



Research article

**Proposal of application for the detection of brain aneurysms using machine learning****Rosa Perez-Siguas, Hernan Matta-Solis, Eduardo Matta-Solis, Anika Remuzgo Artezano, Hernan Matta-Perez, Luis Perez-Siguas**

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**ABSTRACT**

Currently in the world of medicine doctors use computer technology since the use of it can greatly facilitate their work, currently there are brain aneurysms which is a cerebrovascular disease characterized by a dilation of the arterial wall that can trigger internal bleeding and the detection of this has to be carried out by specialized doctors which are trained for an extensive time of training and purpose of this work is to automate the detection of aneurysms by applying artificial intelligence.

**Keywords:** Brain aneurysm, Machine learnig, Python

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**INTRODUCTION**

Brain aneurysms are very vulnerable areas of the blood vessels of the brain which if there is no good treatment to the problem can cause very severe damage <sup>[1]</sup>. To be able to analyze these aneurysms doctors use computed tomography angiography, a very precise review, although it may overlook aneurysms of small size this is due to the complexity of the cerebral blood vessels <sup>[2]</sup>. The aneurysm can be present from birth or also develop in the course of our lives the cause of this disease is by high blood pressure, drug or alcohol consumption and also by other health problems such as polycystic kidney disease and endocarditis <sup>[3]</sup>. In Peru this problem of the aneurysm is also affected, a neucirujan of the National Institute of Neurological Sciences gave that, according to statistics worldwide, it is believed that in Peru 3000 cases of aneurysms can be registered per year deduced that this problem is more frequent in women and from 50 years of age <sup>[4]</sup>. On the subject of health, we have been able to appreciate that in many cases important issues such as annual check-ups that must be done to prevent or treat a disease in time are ignored, but due to the events already mentioned in the previous paragraph it becomes almost impossible for anyone. Aneurysms caused by high blood pressure, cholesterol or smoking, eating disorders is a consequence of the lifestyle that many people have today due to the demands of the modern society in which we live <sup>[4]</sup>. Xi Long a doctor from the radiology department of China was able to develop with his team a very sensitive and fully automatic algorithm to detect possible aneurysms in tomography angiography images making use of 500 tomography scans of different patients they could train the artificial intelligence system; the algorithm could be able to detect 633 of the

649 brain aneurysms. In addition, they found 8 new aneurysms that had not been seen by doctors in their initial evaluation <sup>[5]</sup>. The purpose of this work is to give doctors a tool that can diagnose radiographic images and be able to give a diagnosis indicating two points of the image is a brain aneurysm, using machine learning for learning the system. And another objective is to make computer technology help doctors specialized in this area, it should be noted that this is a tool for doctors to make their work more efficient, but not a replacement for them. Diabetes mellitus could have a negative effect on the formation, growth and expansion of brain aneurysms <sup>[12]</sup>.

**MATERIALS AND METHODS****A. Scrum**

Scrum is a process that is applied frequently that focuses on making good practices when it comes to teamwork, a basis is obtained in which organizations with their objectives and needs have as a benefit flexible selection <sup>[6]</sup>. It is known that scrum is a methodology in which it focuses on the organization, planning and development of very complex teamwork we can give as an example computer systems or projects with some uncertainty to change, in which it prioritizes the delivery of value of the final product. *a) Requirements Analysis:* Scrum is guided in the incremental delivery of value, it also considers the prioritization of user stories that depends on their value assigned by the client, being thus that this methodology fits when an empirical order of the project is required <sup>[7]</sup>. Therefore, the requirements for the development of the application were obtained through research as found in Table 1 of requirements analysis.

**Table 1:** Analysis of requirements

<i>Descripción de requerimientos</i>
Define training flow for the detection of brain aneurysms.
Preparation of data and training on diagnosis of brain aneurysms.
Have an initial screen of the app.
Obtain radiographic image of the cerebral cortex
Analyze radiographic imaging of the cerebral cortex
Obtain diagnosis of radiographic imaging
Sending results to the patient

### b) Sprint Development

The sprint is an iteration that is included in projects that have an approximate duration of two to 4 weeks, the purpose of each sprint is to obtain a delivery of value of the product, being thus that the first sprint will contain the minimum viable version of the product being similar to the elementary functionalities and also considering the prioritization of the client [8]. In order to plan the use of social networks, it had to be divided into 3 sprints as shown in table 2 of the sprint development.

**Table 2:** Sprint development

Item	<i>Descripción</i>
Sprint 1	Define training flow for the detection of brain aneurysms.
	Preparation of data and training on diagnosis of brain aneurysms
Sprint 2	Have an initial screen of the app.
	Obtain radiographic image of the cerebral cortex
Sprint 3	Analyze radiographic imaging of the cerebral cortex
	Obtain diagnosis of radiographic imaging
	Sending results to the patient

### B. Tools

#### *Diagrams.net*

It is a free open-source online program that was developed in HTML5 and JavaScript. The program is made to be able to graph flowcharts, block diagrams, organizational charts, mind maps etc [9].

**Python:** it is a programming language of a very high level that serves to develop all kinds of applications, it is very different from other types of languages since there is no need to compile it to be able to execute the applications made by Python, now it can be executed directly from the computer using a program called interpreter so there is no need to "translate" it into machine language [10].

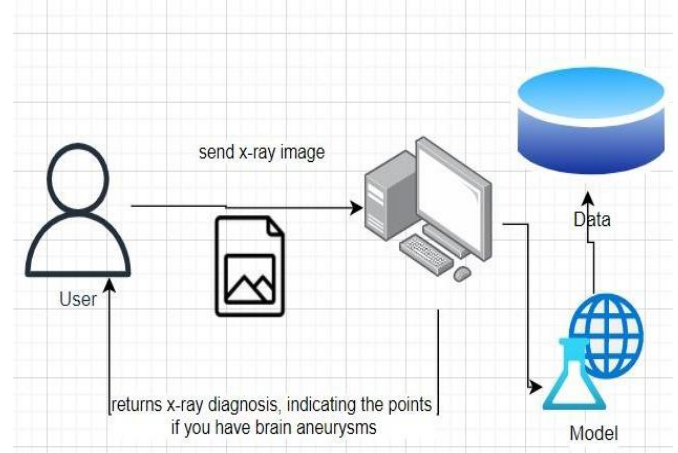
### C. Machine Learning

Es a structure of artificial intelligence where it creates systems that learn automatically, means that they manage to identify very complex patterns which is not an easy process, with this the machine learns the algorithms that review the data and you may be able to deduce problems, commonly these systems can improve over time without requiring help from something or someone [10].

For a person it is impossible to analyze an extensive amount of data and much less want to draw a deduction, which algorithms can detect several types of patterns more with the variables that we add [11].

Figure 1 shows how the flow of information will be from the moment the patient requests a diagnosis until the machine learning app that will be based on a large amount of data from brain

aneurysm diagnoses to be able to perform it on their own based on what they have learned.

**Figure 1:** App usage flow

## RESULTS AND DISCUSSION

The process of the prototypes is guided by the business needs of the user, thus being the process of a mobile application that was carried out through a system design that aims for the application to achieve its purpose by complying with the functional specifications. The prototype has already been experimented and modeled, through an analysis of system requirements in order to identify the business needs for the user with their reference on the deliverables of each sprint.

### *Sprint 1*

Se considers that the requirements of the first sprint are focused on the collection of data and the training of the application so that it has a diagnostic pattern based on all this the following sprints will be carried out, so the model has already been defined, which is a very laborious and necessary process for the machine learning app.

Figure 2 shows the workflow of the definition of the data requirements that will obtain historical data of the symptoms and other data so that it has a pattern of diagnosis of brain aneurysm. The source of information will be medical records that in their entirety can serve as data for learning the application.

### *Sprint 2*

in this sprint I would start with the development of the design of the application in the Figure 3 shows the initial screen to enter the system, only doctors or authorized per solar can enter, in figure 4 shows the screen of the diagnostic process which the application will request the entry of an image to later analyze and obtain a diagnosis, the screen has 2 buttons the first button is to load the image to the application and the second button is to start with the process of image analysis. The screen has a minimalist design which will be very intuitive for users.

Figure 4 shows the image loaded on the screen which is ready for analysis and detect brain aneurysms, then show at what point in the image the brain aneurysms are located.

Figure 2: Workflow of machine learning.

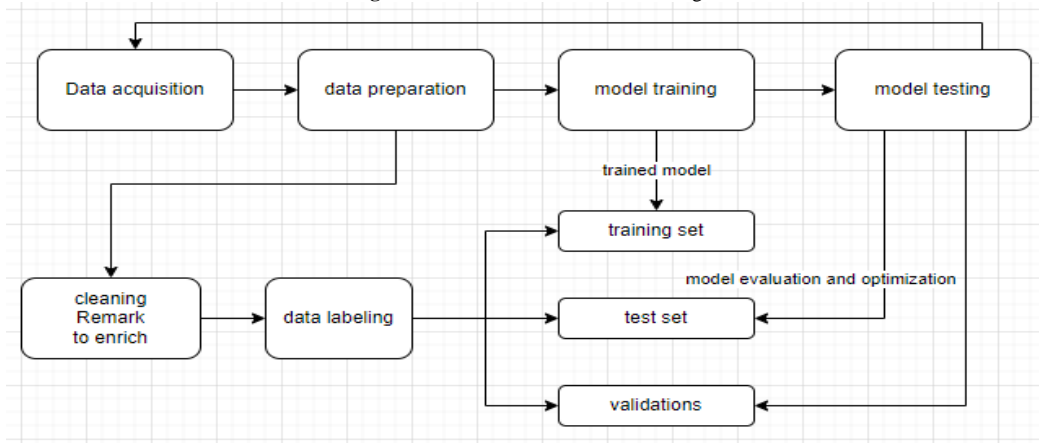


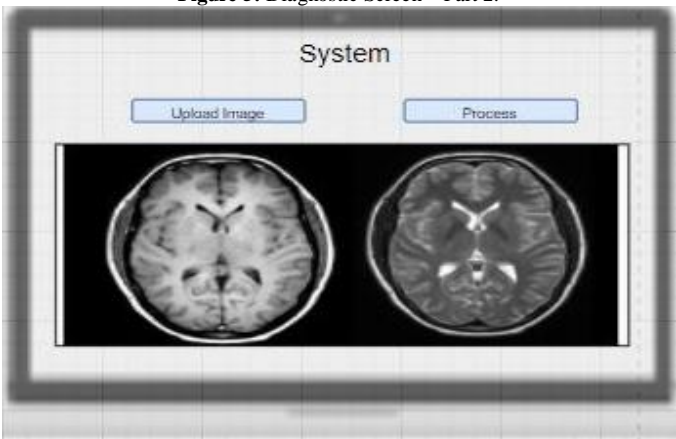
Figure 3: login



Figure 4: Diagnostic screen – part 1.



Figure 5: Diagnostic Screen – Part 2.



For the diagnostic process, machine learning will be used, which deals with the learning of the machine in aneurysm detections based on historical data, the learning process is defined in sprint 1.

**Sprint 3**

In this sprint the development of analysis of the radiographic images and obtaining results will be carried out, this will

be the last step and the development of the application will be concluded.

Figure 6: Processing screen

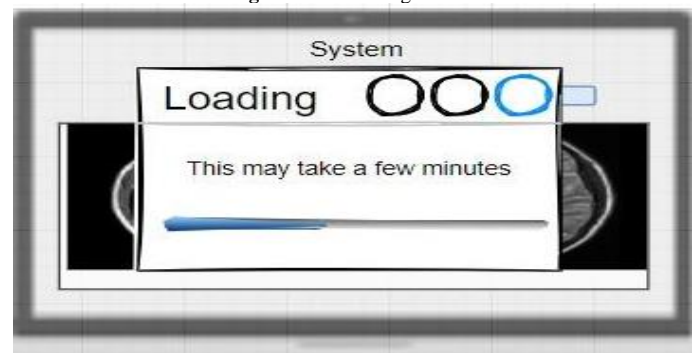


Figure 6 shows a loading screen that lasts approximately 1 to 3 minutes for the process of analyzing the detection of brain aneurysms by applying machine learning. The moment of waiting is due to the time it takes to analyze the image and make comparisons and follow the pattern on positive cases of aneurysms and be able to indicate the point where the aneurysms are and indicate the level of severity it has. Below the result of the analysis process will be shown

Figure 7: Final result screen

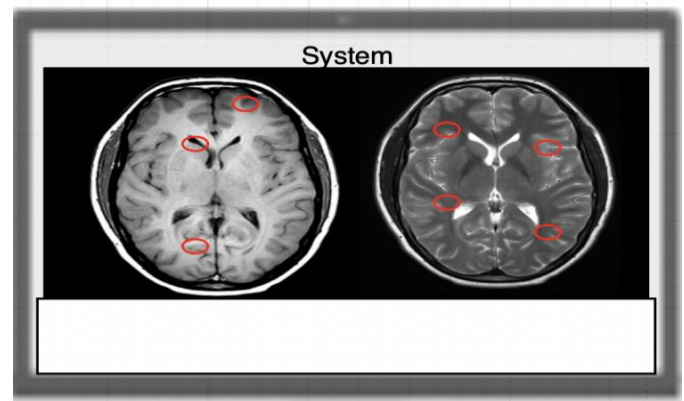
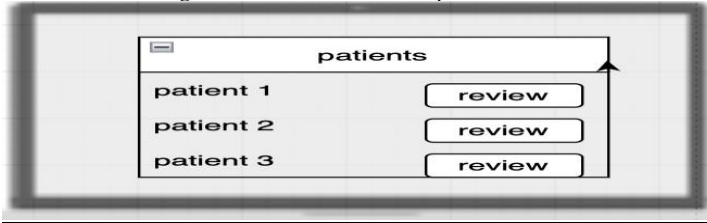


Figure 7 shows the final result indicating the point where it detects possible cases of malformation in the radiographic image.

Then the doctor will have the option of being able to see the record of his patients and be able to see all the results of the analysis process, and he will be able to review them to later send it to

the patient's mail his diagnosis and recommendations and also the image of his analysis process.

Figure 8: Pantalla de listado de pacientes



In figure 8 shows the list of patients of the specialist doctor, on the right side shows the analyzes that were performed and also has the option to send the diagnosis to the patient by email, this will help the doctor in organizing himself in a digital and automated way with his patients.

Figure 9: Screen to send result to the patient

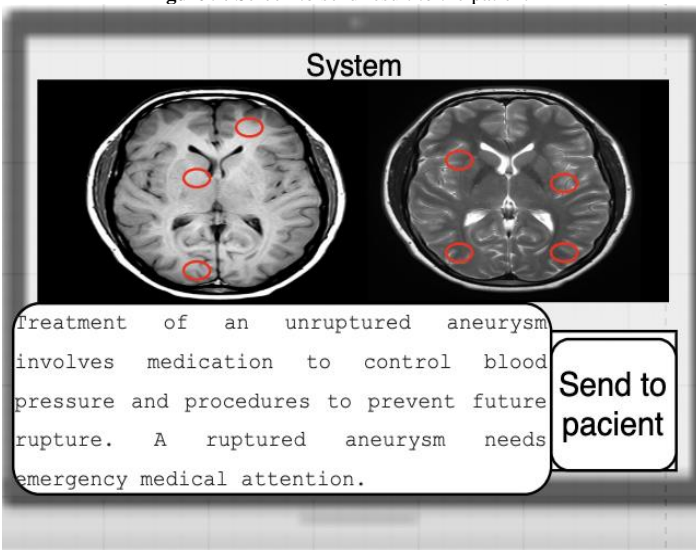


Figure 10: Message received to the patient

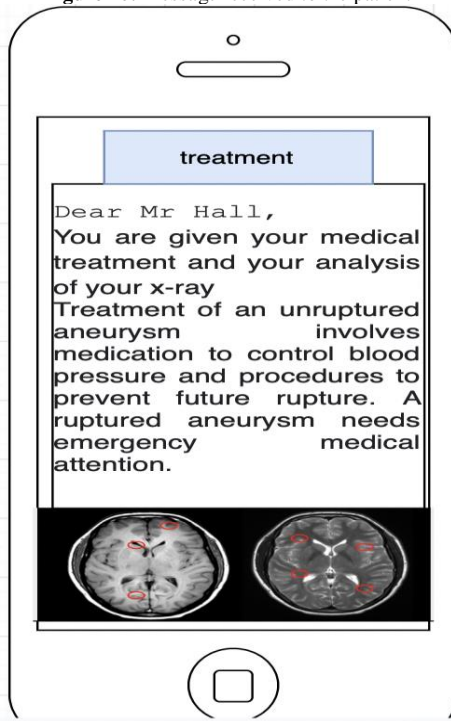


Figure 9 shows the doctor's review package that can also place a description about the image and then can send it to the patient, which speeds up the sending of the result to the patient and will not be necessary assistance to the medical center. And later you can schedule an appointment by the same means of communication. Later the mail will be sent by a courier service to the patient through their personal mail, the shipping time will be instantaneous.

Figure 10 shows the visualization of the mail that will reach the patient through his mobile device, at the top shows the doctor's description of the results and at the bottom the radiographic image with the points indicating where they show the location of the aneurysms. With this research it will be possible to speed up the process of analyzing radiographic images and also the delivery of results to the patient thanks to the development and advancement of technology using artificial intelligence can automate these processes.

Analyzing the Scrum methodology unlike traditional methodologies, Scrum is focused on deliverables at short periods of time giving continuous improvements to the client, thus also giving a retrospective defining what can be improved for the next deliverable, in addition to the fact that the needs can change over time compared to the traditional methodology, that everything is delivered at the end of the project, so you do not let yourself give a review if you are meeting the client's expectations.

As for diagrams.net compared to other design tools, this is worked online because it is not necessary to install on our computer in addition to the fact that the works can be saved in the Google Drive cloud, and on the machine learning applied to this research, it can be concluded that it helps a lot to make clinical diagnoses through its learning system, which can give a treatment to follow the patient. The advance of artificial intelligence is a great impact towards the facilitation of tasks as in this case in the medical field, this tool is not intended to replace doctors specialized in this area but will be a tool to make their work more efficient. For further research, an added value would be to be able to identify the type of aneurysm as an aneurysm due to leakage or without rupture, indicating the point of the related image.

## CONCLUSION

Machine learning was used to automate the process of analyzing brain radiographs based on clinical histories, so you can the points where the bad formations occur and the doctor can identify even those that could not be captured by him, which makes a tool that complements his work. This application is not made to replace the doctor, but to enhance his work, since more criteria are required to be able to have a conclusion regarding the treatment that must be followed. Hopefully this prototype of the development of an application can help doctors in more efficiently detecting the



detection of brain aneurysms.

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