Brain Segmentation – A Case study of Biomedical Cloud Computing for Education and Research

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Abstract

Medical imaging is widely adopted in Hospitals and medical institutes, and new ways to improve existing medical imaging services are regularly exploited. This paper describes the adoption of Cloud Computing is useful for medical education and research, and describes the methodology, results and lesson learned. A working Bioinformatics Cloud platform can demonstrate computation and visualisation of brain imaging. The aim is to study segmentation of brains, which divides the brain into ten major regions. The Cloud platform has these two functions: (i) it can highlight each region for ten different segments; and (ii) it can adjust intensity of segmentation to allow basic study of brain medicine. Two types of benefits are reported as follows. Firstly, all the medical student participants are reported to have 20% improvement in their learning satisfaction. Secondly, 100% of volunteer participants are reported to have positive learning experience.

Keywords

Brain Segmentation; Medical Cloud Computing Education (MCCE); Cloud Computing Brain Segmentation Technology (CCBST).

1. Introduction

Cloud Computing has transformed the way many organisations work and offers added value for operation management and service computing, where both Healthcare and Education sectors have deployed Cloud Computing to the next generation of education, business models and scientific research (Chang et al., 2010 a; 2010 b; 2012 a, 2013 a, 2013 b). Healthcare informatics in particular has played a strategic role in the National Health Service (NHS) and has been influential to the way in the IT project development for different NHS Trusts. The IT initiatives include Cloud Computing, which investigates good procedures for Cloud adoption and the capacity to maximise the added value as a result of

Cloud adoption. Chang et al (2011 a; 2011 b; 2011 c; 2012 a; 2012 b; 2013 a; 2013 b; 2013 c) have demonstrated case studies and successful deliveries for Healthcare, Finance and Education domains. Due to the fusion between Healthcare Cloud Computing and Education, it has become increasingly important for medical scientists and educators to use Cloud Computing (Chang et al., 2013 a; 2013 c). As a result, more universities have adopted Cloud Computing for education and research purposes, and there are case studies supported by NHS, King's College's London and the University of Oxford (Chang et al., 2013 b). Within medical Cloud Computing, there are interests for inter-disciplinary investigations between (a) learning satisfaction and brain response and (b) learning difficulties and brain response.

The advancement in technologies and improvements in learning strategies can greatly influence the way that medical education is moved forward. New and innovative ways for medical education is required to be continuously dynamic and forward-thinking. To fulfil this long-term vision, this paper presents an innovative case study for blending both medical research and education, with an emphasis in brain segmentation. The objective is to study how human brain responds while recapturing a skill that has been learned some time ago in an interactive and motivated environment offered by Cloud Computing. Data collection for medical students and volunteers are conducted and analysed for discussions.

2. Medical Imaging

Medical imaging is widely adopted in Hospitals and medical institutes, and new ways to improve existing medical imaging services are regularly exploited. Chang et al (2012 a; 2013 b; 2013 c) report that pioneering biomedical Cloud platforms have been implemented and serviced at the NHS, which allows scientists to conduct advanced research, exchange thousands of data and backup securely at different sites through the use of private cloud technologies. There are positive impacts for several organisations that adopt Cloud Computing, and there are active scientists using Cloud services on daily basis. It is also reported that more work can be done and Cloud offers a collaborative platform for learning, research, backup and operational activities. Amongst all existing services, brain segmentation is a particular focus with rationale as follows. Firstly, it can enhance teaching, since complex theories can be facilitate with the aid of simulations. Students can understand their lectures much better than without the use of simulations. Secondly, the level of intensity in the brain activities can be presented easily and quickly with the aid of simulations. Each time when a new subject is introduced, the brain reacts differently. Simulations enabled by Cloud Computing can reduce the complexity of presenting brain activities in the learning process by introducing dynamic 3D Visualisation, which is an effective technique demonstrated by Chang et al (2012 a; 2012 b; 2013 b; 2013 c).

2.1 Cloud platform and applications

Chang et al (2012 a; 2013 b; 2013 c) describe the design, deployment and service of a successful Cloud platform at the NHS, which has positive impacts acknowledged by the user community and Cloud-adopting organisations. The implemented Bioinformatics Cloud

platform allows computation and visualisation, and currently brain imaging can be used for demonstration. The aim is to study segmentation of brains, which divides the brain into ten major regions. The Cloud platform has these two functions: (i) it can highlight each region for ten different segments; and (ii) it can adjust intensity of segmentation to allow basic study of brain medicine. This platform can be used by medical students to improve the quality of teaching and learning satisfaction amongst students.

2.2 Results of the two medical cohort group

There are two medical cohort groups with fifteen in each group. They were introduced the use of Cloud Computing for medical training, and surveys were taken before and after the adoption of Medical Cloud Computing Education (MCCE). Each student has used MCCE for at least three months. The focus of the study was to identify the rate of learning satisfaction before and after the introduction of MCCE. Survey questions were taken and an average score for learning satisfaction was recorded for each student. All the records are undertaken with statistical analysis presented in Table 1. The variable "group1_without_Cloud" indicates learning satisfaction for cohort group one before using MCCE and the variable "group1_with_Cloud" is the variable after using MCCE. Similarly, the variables "group2_without_Cloud" and ""group2_with_Cloud" are the same terminology for cohort group two. Mean is the percentage for learning satisfaction before and after using MCCE. There are 20% improvements in learning satisfaction, which include positive feedback from students taking this pilot study.

Table 1: Statistical analysis for two medical cohort groups before and after using MCCE

Variable	Obs	Mean	Std. Dev.	Min	Max
group1_without_Cloud	15	69.33333	3.9036	60	76
group1_with_Cloud	15	89.4	3.601587	80	95
Variable	Obs	Mean	Std. Dev.	Min	Max
group2_without_Cloud	15	70.06667	3.494213	65	76
group2_with_Cloud	15	90.13333	2.899918	85	95

3. Brain segmentation for volunteers

Brain segmentation is an important specialist area for medical research to help scientists to understand how human brains work; to help trainee doctors to have better understanding with physiology and biological sciences related to brain; to help scientists to make more pioneering research for brain segmentation and the use of technologies in the aid of their analyses. Each part of the human brain has important functions to help our learning, memory, emotion and skills development. Simulations help scientists to understand how human learn new objects or skills; and also how scientists can discover better ways of

identifying tumours. Often the detections of tumours require MRI scans to confirm, and any pioneering ways of discovery will help scientists to improve the quality of patients' life in the long term, and reduce the possibility of making errors in the process of treatment and operations (Baillard et al., 2001).

3.1 Set up for Brain Segmentation

There is another initiative to study the intensity of our human brains while recapturing a skill that has not been used for two years. That skill would ideally involve with movements which needs a greater coverage of neurone activities and co-ordination in the brain so that it is easier to capture the brain activities. While using highly-sophisticated equipment is an expensive option, the use of Cloud Computing Brain Segmentation Technology (CCBST) offers cost-saving yet a dynamic, interactive and flexible option for research. Two groups of volunteers with eight in a group were asked to dance in this study and all of them did not dance for two years at least. Each person had attached an electronic device to record their brain activity. CCBST then collected all the data, calculated the average on brain segmentation and drew out the brain activities as a collective result. Results are presented in 3D Visualisation where the more intense the visualisation is, the more activities the brain have undertaken during the dance sessions. 100% of volunteers are reported to have positively increased in their brain activities while recapturing their dancing skills. Results are presented in the next section.

3.2 Results and Discussions for Brain Segmentation

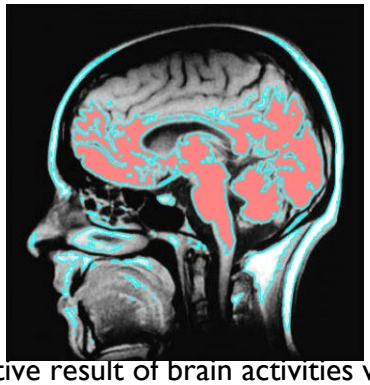

Figure 1: The collective result of brain activities while recapturing dancing skills

Figure 1 shows the core area of the human brain, which covers the frontal lobe, parietal lobe, occipital lobe (these three are grey matters, the last one is situated at the back), corpus callosum, hippocampus (inner brain, the later one controls emotion) and brain stem (middle brain). The objective is to study how volunteers respond when they reuse a skill, which they learn some time ago but do not practice for two years. Sophisticated equipment and expertise can be used but they are expensive. The use of simulations can reduce the costs in a way that results can be repeated. Figure 1 shows how human brain of volunteers (collective results) responds when reusing a skill such as dancing. The result shows that cells in the frontal lobe and occipital lobe are reacting actively, and the entire brain stem is responding very positively. This may mean volunteers require a high level of balancing. When they dance, their movement is fast, and must keep themselves balanced with swift but

steady movements. The areas that represent the emotions are not so obvious but still can be seen with some activities.

4. CONCLUSION

Cloud Computing Brain Segmentation Technology (CCBST) and Medical Cloud Computing Education (MCCE) are extremely useful for the healthcare scientists to make pioneering research. Added values are presented as follows. Firstly, this improves the efficiency for teaching, as trainee doctors can fully understand their expectations and medical lessons. There are 20% improvements in learning satisfaction and MCCE is strategic and influential to medical education. Secondly, simulations can allow scientists to understand human organs such as brain segmentation. Scientists can understand how volunteers learn and their reactions to the brain, particularly the human brain activities while recapturing a skill such as dancing. 100% of volunteer participants are reported to have positive learning experience. Cloud Computing offers cost-effective and innovative way to deliver education and research while maintaining a high level of quality of work for education, research and technology as demonstrated in these two cases.

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