

Maximizing Epilepsy Data Usage for Better Outcomes: Informatics and Common Language

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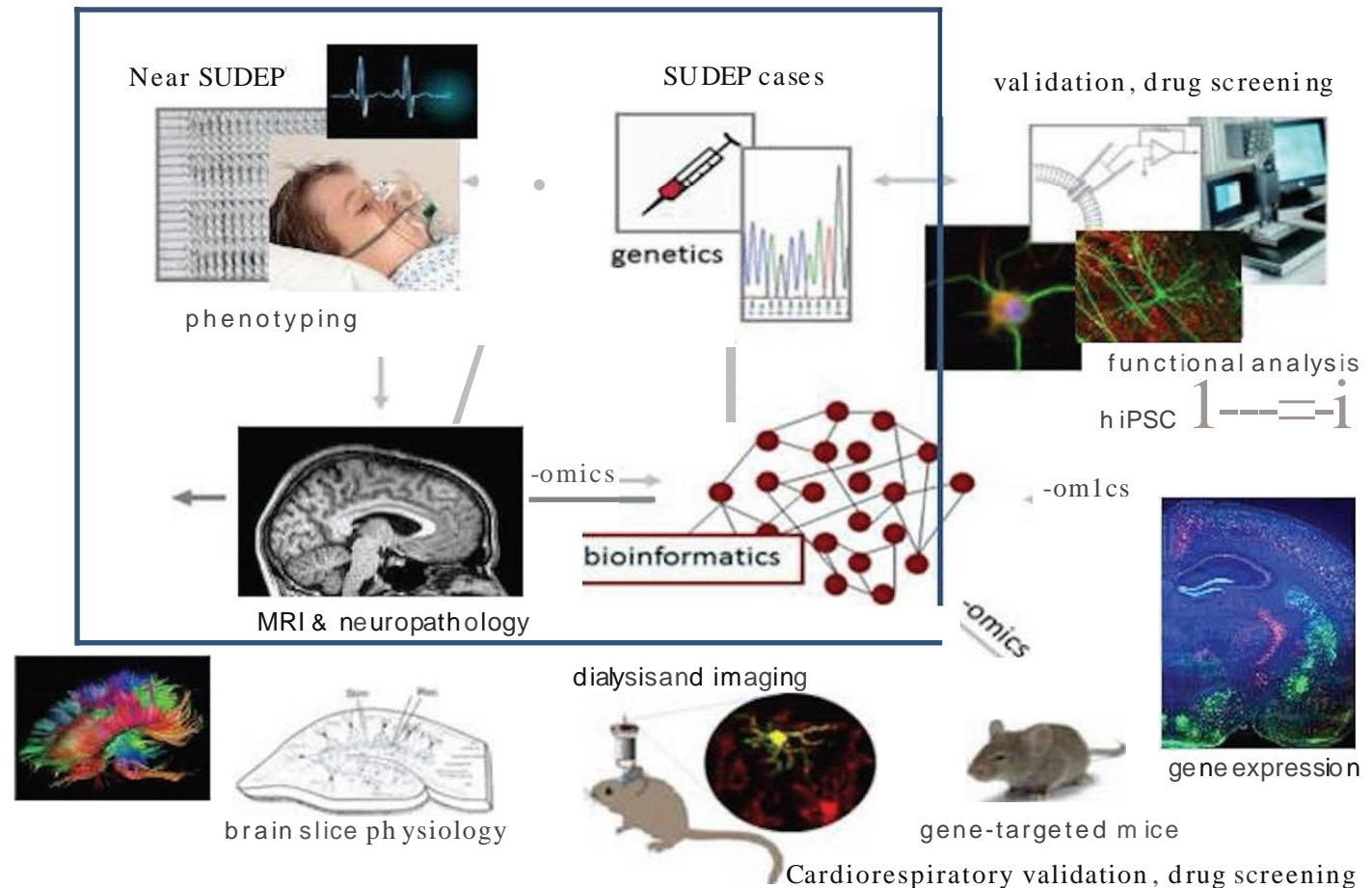
Case Western Reserve University

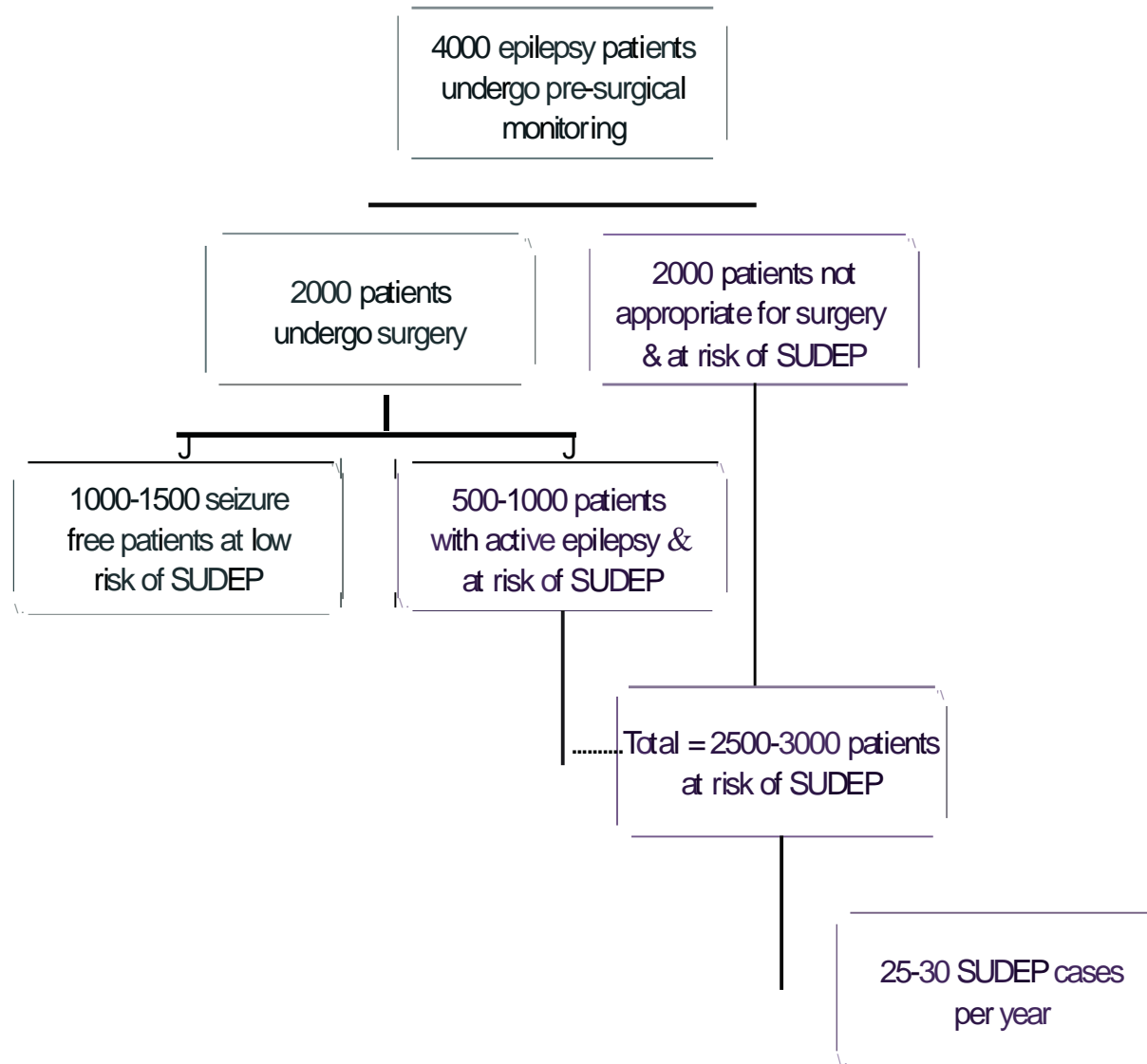
ICARE: Interagency Collaborative to Advance Research in Epilepsy

NIH Center for SUDEP Research {CSR}

Predictive genes, clinical biomarkers and basic mechanisms of SUDEP

BCM
Case
Columbia
Harvard
Jefferson
MIT
Northwestern
NYU
UC London
UCLA
UCSF
U Iowa
U Michigan



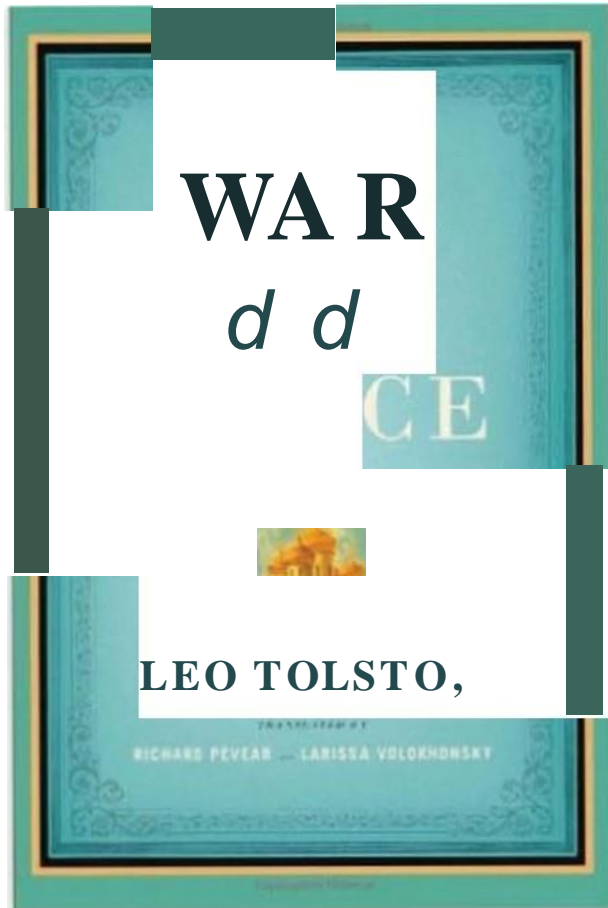


The Challenges

- Multi-center – each center follows different approaches
 - Disparate terminology
 - Paper based, Electronic documents
 - Distinct form structure
- Difficulty in post collection data analysis:
 - Patient cohort identification across centers
 - Uncovering disease association
 - Correlating signal data (EEG) across centers
- Data quality – without increasing workload or cost

- Focal dyscognitive seizure
- Complex partial seizure
- Dialeptic seizure





Classic Literature &
Fiction (6 055)
Literature & Fiction (32,940)
Historical {3,698}
Family Saga (357)
Literary (4,319)
War (1,176)
Military Historical Fiction (453)
History & Criticism (7,436)
Russian Literary Criticism (202)
Politics & Social
Sciences c 405)
Romance 935)

Author

Louise Shanks Maude
Richard Pevear
Larissa Volokhonsky
A. N. Wilson
Pat Conroy
Andrew Davies
Fyodor Dostoyevsky
Leo Tolstoy
Mona Simpson
Nina Nikolaevna Berberova
Alice Walker
Gore Vidal
Richard Tuck
Jimmy Carter
David Grossman

- The Requirements

- Consistent terminology – facilitates interoperability, data sharing
- Real-time data curation – range check, auto-completion
- Optimized data entry – skip patterns to dynamically change form structure
- Structured data stored in patient database – easy to query and analyze
- Shared resource – develop once, deploy at multiple locations
- Easy maintenance – changes are easily propagated

Informatics Highway: Interoperability and Integration



- Common Terminology System – upfront or backend
- Common Data Elements (CDE): NINDS CDEs
- Shared Meaning for Data Integration
- Accurate and Consistent Interpretation of Data

What Can Common Terminology Achieve?



- Reconcile different categories of heterogeneity:
 - syntactic heterogeneity:
Slow Spike and Wave complex vs. Slow Spike-and-Wave complex
 - structural heterogeneity:
ADNFLE vs Autosomal Dominant Nocturnal Frontal Lobe Epilepsy
 - semantic heterogeneity:
Focal dyscognitive seizure vs. Dialectic seizure vs. Complex partial seizure

Managing Epilepsy Well (MEW) Network Informatics



- 8 centers across US
- Multiple approaches for self management of epilepsy
- Integrated data from different studies for cohort studies and comparative analysis


Multi-Center Epilepsy Cohort Identification



- Integrate Multiple Studies






- Common Vocabulary




Insight! 
Clinical Research Platform

SELECT STUDY DATA ELEMENTS




List of Data Elements ▾

RACE   

Race ▾ Asian ✕ White ✕

EDUCATION   

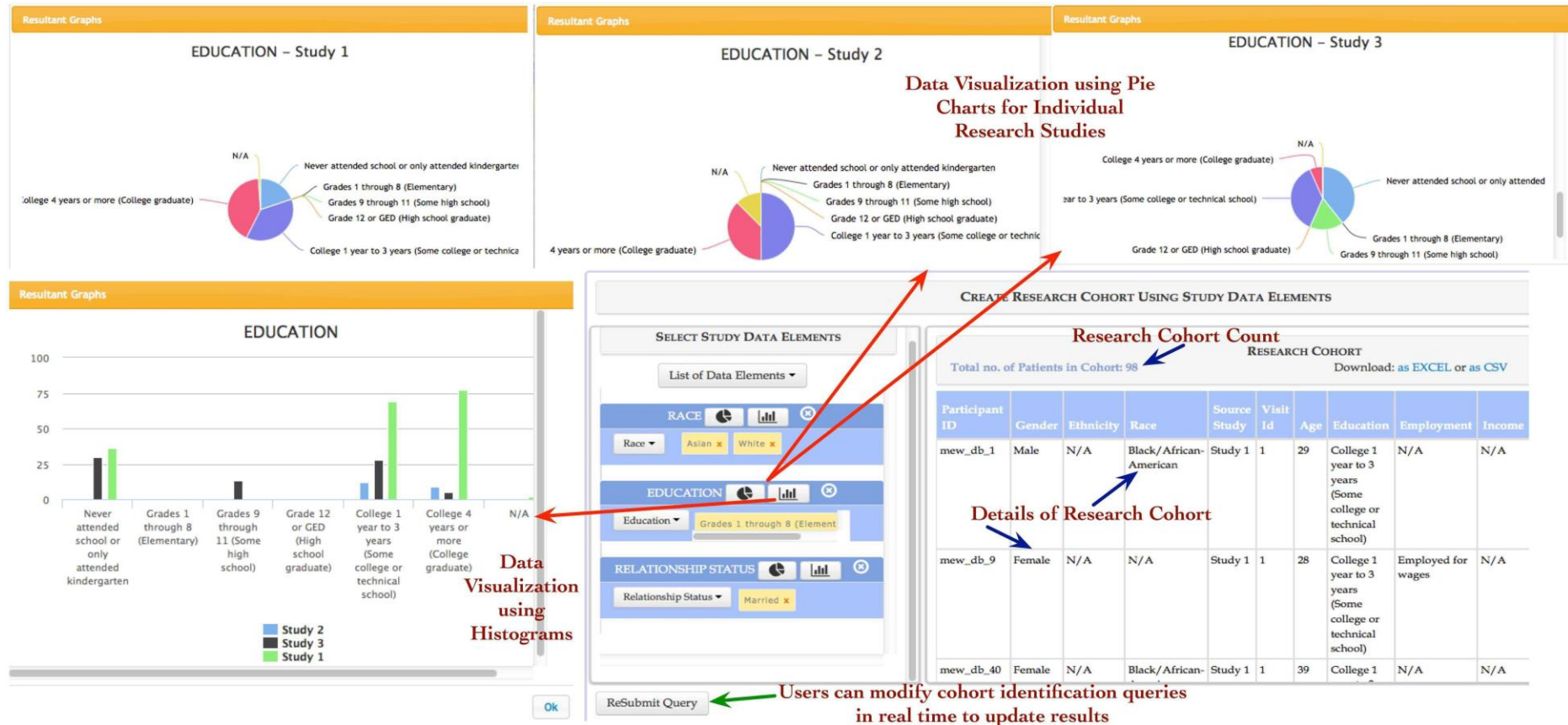
Education ▾ Grades 1 through 8 (Element

RELATIONSHIP STATUS   

Relationship Status ▾ Married ✕

Multi-Center Epilepsy Cohort Identification

Insight! Clinical Research Platform



Ontology-driven Patient Information Capture (OPIC)

- Structured data entry



▶ **DEMOGRAPHIC**

▶ **CHIEF COMPLAINT**

▼ **CLASSIFICATION OF PAROXYSMAL EPISODES**

Diagnosis	Epileptic Paroxysmal Episode ▼		
Epileptogenic Zone	Add ▼		
Seizure Semiologies			
Lateralizing Sign			
Etiology			
Related Medical Conditions			

Generalized

Hemisphere ▶

Anterior Head Regions

Posterior Head Regions

Multi Focal

Unknown

Unlocalizable

Temporal ▶

Frontal ▶

Parietal ▶

Occipital ▶

Central

Cingulate ▶

Insula ▶

Temporo-frontal

Temporo-parietal

Temporo-occipital ▶

Mesial Temporal ▶

Lateral Temporal

Basal Temporal

Temporal Pole

Temporo-opercular

Hippocampal

Amygdalar

Update

Ontology-driven Patient Information Capture (OPIC)

- High level of granularity



Add Seizure Type

Seizure Semiology **Add ▾**

Start From	Aura ▸	
	Autonomic Seizure ▸	dd/yyyy, mm/yyyy, or yyyy)
Frequency	Dyscognitive Seizure ▸	
	Motor Seizure ▸	Simple Motor Seizure ▸
	Special Seizure ▸	Complex Motor Seizure ▸

Epileptic Spasm

Tonic Seizure

Clonic Seizure

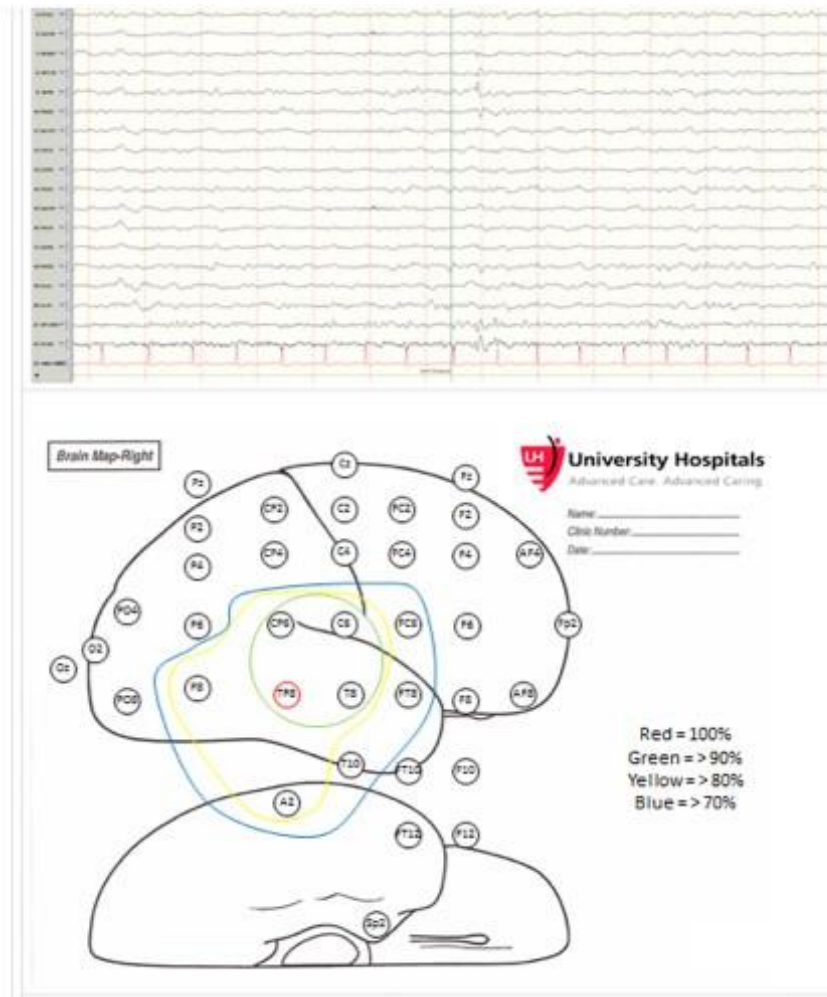
Tonic-Clonic Seizure

Myoclonic Seizure

Versive Seizure

Add or cancel

Ontology-driven Patient Information Capture (OPIC)



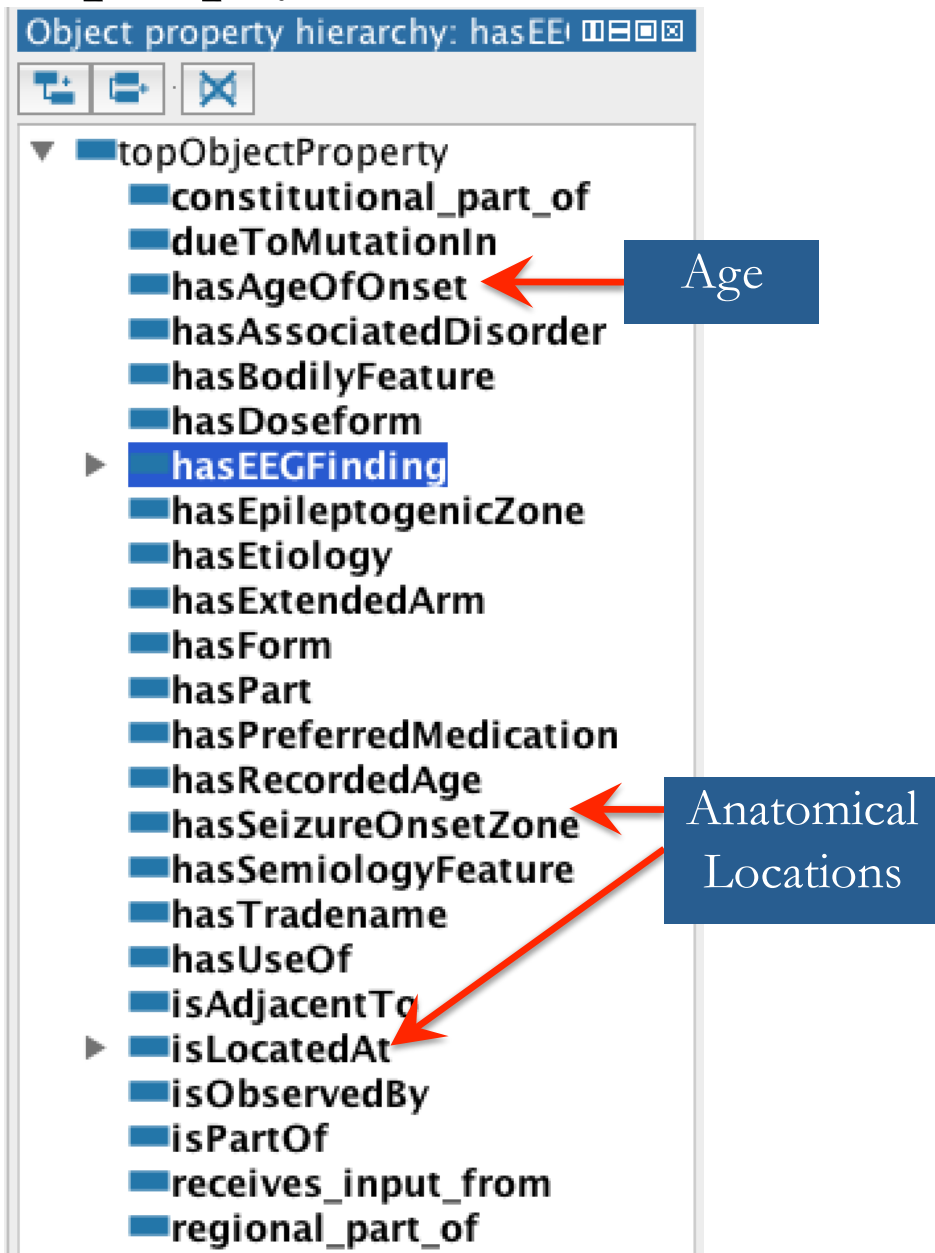
- Support embedding of multi-media images
- Data entered can be immediately queries
- Important for both care and clinical research
- Easier sharing across multiple collaborators

Epilepsy and Seizure Ontology

- ▼ ● Etiology
 - ▼ ● GeneticDefect
 - ChromosomalAbnormality
 - ▼ ● GeneticMutation
 - MitochondrialEncephalomyopathy
 - ▼ ● MetabolicCause
 - ▶ ● SubstanceAbuse
 - ▼ ● StructuralCause
 - ▶ ● BifocalEncephalomalacia
 - ▶ ● BirthInjury
 - ▶ ● BrainTumor
 - ▶ ● CerebralPalsy
 - ▶ ● CerebrovascularDisease
 - ▶ ● CorticalDevelopmentMalformation
 - ▶ ● HypoxicIschemicInjury
 - ▶ ● Infection
 - ▶ ● Inflammation
 - ▶ ● LeftFrontalAstrocytoma
 - ▶ ● LeftHemisphereTumorResection
 - ▶ ● LeftMesialTemporalLesion
 - ▶ ● Neoplastic
 - ▶ ● PrenatalBirthInjury
 - ▶ ● RightFrontalEncephalomalacia
 - ▶ ● RightFrontoParietalAbscess
 - ▶ ● RightFrontoTemporalGlioma
 - ▶ ● RightHemisphericStroke
 - ▶ ● RightMesialLesion
 - ▶ ● Sclerosis
 - ▶ ● TraumaticBrainInjury
 - ▶ ● VascularMalformation
 - ▶ ● UnknownCause

- Follows four-dimensional classification approach
 - Etiology
 - Seizures
 - Anatomical Location
 - Related Medical Conditions
- Uses Web Ontology Language (OWL2)
- Description Logic allows consistent and accurate interpretation of terms

Epilepsy and Seizure Ontology: Multi-axial Structuring



- **OWL2 Object Properties:**
Allows classification of ontology terms along multiple dimensions
 - Etiology
 - Anatomical Location
 - Genetics
 - Others...
- Objects properties link terms together: Networked terminological system

Epilepsy and Seizure Ontology: Links to Existing Terminological Systems

The screenshot displays a web application interface. On the left, a vertical list of drug ingredients is shown, each preceded by a yellow circle icon. The list includes: Amisulpride, Amitriptyline, Amoxapine, Amphetamine, Aripiprazole, Asenapine, Atomoxetine, Bupropion, Carbamazepine (highlighted with a blue background), Chlorpromazine, Chlorprothixene, Citalopram, Clobazam, Clomipramine, Clonazepam, Clozapine, Cyamemazine, Desipramine, Desvenlafaxine, Dexmethylphenidate, Dextroamphetamine, Diazepam, and Dosulepin. On the right, a detailed view for Carbamazepine is shown. It features a 'comment' field with the text 'Antiepileptic Drug', an 'isDefinedBy' field with a description of its uses, and two 'seeAlso' fields with URLs. Below this, a 'Description: Carbamazepine' section shows 'Equivalent classes' and 'Superclasses'. The 'Superclasses' section lists 'DrugIngredient' and 'hasTradename some (Carbatrol or Tegretol or TegretolXR)'.

▼ ● DrugIngredient

- Amisulpride
- Amitriptyline
- Amoxapine
- Amphetamine
- Aripiprazole
- Asenapine
- Atomoxetine
- Bupropion
- Carbamazepine
- Chlorpromazine
- Chlorprothixene
- Citalopram
- Clobazam
- Clomipramine
- Clonazepam
- Clozapine
- Cyamemazine
- Desipramine
- Desvenlafaxine
- Dexmethylphenidate
- Dextroamphetamine
- Diazepam
- Dosulepin

comment
"Antiepileptic Drug"

isDefinedBy
"Treats different types of seizures. Also used to treat nerve pain and bipolar disorder, also known as manic-depressive illness."

seeAlso
"RxCUI 2002"

seeAlso
"http://purl.bioontology.org/ontology/RXNORM/2002"

Description: Carbamazepine

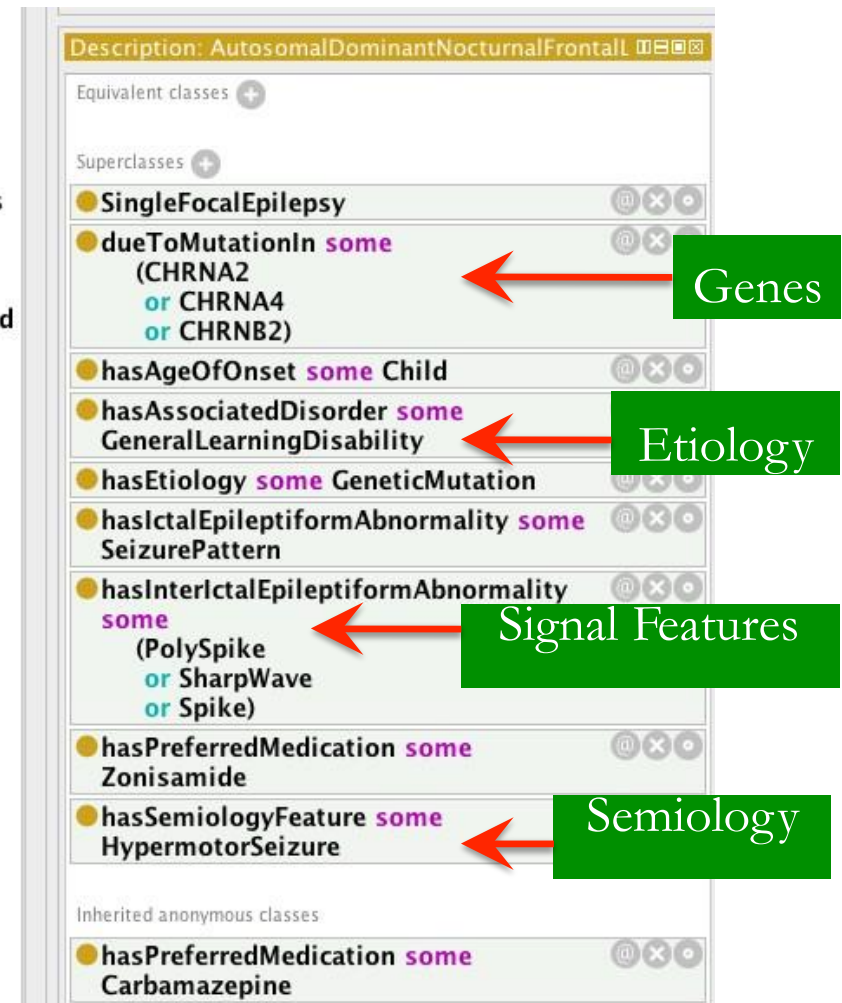
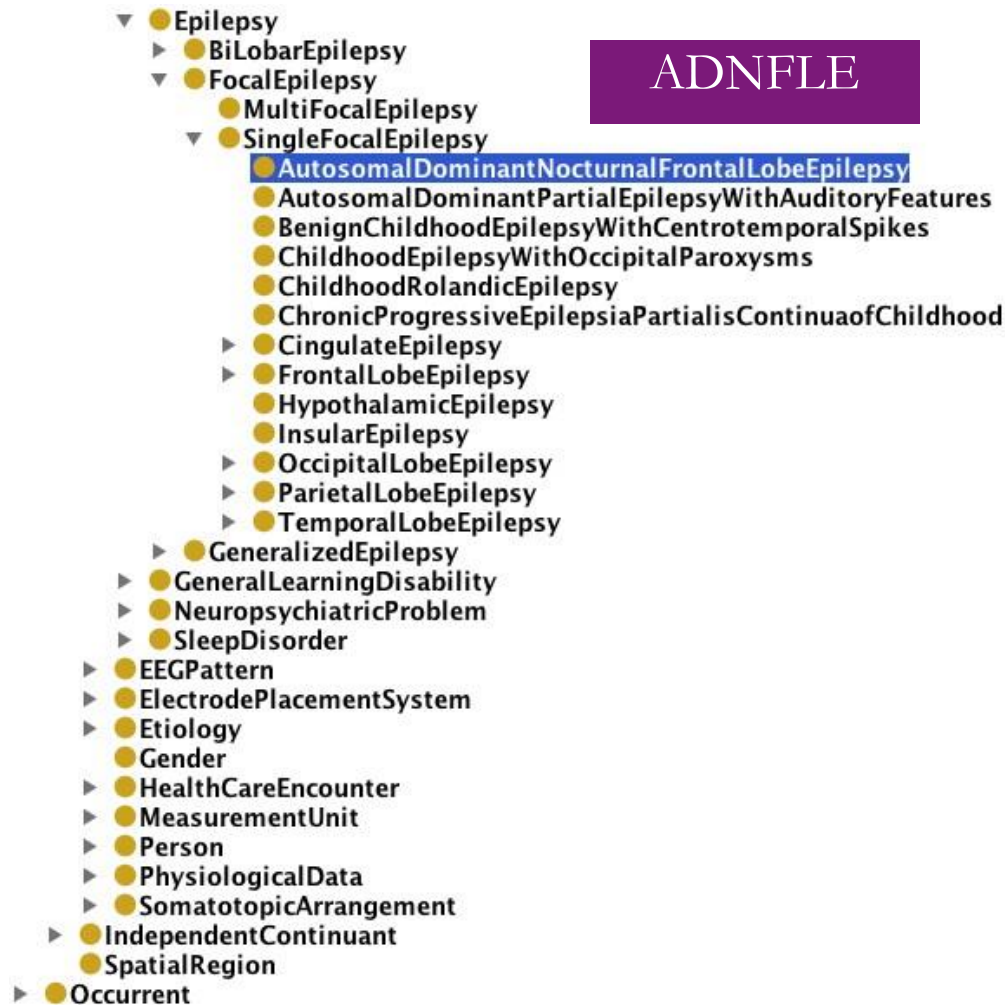
Equivalent classes +

Superclasses +

- DrugIngredient
- hasTradename some
(Carbatrol
or Tegretol
or TegretolXR)

- RxNorm: Developed by the NLM
- Gene Ontology
- Foundational Model of Anatomy (FMA) Ontology

Epilepsy and Seizure Ontology: Formal Model and Multi-Dimensional



Community Participation: Epilepsy Ontology Consortium

Epilepsy Ontology Consortium

Logged in as Admin. [Log out](#) 

1. Add Name of Syndrome

 Add New Syndrome

 [Edit Syndrome label](#)

2. Add Details of the Syndrome

List of Syndromes ▾

Childhood Epilepsy with Occipital paroxysms

Primary Reading Epilepsy

Parietal Lobe Epilepsy

Generalized Epilepsy with Febrile Seizures Plus (GEFS+)

Autosomal Dominant Nocturnal Frontal Lobe Epilepsy (ADNFLE)

Autosomal Dominant Partial Epilepsy With Auditory Features (ADPEAF)

Community Participation: Epilepsy Ontology Consortium


Epilepsy Ontology Consortium

Logged in as Admin. [Log out](#)

[Home](#)

Primary Reading Epilepsy

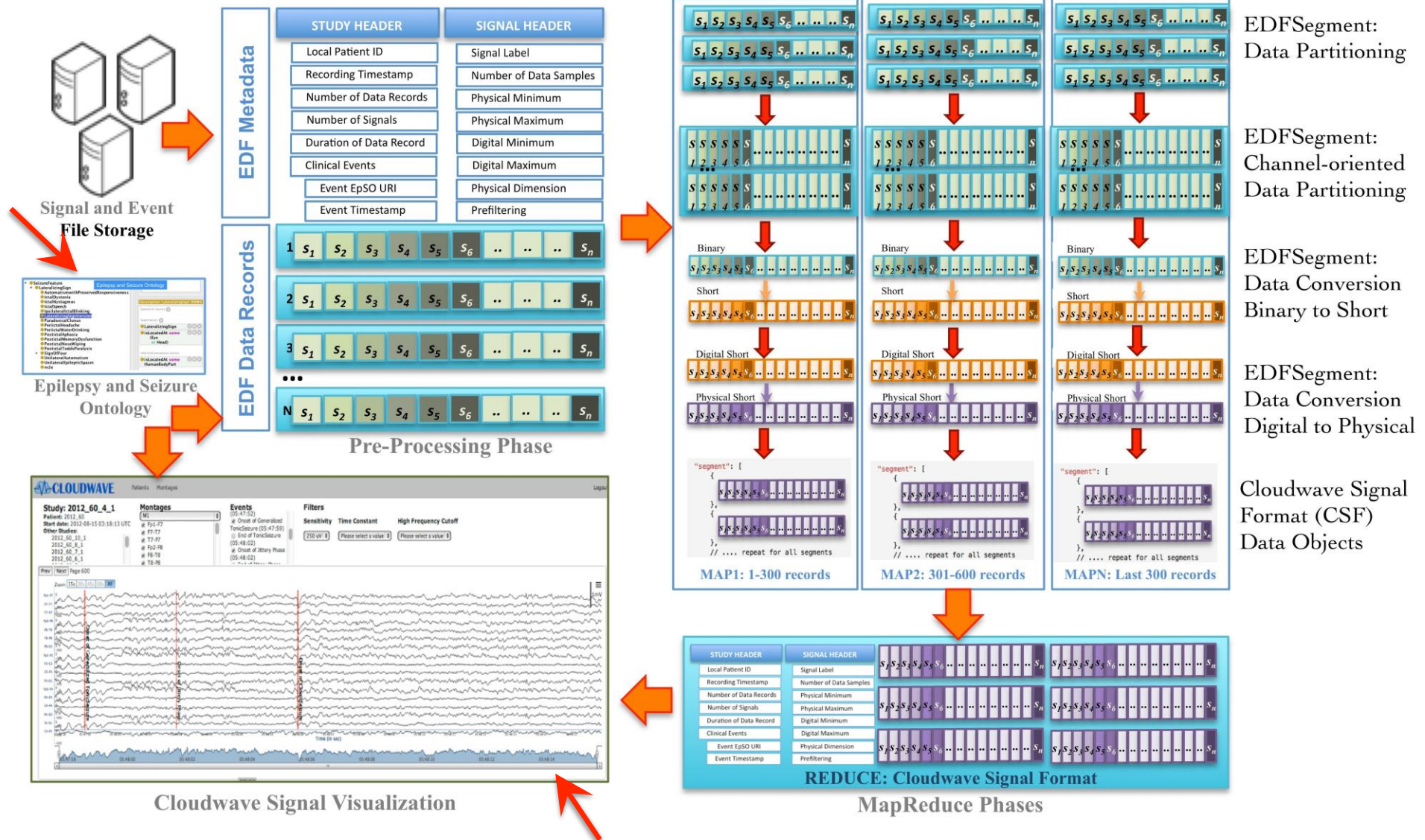
Existing User Entries

USER ID	CLINICAL FINDINGS				ETIOLOGY	MEDICATIONS OF CHOICE	EEG				MRI	GENES
	Age of Onset	Unique Clinical Features	Mental Retardation	Physical Findings			Ictal Onset Zone	Interictal Epileptiform Abnormalities	Interictal Non-Epileptiform Abnormalities	Ictal Epileptiform Abnormalities		
 Admin <small>Entry Date April 13th, 2015 17:12</small>	8 to 20 Years	Myoclonic Seizure			Genetic	Lamotrigine, Levetiracetam, Topiramate, Valproate, Zonisamide		PolySpikes, Spike-and-slow-wave Complex		Polyspike, Spike Slowwave Complex		CACNB4, CLCN2, EFHC1, GABRA1, GABRD

- Community participation through wiki-based features
- Interactive discussions and threads
- Community agreement towards a common epilepsy terminology

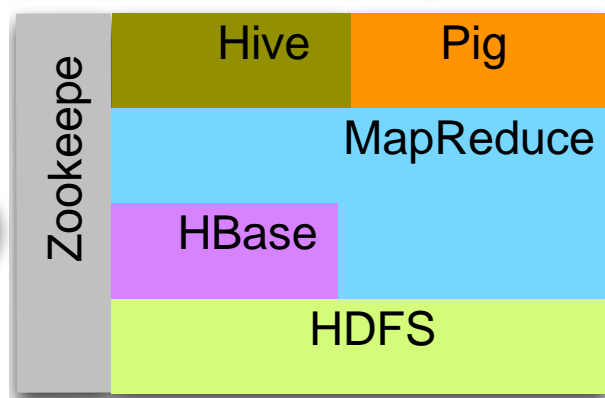
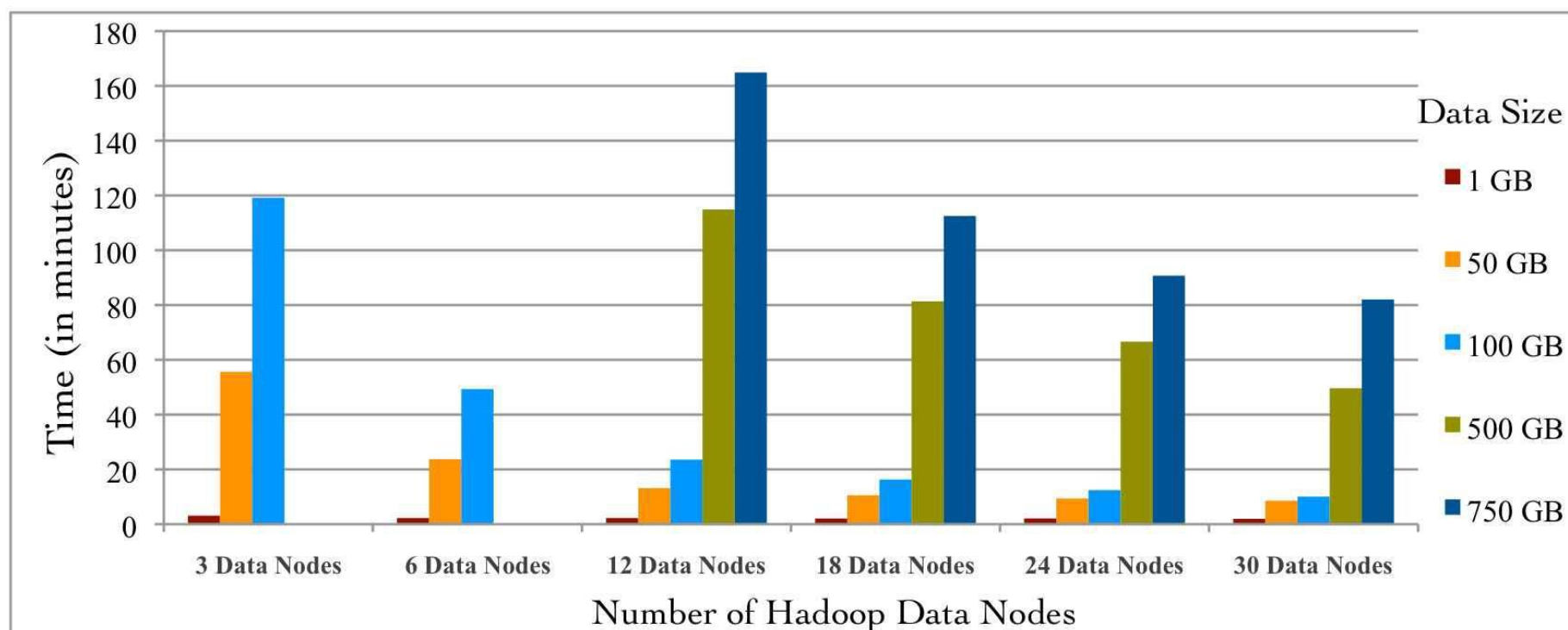
Ongoing and Future Directions: Neuroscience Big Data

- High performance computational pipeline for electrophysiological data



Ongoing and Future Directions: Neuroscience Big Data

Scalability and Adaptability of NeuroPigPen with Increasing Data Size and Hadoop Data Nodes



Acknowledgements

