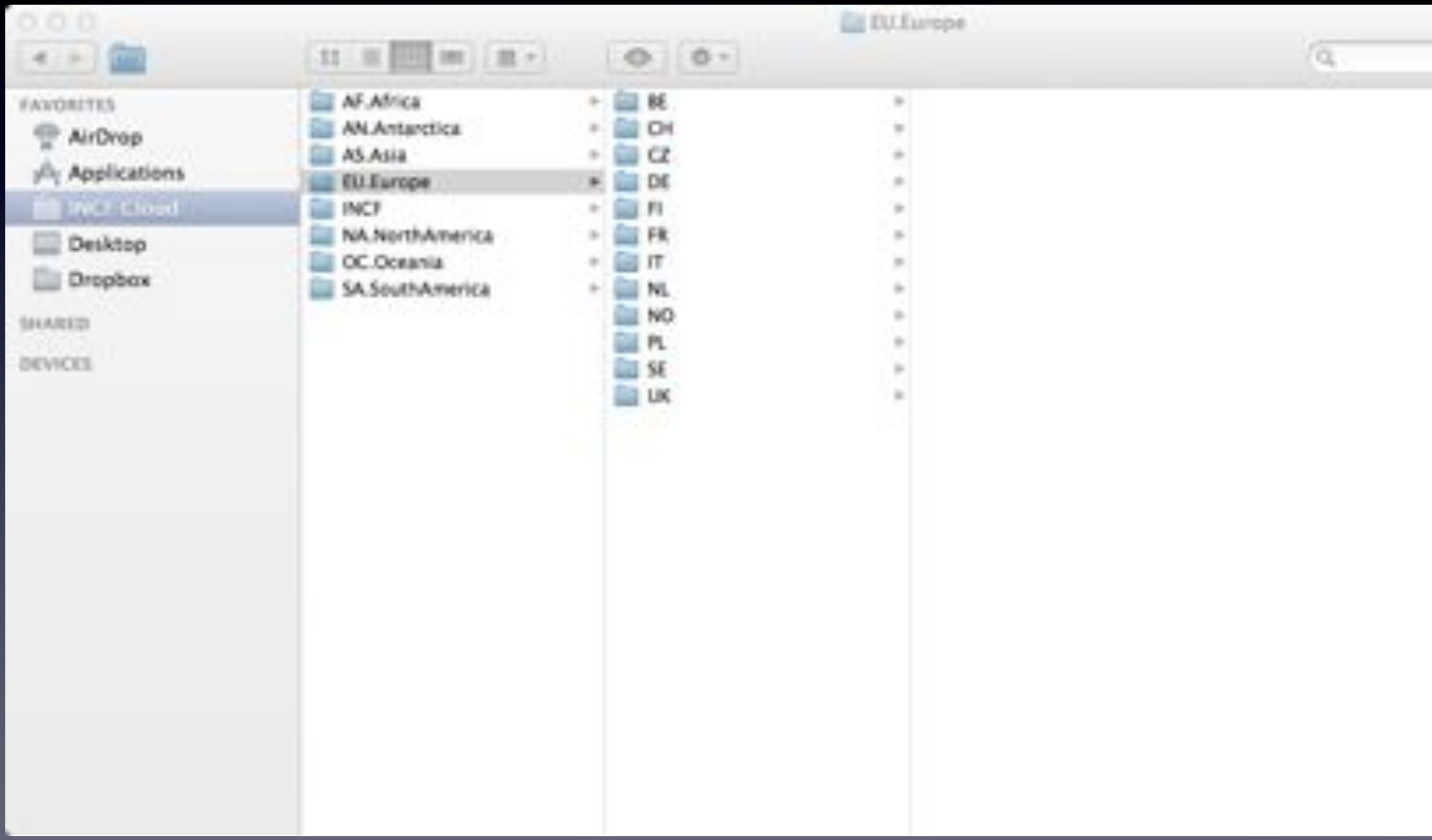
Point to your data



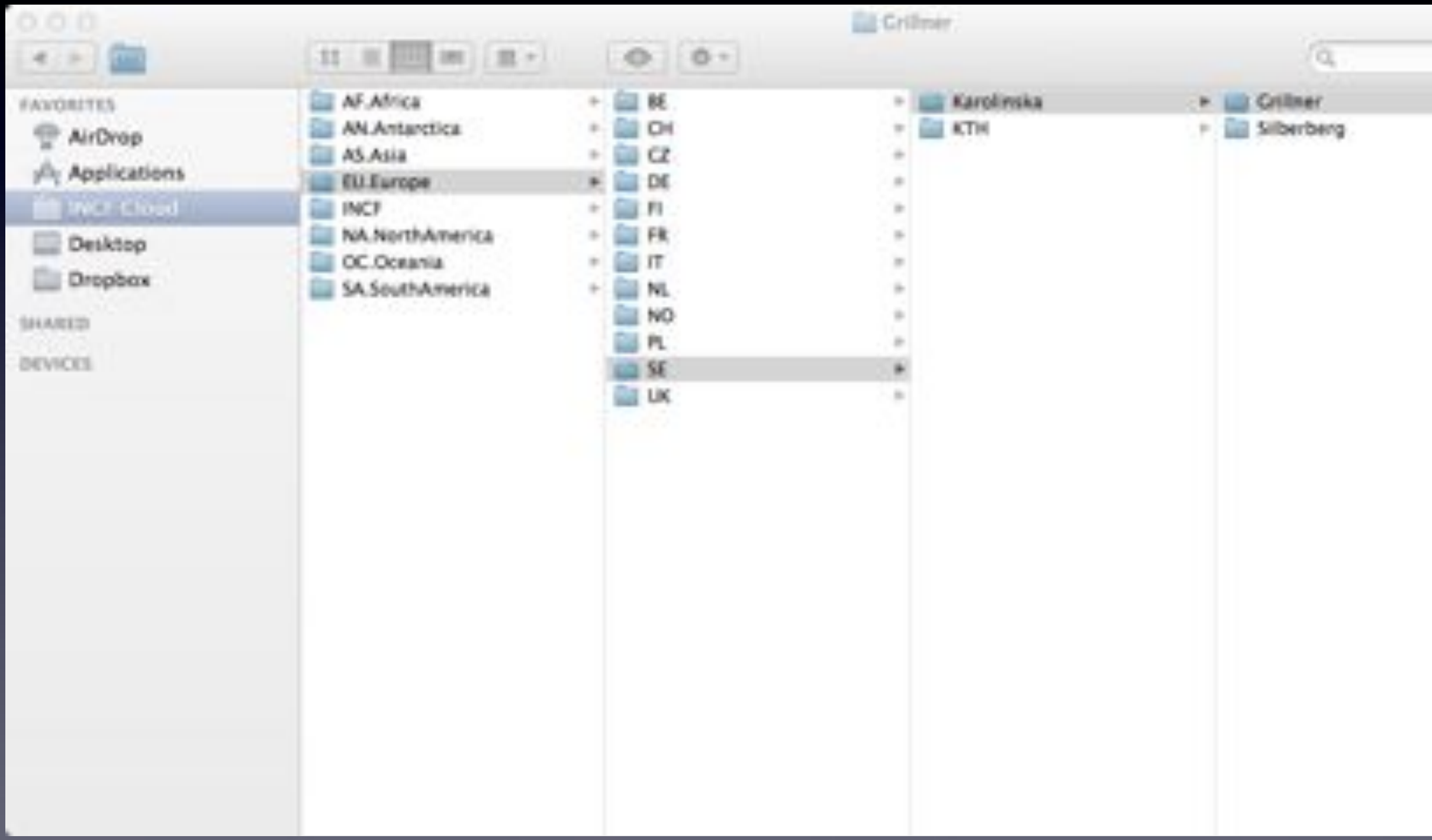
Worldwide data through your file browser



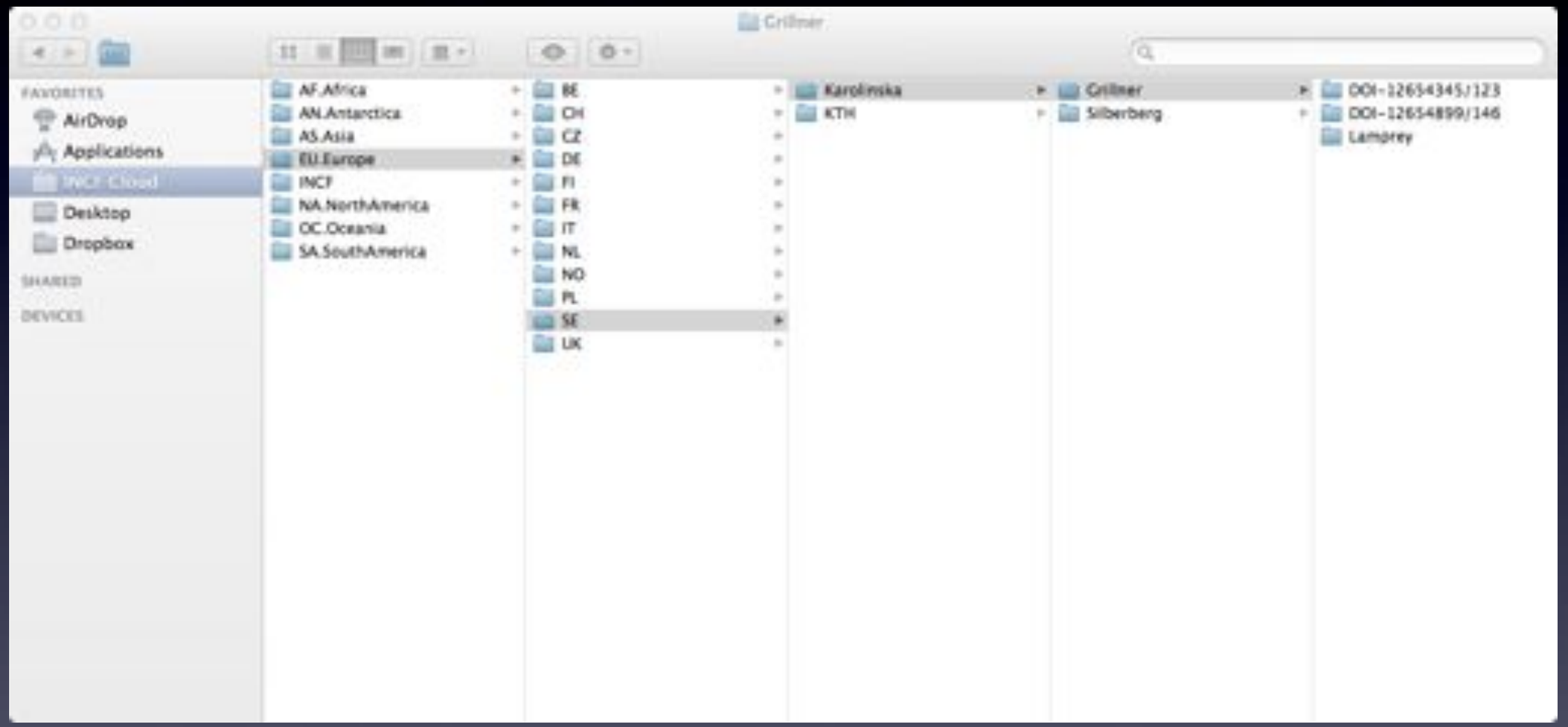
Organized by regions, countries and labs



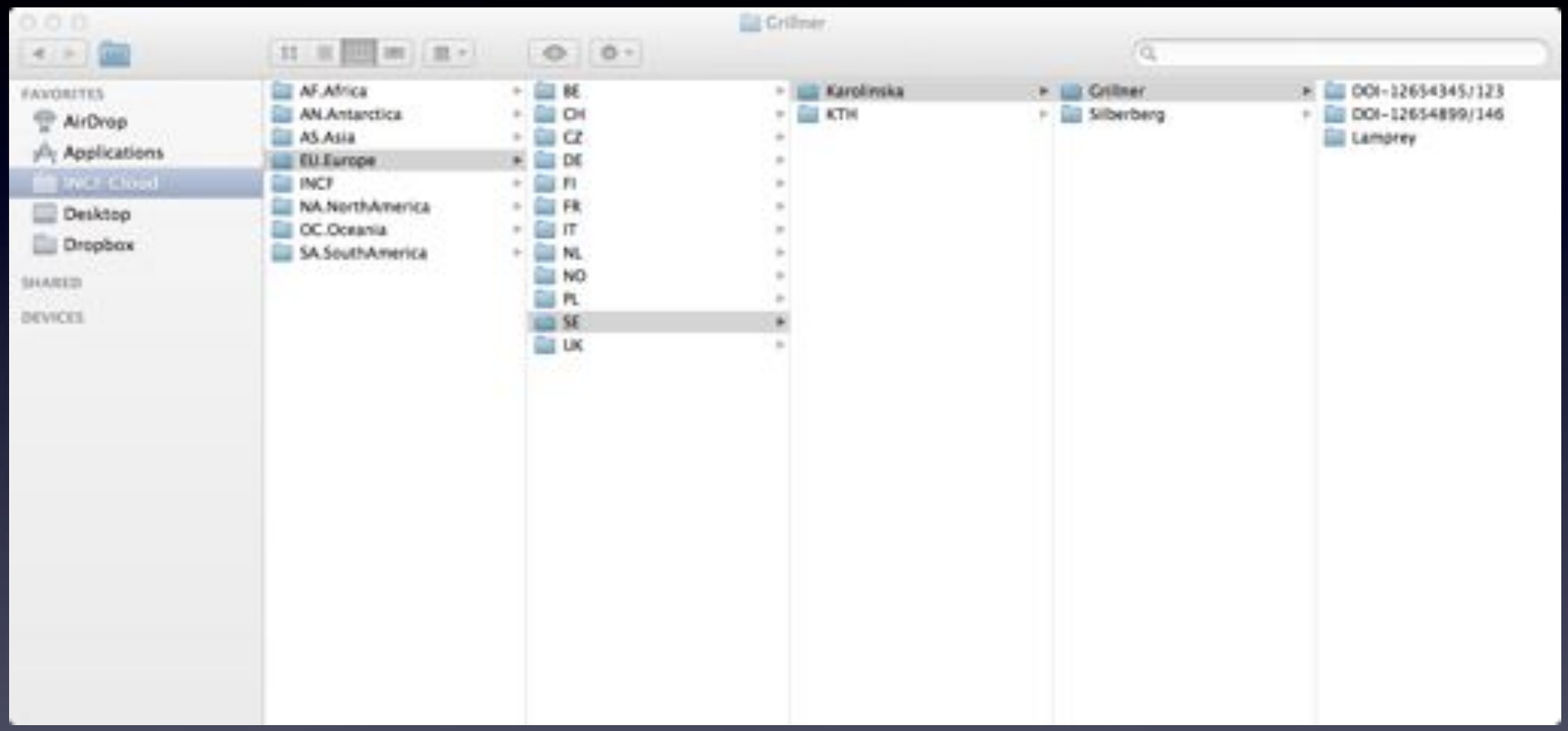
Browse all public data



Make any local data visible globally or only visible to collaborators.



Drag and drop any data to make
a local copy of available data



Drag and drop to place data on
a remote site for sharing or backup

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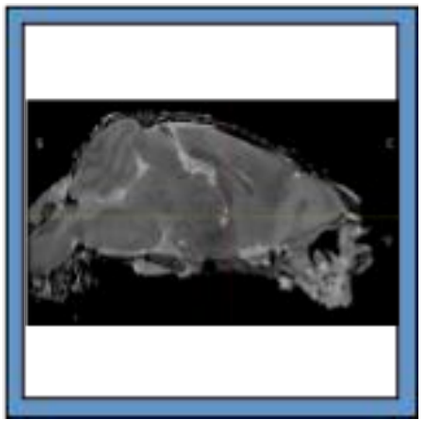
Installing on national infrastructures

- Working with Sweden (PDC), Finland (CSC), Germany(BCCN) and San Diego (UCSD) for first trials
- Brain image stacks and electrophysiology data as first test datasets

Next steps:
Set metadata tags to reveal data for global search

www.neurolex.org

www.incf.org/programs/atlasing



Species: Mus musculus

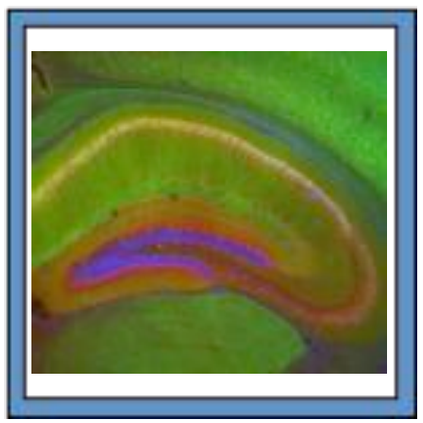
Age: 30 days

Structure: Whole brain

Modality: T1 MRI

Reference space:
Waxholm mouse 1.1

Whole brain data



Species: Mus musculus

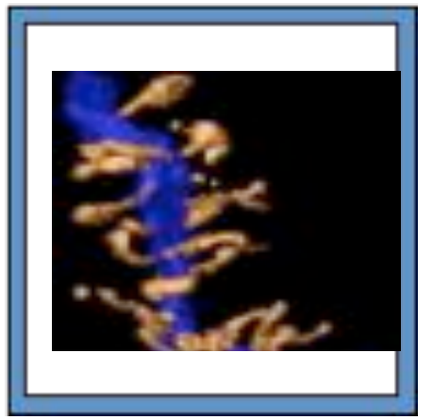
Age: 30 days

Structure: Hippocampus

Modality: Immunostain

Reference space:
Waxholm mouse 1.1

Light microscopy images



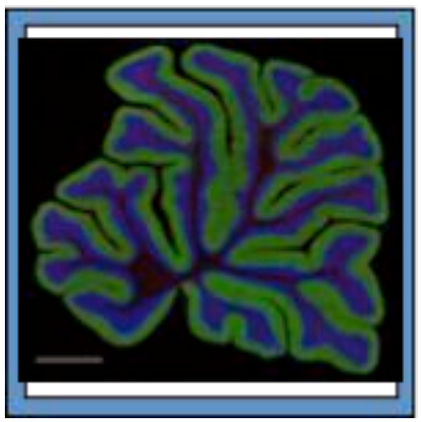
Species: Mus musculus

Age: 30 days

Structure: Hippocampal Pyramidal neuron dendrite

Modality: 10TV EM

EM volumes & reconstructions



Species: Mus musculus

Age: 30 days

Structure: Cerebellum

Modality: Immunostain

Brain region data

Species: Rattus norvegicus

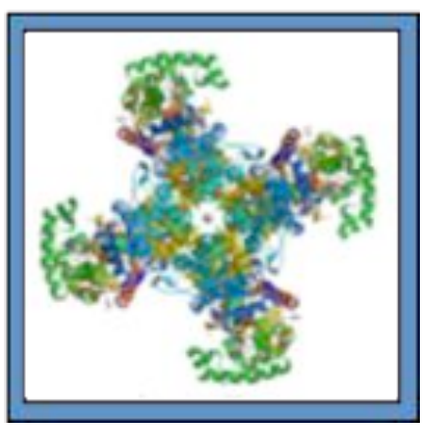
Age: 30 days

Structure: Cerebellum

Modality: Immunostain

Reference space:
Waxholm rat 1.0

SIngle cell data



Species: Drosophila

Age: NA

Structure:KV1.1

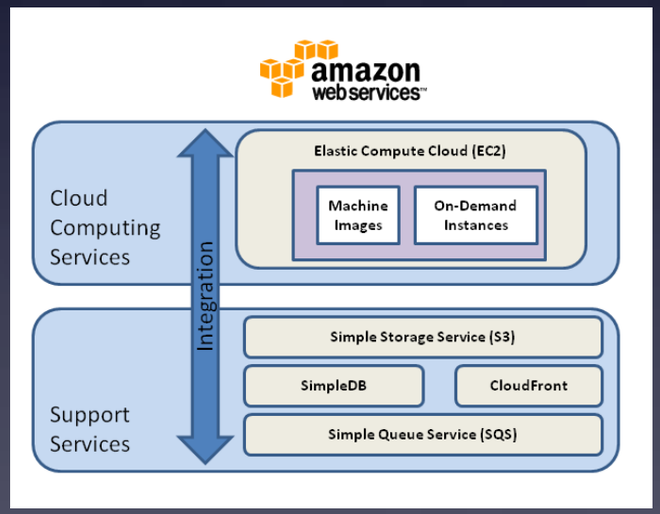
Modality: Protein structure

Spatial scale: 10 Ångstroms

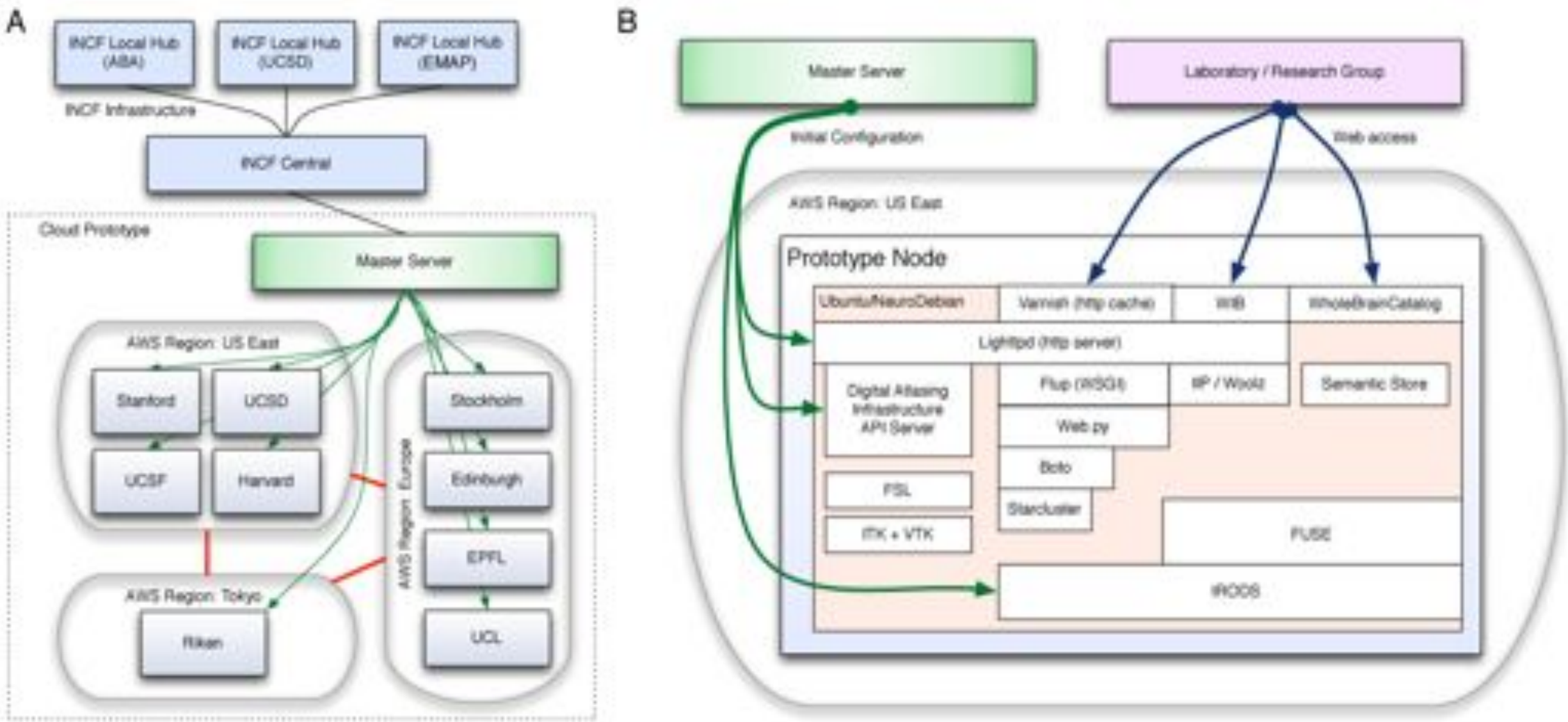
Molecular data

Cloud App

- Virtual machine image that can be run anywhere (or Fabric script for existing servers)
  - Lab server
  - Compute cluster
  - Amazon Cloud
  - Hosting service



INCF Cloud App
built on existing, tested technologies

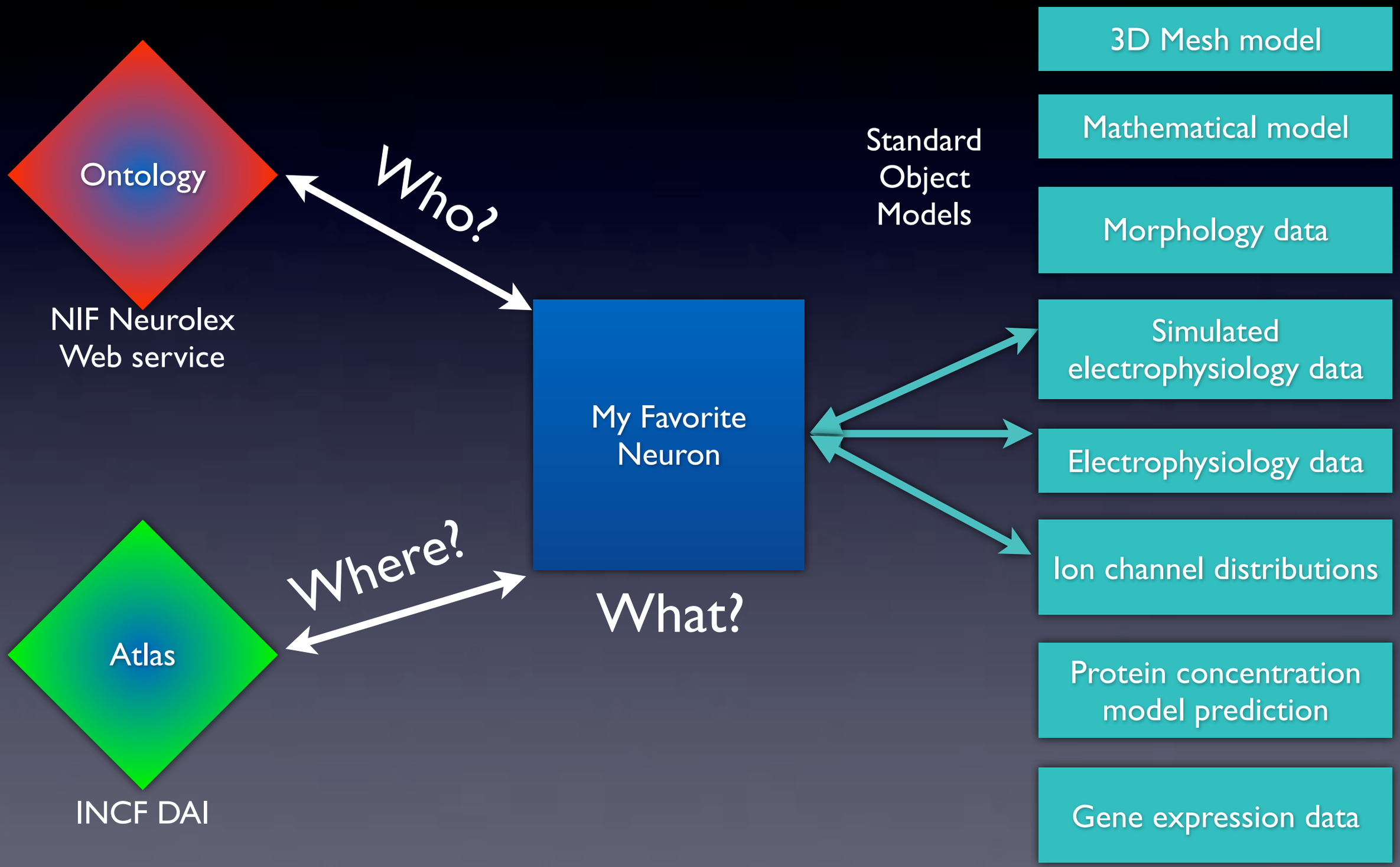


Rich Stoner, Stephen Larson, UCSD

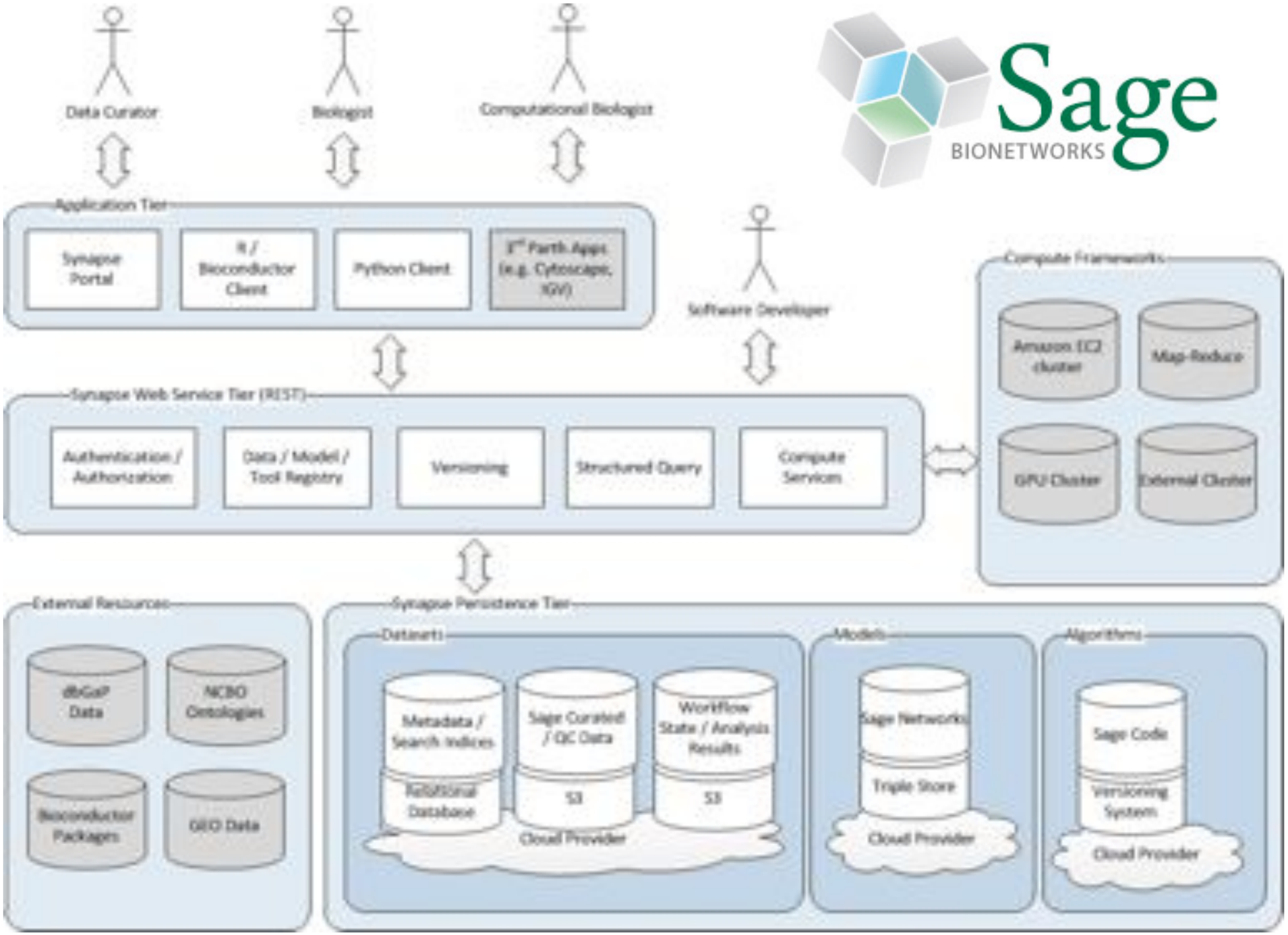
Key identifiers for data integration

- **Ontology**
  - Standardized names for metadata, species, developmental stage, brain structures, diseases, behaviors
- **Space**
  - Standard reference coordinate systems
- **Time**
  - Standard temporal references
- **Genetic identity**
  - Individual variation
- **GUID - Globally Unique Identifier**
  - Patient/citizen identifier

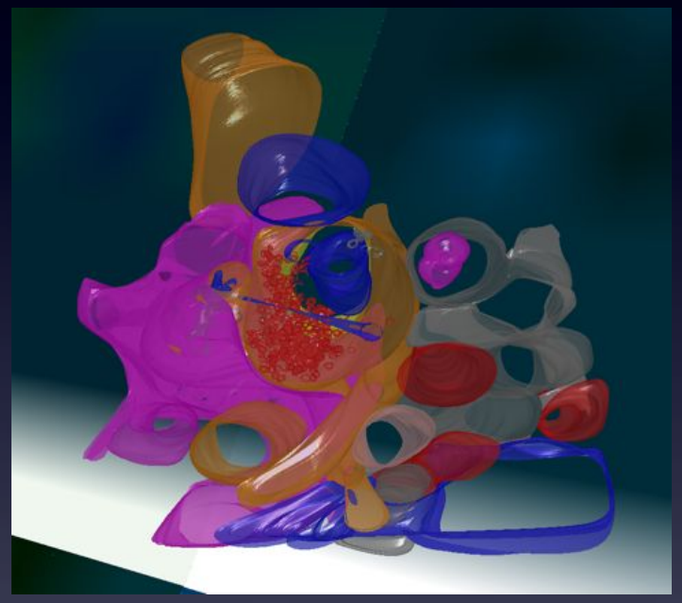
Data Integration:
Object Model for Neuroinformatics (OMNI)
Provides object-oriented view of data space

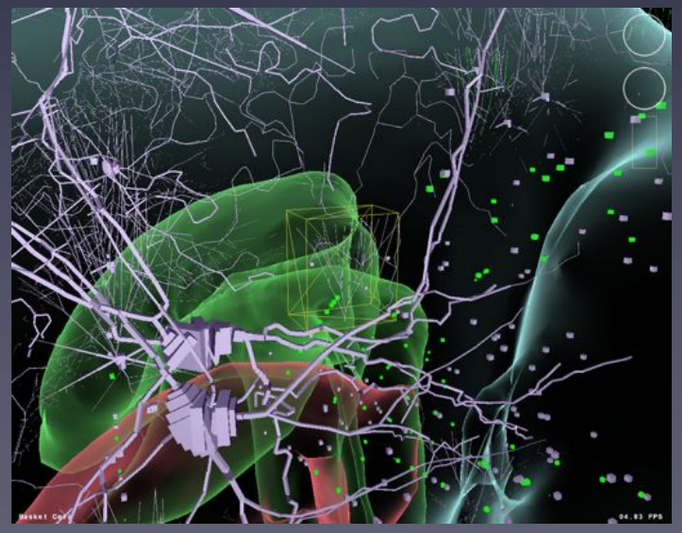


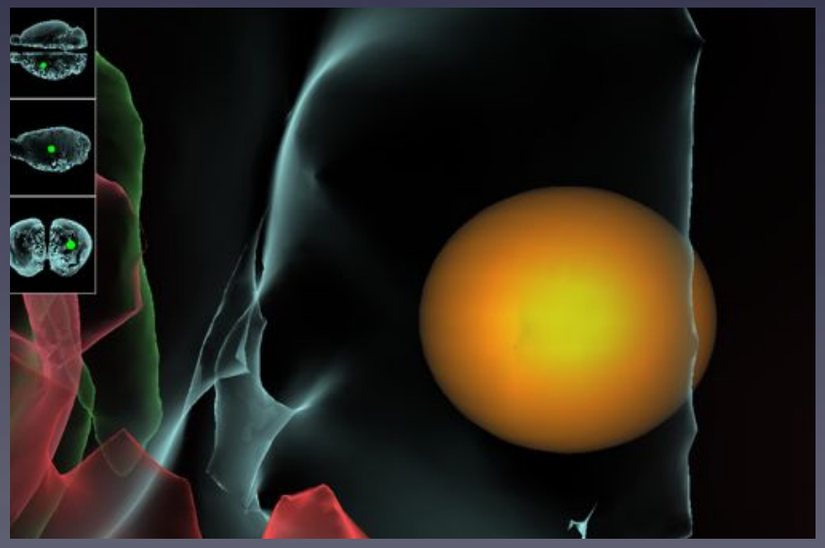
Synapse from Sage Bionetworks

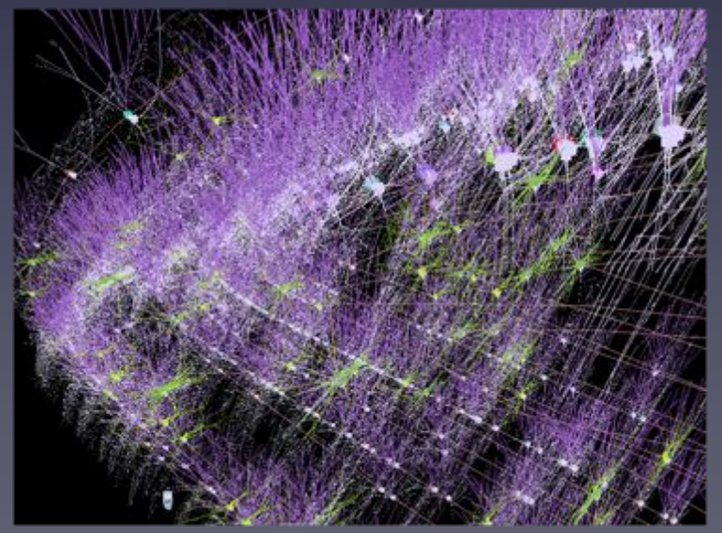


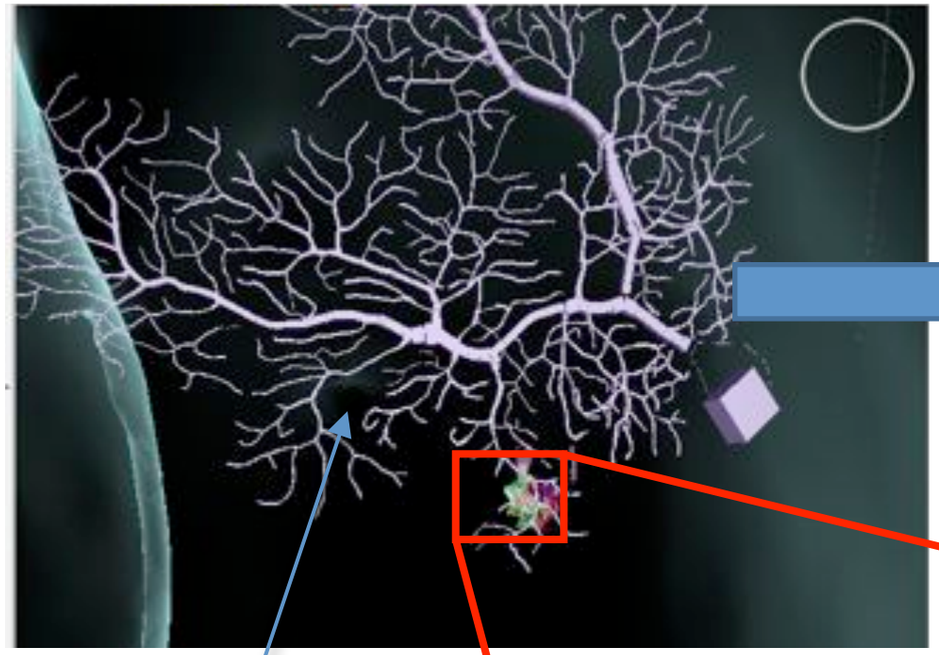
whole brain catalog

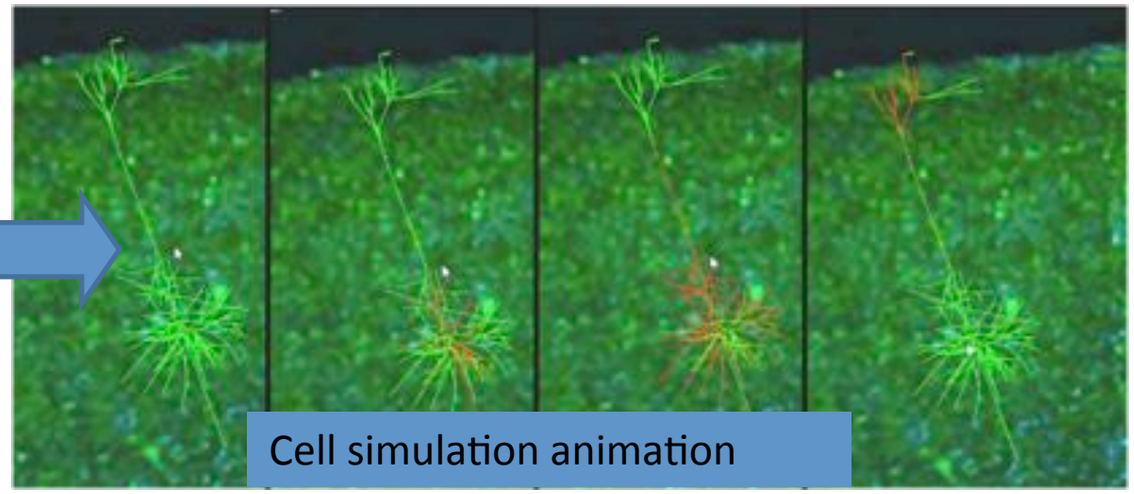






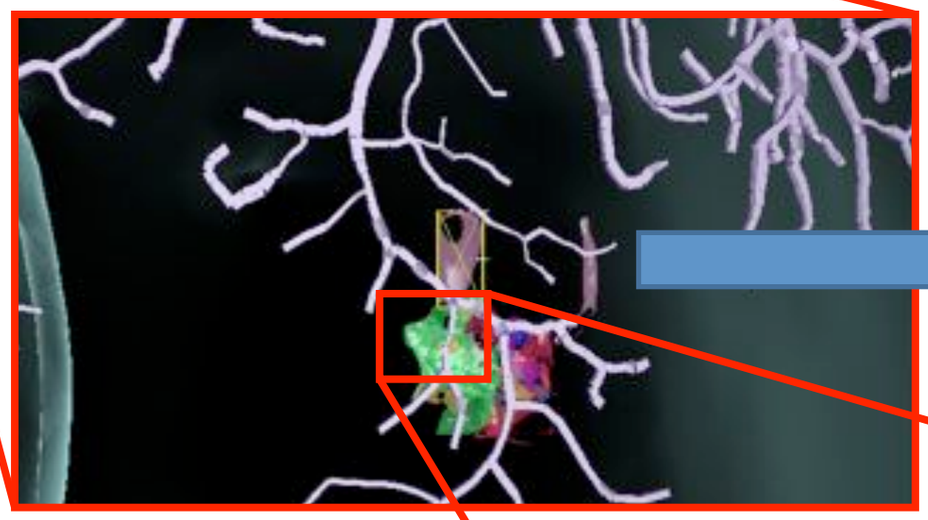


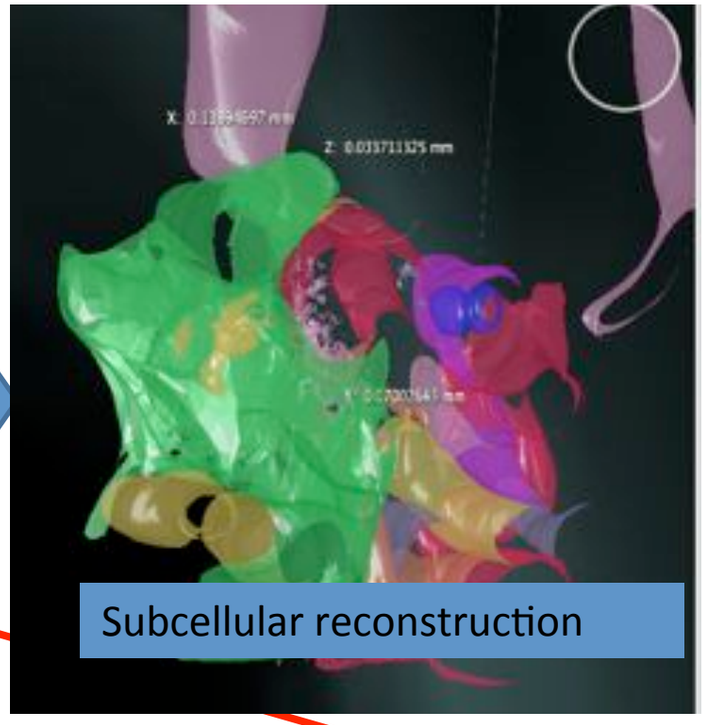




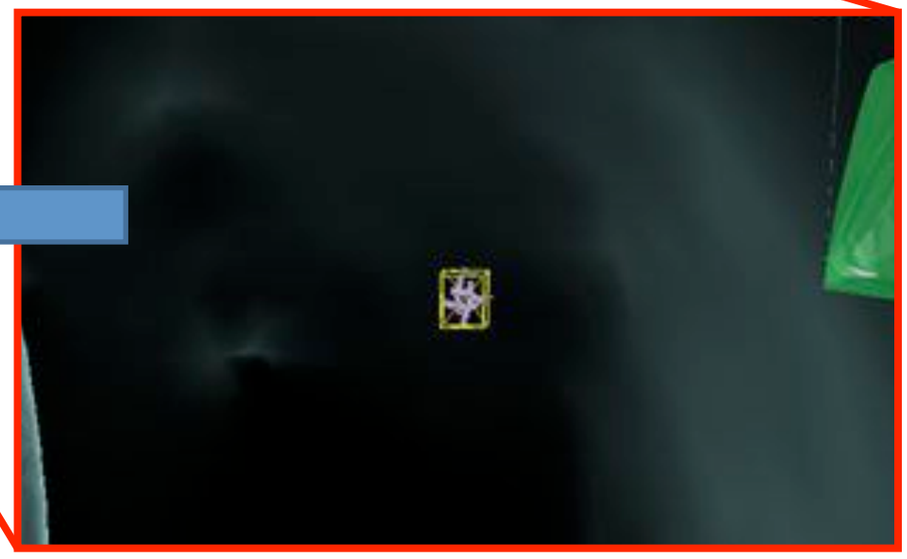
Cell simulation animation

Digital reconstruction from cell fill





Subcellular reconstruction



Potassium channel

whole brain catalog

Current Infrastructure Status

- Data Federation - INCF Cloud App
  - Runs on Amazon cloud or server. Includes data federation, digital atlasing services, semantic lookup, image stack browsing. http://software.incf.org/software/incf-cloud-app
- Ontologies - NIF/INCF Neurolex
  - Community site for developing ontologies, linking to data, models, literature. http://www.neurolex.org
- Digital atlasing infrastructure
  - http://atlasing.incf.org
- Data integration - INCF Omni
  - Data integration object model: http://code.google.com/p/incf-omni/
- UCSD/INCF Whole Brain Catalog
  - http://wholebraincatalog.org
  - Extend to include derived visual representations
  - Analytics layer

What already exists?

- International organization coordinating data sharing and integration for basic, translational and clinical data in neuroscience
- Partnerships with large projects that want to collaborate (Allen Institute, Blue Brain Project, One Mind for Research)
- Neuroscience Information Framework - www.neuinfo.org
  - Federated search of neuroscience data sources
- Neurolex
  - Community editable lexicon, web API to ontology resource
- Digital Atlasing Infrastructure
  - Standard APIs for spatial registration and query

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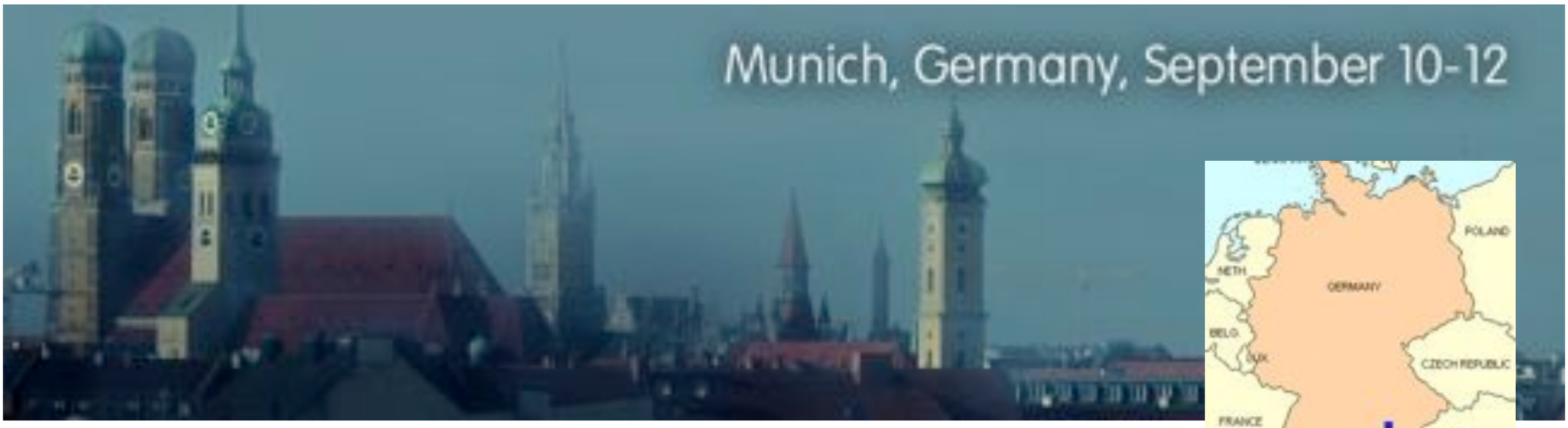
What could EUDAT provide?

- What about a GitHub for collaborative data infrastructures? Community repository of best practices
- Coordination of national infrastructures - establish interface for international community to request and deploy service hosting
- Interaction with task forces (Data management, AAI, PIDs, Hosting and Services) - Access to expertise

Looking for feedback, partners, data, use cases and integration with existing infrastructures!

Enable world-wide federated neuroscience data integration

incf | Neuro Informatics 2012



Keynotes from:
Gordon Shepherd, Atsushi Miyawaki, Michael Brecht, Sonja Grün, Russel Poldrack

Further information

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