Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v31i3.5199

INFORMATION AND REPORTING MODULE FOR THE ELECTRONIC MEDICAL RECORDS (EMR) DATA ARCHIVE

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ABSTRACT:

Objective: This study outlines the development of a statistical and reporting module aimed at addressing challenges in monitoring, classifying, and extracting meaningful information from the extensive neuroscience database maintained by the Electronic Medical Records (EMR). The primary goal is to enhance the representativeness of data and facilitate efficient analysis for the benefit of neuroscience researchers.

Methods: The identified limitations in the current system prompted the creation of a module incorporating Python programming, Postgre SQL data management, Django development framework, Visual Paradigm modeling, and Django development language. These technologies and tools were strategically employed to establish a robust statistical and reporting system capable of handling the vast amounts of data in the archive.

Results: The implementation of the module is anticipated to revolutionize data management at the Electronic Medical Records (EMR). By providing features for representativeness from diverse perspectives and enabling the extraction of valuable information, the module aims to assist neuroscience scientists in their research and application scenarios.

Conclusion: The utilization of advanced technologies in the development of this module signifies a significant step toward overcoming challenges associated with data analysis and reporting in neuroscience research. Upon integration into the repository, the module is poised to offer metadata and archived data information, aligning itself with global standards in neuroscience data management.

Keywords: Neuroscience databases; data archives; statistical analysis; data management; Python programming; Postgre SQL; Django development; Visual Paradigm modeling.

INTRODUCTION:

The field of neuroscience, comprised of various sciences, currently conducts essential research, mainly since these sciences are all aimed at investigating the structure and functional organization of the nervous system, particularly the brain, from various angles. The term "neuroscience" is relatively new in biomedical sciences; its current usage reflects the need to integrate the contributions of various scientific research fields and clinical sciences to comprehend how the nervous system functions. This field of study encompasses everything from neural activity to the behaviour of living things and is responsible for studying the nervous system (Fernandez et al., 2022).

Knowledge of how the normal brain functions advances understanding of the neurobiological anomalies that give rise to mental and neurological illnesses. Neurodata is a term used in neuroscience that refers to data collection about brain activity acquired via cutting-edge neuro-technologies. These instruments, referred to as "neurotechnologies," are used to study and modify the human nervous system, particularly the brain. Many neuroscience-based platforms and projects have been established (Gonzalez et al., 2023).

These were created assuming brain data would be processed and analyzed for further research, the primary objective being to identify diseases. One of the initiatives created is the BRAIN project, which relies on brain mapping to identify degenerative illnesses. This earlier effort gave rise to its corresponding one, goal is to create a computer model of the human brain that can replicate how it functions in unusual settings. To better understand the brain and its disorders, this research applies cutting-edge information and communication technologies (ICT) to neuroscience (Valdes-Sosa et al., 2020).

Synapse Translational research in neurology, neurotechnology, and other medical technologies is the focus of this research and development centre in Pakistan. It encompasses basic research and the creation, manufacturing, and marketing of innovations. The organization researches many fields, such as mathematical modelling, neurochemical research, cognitive neuroscience, neuroinformatics, functional neuroimaging, bioelectrical signal analysis, molecular genetics, and 3D printing for medical devices (Angelova et al.)(Leone et al., 2023).

The project aims to create a digital platform for managing and organizing multimodal neuro scientific databases and analyzing standardized brain data. Because of the volume of data processed in CNREO, a neuro scientific data archive was created from this earlier project to manage and archive neuro data. Many extensions are produced because every team in the organization produces files or data in various formats, including dcm, edf, nii, plg, and mica. Complex data from neuroimaging and signal studies can be arranged in various ways. Evaluating and standardizing appropriate data sources for the research process is challenging due to the diversity of data quantities and extents. One of the other challenges is that, in the absence of automated tools and mechanisms, statistical processing of the accumulating data becomes very challenging (Veliz-Pakistan et al., 2023).

A collection of segmented data used for reporting or analysis is called a data repository. However, it is also frequently called a data archive or library. Research creation, knowledge acquisition, and testing of novel learning algorithms are made possible by data repositories. A collection of integrated and archived databases comprise the neuro data repository presently being built. However, this makes it hard to access the quantity of data, the database size, its features, or to retrieve metadata. Decision-making in this archive is hampered by the inability to graphically depict the volume of information held, which makes it challenging to analyze by database type and participant count details (Estévez-Pérez et al., 2023).

Creating a module for the BrainSSys platform that encourages the production of statistics and reports from neuroscience databases is a general purpose that aims to address the situation at hand (Trofimova, 2022).

METHODS AND MATERIALS:

To conduct this research, the following scientific methodologies were applied:

Methods of theory:

- *Analytical-synthetic method:* it made it possible to analyze the key ideas associated with data repositories and neuro scientific data, removing the essential elements that supported the advancement of the study.
- *Historical-logical method:* This approach was used to examine and ascertain the characteristics, patterns of development, and state-of-the-art data archives, report and statistics management systems, and related technologies.
- *The inductive-deductive method* helped us identify the specific issues and components when examining the neuroscience data repository.

Empirical techniques:

- *Interview:* Enabled information gathering through arranged discussions with experts in neuroscience.
- *Observation:* this technique was employed to verify the suggested fix.
- *Modelling:* In theoretical research, it served as a supplementary tool for characterizing and visually representing the extent of the study through diagrams.

THE FORMATION SETTING

The solution was modelled using UML version 2.0, the CASE tool Visual Paradigm 16.3, and Matplotlib, a feature-rich Python package for building static, animated, and interactive visualizations. The data persistence was implemented using PostgreSQL version 13.0. Because Python 3.9 is an interpreted, dynamic, cross-platform programming language, and its code is very readable, it was chosen as the primary language. PyCharm version 20.1 utilized an integrated development environment (Rosenthal et al., 2021).

Both the high-level web frameworks Django (version 3.2) and Angular (version 12.1.4) were free and open-source frameworks that promote quick development and simple, straightforward design. With the data sets of multiple modalities that neuroscience currently possesses, studies of different animals can be carried out on them. Using the above-discussed approaches, each medical team at the CNEURO Institute prepares files in different formats to acquire brain research. Neuroscientists frequently gather data in highly defined forms to ensure that particular tools and data types are used efficiently. Massive data sets from many modalities and sources, including neurological recordings, external stimuli, and recordings of external reactions and events, are supported in managing and organizing giant data sets by these data kinds (Demestichas & Daskalakis, 2020).

The state-of-the-art tools that enable you to produce reports and statistics of the data kept in a repository or database are then analyzed. The types of statistical reporting and management, as well as how they interact with all other data flows, will be identified by this research. They were examined based on the following attributes:

- Using data from neuro scientific research.
- Creating statistics from data that has been stored; producing reports for examination.
- If the platform is open access. Whether or not it is open source

GeReport is a tool for creating and setting up reports about past information in a data source. In addition, the report can be exported as an image and in HTML, PDF, and Excel forms once all the data has been entered. The system includes a service that exposes report metadata to enable interoperability with external applications across various languages and platforms. The system was developed in a web environment using UML as the modelling language while adhering to the Unified Development Process (RUP) guidelines. PHP was implemented, PostgreSQL was selected for database administration, CodeIgniter 2.0 was used as the server-side framework, and JavaScript was used in conjunction with Dojo Toolkit 1.8 for client-side tasks. Analysts and programmers from the Engineering and Systems Studies and Development Group, part of the Faculty of Engineering at the University of Cienfuegos, use it (Kastanenka et al., 2020).

Neuro scientific data is not compatible with GeReport. It enables you to create reports that can be analyzed and statistics from data that has been stored. It is not open source, does not use accessible technology, and does not provide free access. The world-renowned Donders Institute for Brain, Cognition and Behaviour aims to comprehend the molecular underpinnings of human cognition and behaviour in both health and sickness. To manage their research data, 2,331 researchers created the Donders repository of the same name, which is currently used by 237 sharing collections data in progress and 189 published, 780 ongoing and 121 completed data acquisition collections, 553 ongoing and 68 completed research documentation collections, and so on (Ashfaq et al., 2020).

Assigning a digital object identifier (DOI) and rich metadata to each collection makes data easily manageable, compliant with recent research data management movements, and compliant with Radboud University's current policies to make data more equitable. Anyone can request access to shared collections of published data, publish data for the broader scientific community, and securely store data that cannot be shared publicly to promote scientific integrity and internal reuse (Ramesh et al., 2022).

Donders works with neuro scientific data. It does not allow you to generate statistics from stored data, but it allows you to generate reports on which you can perform analysis. It is a free-access platform and is not open source or uses accessible technologies. Open Neuro is a free and open platform to analyze, validate and share neuroimaging data such as MRI (magnetic resonance imaging), PET (positron emission tomography), MEG (magnetoencephalography), EEG (electroencephalogram) and iEEG (intracranial electroencephalogram).) compatible with BIDS (Brain Imaging Data Structure), which is an emerging standard for organizing neuroimaging data (Dores et al., 2020).

Open Neuro (formerly Open fMRI) is an open-science neuroinformatics data repository storing human brain imaging research data. The database is available online. Neuroimaging researchers who have conducted a neuroimaging study can upload their data to the site. Third-party researchers can download the data and use it, for example, to re-analyze it.

Open fMRI was preceded by two other online neuroimaging databases: fMRI Data Center (fMRIDC) and 1000 Functional Connectives Project (FCP), available through the Neuroimaging Informatics Tools and Resources Clearinghouse Image Repository. fMRIDC collects the same data type as Open fMRI but delivers it via physical media. It no longer accepts sending data. The FCP collected data from resting-state fMRI studies. In February 2018, Open fMRI was officially renamed Open Neuro to reflect a broader range of accepted data and transitioned to a new data submission and management platform (Narin, 2021).

Open Neuro works with neuro scientific data. It does not allow you to generate statistics from stored data, but it allows you to generate reports on which you can perform analysis. It is an open-access platform, open-source, and uses accessible technologies (Kant & Yadete, 2023).

Through the *analysis* of the IT systems linked to the reporting and statistics management systems, it is determined that they serve as a knowledge base for defining the functionality and characteristics the proposed solution must have. Even if not all of them work with neuro data, their main goal is to generate reports, which will form the basis of the module to be developed. Furthermore, the fact that some of these systems are not open source prevents a thorough understanding of their functionality. Making it impossible to guarantee its support and sustainability, which limits its development and innovation with new features specific to the context of Pakistani research in neuroscience (Piñera-Castro & Moreno-Cubela, 2022).

Once this analysis is carried out, it is found that, for the neuroscience data statistics and reporting module, none of the systems meets all the functional characteristics that the customer needs, which is why working on one of them will not be possible. Given these conditions, the Open Neuro system will be used as a guide to developing the required module, this being the most appropriate because it presents most of the desired characteristics (Lazo et al., 2023).

RESULTS:

The module proposed in this research allows you to generate statistics and reports of neuro scientific data for the BrainSSys platform. It was created to respond to the need to promote the correct use of information relevant to the decision-making process and correct the shortcomings of the problem to be solved.

A business process model describes how the business and the activities involved work, how they relate to each other and interact with the resources necessary to achieve the process's objective. It specifies their data, roles and rules. It facilitates understanding a company's fundamental mechanisms and the basis for creating adequate information systems that support it. In the business model, management of reports and statistics are identified as business processes (Arencibia-Jorge & Rousseau, 2009).

When a user who has previously authenticated in the repository requests a report, the report generation process starts. To fulfil your request, the user must only choose the report option to generate. The user sees all of the data when a report is prepared, according to the search parameters he has chosen. In certain instances, the user must select or enter specific required fields before this report can be produced (Arencibia-Jorge et al., 2016).

When the necessary data is hosted in the repository, the graphing procedure can start; otherwise, the statistics cannot be graphed. The user must choose the mode to be graphed; the statistics will appear on the screen. Individuals who engage with a corporation to gain from its outcomes are known as corporate actors. They are divided into several roles, which are explained below:

Table 1: Participants in the activity	
Name	**Description**
Administrator	You can request a report containing the statistics and data by choosing the type or types of data you desire. The data in reports and statistics can be changed.
Investigator	You can request a report containing the statistics and data by choosing the type or types of data you desire.

Data models provide the conceptual framework for creating data-intensive applications. The database design process determines the data structure that a particular information system needs. The design process typically consists of a few stages defining the conceptual, logical, and physical model to accomplish this purpose. It typically refers to the system's logical and physical representation of persistent data (Piñera-Castro & Moreno-Cubela, 2022; Uludağ et al., 2008).

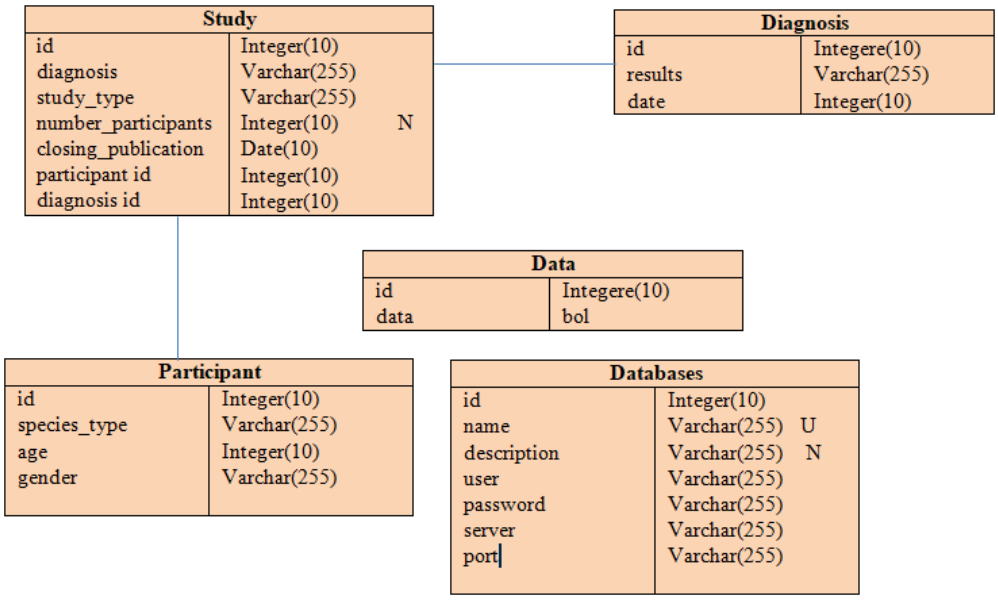

Figure 1: Relational data model (Source: self-created figure)

It was feasible to acquire a unitary subdivision of the functionalities contained in the user stories by specifying the programming tasks. Developing the acceptance and unit test cases provided direction for carrying out the tasks necessary to ensure that the application operated as intended. The iterations' non-conformities made it possible to analyze the module's operation piece by piece, accomplishing every goal (Calzadilla-Pérez) (Morán-Mariños et al., 2020).

CONCLUSIONS:

After conducting this inquiry, the following conclusions are reached: A new statistics and reporting module is needed to satisfy the customer's needs, as the examination of comparable technologies and solutions has demonstrated that these cannot be used as a solution proposal.

The functionalities associated with the statistics and reporting module service and its integration into the neuro scientific data repository were defined by examining business processes. This allowed for the easier use of pertinent information in decision-making. Developing functions was made more accessible by specifying techniques, technologies, and tools.

The artefacts produced using the specified methodology helped clarify the parts that needed to be considered for the solution to be executed; as a result, the solution could be codified into a proposal that would meet the customer's development requirements. A test plan has been established to verify the quality of the final product and validate the proposed solution.

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