Online Spinal Consulting System

By Alexandre Billard (6812210)
Supervised by Dr. Abdulmotaleb El Saddik, Dr. Mohamad Hoda
University Of Ottawa, Ottawa, Ontario
April 27th 2018

Abstract

The online spinal consulting system is a full stack web application which allows for doctors to classify their patients in accordance to the answer that the patients have provided to an in-depth questionnaire. This scalable application for mobile devices, tablets and computers analyzes the patient's inputs to assist in the difficult task to which they must decide which patients are suitable for surgery, and which patients are to be rejected. Machine learning is the ideal classification tool for the thousands of patients per doctor. By specifying precise words which may hinder a weight of positive or negative classification for each patient would allow for a detailed categorical placement of this said patient.

Keywords: Surgery, patient, doctor, threshold, trigger, qualify, self-help, overall health, Euroqol5D, leg pain.

1 Introduction

As it always has been and will continue to be a struggle for surgical medical doctors to decide who is the ideal candidate for surgery. How exactly can these highly educated individuals evaluate and decide which patients should require a surgery? If there are only a few patients, then yes these doctors would proceed to have time to evaluate each patient manually, but what if there are thousands of patients, how would they all be evaluated, could this be automated? This dilemma then evolves to the issue of which patient should have priority over other patients. There would need to be a questionnaire that would allow doctors to classify patients in their respective surgical categories of either admittance to surgery or rejection to surgery based on the answers provided by the patient. With the ever-evolving field of technology and medical practice, doctors would need a questionnaire that is flexible enough to be modified for years to come.

The Ottawa Hospital, specifically the doctors performing spinal surgery required such a system that had the ability to help them evaluate each patient based on a threshold their answers provided to a medical questionnaire. This interactive system would push beyond a conventional pen and paper questionnaire to allow for a more dynamic and user-friendly experience for the patient. It was at this moment that the Ottawa Hospital had approached Dr. Abdulmotaleb El Saddik and Dr. Mohamad Hoda to hear their take on the interactive system. The ideal solution came to be an online web site where patients would enter their pain, worries, hobbies, injury, activities, habits, etc. into a questionnaire and where their entries would be analyzed and would finally classify the patient into their surgical category.

Some of the questions where derived from internationally acclaimed questionnaires such as the Patient Health Questionnaire-9 (PHQ-9) [1][2], the Keele StarT Back Screening Tool [3][4], the International Physical Activity Questionnaire (IPAQ) [5], the Euroqol5D (EQ) [6], the Oswestry Disability Index [7], and the 3 Incontinence Questions (3IQ) [8]. The

remainder of the questions stemmed from the Spinal Consultation Patient Intake Form from the University of Ottawa Spine Unit under the direction of surgeons Dr. Philippe Phan, Dr. Eugene Wai, Dr. Stephen Kingwell and Dr. Alexandra Stratton.

The questionnaire currently holds just over one-hundred-and-fifty questions, however, only a dozen of these questions triggers the static threshold algorithm as to which patient should require surgery or should not require surgery. This static algorithm is a temporary solution to classify the patients. The goal of this system is to push towards supervised machine learning, specifically a Support Vector Machine (SVM) to classify patients based on their answers from the training set which will be ever expanding.

2 Website Design

2.1 Overview

Upon entering the website, a header bar is present which allows easy navigation for the patient.

Under the direction of Dr. Eugene Wai, the view for the general patient contains a header bar that has multiple indexes. The first of these indexes is named "About us" which contain the subcategories of explaining the overall mission of the hospital, portraying the key statistics and illustrating the staff listing and research programs. At the time that this web system was delivered, most of these sub-indexes are empty as their content has yet to be decided by Dr. Eugene Wei.

A second index on the header bar seen across every page of the website contains a section deemed "For Professionals". The "For Professionals" index contains subgroups that explain how to refer doctors to this cause, useful links for up-and-coming medical doctors and information pertaining to the fellowship of the Spinal Consultation team. Again, the content for this information has yet to be explained and delivered by Dr. Eugene Wai.

The third and final index on the header bar is the most pertinent since it allows the patient to be directed to self-help links, the questionnaire and surgical information. This index, named "For Patients", has a subgroup that leads to a video link provided by Mike Evans on explaining chronic back pain and how to help the patient. The second index is a quick link to the login page for registered patients or patients provided with a hospital administered identification code. The third, fourth and fifth items in this index point to the questionnaire and their types; with registration, with a hospital provided identification, and without registration. Finally, this index has as sixth subgroup that leads the patient to surgical information such as procedures and complications and post-surgical protocol.

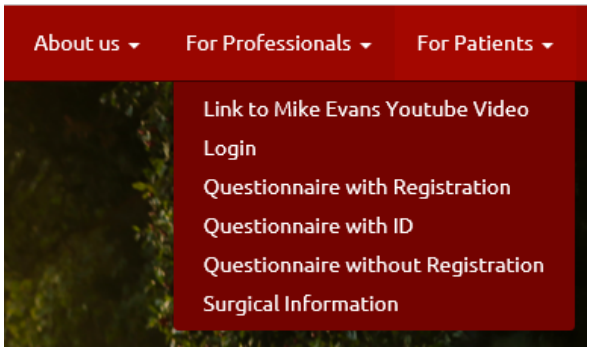

Figure 1: Website header index.

In order to allow patients ease of access to either their registered account or the questionnaire, these links are also found on the main index of the site. The login button brings patients to their previous answers they had provided as well as the ability to modify these questions or even to take the questionnaire again.

There are three ways to access the questionnaire. The first is to register from the website which prompts email verification before leading to the patient to the questionnaire. The second method is to enter the questionnaire from a hospital provided identification code; the doctor

recommending them to this questionnaire gives this identification code to the patient. The final way to access the questionnaire is without registration which does not prompt the user to provide any information, however, the patient will not be emailed with useful links and other very important information, he will see these in a webpage on the website.

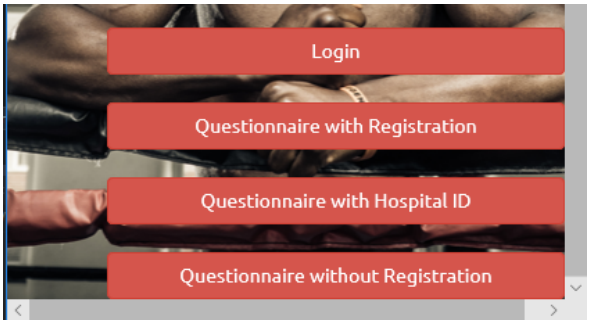

Figure 2: Buttons to the questionnaire.

2.2 Patients Questionnaire

As mentioned previously, the questionnaire currently holds over one-hundred-and-fifty questions. These questions are separated to their specific types. Those types being "Yes or No" questions, "Radio Button" questions, where the patient can only choose one of the available options, "Text" questions which are open ended, and finally "Checkbox" questions, where the patient will choose one or a multiple of answers pertaining to their situation.

The ability to split these questions into their category types allows for a dynamic binding when presenting these questions to the patients when they will out the questionnaire.

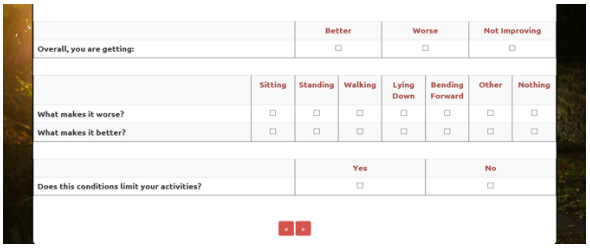

Figure 3: Sample of questions from the questionnaire.

The one-hundred-and-fifty questions are currently spread over ten web pages in order to not overwhelm the patient with questions, they are portrayed in a clear and simple manner in order to prompt the patient to answer as many questions as possible. Every click to the following pages saves the answered questions from the previous page into the database and in the static algorithm. It is written in this manner in the unlikelihood that the patient quit the questionnaire it has been completed, allowing for some data to be built on that patient.

2.3 Doctors and Administrator Privileges

In order to build a dynamic questionnaire, doctors and administrators must have the options to add, edit, and delete questions in the questionnaire. Therefore, if the doctor or administrator enters their credentials in the login page, they will be prompted to a webpage that allows the super user the option to manage questions in the questionnaire. The current credentials for the Administrator or doctor to have the ability to add, edit and delete questions is username: "Administrator" and password: "P@ssw0rd". This can be later changed in the backend of the

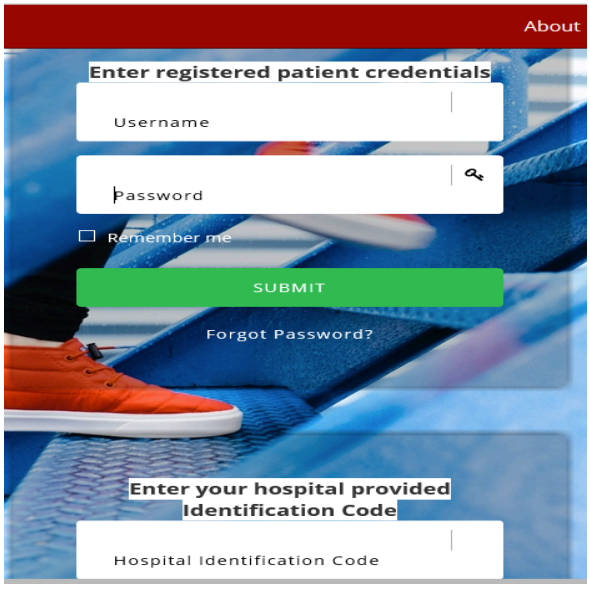

Figure 4: Login page.

Furthermore, at this administration page, the administrator or doctor can also see all patients who registered from the website and all patients who were given a hospital identification. For patients registered with the website, this will show their emails, gender, the first three digits of their postal code, their decade of birth and finally their patient identification (RegisteredPatientID). For patients who were previously given a hospital identification code by a doctor, the super-user will be able to see their email and their Hospital identification code (HospitalID).

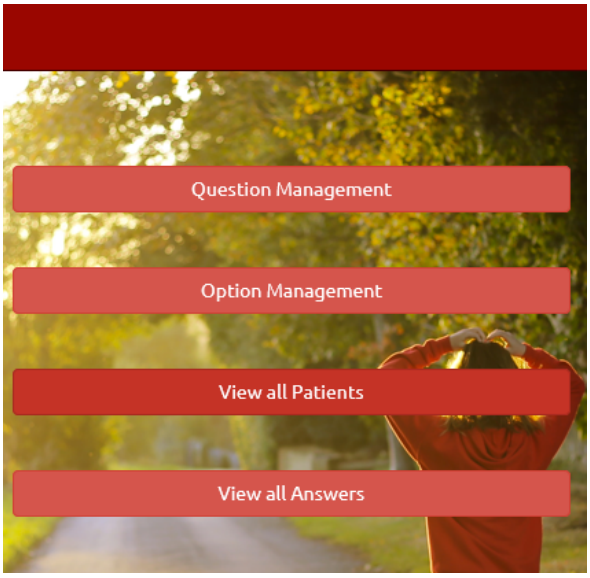

Figure 5: Administrator page.

Critical for analyzing the patients' well-being would be the ability to allow the doctor or the administrator to see all the patients' answers to the questionnaire. This allows for an export to a comma-separated-value (.csv) format to be applicable to allow machine learning on the data of all patients since most machine learning tools, such as WEKA for example, can import data from comma-separated-value (.csv) format.

3 Source Code Design

3.1 Overview

The web system was created entirely in a windows format. The database system that held all the necessary information for the patients, questions and answers was created in MySQL. The frontend and backend were created in Microsoft's Visual Studio 2017. This interpreter allowed for the ability to incorporate ASP.NET. ASP.NET is an open source web framework for building modern web applications and services with .NET. This Microsoft service creates websites based on HTML5, CSS, and JavaScript that are simple, fast, and scalable if multiple users are using the site [9]. In order to host the web server, Visual Studio easily allows for the incorporation of an IIS Server. The Internet Information Services, or IIS for short, is a Windows Server that allows for a flexible, secure and manageable Web server for hosting anything on the Web. Furthermore, this service allows for a scalable and open architecture that entails the allowance to enable even the most demanding tasks and requests [10]. The ability to have all the services built in Microsoft's Visual Studio allowed for a clean and simple application. Nevertheless, it also allows for an easy transition for the next recipient who will push the boundaries of this Online Spinal Consultation System to further heights.

3.2 Database

Knowing that MySQL transitions well with Microsoft's Visual Studio, this database server was chosen to host the "localhost" database that maintained the data that the Online Spinal Consulting System needed. The ultimate goal of this web system is to analyze and understand the answers provided by the patient. Therefore, the best method to see their answers in a clear and organized manner would be to have a database that would manage the various variables that this system generates. As mentioned earlier, there are three approaches to enter the

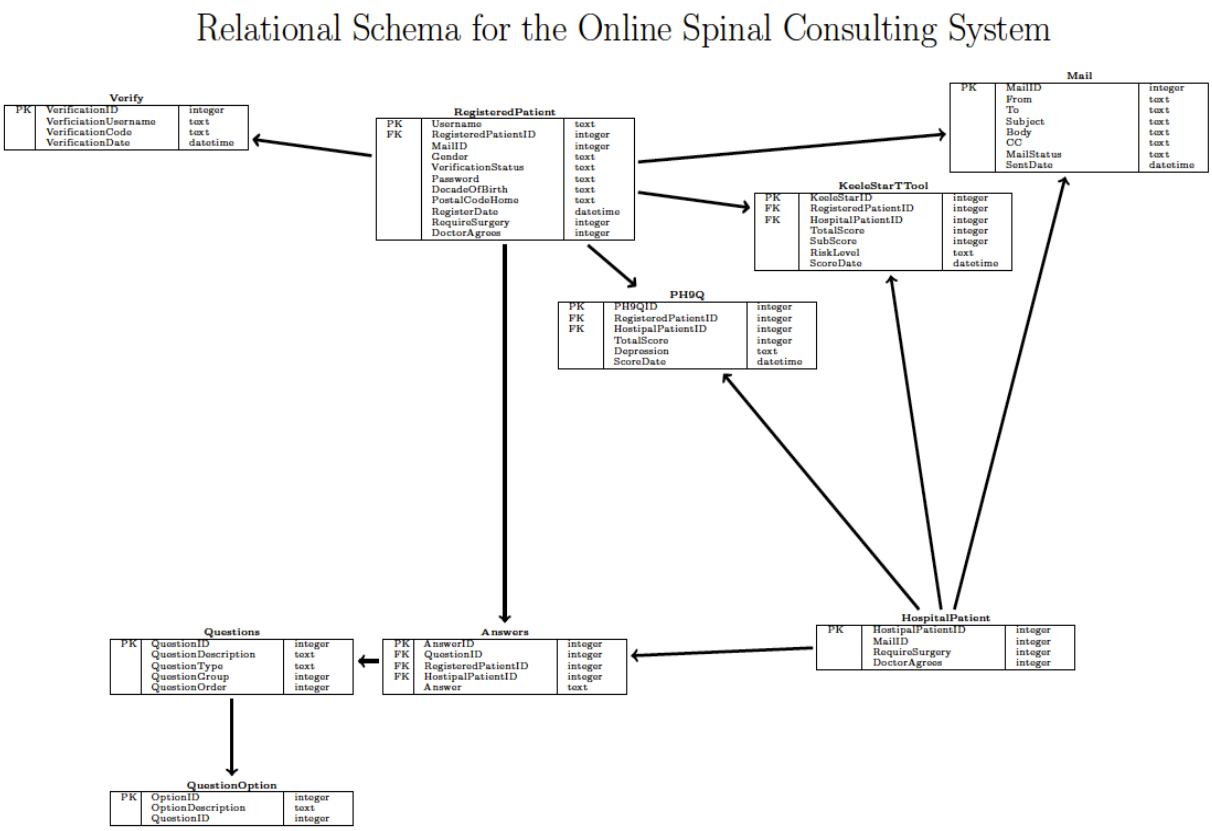

Figure 6: Relational Schema for the Online Spinal Consulting System

questionnaire. In the first approach, the patient registers in the web by promptly entering their gender, first three digits of their postal code, their decade of birth, a username which becomes encrypted in the database, and a password which also become encrypted in the database. When the patients register on the web site, a registered patient identification code is provided to them (registeredPatientID). This integer which auto-increments per every newly registered patient is the only thing that links a patient to their answers and their email to their registered patient identification code.

The purpose to conceal as much patient sensitive information in the database was a direct request from Dr. Eugene Wai to have a "blind database" for his patients. Therefore, the only two pieces of information that could potentially lead a patient to their information is their email, which is encrypted and only decrypted when the questionnaire has been completed and the patients' email has been sent via email to their doctor. Furthermore, the patient will get an email from the web system informing them of their patient identification number and their answers to the questionnaire.

Similarly, the second method that patients would access the questionnaire, once the patients enter their hospital given identification code and complete the questionnaire, their answers are kept in the database under the "Answers" table. However, instead of each answer having a registered patient identification code attached to it, this variable is "null" and there is a hospital given identification code which is alphanumeric that is attached to every answer. This allows for once again the doctor having the ability to search each patient's answers based on either the registered patient identification code or the hospitals' given identification code.

The third method of gaining access to the questionnaire is without registering or without having a hospital given identification code. If the potential patient, or user in this case, chooses to complete the questionnaire in this fashion, their answers will not be recorded in the database.

However, their answer will still be monitored by the backend system and will invite them to register after they trigger the thresholds of potentially being an ideal candidate for surgery.

3.3 Backend

The heart of this application is its backend component that handles all the patients, users and administrators/doctor's requests. The backend, entirely written in C#, has the initial role of populating the fields necessary for the current form to which the patient or administrator/doctor would need for their goal. This is clearly illustrated in how each question is bounded to the questionnaires webpage allowing for the patient to view all the questions in a clear and simple manner. Since every question is stored in the database, it is up the backend component to pull all these questions to the right data-grid that is based on the question type of each matter.

Similarly, the backend component which administers the right that the doctor would have to view all patients and their answers is built entirely with a Structured Query Language (SQL) statement which is bounded to a data-grid on the front end.

```
DataSet ds = new DataSet();
if (connection.connection.State == ConnectionState.Closed) { connection.openconnection();  }
cmd.Connection = connection.connection;
cmd.CommandText = "Select questionid, questiondescription " +
                  "from questions " +
                  "where questiontype = 'General' and questiongroup = '3' and questionorder <=2";
da = new MySqlDataAdapter(cmd);
da.Fill(ds);
dt = ds.Tables[0];
Session["MAINSORTING"] = dt;
this.Stringquestions1.DataSource = dt;
Stringquestions1.DataBind();
connection.closeconnection();
```

Figure 7: Typical SQL statement in the backend to bind to a frontend data-grid.

The backend component also has the responsibility to allow certain privileges based on the role of the user. This is explained when a doctor or administrator enters the rightful login information that authenticates the privileges this super-user has. However, in order to not allow page surfing by entering various different web addresses, restricted pages to patients will not populate if the global variable that confirms the super user's role is not activated. This is just one of the many examples where a simple integer flag verifies a certain permission is permitted or a certain threshold is met.

3.4 Frontend

The frontend of the online spinal consulting system followed extensive re-modelling and endless hours of attention to detail in order to allow for a positive experience for both the patients and doctor/administrators. Visual Studio allows for the ease to implement Bootstrap version 3.3.6. Bootstrap is an open-source toolkit that is used when developing with HTML, CSS and JavaScript. This extremely popular framework is ideal for building responsive and dynamic web sites that allows for scalability across various devices [11]. Since Dr. Eugene Wai had directed that the patients could be answering the questionnaires from their personnel devices, including a tablet or mobile, it was crucial to build this website with the goal to keep it quick and responsive to the various devices.

The method to allow this application to be reactive and scalable to the users device invokes the Bootstrap classes of "col-xs-*x* col-sm-*x* col-md-*x* col-lg-*x*" for each gridview to which the value of *x* was the variant to permit for a clean and reflective interface.

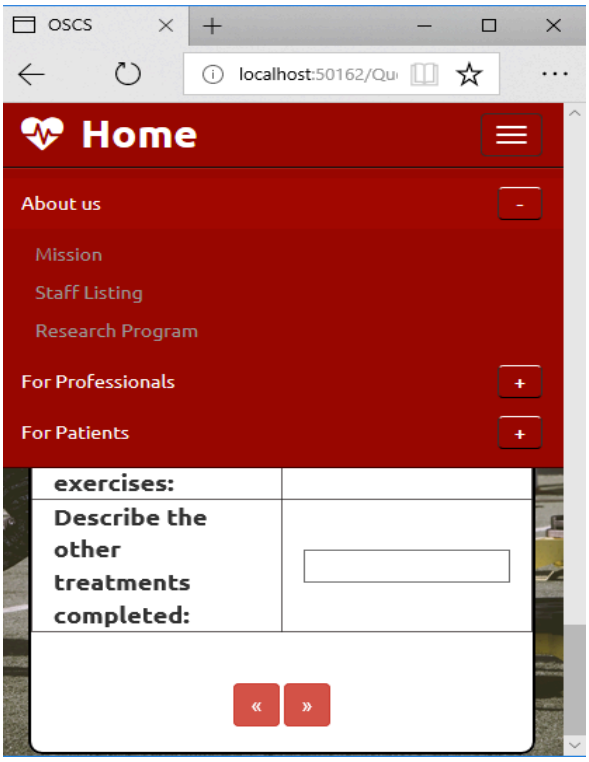

Figure 8: A reactive and scalable application due to the Bootstrap column classes.

In this application, in order for the patient to locate themselves to all the abilities of the system, a master header exists across the entire site. This master header, named "Mastermain", holds all the indexes that can lead to the various methods to take the questionnaire, to the login page and the information pertinent to the patient. This "Mastermain" extends to even beyond the header for the patient. In this frontend form, there exists a transition of fourteen images that inspire fitness and healthy living. This request by Dr. Eugene Wai is seen across every page of the website.

These images were from a free-to-use website named unsplash.com, this website is an open-source image repository where there is no restrictions or rights that must be requested in order to download the images [12].

The importance of the frontend as a whole to the functionality and visual appeal cannot be undermined as this allows for the patients first and positive outlook at their personal well-being while also serving the absolute goal of monitoring their answers to understand if they fit the criteria to be a candidate for surgery.

4 Static Algorithm

The difficulty to decide which patient should require surgery and which patient should not is a held confidentiality that only a doctor may share. Fortunately, Dr. Eugene Wai shared his logical process in establishing such a difficult decision.

This algorithm is the first step to in an attempt at classification for the patients in their respective surgical recommendations. This algorithm first notices if a patient scores a specific threshold on both the mobility pain index on the Euroqol5D, this is marked as one of the triggers in a series of conditions that must all hold true. The second trigger is all relatively centralized around the notion of leg pain dominance over other body pain. Specifically, two of the three following conditions must be met in order for the second trigger to hold true; the leg pain index must be higher than the back-pain index on the ten-point scale, the patient must specify that they would prefer treatment on leg pain, and finally, the majority of the answers by the patient point towards leg pain. The third and final trigger is if the patient selects that his pain has not improved or is worsening. These three triggers must be held in order to classify a patient as recommended for surgery, figure 9 demonstrates the details of this static algorithm.

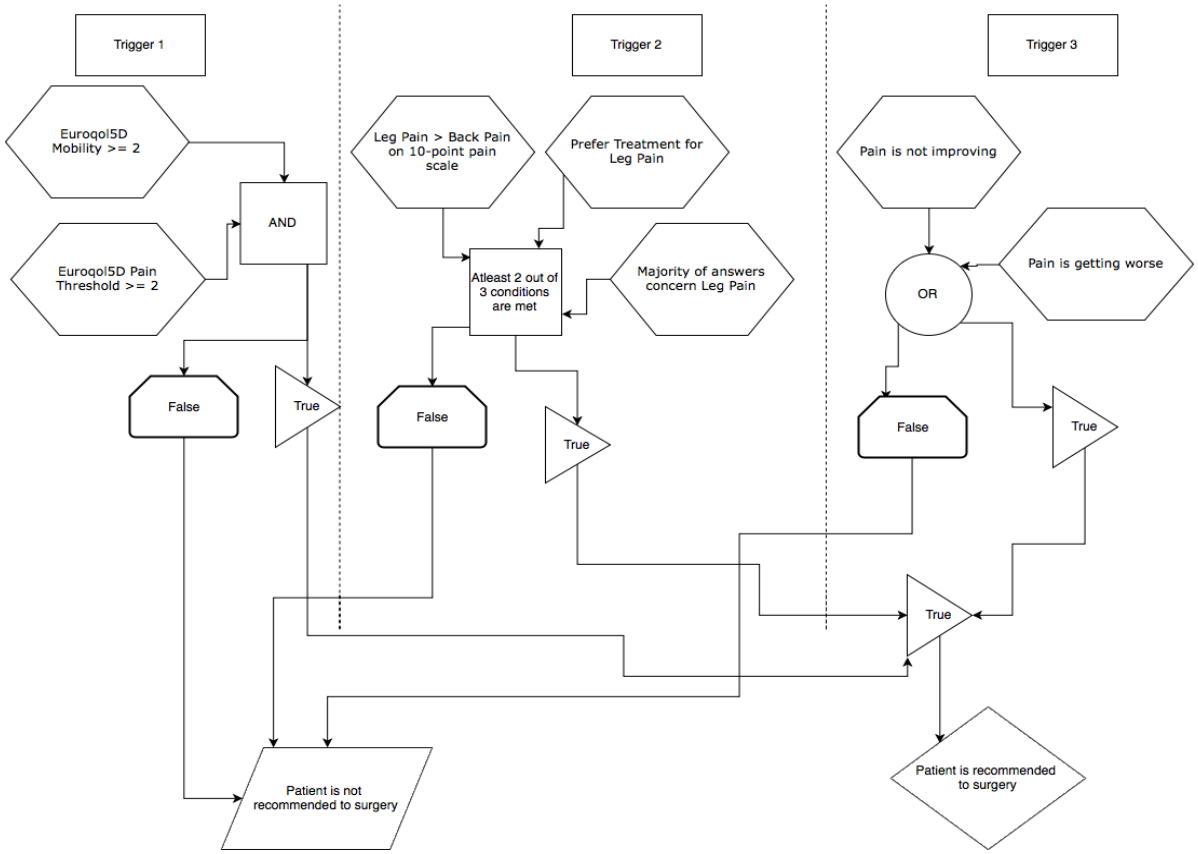

Figure 9: Flowchart for the static algorithm to suggest if a patient should have surgery or not

There is a fourth trigger which is optional and kept to the discretion of the doctor who may change the classification of the patient in regard to a being a candidate for surgery. This fourth trigger concerns if the patient is a smoker and if they maintain a healthy and active lifestyle.

In order to facilitate a transition from the static algorithm to machine learning, the system would need to understand if it is correct and approved manually by the doctor. Therefore, the variable of "DoctorAgrees" is imbedded with every patient, this allows for manual review by the doctor in order to build a training set, this manual review by the doctor is the absolute accuracy which is ideal for allowing a supervised machine learning to take place.

5 Machine Learning

Originally, the goal of this system was to invoke machine learning in order to generate a classification of each patient based on a training set provided by the hospital.

In detail, the specific machine learning used for this type of system would have been supervised machine learning, more specifically using the Support Vector Machines (SVM). An undergraduate degree in Computer Science at the University of Ottawa has taught students the rudimentary definition of supervised machine learning as the instance where the data scientist or software engineer has both the input variables and the outputs variables. Thereafter, an algorithm is used to learn how exactly the mapping function in the transition from the input to the output is processed, what values from the input would trigger a specific output and can the machine learning detect these specific triggers. This simplified definition fits ideally with what the doctor and other super-users would attempt to complete since all the input parameters would be the answers provided by the patients and the output would be the

final review provided by the doctor on the recommendation to a patient having surgery which is the ultimate accuracy.

The Support Vector Machine would be the chosen machine learning technique since this system is defined as a classification problem. The goal of this supervised machine learning using Support Vector Machine (SVM) would be to approximate the mapping function at such an accurate rate that when new input data is presented, the output would become predictable for the provided answers of the patient. Figure 10 illustrates how machine learning created the full dataset that is predictable based on the training set of patients review by the doctor and the test set of patients reviewed by the static algorithm.

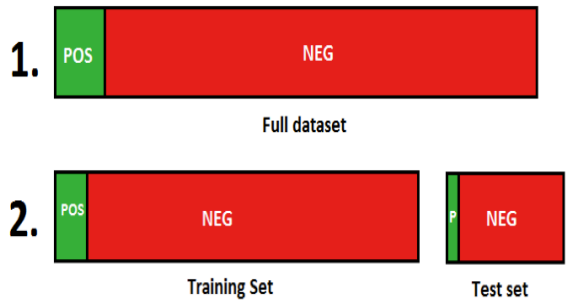

Figure 10: Training set working with the patients answered data (test set).

6 Results

6.1 Patient Self-Help

Although the main goal of this system was to use classification for patients based on their input of answers, as a medical tool, it is crucial that this web site promotes healthy living.

Therefore, certain answers from the patient would return a result after the questionnaire would be completed. For example, if a patient stated that they smoked, then they would be suggested to the Ottawa heart institute smoking cessation program which is a nurse-led clinic that provides patients with one-on-one support during their attempt to quit smoking [13]. There are other thresholds that are activated by the patient's responses, these thresholds imply that if the patient has pain while walking or standing, they are recommended exercises via stationary bike. If the patient has pain whilst sitting or bending forward, they are recommended walking exercises.

Patients are suggested to visit the site of manipulativetherapy.org for their quality physiotherapy links [14]. The provided links to a patient that would be recommended every self-help tool is found in figure 11.

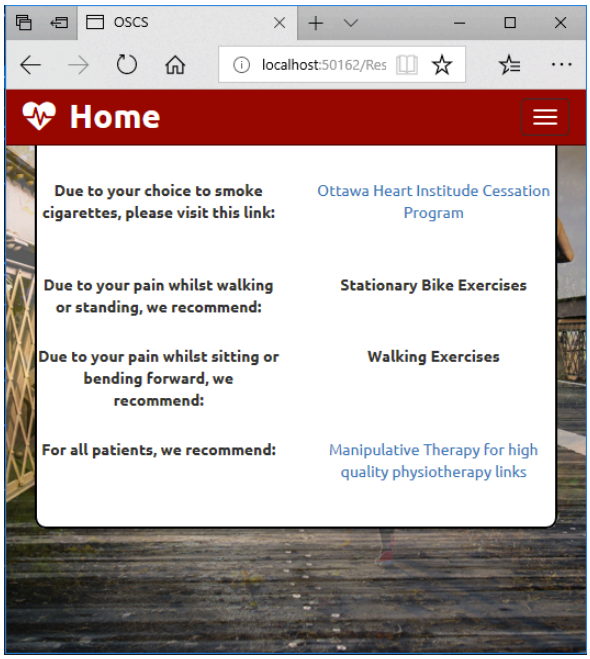

Figure 11: Self-Help Links provided based on the patients response

6.2 Percentage of patients who would be recommended to surgery

Naturally, patients do not see if they are recommended for surgery or not, only the doctor is informed of the systems decision of classification where the doctor can then either agree or reject the proposal. The ideal percentage of candidates that would be recommended for surgery would be that of around 25% to 30%. It would be very interesting to see once machine learning is implemented if this percentage rate follows

that of the ideal percentage of patients who would be candidates for surgery.

7 Discussion

7.1 Overview

The experience gained when developing and designing the online spinal consulting system was extremely valuable since it taught the notion that requirements and variables can change in an instant and to always be prepared to modify changes for the better when working with a client.

As much as an undergraduate degree in Computer Science allowed the ability to handle various large project and systems to administers, having to work with a client as opposed to a course assignment was very valuable in educational growth and will have prepared me for my career as a programmer when working with non-technical client.

This honours project also allowed me to understand the importance of patient confidentiality and integrity when creating a system that would handle patients answers regarding health.

7.2 Privacy and patient integrity

Whilst in a meeting with Dr. Eugene Wai, he explained the importance of privacy and patient integrity in regard to the patient-doctor confidentiality. PHIPA was first mentioned here. PHIPA refers to the Personal Health Information Protection Act.

This Ontario legislation is one component of the Health Information Protection Act to which PHIPA portray a set of strict rules whilst collecting, using or disclosing personal health information which entails that there must be consent required for this collection, that the information is maintained as confidential, that individuals have the right access their personal health information as well as the ability to correct it, and various other rules which entail absolute integrity for the individuals information [15].

Furthermore, the important notion of privacy impact analysis was discussed. Privacy Impact Assessments (PIAs) are ideal tools to allow the identification of potential privacy risks. They are useful to invoke the elimination or reduction of those risks to an acceptable level [16]. Privacy Impact Assessment can be a very useful tool to understand exactly how the online spinal consulting system can be used to eliminate patient exposure and risk, which would ultimately break the highly regarded patient-doctor confidentiality.

The importance of transparency and patient-doctor confidentiality transpired to influence the application in a manner to portray a privacy policy to be accepted by the patient prior to performing a questionnaire without registration.

7.3 Difficulties

Initially, having relatively little experience in dealing with a full stack web application, there was learning curve to properly implement this web system. However, I was later able to understand how to invoke such a system in Visual Studio with the help of examples and guidance provided by Dr. Mohamad Hoda and his sibling.

Furthermore, the online spinal consulting system had the notion of using supervised machine learning to invoke classification for the patients on whether or not they would be recommended for surgery. However, the trained dataset provided was judge not be sufficient enough to invoke machine learning, therefore, the focus to implement machine learning shifted to implementing a web system which could prepare for machine learning once a proper training data set is established. Therefore, a difficulty was changing the end goal, however this was achieved with dedicated planning to administer a web system that could prepare to return the needed inputs for machine learning in future work.

7.4 Future Work

Although the task of creating a web system that would allow for patients to respond to a questionnaire and then storing those answered in a database was successful, there is future work that could be extremely beneficial to the progress of this web system.

Firstly, the web site would be activated online on a public server to allow for patient collection to proceed. When a certain number of patients have submitted accurate answers to their pain threshold and they have been given a recommendation by the system to which the doctor has either agreed or disagreed, the important step of machine learning can be used on the now viable training data.

Furthermore, the static algorithm could be advanced to a measure that propels its accuracy in determining if a patient is suited for surgery or not.

8 Conclusion

This paper first outlines the original problem of how a doctor would decide who is the ideal candidate, if there are only a few patients then yes, the doctor could perform the task manually, however, if there are thousands of patients, the original problem persist that there would never be enough time to know which patient should require over the precedence of another.

At this point, the online spinal consultation system was born, this web system had the task to perform classification to the patients based on their candidacy for surgery. By allowing for a scalable system where patients would enter their answers to pain, habits, hobbies, etc. a dataset would be built.

Using MySQL and ASP.NET allowed for a powerful combination which enabled the goal to analyze the patients answered questions to build a classification using machine learning.

Machine learning was the initial idea to allow for classification of the patients' surgical categories, however, due to a lack of proper training set to complete the supervised machine learning using Support Vector Machines (SVM), this step was ignored for now. However, this turn of events allowed for the ability to invoke a static algorithm which was on thresholds decided by Dr. Eugene Wai.

This static algorithm became a stepping stone to initialize a training set for the machine learning since there will now be the inputs of the patient and outputs of the knowledge which claims if these same patients had been classified as a suitor surgery by the doctor under their manual review in the category of "DoctorAgrees".

The online spinal consulting system is a powerful tool which can assist many doctors and can help improve lives once the classification has been set for a specific patient to allow them to get the treatment they rightfully deserve.

9 Acknowledgements

Firstly, I would like to thank Dr. Abdulmotaleb El Saddik for allowing me the opportunity to work on this interesting and crucial topic. The educational and professional growth I have obtained in this honours project cannot be measured and will impact me in a very positive way in my future professional goals.

Secondly, I would like to thank Dr. Mohamad Hoda for his weekly guidance and support in this task whilst also, with the help of his sibling, providing me with basic steps and examples of backend binding in Visual Studio.

Thirdly, I would like to thank Dr. Eugene Wai for having the patience to explain medical terms to myself, a non-medical student. I would also like to thank him for providing clear guidance in the algorithms used and for his positive feedback concerning the websites frontend.

10 References

[1] "PHQ-9 Depression Test Questionnaire", Patient.info, 2018. [Online]. Available: https://patient.info/doctor/patient-health-questionnaire-phq-9. [Accessed: 18- Apr- 2018].

[2] "PHQ-9". *Phqscreeners.com*, 2018. [Online]. Available: http://www.phqscreeners.com/sites/g/files/g10016261/f/201412/PHQ-9_English.pdf. [Accessed: 18- Apr- 2018].

[3] "STarT Back Tool - Keele University", *Keele.ac.uk*, 2018. [Online]. Available: https://www.keele.ac.uk/sbst/startbacktool/. [Accessed: 18- Apr- 2018].

[4] "STarT Back Tool – Agency Medical Directors' Group ", *Agencymeddirectors.wa.gov*, 2018. [Online]. Available: http://agencymeddirectors.wa.gov/Files/AssessmentTools/5-Keele_STarT_Back9_item-7.pdf. [Accessed: 18- Apr- 2018].

[5] "International Physical Activity Questionnaire" (IPAQ), *Sdp.univ.fvg.it*, 2018. [Online]. Available: http://www.sdp.univ.fvg.it/sites/default/files/IPAQ_English_self-admin_long.pdf. [Accessed: 18- Apr- 2018].

[6] "EQ-5D-5L – EQ-5D", *Euroqol.org*, 2018. [Online]. Available: https://euroqol.org/eq-5d-instruments/eq-5d-5l-about/. [Accessed: 23- Apr- 2018].

[7] "Oswestry Disability Index", *Physiopedia*, 2018. [Online]. Available: https://www.physio-pedia.com/Oswestry_Disability_Index. [Accessed: 18- Apr- 2018].

[8] "3 Incontinence Questions (3IQ) " Coe.ucsf.edu, 2018. [Online]. Available: http://coe.ucsf.edu/wcc/3questions.pdf. [Accessed: 18- Apr- 2018].

[9] "The Official Microsoft ASP.NET Site", The Official Microsoft ASP.NET Site, 2018. [Online]. Available: https://www.asp.net. [Accessed: 18- Apr- 2018].

[10] "Home : The Official Microsoft IIS Site", Iis.net, 2018. [Online]. Available: https://www.iis.net. [Accessed: 18- Apr- 2018].

[11] "Bootstrap", *Getbootstrap.com*, 2018. [Online]. Available: https://getbootstrap.com. [Accessed: 18- Apr- 2018].

[12] "100+ Fitness Images | Download Free Pictures on Unsplash", *Unsplash.com*, 2018. [Online]. Available: https://unsplash.com/search/photos/fitness. [Accessed: 18- Apr- 2018].

[13] "Quit Smoking Program", *Ottawa Heart Institute*, 2018. [Online]. Available: https://www.ottawaheart.ca/clinic/quit-smoking-program. [Accessed: 18- Apr- 2018].

[14] "CAMPT - Canadian Academy of Manipulative Physiotherapy", *CAMPT*, 2018. [Online]. Available: http://manippt.org. [Accessed: 18- Apr- 2018].

[15] "PHIPA". *Ontario.ca*, 2018. [Online]. Available: https://www.ontario.ca/laws/statute/04p03. [Accessed: 20- Apr- 2018].

[16] "Privacy Impact Assessments - Office of the Privacy Commissioner of Canada", *Priv.gc.ca*, 2018. [Online]. Available: https://www.priv.gc.ca/en/privacy-topics/privacy-impact-assessments/. [Accessed: 18- Apr- 2018].