HUMAN BRAIN PROGRAM RESEARCH PROGRESS IN NEUROINFORMATICS

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ABSTRACT- Neuroinformatics is science that research on particular field of neuroinformation and organization of neuroscience data. That concerned with the scientific study of biological cognition with a specific field focus on the neural of mental process. Which addressed in brain with psychology and cognitive functions are produced by neural circuits. Neuroscience is biology research field is related with molecular data, genes to cell expression, medicine, synapse structure, synapse system, engineering- electrophysiology, brain imaging, computer science- database, software tools, data acquisition, data visualization, data analysis, distributed neural system data, mathematical science- model, theoretical model, computational model, simulation model, chemistry- neurotransmitter, etc. that fields and subfields are theoretical and experimental studies learn about brain system and various levels. This paper identifies and difference three different directional views of Neuroinformatics: Database and tools for sharing and management of neuroscience data and analysis of all levels, Tools for modeling and analyzing neuroscience data, computational models of neural system and process.

Keywords-Neuroinformatics, Psychology, Cognitive function, Neuroscience, Molecule data

INTRODUCTION

Neuroinformatics is research field that organization that related with neuroscience, information science, bio-informatics. These areas is analysis and integrated large volume data, fine grain experimental data, high dimensional data, computational data, theoretical data, simulation data, acquisition data, virtualizations data, analyzed data, distributed neural system data etc. Neuroscience added data from many areas or fields behavioral neuroscience, cognitive psychology, behavioral genetics, understanding the brain process system and finding the meaningful way to share data into the neuroinformatics system for study.

Neuroinformatics is introduced in 1989 from the United States National Institute of Mental Health (NIMH), National Science Foundation (NFS), National Institute of Drug Abuse (NIDA) that provide the funds to National Academy of Sciences Institute of Medicine for study, analysis and share neuroinformatics data.The data of neuroinformatics has been studies in many fields as well as brain aging, neuro degeneration, cellular neuroscience, molecular neuroscience, genomic neuroscience, behavioral neuroscience, cerebrospinal fluid, cognitive neuroscience, neuropsychology, computational neuroscience, neurology, developmental neuroscience, evolutionary neuroscience, neuroanatomical, stem cell and transplantation, neurooncology, neuropathology, neuroophthalmology, neuropharmacology, psychopharmacology, sleep medicine, neurophysiology, neurorobotics, psychiatry, neuroprosthetics, neuroradiology, neurosurgery, neuroimaging, neuroscience methodology, synaptic neuroscience, systems neuroscience, neurobiology, neuroendocrinology, neurochemistry, neuroimmunology, neurotoxicology, neuromorphic engineering, etc.

NEUROINFORMATICS

Neuroinformatics [1] is sciences that organize, manipulate, analyze, the large volume data, fine grain experimental data, high dimensional data, computational data, theoretical data, simulation data, acquisition data, virtualizations data, analyzed data, distributed neural system data etc. That provides computational application and tools, mathematical models, management and sharing neuroscience data, level based analysis, modeling of neuroscience data, neuroscience informatics database, computational models of neural system and process etc.

Neuroinformatics has three main directions that can be applied to study are [2]:

- Database and tools for sharing and management,
- Tools for analyzing and modeling neuroscience data,
- Computational models of neural system and processes.

Neuroscience is fields that connected from many sub-fields brain aging, neurodegeneration, cellular neuroscience, molecular neuroscience, genomic neuroscience, behavioral neuroscience, cerebrospinal fluid, cognitive neuroscience, neuropsychology, computational neuroscience, neurology, developmental neuroscience, evolutionary neuroscience, neuroanatomical, stem cell and transplantation, neurooncology, neuropathology, neuroophthalmology, neuropharmacology, psychopharmacology, sleep medicine, neurophysiology, neurorobotics, psychiatry, neuroprosthetics, neuroradiology, neurosurgery, neuroimaging, neuroscience methodology, synaptic neuroscience, systems neuroscience, neurobiology, neuroendocrinology, neurochemistry, neuroimmunology, neurotoxicology, neuromorphic engineering, etc.

Neuroscience provides types of data and information that used to studies, examination, investigations, research and development and neuroinformatics operations are following [3]:

- Cellular data and molecular (e.g. genetics, protein pathway, ion channel, cytology of neurons, action potential)
- Information for development (e.g. growth factor, cell survival, neuronal differentiation, synaptic formation, injury and regeneration, motor differentiation, axon guidance)
- Neural engineering data (e.g. brain computer interface)
- Cognitive data (e.g. emotion, language, sexual behavior, motor learning, social neuroscience, decision making)
- Information of aging and diseases (e.g. Parkinson's diseases, addiction, memory loss, autonomic neural system, depression, anxiety)
- Computational neuroscience data (e.g. computational models of various types of neural network system, membrane current circuits, proteins to memory and learningbrain addressed occupy)
- Systems and organs data (e.g. spinal cord, visual cortex, taste, pain, sensory system, audition, motor system, perception)

Research groups and activities are following:

- The Cognitive Atlas is research activities that aims to provide and share knowledge of cognitive science and neuroscience.
- The Neuroinformatics Portal Pilot is research activities project that exchange the neuroscience data, function modeling software, structure and process modeling software, data analysis tools. And is promoted from German Ministry for Science and Education.
- Genes to cognitive project is a neuroscience research program their studies of genes, brain and behavior activities. In that large scale examination of molecules functions, synapse mainly focused on proteins interact with NMDA receptor.
- Genenetwork is established in 1999 from National Institute of Health (NIH) started Human Brain Project which is focus on genetic analysis of brain function, structure, and process.
- The Blue Brain Project is started in 2005 from IBM that studies on to understanding brain structure, function and process of different species.
- The Japan National Neuroinformatics resource as well as Visiome Platform is the neuroinformatics search service that aims to provides data access visualization of data, analysis data, simulation and experiments, Data analysis libraries, mathematical models, experimental data and related resources.
- The Neuronal Time Series Analysis (NTSA) is a project is aim to develop information system of database, organization of data, storage information in meaningful way, visualization of data, simulation environment, analysis data, share simulation and experiments.
- The CARMEN project is collaboration of 11 universities of United Kingdom research project aims to using GRID computing for experimental process.

- Neuroscience Information Framework (NIH) provide blueprint for studies whish was establish in 2004 from National Institute of Health.

Neuroinformatics mainly data collaboration or interaction with following sub-field of study:

- Neuroscience
- Computational Neuroscience
- Behavior Neuroscience
- Cognitive Neuroscience
- Neural Network and Neuroscience
- Experimental Neuroscience
- Neuroscience and Intelligence
- Computational Anatomy

NEUROSCIENCE

Neuroscience [4] is the branch of biology scientific study process of neural system, function, process, and structure. Neuroscience collaborates with other field that helps in study process such as cognitive science, medicine, chemistry, genetics, mathematics, engineering, computer science, linguistics, neurology etc.

The scope of neuroscience [5] different approaches studies neural or nervous system, function, structure and process, molecular, computational, cellular, evolutionary, developmental, functional, structural it is used from neuroscientists, neuroscience organization, and educational.

Modern neuroscience is used in education and scientific research activities approaches into major branches as system examination for experimental approaches are following:

- Clinical neuroscience
- Cellular neuroscience
- Behavior neuroscience
- Affective neuroscience
- Cognitive neuroscience
- Computational neuroscience
- Neuroimaging
- Neurroiformatics
- Cultural neuroscience
- Neuroheuristics
- Neuroengineering
- Neuroethology
- Molecular neuroscience
- Developmental neuroscience
- Evolutionary neuroscience
- Social neuroscience
- Neurolinguistics
- Paleoneurology
- Neurophysics
- Neurophysiology
- Neuropsychology
- System neuroscience

COMPUTATIONAL NEUROSCIENCE

Computational Neuroscience [6] also known as theoretical neuroscience is study of brain function, structure in terms of information processing that make neural system, structure, processes etc. It is a science or

complex system that links with related with fields, bioengineering, neuroscience, cognitive science, neurology, psychiatry, neurobiology, physics, philosophy, linguistics, neuropsychology, mathematics, computer science, engineering and computational modeling etc.

Computational neuroscience is capture data from multiple way and processed in computational form machine learning, computational learning theory, neural networks, system, function and structure, models capture of biological system, membrane currents, proteins, chemical coupling of brain networks, topographic architecture, learning, memory system (working memory, semantic memory, instrumental learning, episodic memory, motor learning) etc.

Computational neuroscience is used in modern education and scientific research activities approaches into major branches as system examination for experimental approaches are following:

- Single neural modeling
- Computational clinical neuroscience
- Development
- Guidance and axonal patterning
- Consciousness
- Sensory processing
- Cognitive function
- Learning and discrimination
- Behaviors based networks
- Synaptic plasticity and memory

BEHAVIOR NEUROSCIENCE

Behavioral neuroscience [7] or biology psychology or biopsychology or psychobiology is the field of biology in which study of genetics, physiological, and developmental mechanisms of behavior in animals and humans. It typically studies of system examination, investigation for experimental approaches all level of brain circuits, function, structure, process, neurons, hormones and evolutionary, neurotransmitters, and the development process of abnormal and normal behavior. In experimental approaches behavior neuroscience involves animal model that used for studies better understanding human body structure, function, behavior, development process etc. therefor contribute to studies of system examination, investigation, experiments, and evidence based practice. Human is an experimental subjects in behavior neuroscience experiments, behavior neuroscience comes from to study of non-human body function, structure, process, genetics, development behavior etc. As an experimental, or examination, or investigation results closely relationship with other fields psychology, neurobiology, evolutionary biology, and evolutionary psychology.

Neuroscience is used in modern education and scientific research activities approaches into major branches as system examination for experimental approaches are following:

- Enhancing neural function
- Genetic technique
- Decreasing Neural Function
- Measuring neural activity
- Decision making and reasoning
- Perception and sensation
- Emotion
- Motivated behavior
- Memory and learning
- Movement control
- Biological rhythms

COGNITIVE NEUROSCIENCE

Cognitive neuroscience [8] is a science and research field in that studies about biological structure, function, process specific focus on the neural structure, process of networks, function, development with brain function, structure and process. It controlled and address access from brain with psychological and cognitive functions that are processed from neural circuits with complex neural system networks. Cognitive neuroscience is a branch that theoretical approaches studies from sub-fields psychology, computational neuroscience, cognitive psychology, neuropsychology, physiology psychology, bioengineering, mathematics, psychiatry, philosophy, neurology, physics, linguistics, and computer science. And methods of cognitive neuroscience experimental approaches are studies from computational model, behavior genetics, transcranial magnetic stimulation, gestalt theory, magnetoencephalography,psychophysics, cognitive psychology, cognitive genomics, electroencephalography, positron emission tomography, functional neuroimaging, functional magnetic resonance, and electrophysiology.

Cognitive neuroscience major approaches to studies are following:

- Transcranial magnetic stimulation,
- Gestalt theory,
- Magnetoencephalography
- Electroencephalography
- Positron emission tomography
- Functional neuroimaging,
- Functional magnetic resonance, and
- Electrophysiology

NEURAL NETWORKS AND NEUROSCIENCE

Neural networks and neuroscience [9] is fields that models inspired from biological neural networks is studies data come from neuroinformatics. The neural network is branch to study comes from biology that are family of models inspired by biological complex neural networks system that studies on brain system, function, process and structure of human and animal or non-human spices. It represents as system that interconnected through neurons which swapping message from one node to another node. And it has been used to solve machine learning methods, rule based programming, speech recognition, computer vision etc. methods. Neural network used only one or two layers of single or signal directions logic that added multi-input from many direction feedback layers and loops. That whole system used brain inspired algorithms and programming that controls and organizes their function. That can be learn from outside environments, self-written rules, experience, emotion, motivation, perception, attention, social, culture, and any other learning or educational environment etc. Theoretical and computational is the branch that connected with the computational modeling of biological neural system and theoretical analysis. The aims of the fields to make model of biological neural system to understand biological systems works, biological data processes, biological mechanisms, neural networks information, neural networks learning techniques, and theory of statistical learning theory and information theory processing into the brain.

Neural networks and neuroscience is used in education and scientific research activities approaches into major branches as system examination for experimental approaches are following:

- Regression analysis or functional approximation
- Pattern, classification, and sequence recognition
- Detection and sequential decision making
- Data processing
- Data filtering
- Data clustering and binding
- Data source compression and separation

EXPERIMENTAL NEUROSCIENCE

The experimental neuroscience that represent information with the use of modern technologies as well as graphical representation.

Modern methodologies or technology are computation model, mathematics for problem solving, analyzing tools, measuring efficiency, data processing, data filtering, clustering and binding, decision making, function analysis, etc.

Experimental neuroscience is used in modern education and scientific research activities approaches uses tools [10], analysis, methods, as system examination for experimental approaches are following:

- Explore DTI use as fiber tractography and MRI.
- Amira 3D use as analysis and visualization.
- Bioimage suite
- BESA (Brain electrical Source Analysis)
- Brain VISA
- CamBA
- Camino Open-Source toolkit use as MRI
- CONN (functional connectivity toolbox)
- COINS (Collaborative Neuroimaging and Informatics Suite)
- FMRIB software library
- Freesurfer
- FMRLAB
- Brain Image Analysis Package
- BrainSuite

NEUROSCIENCE AND INTELLIGENCE

Neuroscience and intelligence [11] is referring to collection information through modern technology and focus on neurological factors. This factor is responsible for type of intelligence within species and different different types of species. Research in this field has been focus on large amount of neural basis of human intelligence as well as brain weight measured, brain volume has been examination, or investigation, from various types of methodologies modern technique such as transcranial magnetic stimulation,magnetoencephalography, gestalt theory, electroencephalography (EEG), positron emission tomography, Functional neuroimaging, functional magnetic resonance, and electrophysiology, magnetic resonance imaging (MRI), measures of brain activity and structure, and functional MRI (fMRI). That is useful information for researcher activities and educational activities purpose to identify intelligence within brain structure, process, neural system controlled activity, and its functionality. These studies is include overall focused on brain volume, white matter volume, grey matter volume, white matter integrity, neural efficiency, cortical thickness, and understanding the process of neural network based human intelligence growth increased its depends on age.

Neuroscience and intelligence is used in modern education and scientific research activities approaches into major branches as system examination for experimental approaches are following:

- White matter
- Gray matter
- Brain volume
- Brain size
- Neural efficiency
- Cortical thickness
- Cortical convolution

- Theory of intelligence

COMPUTATIONAL ANATOMY

Computational Anatomy [12]is a research activities is studies of medical imaging that related with development and application of data analytical and theoretical methods, computational simulation techniques and mathematical modeling for study of function, shape, structure, process in various types of species. The fields of computational anatomy is included various sub-fields as well as statistics, neuroscience, probability, physics, mathematics, applied mathematics, computational science, computational mechanics, and medical imaging etc. its information processed as in knowledge base purpose to share studies, experiments, or examination, or investigation into the neuroinformatics.

Computational Anatomy is used in modern education and scientific research activities approaches into major mathematical methodologies as system examination for experimental approaches are following:

- Surface matching
- Surface volume matching
- Metamorphosis represent orbit model
- Curve matching
- DTI matching
- Dense Image matching
- Deformable Template Model

CONCLUSION

Neuroinformatics is research related activities as well as information processed from various fields neuroscience, computational neuroscience, behavior neuroscience, cognitive neuroscience, artificial neural network, experimental neuroscience, neuroscience and intelligence, and computational anatomy is that used to studies, examinational activities, or investigation activities, or experimental activities that can be stored in neuroinformatics knowledge database as to share.Neuroscience provides types of data and information that used to studies, examination, or investigations, and research studies Cellular data and molecular, Information for development, Neural engineering data, Cognitive data Information of aging and diseases, Computational neuroscience data, Systems and organs data.

In this research paper neuroinformatics studies on various fields or branch for, examination, investigations, research, development and neuroinformatics operations, data processing, analysis, tools, visualization of data, simulation environment and various sub-fields are computational modeling, statistics, neuroscience, probability, physics, mathematics, applied mathematics, computational science, computational mechanics, and medical imaging etc. That various kind of field make a sharable meaningful knowledge database for studies and various kind of research group are summarized.

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