Department of Computer Science

6001COMP Software Development Project

Final Report Submitted by

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Programme (Computer Studies)

Title

"*Smart Health, The Internet of things, Web of things, and Web resources*"

Supervised by

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Submitted on

21st April 2017

Contents

Department of Computer Science

Final Year Project Specification (6001PROJ)

Project details

Name	Osman Demir
Student No	680914
Programme	Computer Studies
Supervisor	Thar Baker
Project Title	Smart Health, the Internet of things, web of things and web resources
Brief description (up to 100 words)	My project is about the internet of things. The Internet of things integrates physical devices into the digital world. Smart devices can use the internet to communicate with other devices, collect data and even control sensors and other smart devices through the internet. Currently it is difficult to integrate smart devices into the internet of things because of architectural problems at the application layer.

Checklist

Meeting	I have met with my supervisor **in person** to discuss my ideas	YES
Approval	I have received my supervisor's approval for the specification	YES
Management	I have arranged regular meetings with my supervisor	YES
Ethics	I have discussed ethical approval for the project	YES

Chapter 1

Project Introduction

1.1 Introduction

My project is about the internet of things. The Internet of things integrates physical devices into the digital world. Smart devices can use the internet to communicate with other devices, collect data and even control sensors and other smart devices through the internet. Currently it is difficult to integrate smart devices into the internet of things because of architectural problems at the application layer.

I will be looking into how to make it easier to integrate and develop smart devices for the internet of things by using the Web of things and Web resources. The web of things is a new approach on developing new apps for the internet of things. The web of things reuses the current standards in place to simplify the application layer, which means it will be easier to develop applications. I will also be looking how we web resources can make integrating devices into the internet of things easier. Currently there is research being done at LJMU that involves creating a new development standard for the internet of things. This standard will propose three different web resources that Internet of things app development must follow. The resources are:

-Consumed –Device / data being inputted

-Computational –Where API's, services and servers do any computational processing

-Produced –The results from the computational processing

This will mean all apps and the internet of things will become standardized, and much easier to implement.

This topic already relates to some of my modules that I have already studied during my first and second year of university. My computing in society course looked into the internet of things, smart cities, how all smart devices and society will connect to each other and to the web. In my principles and computing course, we learnt how networks connect to other networks, designed around other networks and what types of protocols connect different devices and applications together. This is very important as more and more devices will be connecting the web, connection and speed will become a problem in the future. Web development and advanced web development courses have shown me what different types of API's, programming languages and scripts I can use.

1.2 The Problem

The main problem that I am focusing on is the internet of things does not have a simple application layer that I can use to create applications for the internet of things. This is a computing problem that is currently being researched by computer engineers and scientists in several universities around the world. My project will be specifically looking into smart health devices and using the internet of things to benefit patients and doctors. I will mainly be focusing on the connection of devices (vital reading sensors) to the web and then how the data will be stored (Cloud based, normal database) and processed (Web API) into readable information on a web interface. I will be using the web of things and the web resources proposed above as my method of development. current research that is being done in LJMU university by my supervisor and his project team on the web of things on how I could implement my project and other smart devices into the internet of things more easily.

There have been solutions that uses sensors that monitor vital patients but these solutions are expensive and not used in normal hospitals only in tertiary hospitals and research and development labs in hospitals. There are also solutions that can be attached to phones as an extension or even the phone itself may have the capabilities but these solutions are not the best for professional doctors who will need professional equipment. The current solution for the web of things is being researched still so it is not possible for me to have a working solution only a solution that is theoretical, and a solution that is based on the current system in place.

I think that I have the skills to develop the smart health system that I am proposing using the current system of the internet of things. This means connecting the sensor to some sort of database system and creating a web service for the data to read off the database onto a web page. I think this a challenge and realistic for my skills but the most challenging part will be thinking of a way to connect the sensor wirelessly to the database system, if I cannot do that I will use simulation data and only create the web service and database that will be used.

1.3 Aims

My main aim is to create a web application that will be using the proposed web of things architecture for application development. The new architecture will consist of a sensor (consumed web resource) connecting to a web service (computational resource); the computational resource will add the data to a database where it will become a produced resource. Then the data will come out as the database as a consumed resource into a new web service (computational resource), through the web service it will be produced on to a web application to view therefore becoming a produced resource.

1.4 Objectives

I have several objectives that I will need to accomplish during my project, they are:

1. Finish literature review
2. Problem analysis
3. Finish design phase
4. Finish Implementation
5. Testing Phase
6. Finish Report
7. Presentation

1. Finishing the literature review means that I have fully researched the area of topic and have a good knowledge of the new theoretical standard of the web resources that I will be using.
2. When the design stage of the application is completed
3. The programming section of my project, when I create the database, web service and web page. This section is probably the most time consuming and largest section right behind the design section.
4. I will be testing to make sure the web application works as intended. When I reach testing the final phases of my project will be slowly starting.
5. This is my final report about my whole project.
6. The presentation that I will give to my supervisor and a small audience about my project. At this stage, the project will be finished.

1.5 Milestones

I will have a few milestones that I will be use to judge my pace.

1. Specification approved
2. Starting Research phase
3. Finishing research
4. Starting design phase
5. Finishing design phase
6. Starting Implementation phase
   6.1. Sensors connected to database / or using simulation data
   6.2. Database storing data
   6.3. Web Service connecting database and web page
7. Testing
8. Results
9. Draft Report
10. Final Report
11. Presentation

1.6 Hardware and software

All the software and hardware that maybe needed for my project is available at LJMU, the only issues that may arise is getting the hardware sensors that may be used. If it's not possible to use any hardware sensors like mentioned above I will use simulated data in the database only and then connect the database to the web application.

1.7 Summary

In this section I have introduced the problem that I think exists and have spoken about the theory of my solution. I have introduced the concepts of consumed, computational and produced resources and how they are related to the web of things. I have laid out the aims of my project and the objectives which I will need to achieve. I have created milestones for this project. I have used these milestones in the GANNT chart I have created. This will allow me to keep track of my progress whilst development and make it easier to manage my time. I also spoke about the possible hardware and software issues that I may face during the development. Such as the hardware sensors.

Chapter 2

Researching the Problem

2.1 Introduction

In this section I will be going over several research papers that are related to what I am studying in my project. I will be focusing on the contents of the research papers, and what they provide for me and my project. I will be commenting and critically evaluating on what they propose in the papers and providing my own opinions about their ideas and my own ideas. The main problem that I will be researching is if the Internet of things currently needs to update the process of creating applications that interact with the Internet. The research papers that I will be looking into will be providing different possible solutions to this problem. I already know that there are multiple solutions proposed in these papers and multiple ways to tackle the current issue.

The research papers that I will be looking into were sent to me by my project supervisor. My project supervisor has background knowledge on the topic I am doing, so I will be using these as my first research papers I analyze and comment about. If I think that I need to analyze more research papers I will do so.

My main idea that I will be proposing and comparing against the research papers ideas is that the web of things must have a standardized platform. This platform will have three main components, which will be based upon web resources. The components are:
-Consumed resources
-Computational resources
-Produced resources
Each resource will have its own main functionality.

2.1.1 Consumed

Consumed resources is data that has been sent from either the smart device or new data that has been inputted into some sort of database. An example of this is the patient's vitals being sent over to the database.

2.1.2 Computational

Computational where API's, services and servers do any computational processing required for it to become a produced. An example is the Patients data being formatted to a specific format to be stored in the database or shown on the web application in a specific format.

2.1.3 Produced

Produced is the results from the computational processing. This will standardize the entire industry to a specific method of working therefore making it easier to develop web of things applications. Different research papers have proposed different solutions to the web of things problem. I will now start to analyze the research papers.

2.2 Virtual resources for the Internet of Things

[1] In this paper they are presenting the idea of virtual resources which is a software architecture to solve the effective development and efficiencies of Internet of things applications. They are talking about how Internet of things architectures have recurring traits,

such as the Internet of things device is using a Restful interface and then directly connecting to the cloud processing unit where all the processing is done for the data acquired. They conclude that this normal method is causing delay and reducing efficiencies at the cloud/application level when the data is being processed. The proposed virtual resources will be an intermediate where developers can create a "*virtual sensor* (For devices that use sensors)" and in the virtual sensor there will be the pieces of logic (code) from the cloud based application. This means reduced latency when two IOT things devices have to communicate with each other. For example in an office scenario the temperature sensors see that the office is too hot, the data that is processed for that room is only sent from the virtual sensor to the cloud computing then to the nearest fan virtual actuator, which then activates the relevant fan. Here are some benefits that they say from virtual resources:
"- Network resources are better utilized. The ability to push a slice of the application processing to intermediate IoT devices enables, for example, a reduction in the amount of data coming from sensors, which helps prolong the system's lifetime. Similarly, lower network traffic is less likely to generate congestion within the IoT network, improving on the application's perceived latency.

-The Cloud-hosted application becomes simpler. For example, driving one actuator for all lights in public areas is easier than a varying number of individual actuators. Notably, the set of resources representing inputs (outputs) for a virtual sensor (actuator) is evaluated only at run-time. Therefore, changes in such sets are dealt with transparently w.r.t. the Cloud-hosted application.

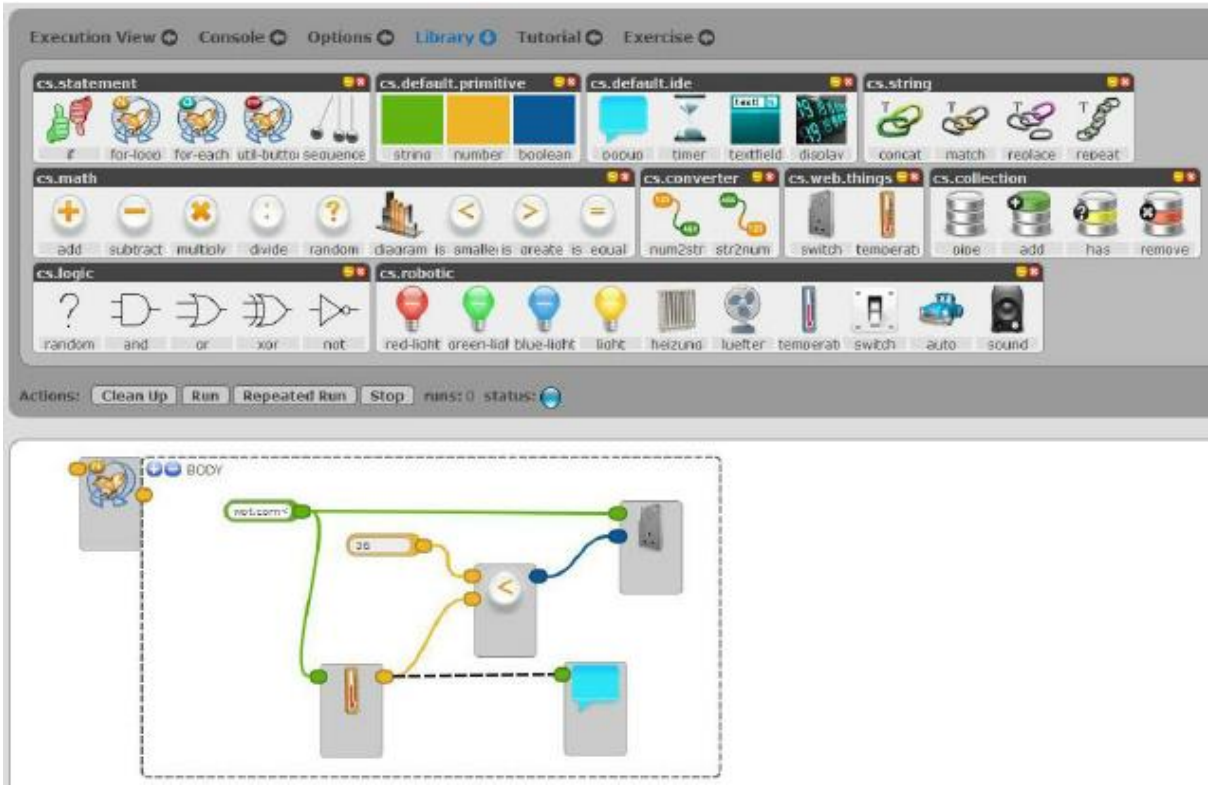
-Developers can separate out low-level concerns and move them to other devices, fostering a better separation of concerns. For example, the manufacturer the IoT devices may provide a library of virtual resources useful in paradigmatic scenarios, used by domain-experts when implementing the high-level application logic at the Cloud." (Direct quote from paper)

Overall I think the paper has some relevance to the area I am researching, here they are trying to tackle the efficiency and latency issues by just introducing virtual resources which will help in those areas. But the main issues are not solved which is not having a standardised system in place that all developers must follow when creating applications for the use of the Internet of things. The system they propose will come under a computational resources in my proposed theory. I think that the system is very good and if the benefits are correct it should be adopted by developers.
The paper goes into a lot of detail on how they tested their theory and how it works. This is very good for the people who understand what they are saying because there is a lot of jargon that is used, but a normal person will find it difficult to understand the detailed sections. I think that they emphasise the benefits quite clearly and provide some sort of evidence as well of their claims with the results of the test they conducted with the use of virtual resources. I think that the only vague sections is that they don't mention any downsides to this system. Not system is perfect and there must a downside to the system that they have proposed I think.

2.3 A resource oriented architecture for the Web of Things

[3] In this research paper they are focusing on the application layer in the web of thing. They are proposing that we should focusing on the web of things by integrating the smart devices

into the application layer. They propose to do this by implementing web servers into smart devices and using the REST architectural style. This then allows them to use URI's to communicate with other smart devices through web browsers, and the interaction with smart devices can happen through the browser using well know web tools such as HTML, JavaScript, Ajax PHP, Python. This is one section they propose and the next is smart gateways for devices that can't fully support the REST API and devices that may not have a full Internet connection. *"Smart Gateways which are embedded Web servers that abstract communications and services of non Web enabled devices behind a RESTful API"(quote from paper).*
A test they ran for their implementation of the smart gateway is to use a ploggs and a sunspot. The test was to compare two different architecture types an embedded HTTP round trip and synchronised based round trip. The test was issuing a GET request to read the current light sensor value of a sunspot located one radio hop away. Embedded HTTP is directly connected to the web whilst a synchronised based system is done through a proxy which need to use a smart gateway. The results is: "*With the embedded HTTP running on the device, the response time is higher because the HTTP request must be propagated to the device over a radio connection, while it is served directly from the gateway in the synchronization version.".* They show that using a smart gateway is much faster because the sun spot sends regular intervals of data to the proxy cache, and when the data is requested it gets it straight from the proxy. But unfortunately they state caching doesn't work for non-cacheable write requests.



(Figure 1[7] Mash up of Testing from paper 2)

In this research paper they propose quite a few things that is relevant to my area. The idea that they want to integrate the smart devices and the web of things application layer more into each other therefore "mashing up" physical devices. I think the idea proposed is a good one but unfortunately the research paper is pretty old (2011) meaning that I don't think the idea for smart gateways was ever put into place and the sunspot system has been abandoned

by oracle systems. The data they provided did show promising results for systems that could use caching. I think that the article is written properly and they go into a lot of details when they talk about how they came up with the idea, created and tested the system they proposed, meaning that there isn't really any areas that they are vague in. What is common about this system with the previous one is that they both use a RESTful API to connect the smart device to the web of things. Overall I think that this idea that they proposed was a good one but I think it was proposed too early (2011). At 2011 there wasn't as much adoption for smart phones and smart devices across the globe and especially for the internet of things only in western markets, it wasn't until later that more people could buy smart phones or other smart devices which could integrate with other applications. The system is also using a product that isn't sold anymore, but I'm sure there is something else that It could replace it. Compared to what I propose this would be considered a part of the computational and consumed resource sections of the standardization of the development. Once again this idea doesn't fix the main issue of development for the application in the web of things only a small section of it, my idea is making sure there is a standardisation that is followed in every step of development, therefore making it easier to develop.

2.4 A Web of Things Framework for RESTful Applications and Its Experimentation in a Smart City

[5]In this research paper the author states that little has been done to improve the development for web of things applications using the REST API therefore the REST API wasn't being fully utilised to the maximum by developers. So they propose a framework, which supports developers in modelling smart devices as web resources through the REST API and then developing the application on top. This framework that they are proposing consists of a Web resource information model, middle ware and tools for developing and publishing. They create their system and test in the context of the Smart Santander European union project (Smart City project). The system has several sections:

Middleware IDN- This is the main section that will be handling the virtual resources, Information history and the storage interface.

IDN studio- The application that manages visual management for the web resources, this interacts with the middle ware section through the REST API. It allows users to create, delete and edit virtual resources.

IDN viewer- Its main task consists in parsing the resources returned by the middleware and, depending on their structure, generating rich HTML web pages.

IDN java library- The IDN-Java Library provides features for easing the server-side programming of web applications that handle Web Resources exposed by the IDN middleware.

The testing method for the IDN viewer and studio was done with a questionnaire. I think this is a good method to test the interface but they don't mention how many users/people

answered the questionnaire, therefore the percentages shown in their table could be manipulated into their favour. They also don't mention how many hours/days the people who used the IDN studio and IDN viewer meaning they might have not had a full experience to full evaluate the system they used. They also provide performance data but this data is can't be used to analyse speed because they don't provide old data using a conventional system to compare to. I think that the middle ware section and the IDN viewer and studio .I think that the idea of the system is good if the user data is provided is good. Compared to my proposed system I think that this will fit in perfectly because if it does make development easier by smart devices using REST API to communicate with each other and the servers using URIs. In my system this will fit into the computation and produced resources. Their system doesn't not address the problem of the entire development process is not standardised, this method of using web resources is similar but it only uses it in the section of getting the data and computing the data that's been sent. As always the paper uses very complex language to present their proposal. Overall I think that it's a good system and it has lots of potential.

2.5 RESTful Web Services for the Internet of Things

[4]This paper is talking about how to integrate physical smart devices that are constrained when connected to the web. There solution to the problem is using technologies such as CoAP (constrained application protocol) and RESTful web service based architectures. They want to unify the web and physical smart devices by using existing technologies. Using the web of things as a basis they want applications and devices to speak to each other using the same language, but they can't do it in the current state of the Internet of Things. Meaning that they will be redesigning and optimising payload encoding and application protocols. The article goes on to talk about the normal the advantages of RESTful web services compared to other services such as SOAP. Stating that RESTful performs better over wireless and is easier to learn and implement. RESTful has a close relationship with HTTP, which brings advantages such as less parsing complexity and overhead. Now they move onto talking about CoAP and how this is an alternative to the normal RESTful approach. The author states that CoAP was designed with M2M communication in mind, and that it still uses the RESTful API but it has been improved with more HTTP functionalities, and takes into account the constrained environments that a smart device could be in.

Overall this paper is proposing CoAP, a system that should be used instead of normal RESTful services to communicate with different smart devices and the servers. In the paper they do not provide any real world testing that this CoAP to show the results of CoAP instead of the normal way. But they do provide an in depth detail on how CoAP is more advantages than using the standard HTTP communication methods, they go into some detail on what each layer provides and how it has more advantages over HTTP. The main goal of CoAP was for low powered devices and constrained devices on the same network to communicate with each other and the rest of the web. The CoAP protocol is being used today so it has succeeded in its job. This CoAP protocol is only addressing the small issues. In my system of standardisation CoAP will fall under the produced and computational section of resources. Therefore it would fit into my system of standardisation very well, because using CoAP means more smart devices can access the web. If the web of things development was standardised across all sections of development not just the communication of devices like in this paper it would mean developers can easily develop for all smart devices and integrating some of the

technologies proposed in the research papers I've looked at already can mean a big difference and much faster adoption of devices being connected to the Internet and each other.

2.6 A resource oriented integration architecture for the Internet of Things: A business process perspective

[2]In this article they are proposing a REST inspired architecture for interconnecting business processes with Internet of things resources. They use a resources oriented architecture for the design and implementation which provides the core of their end to end integration of Internet of things services, but with a specialised focus on Internet of things aware business processes (Business process management systems are systems that collect real time data from different IoT devices and then is combined with other data to make business decisions or to show different data models in real time). This in the end will provide better discoverability for smaller Internet of things devices and can be easily accessed by business processes.

The scenario that they talk about where they can apply this system is with ambient assisted living systems. Smart devices will collect the data from the various sensors then the data will be stored locally. When the data is actually needed by a doctor the data is sent to a remote Business system being used by the doctor, this means with their architecture it can provide real time analysis of patient vitals and send the appropriate medical help or medication without even having to leave the GP. They specify some problems with the system that needs to be addressed such as the battery life of certain smart devices and the issue of devices loosing connection to the business system enjoinment such as smart phones. Business process needs to be able to handle these things and they say they address these issues, in the programming frame work, event manage, device status monitor, service replacement manager and distributed business process. In the paper they do run real world tests and some simulated tests with their framework, such as smart device load times when send data, delay time when there are more and more sensors.

Overall I think that the system they have proposed is good one because smart devices will definitely benefit from being connected to different businesses process and systems, and that will benefit the users in the real world. The focus of this system is mainly for business processes and connecting to business systems, meaning that they only have considered this. They don't mention anywhere how easy it would be to develop for a business process; therefore it could be more difficult for new developers to develop for these Internet of things devices. I think that they don't speak about the disadvantages that their system will have with much lower powered smart devices that may not be able to handle the processing required, even though they use a modern smart device in testing there are many older smart devices which may not be compatible with their system. Overall there system is only focusing on the small section of devices communicating with each other and it is very specified situation of business processes, unlike my system where the end goal is to have a fully standardized system for all developers to follow. The systems I've been looking at so far all make it easier for it to develop in the communication of smart devices and the processing but these systems still are being developed differently and not in a standardised format.

2.7 Summary

So far all of the papers I have looked at have been proposing a new way of smart devices to communicate with each other. The majority of systems have been using the RESTful API and

have been modifying to their specific needs depending on what the systems main purpose is. I would say that the most popular application protocol for the internet of things is CoAP which is based upon the RESTful API. The CoAP protocols main aim is to make low powered devices and constrained devices to be able to communicate with each other. Many of the papers here also use take advantages of using resource based (REST) for many of the web service interactions between devices and between the main servers. Overall I think that this shows what the web of things needs is a new standardisation of using web based resources to be integrated into the web with better functionality than the current system. The standardisation that I'm proposing means that there will only be three main sections of an internet of things device. The standardisation should make development cycle clearer for new developers, and using a resource based system will allow more functionality.

Chapter 3

Requirements and Problems

3.1 Introduction

In this section I will be tackling the problems and the solution of a real world system. I will also be defining the problems for my systems and the requirements needed to create a working solution. I will go over the main problem first then propose a solution. Once I have proposed a solution I will look at the requirements for the proposed solution.

3.2 Requirements and Problems

3.2.1 Defining the problem

The problem that I am tackling is that the Internet of Things doesn't have a standardized platform that can followed by all developers when creating new smart things that will be connecting to the internet. Currently the system how everyone develops smart things/devices for the internet of things is different from each other. This means that there are several different complex ways that a single smart device can connect to the internet, get data from other smart devices and process the data gathered. Normally this wouldn't matter because there aren't that many systems that fully utilize the devices of the Internet of things. But towards the future this would matter a lot, as more and more smart things emerge and are developed it can lead to more different ways of connecting to each other(smart things) and the Internet. This will lead to inefficiencies across the network, inefficiencies during development, and inefficiencies when trying to use smart things with multiple systems.

Here is an example of this problem in the medical field; in a hospital multiple smart devices/things are connected to the hospital system. To connect the devices the hospital system must have been modified or developed around it so that each smart thing can connect correctly. Once the connection is established and everything is setup the smart device can now use the hospital system as a storage and processing centre for the data it collects, and this data can be viewed by staff. The smart thing could be a temperature sensor for a patient, and this sensor is connected to the system where it is sending in the data. Another smart thing could be an air con unit. These smart things once installed can talk to each other and operate without user input, e.g. if the patient is too hot it can send a signal to the air con unit to switch it on, then once the correct temperature is reach another signal to turn it off. This is just one small system in play out of thousands. Now let's say that another hospital uses the exact same smart device setup but this system doesn't allow the same data storage methods as the other system. Now imagine this across a whole country, when the government or NHS wants to analyze the information and data gathered from different smart things the data will have to be normalized for another system, and this will be very inefficient at huge scales because of the amount of different system in place not being compatible with each other, and the amount of data that will have to be gone through. But if there was a standardized system in place for the development of smart things/devices.

3.2.2 Proposed Solution

My solution to this problem is to have a standardized system that is split up into three different sections. The three sections can be universally used across all smart things/devices. The three sections/components are going to be based upon resource oriented architecture. The sections are:

-Consumed

-Computational

-Produced
Each resource section is directly related to a function that the smart device will do. The Consumed resource section is the section where data is gathered by the smart device, this can be done in any way but in this section only data collection is done. Then it moves the computational section. Here the data gathered is stored or processed, this can be done on the smart device or by an external system which the data is sent to. In the end the system know that in the computational resources section that some sort of computation happen. The final resource section is the produced resources. This is the data that has been produced into information and is sent to another smart device possibly or onto a screen/database. This is my solution to the problem that will arise in the future if not tackled now.

The example provided above would change, because there would be a set areas for each process (collecting data, processing data, and serving the data) it would mean smart things can be easily ported from one system to another because developers and the system would know automatically where what process happens and how that process happens because only in that section can that process can happen; for example sensory data being processed would be happening in the computational area, when the other system is connected it will have a computational area that is being used by the other smart things, the new smart device can be directed to that section of the system to do its processing. This overall means that smart things can easily adapt to new conditions without having to go through a development process just to get the device working on another system.

3.2.3 Requirements to the Solution
There are some requirements that need to be considered when creating the solution to this problem. These are some of the requirements that needs to be taken into account when creating the solution:
-User
-System

The user requirements that need to be considered for the solution are the users such as the end user of the system and the developer of the system. Each of these users will have different requirements from each other.
The main end user requirements will be mainly focused on making sure that the user interface that they are using to use is usable and useful. This is important because the main user needs to have a good experience to fully utilize the system.

3.2.4 Real world system Requirements
The system I am proposing and will develop a mock basic version will have two different types of requirements. These requirements are non-functional and functional requirements. Human interaction functions for the smart devices are pretty low because most of functions will be done automatically. Most of the functionality comes from the system it's a part of. The system will normally allow more functionality for the smart thing. Here are some functional requirements that the smart thing and system may provide in the real world:
Functional
-Store collected data
-Compute the data gathered
-Data analysis

-Provide different graphs and charts based upon the data
-Allow the user to create new produced data with the consumed data

Non-functional requirements are all about non user or smart device functions. These functions will be mainly about the smart device because the non-functional for the system is completely separate because it could be a part of a larger system which has lots of processing. Here are some non-functional requirements:
Non-Functional
-Fast communication on the network with other smart things
-Fast communication with system the smart thing is connected to.
-Proper security measures in place so that the smart thing can't be hijacked

3.2.5 Project System Requirements

My system will be a mock system of a smart device that has already sent over the consumed data to another database. The database is sending the consumed data to a web application where it can be viewed by a user**.** Functional and non-functional requirements.
Functional
-Display individual records from the database connected

Non functional
-Fast database connection
-Secure database connection

3.3 Summary

During this chapter I have spoken about the main problem of not having a unified development strategy. Also talked about possible future problems if the problems aren't solved now. I present the possible solution to the problem that I discussed, and the requirements for a solution. Then I spoke about the requirements for my solution that I will be developing, and the projects system requirements.

Chapter 4

Conceptual Design

4.1 Design Introduction

In this section I will be designing the web application that I will be using to demonstrate my solution. For my solution I will be using a basic web application to show how data is transferred from a smart device (Simulation) to a local database and from the database the data will be displayed on a web page. The actual smart data will be simulated so only the database will have to be designed and the web page that the data is going to be displayed on. I will be using a glass fish server and NetBeans to run my webpage and database, these programs will allow me to create a web service to collect the data from the database and show it on the webpage.

I will be creating several diagrams that will be used to outline the web application. I will create a UML case diagram, UML class diagram and a site map.

4.1.1 Methodologies

There are different types of methodologies that can be used when developing a pieces of software or a system. There are three main methodologies that I will be considering to use during the development of my system. The three methodologies are the water fall method, Agile development and prototyping. Each of these solutions provide a different development strategy that can be used whilst following the systems development life cycle. The software development life cycle is a development process used by developers when developing software. The SDLC has six stages that needs to be completed for apiece of software to be considered finished. The six stages are Requirements analysis, Design, Implementation, Testing, Deployment, and maintenance. Each section does a different job from the other. Depending on what development method is being used the way that the SDLC is being followed can change.

4.1.1.1 Waterfall

[8] [9]The waterfall method is a simple way of developing software. In the waterfall method each section of the software development must be completed and agreed on before moving onto the next stage of the development. This means that it is a liner approach to development and stages do not mix together unlike agile and OO development. This approach means that not every software development project cannot use the waterfall method. An ideal project to use this method must have:

A Stable product definition, this is very important because once the project starts it is very hard to go back and change different areas from different stages. If changes are made from previous stages it would mean that progress made after that stage would be scrapped because it may not fit purpose anymore. This can lead to a waste of time and money.

The Requirements are properly documented and isn't ambiguous. This is very important and is similar to the problems mentioned above. If the requirements aren't understood properly and during the development process changes need to be made it can lead to a waste of money and time for the company.

There are different advantages and disadvantages for using the waterfall method. The advantages are:

- Easy to manage because each stage has specific deadlines, deliverables and a review process.
- Once each stage is done there is no need to go back to revaluate

- The milestones and tasks are well defined, which means it can be very easily processed and documented

There are disadvantages as well to using the water fall development process:

- If the requirements are poorly assessed, it can lead to problems later down the cycle
- It is harder to make revisions to the software later down the line without a lot of sacrifice
- For large projects that may change over time this model is not ideal

4.1.1.2 Agile

[10]Agile development is another approach to software development that is used. It is based upon adaptive methods of software development. The planning stage for agile development is not as detailed as the water fall method. This is because that teams are more focused just the features of the system, and they adapt accordingly to the changing requirements of the system. The product is tested frequently and goes through many iterations before it is released. These iterations can be very different from each other or just small improvements. This depends entirely on the customer that has requested the product and if the system meets their satisfaction. Agile development relies on the customer feedback from iterations. Normally to get these iterations out so quickly the team working on the system will be geographically located in the same place. They work in close collaboration with each other (e.g. the design team and software development team). There are many advantages and disadvantages for developing using the agile development.

Advantages

- Lots of team working
- Functionality can be developed rapidly and added into the next iteration
- Documentation can easily be changed
- Flexibility for developers

Disadvantages

- If the customer isn't clear it could lead the team into the worn direction
- Teams must be able to agree and interact with each other.

4.1.1.3 Prototyping

Prototyping is a when a software application is built with the functionality of the system being developed but doesn't have the exact code of the program. Prototyping is used a lot in software development to get an understanding of the customer needs at an early time. It will show the customer and developers requirements that may have not been seen or requirements that may not even be needed, it allows the customer to evaluate very easily. There are few different ways of prototyping.

4.1.1.4 Rapid prototyping

This type of prototyping uses the bare minimum form the requirements document to build. Once the requirements have been set in stone a more complete system is built.

4.1.1.5 Incremental prototyping

In this type of prototyping multiple prototypes are built that have different features of the system then once all the prototypes are complete they are merged into one large system.

4.1.1.6 Evolutionary prototyping

[11]This is when an early prototype is built upon. More and more features are added along the life cycle of the system until a complete.

There are advantages of using this during development and disadvantages.
Advantages

- Customer/user input is very high
- Much quicker feedback from the customer
- Ideal for systems that will have high user interaction
- Missing functionality can be identified easily

Disadvantages

- Not ideal for software development programs that don't have a lot of user interaction with the end software
- System could spiral out and more and more requirements and functionalities may be added in
- Developers could try to use the prototype to create the actual system.

In the development of my system I will be using different methodologies. The main methodology I will be using is the waterfall method. The waterfall method will allow me to plan out my system and design my system beforehand and then I can start the development knowing that I can build a working system step by step. During the actual development I will be using prototypes to create a mock system with working functionalities to get an idea of how the system will be. Then I will most likely improve upon the prototype whilst developing. During development it may be possible for me to use agile development to look back at the requirements and adjust accordingly.

4.2 Design Graphs

There will be a few graphs that will be created to support my design of the software system. These graphs are a called a case diagram, UML class diagram, and a site map diagram. Each of these diagrams will help me in different ways to design the software and get an idea on how it will be programmed.

4.2.1 Case diagram

A case diagram is a basic high level model of the system. In the diagram it shows what kind of users will be interacting different parts of the system. It shows what parts of the system interact with each other and what system uses other internal systems. Because it is a high level model it doesn't go into in depth detail of the actual system, this is done later on.

4.2.3 UML class diagram

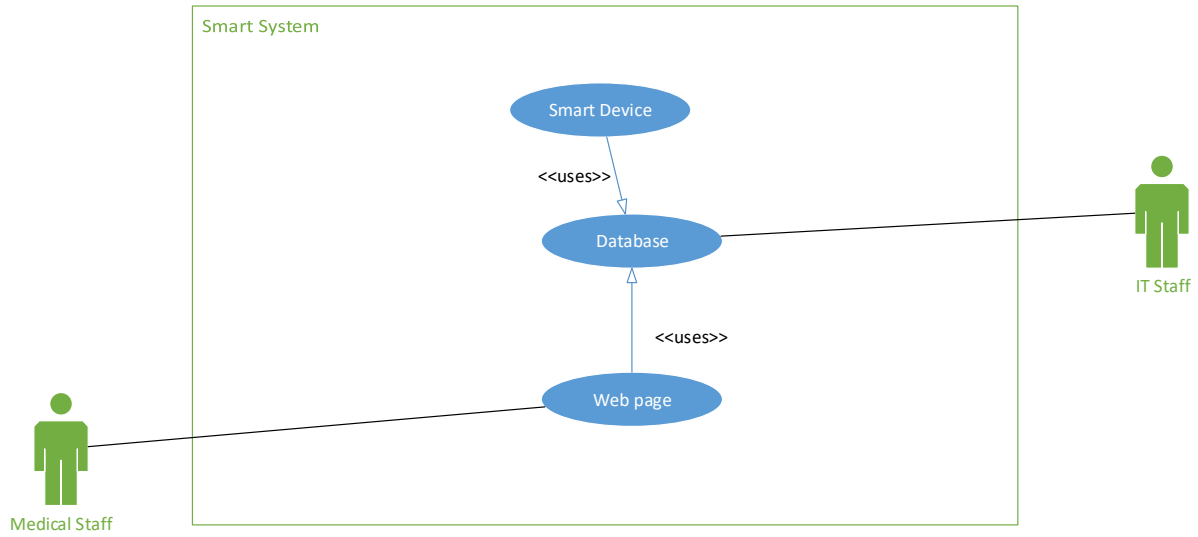
This is a diagram that will show the class diagrams of the software systems. Each class will show the attributes and the methods that may possibly be used within the system. It also

shows if the classes are connected to each other and how they will be connected to each other. It can show if they are a one to many or many o many relationships, or if there are dependencies or aggregations.

4.2.4 Site diagram

A site diagram will show what the basic design layout of the actual web application is. This is ideal for looking at the layout of the site and what webpage connects to what.

4.2.5 UML Case diagram

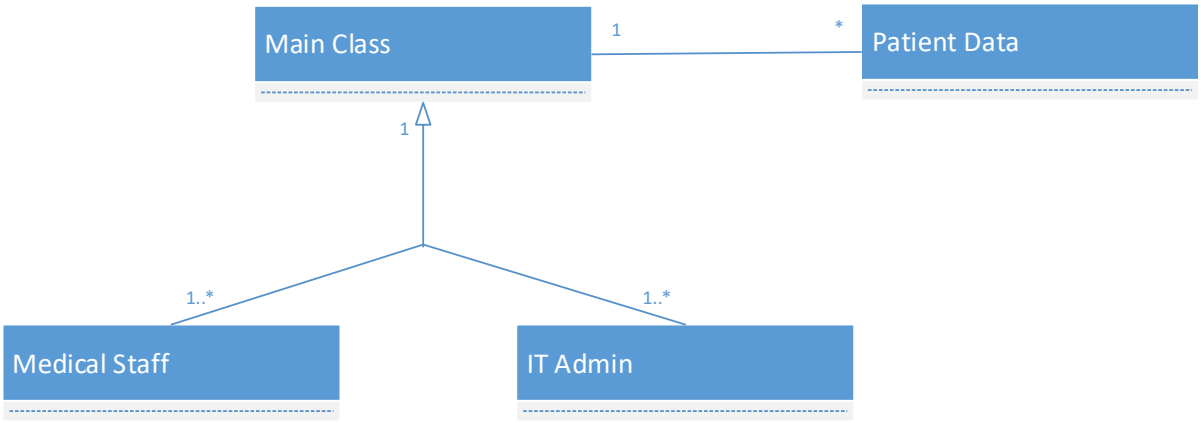


(Figure 2)

This diagram is showing a high level version of my systems and its users. There are two actors that will be the main users of the system. The IT staff and the Medical staff are the two main users. The Medical staff is high level in this diagram but it goes deeper because there are multiple levels of medical staff that could be using the system and all those will have different levels of access to the patient's data in the real world. The medical staff only have access to the webpage of the patient's data they have no need to have access to the database of all the medical patients because they only need access to their specific patient's data. The IT staff will only have access to the database system. They will make sure the system is running properly and that there are no faults.

The diagram shows that the smart devices will be sending data over to the database. The uses means that the database uses the smart devices and the webpage uses the database. The webpage will be using the database to get the data to be shown on to the medical staff.

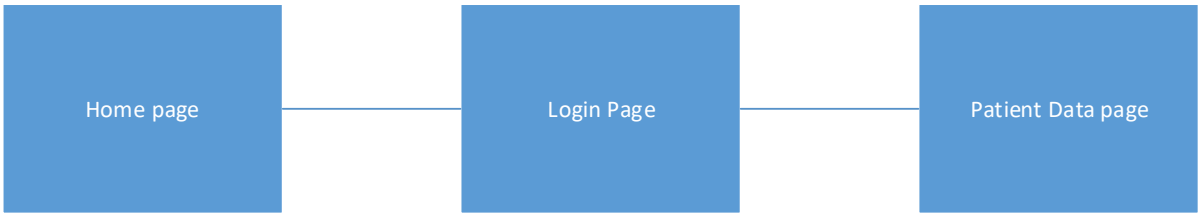
4.2.6 UML Class



(Figure 3)

This is a basic UML class diagram of my system. There are four main classes the main Class, medical Staff, IT admin, and the patient data class. The main class will hold all of the main code for the application. The medical and IT admin classes will be inherit some of the Main class data. In the medical and it staff classes there will be specific methods that apply to them possibly. In the Patient data class the code in there will be to get the data from the database, and then the formatting will probably be done in the main class. There are several relationships in this diagram. The main relationship is the main classes and Patient Data class. It is a 1 to many relationship because there are many patients can be shown on the web application. The medical staff and the IT admin are both 1 or many to 1 because there has to be at least 1 medical staff and 1 admin staff in the database. But there can only be one account per person.

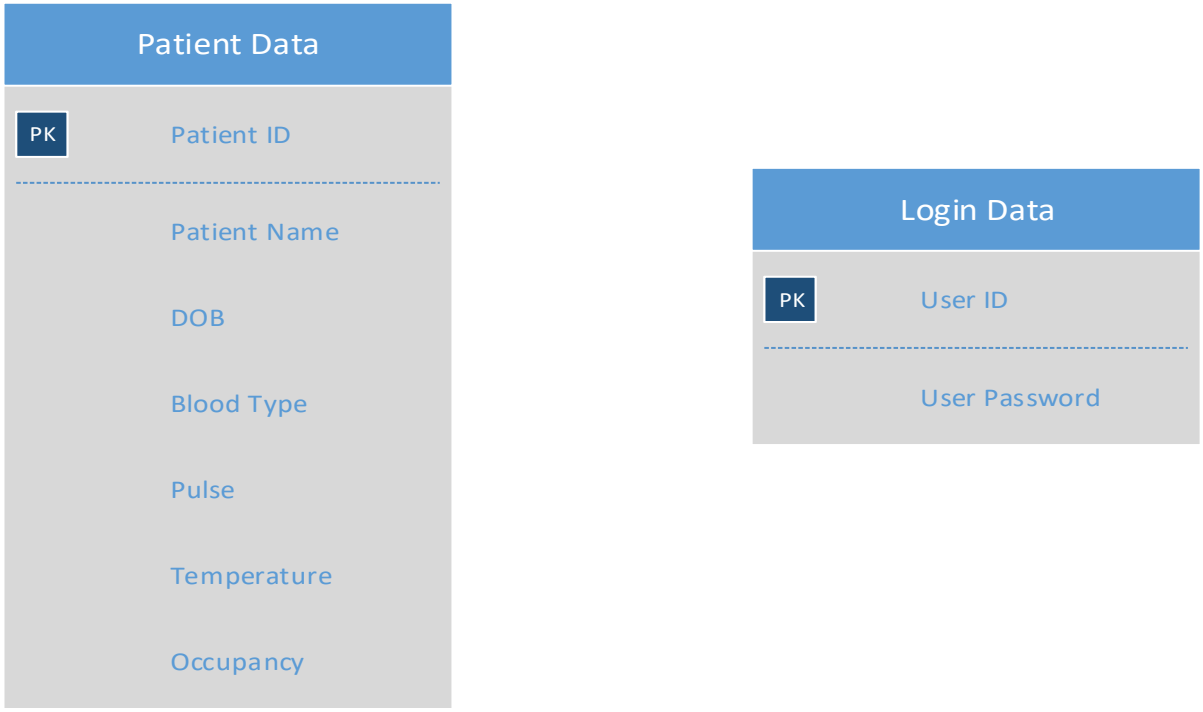
4.2.7 UML site diagram



(Figure 4)

This is a site diagram of potentially my system. It shows each possible web page that could be in. it shows that to get to the patient data page you need to get through the login page. This is done so that the patients data is secure form unauthorized sources.

4.3 Database Model



(Figure 5)

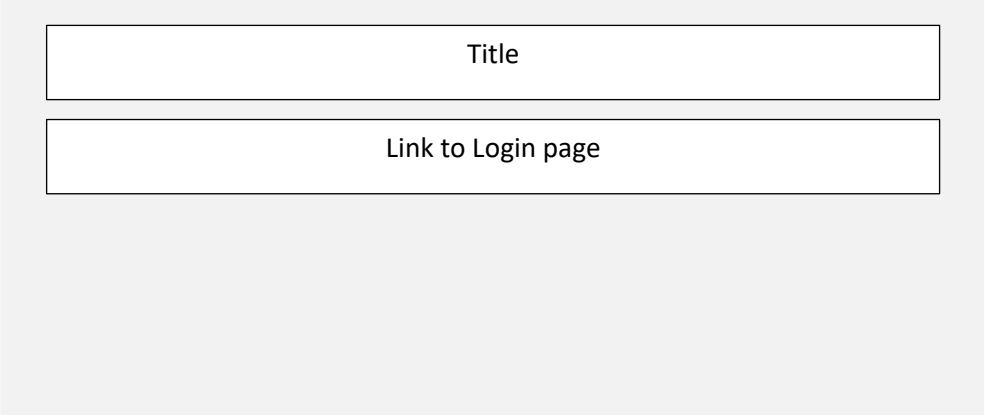
There will be a database that the patient data and login information will be stored in. this database will be integrated into the web application therefore making easier to get the data.

There will be one database and in that database there will be only two tables. One table will be the patient's data and the other table will be the login details for the users. Each table will have a primary key but no foreign key because the data is not going to be used outside of this table in another database. There will only be two columns in the login data table a User ID (PK) and the User password. The patient data table will have some extra data that is relevant to the patient's vitals.

4.4 UI Prototype design

I will be creating a prototype version of what I want the user interface for the web application will look like. This design will be a prototype meaning that it is not the final version of what it will look like. The ideal user interface should be clear. There will be a few user interfaces that will be prototyped, starting with the home page then the login page and lastly the page that shows the patient details.

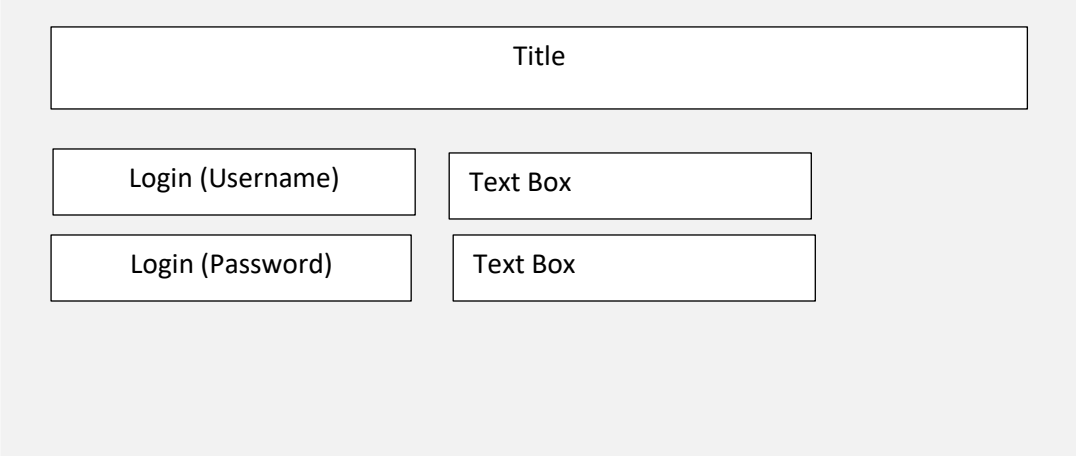
4.4.1 Home page



(Figure 6)

The home page is very basic because it will only have the link to the login page. It will have a title as well. Not much formatting is needed because of the lack of things on the page.

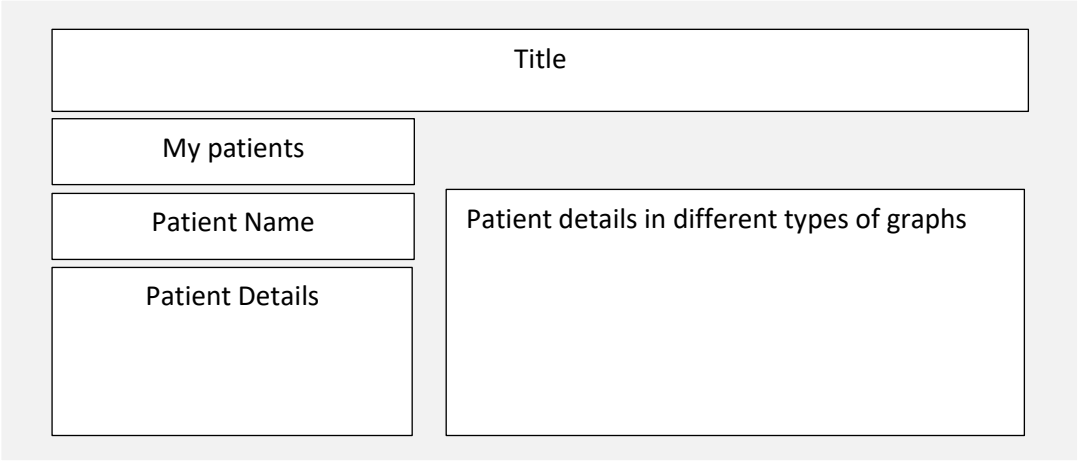
4.4.2 Login Page



(Figure 7)

This is the basic prototype login page that the user will possibly see. There is the main title notify it's the login page at the top. There are the login text and password text. Next to each of these texts will be a text box where the user will be able to enter their details to get to the patients details page.

4.4.3 Patient details page



(Figure 8)

This is the page where all the patient details are kept. There is the “My patients” section where doctors who have multiple patients can view the different patients and the data on screen could change to that patient when selected. The name of the patients will be displayed and their vital details. Graphs could also be shown to the side to see a long term view of the vitals.

4.5 Summary

In this chapter I have gone over the conceptual designs for my proposed system. I have created a class diagram which will be used as the base of my design. I have created a mock-up of the user interface that could be implementing into the system. I go into depth on what different types of development methods I could use for developing my system, and I decide on the specific method that I will be using during development.

Chapter 5

Project Development

5.1 Implementation Introduction

This section will be going over how I developed the basic prototype of my proposal. This prototype is intended to show a basic model of how a smart device may store data in a database, then the data is fetched to a web application where it is displayed on a dashboard BI system.

I decided to do development in stages. The first stage would be getting the database connected to the web application. Then the second stage would be getting the data to display on the web application. The final stage would be adding extra features such as more web pages, some sort of login system (shown in design), and a method of searching through patients to show different patient data.

This system will outline how my consumed, computational and produced data will operate on a very small scale. My system will not demonstrate the part where consumed data is taken directly from the smart device. The Consumed data will already be present inside the database.

5.2 Consumed Resources

The consumed resources in this scenario will already be present in the database. In a real world application the smart thing would send the data that it's collecting to the database to be computed and then stored which it then become produced data. But certain pieces of consumed data can come from the web application such as the patients name and other personal details whilst other consumed data is coming from the smart thing such as the patient's vitals. Once all together it can be processed by the Web applications Java Bean where it can become shown as tables or graphs or just plain normal.

5.3 Computational Resources

In my system computational is in the Java Bean. There I can adjust the data shown, and the format of the data. Once the data has been adjusted to what's going to be shown it can be called from the web application to be used. But the only way for this to happen in my system is to make sure that the database is connected to web application using the glass fish server.

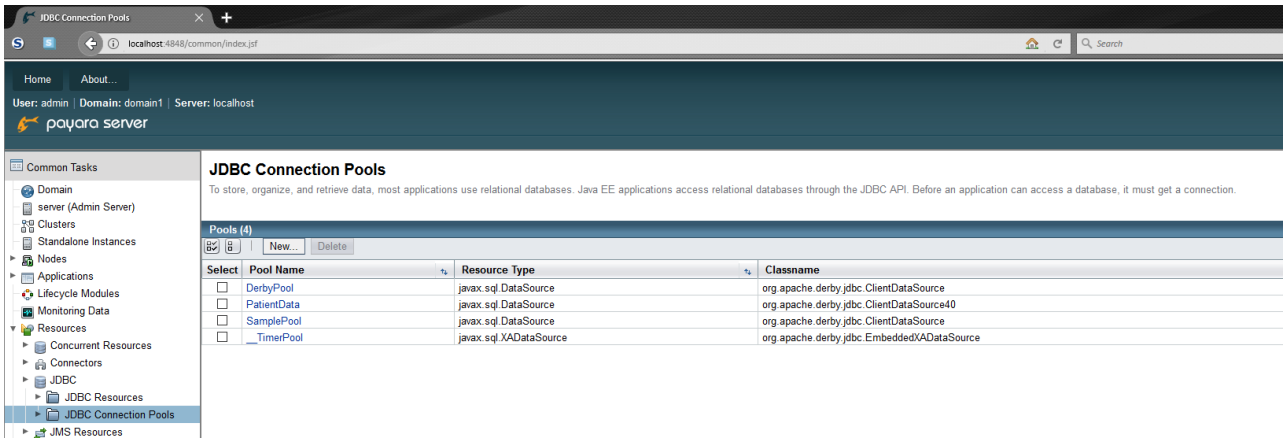
5.4 Produced Resources

There can be different types of produced Resources. The data that is shown on the web application straight from the database can be considered produced resource. This is because it has been taken from the smart device and then computed in the database to the proper format, once that happens and it is shown in the application it can be considered produced data. So the data such as Temperate, Date of birth etc. can be considered produced data. The other types of produced data can be data that the User applies to the data shown. For example in a real world system the doctor could apply more context to a piece of data shown by creating a graph that uses 1 piece of data and another together to make a completely 3rd new graph. The data derived from those results can be computed and then it will become new produced data.

5.5 Development

5.5.1 Server Connection

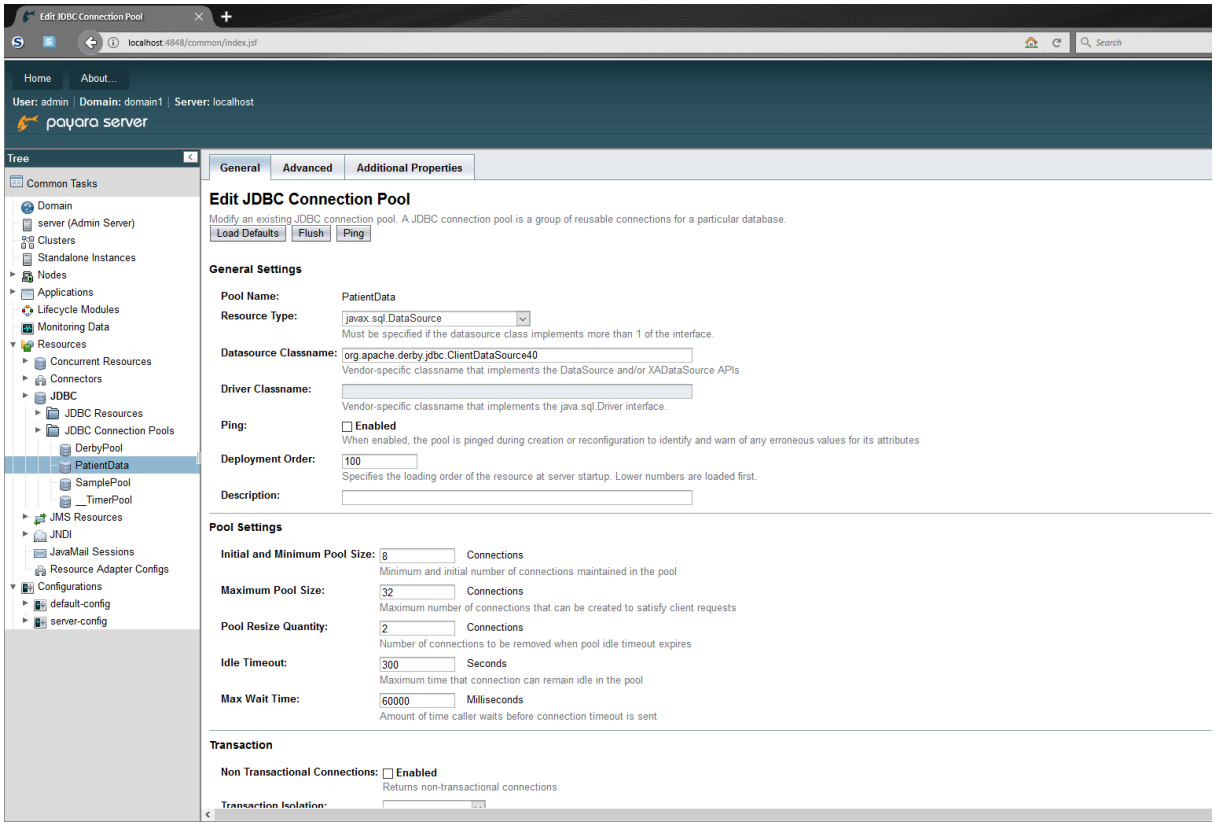
Connection Pool



(Figure 9)

I will be using NetBeans to create the entirety of this database and web application. The first thing I did was to create the database that is needed. I downloaded the glass fish server, which will be used to connect the web application and the database together. The first thing I did was create a connection pool on the admin consoles of the glass fish server (Figure 9).

Connection Pool

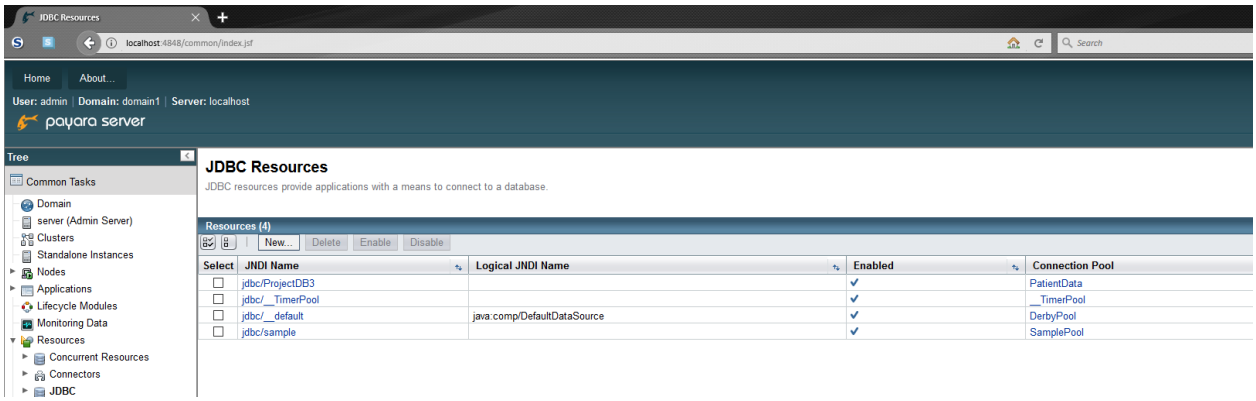


(Figure 10)

Creating this pool (Figure 10) will allow me to create a password to the database connection. It also creates the database that will be used. Currently though the database is not connected

to the NetBeans application and to the web application. Once this section is complete I can use the ping button to ping the database to see if it connected to the NetBeans application.

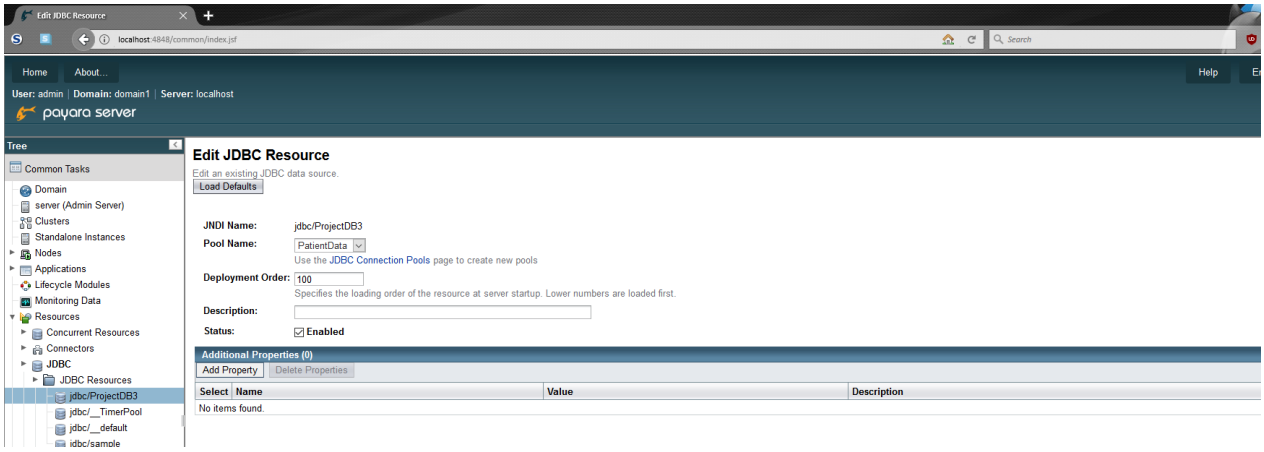
JDBC Resources



(Figure 11)

Now that the database is connected to the NetBeans application I create a JDBC resource (Figure 11). This application will allow normal web applications to connect to the java database, without this the web application will have no way to connect to the database.

JDBC Resources

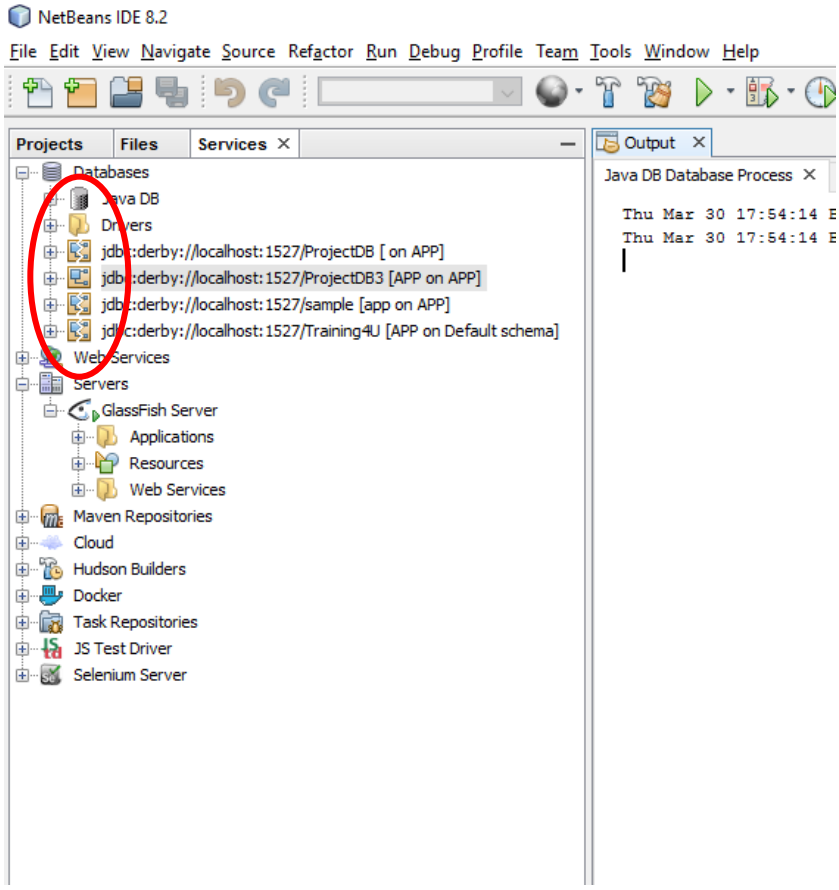


(Figure 12)

Now that this has been created all web applications should be able to connect to the database when using NetBeans. But for security reasons the database does have a username and password that is needed to connect before any application can utilize it.

5.5.2 Database Creation

Database connection

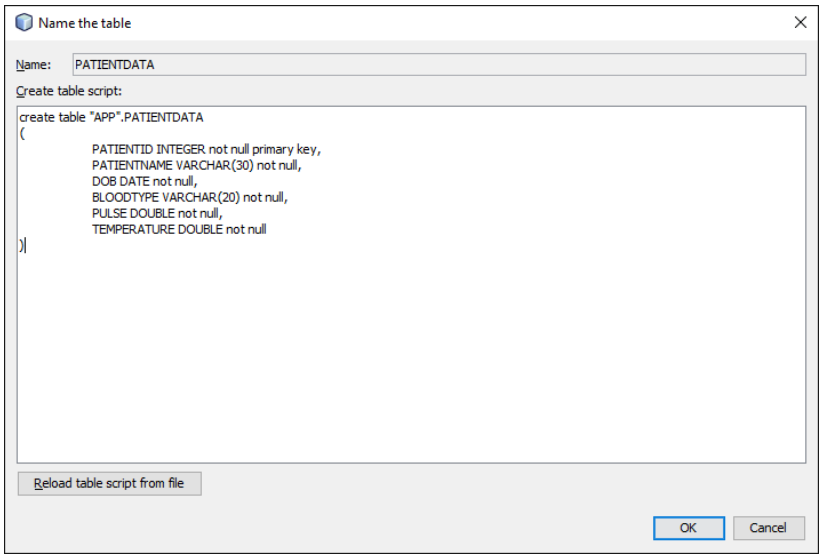


(Figure 13)

The small connection icon (Circled (Figure 13)) identifies if the database is connect or not. If it is not connected there is a split between image, if it is it connected the image is whole. Here we can see the image is a whole.

The database that I am using is called “ProjectDB3” (Figure 13). The next step is to add the table and data. The table that I have created in the design phase is the table that I will be adding. The table’s structure and names have not changed since the design phase. Below you can see that.

Creating table

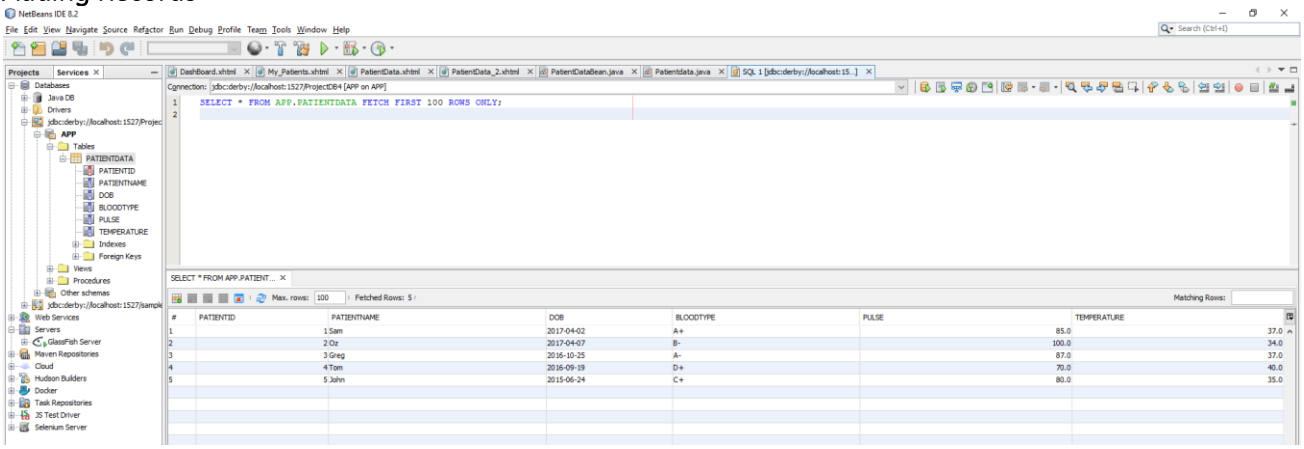


(Figure 14)

There are six main column within the table (Figure 14). In a real world situation this table and database would be hundreds of times larger and contain significantly more data about the patient. Data such as previous medical history, current medical diagnosis, and personal details that contain address and contact information. Obviously some of these details will be available to the doctors and some wouldn’t be through the dashboard/BI web application. No one except the IT management will be allowed access to the backend of this database, so all other personal can only get their data through the web application. This is done for security. There are only six columns in the database. Patient ID, Patient Name, DOB, Blood Type, Pulse, and current temperature. Depending on the systems some of the real time features may not be available, but with the growth of the IoT it is becoming more and more likely they will.

(Figure 14) As we can see PatientID is the primary key, an individual unique key for each record that is placed into the database, this record cannot be null meaning it must be filled in. PatientName is a VarChar(30) I didn’t think any higher was necessary, also not null. DOB is Date format and not null. BloodType is also using VarChar(20) which is slightly lower than the name, after doing some research I don’t think it would be necessary for the VarChar to be any longer than 5 characters. Pulse is a double and not null. Temperature is also a double and not null.

Adding Records

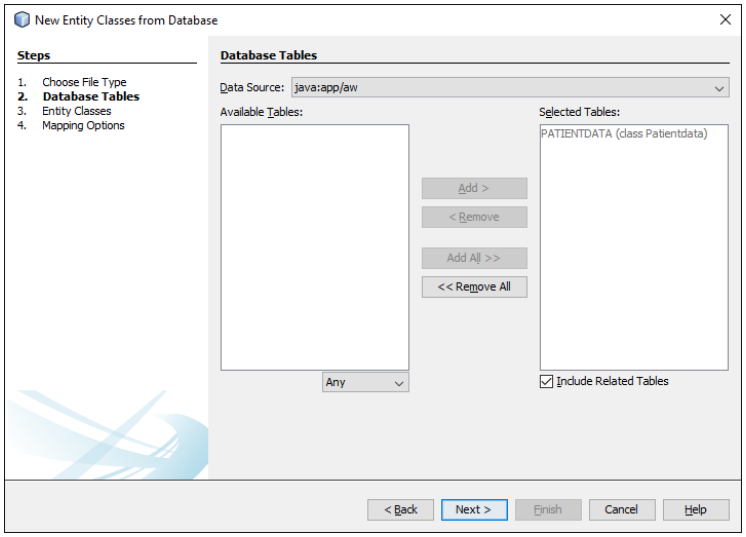


(Figure 15)

After creating the table the next logical step is to add in some data (Figure 15) that can be used within the application. To make things easy whilst developing I have only added in few records into the table. This will allow me to easily identify any database related errors that may occur with the web application.

5.5.3 Java Bean

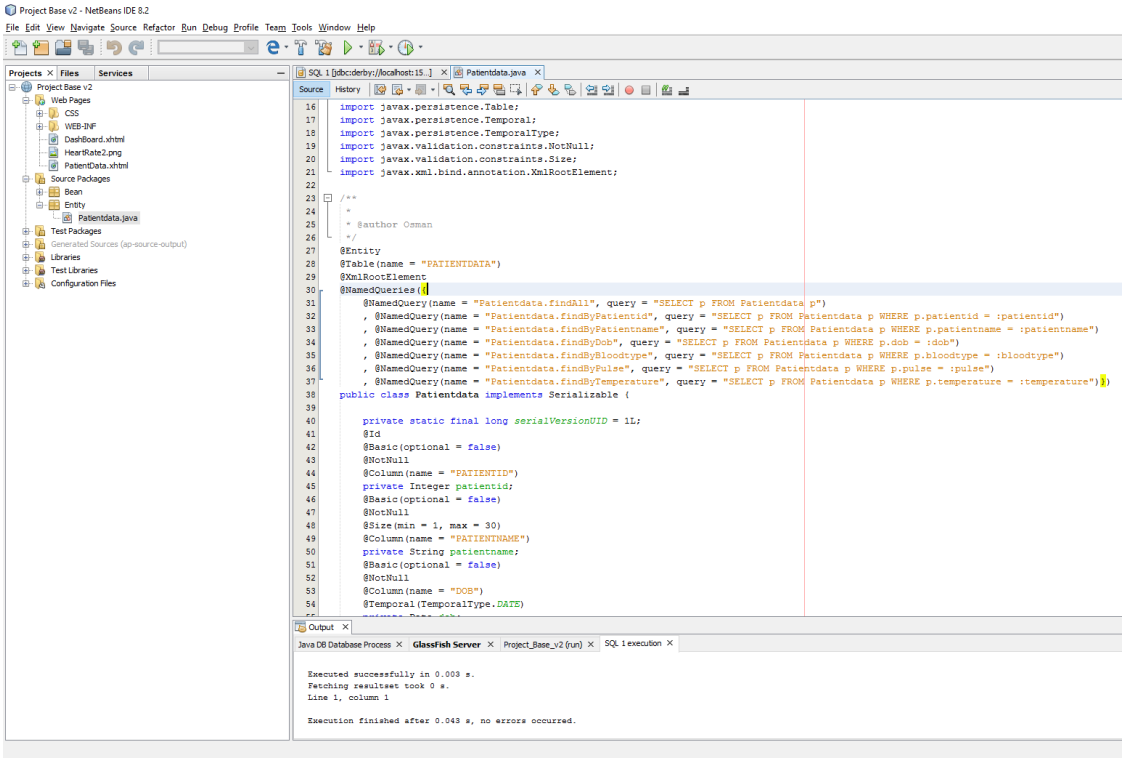
Entity Class



(Figure 16)

Now that the database is connected I will need to connect the project to my database. Doing this will allow me to use queries to get data from the table I have created. For this I will need a java entity class created from the database (Figure 16).

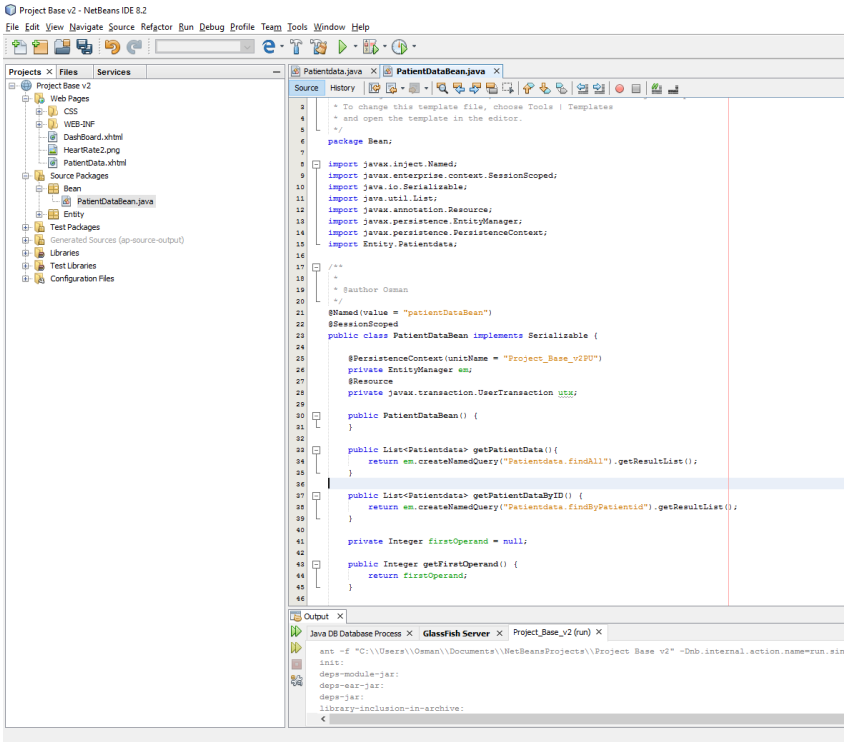
Java Entity Class



(Figure 17)

(Figure 17) Once that the entity class has been made its time to make a ManagedBean which provides a service layer to the entity class, it provides only the required functionality that is needed.

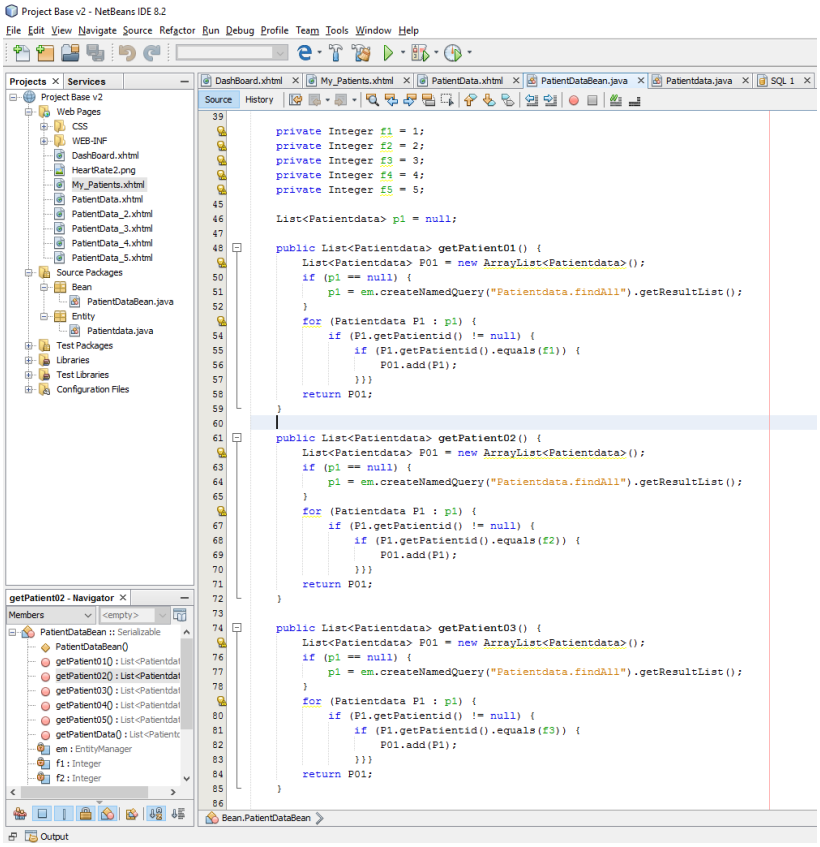
Java Bean



(Figure 18)

(Figure 18) From the managed bean I can create specific queries that can be used in the web application. I will be using the final query for 5 different patients that the user will be able to access from the database.

Java Bean



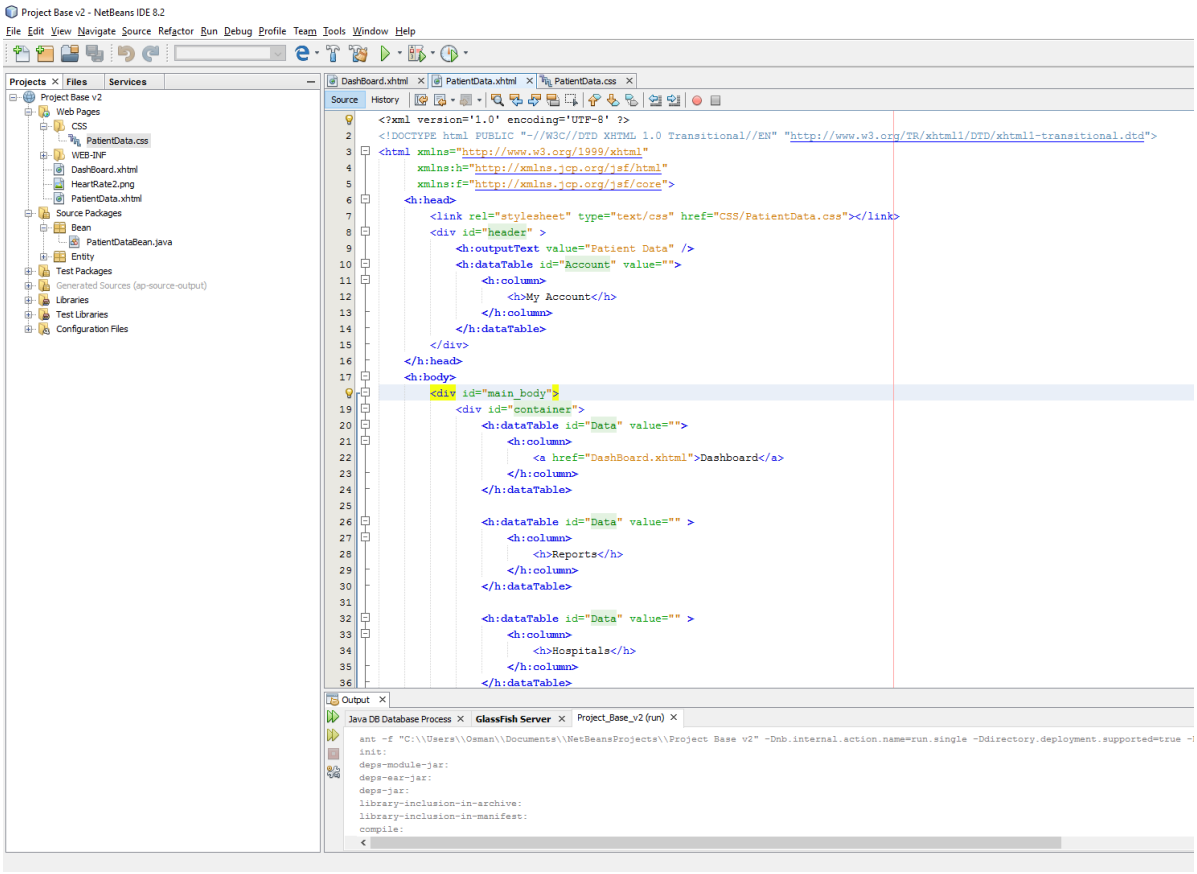
(Figure 19)

Figure 19 shows I have created the methods that will be getting the specific users from the database when the a certain user page is loaded. There is a few if statements and a for loop. The first if statement checksto see if the p1 array is created or not. If it is it then fills In the array with all the records from the database. Then there is an if statement to to find the specific user and then add into the PO1 array which only holds 1 record, and then return that array. There are 5 methods each one for a user, I am sure that this method could be altered to only have one method for all the users.

5.5.4 HTML and Web Pages

The first thing I have done is create the patientdata.xhtml file (Figure 20). This file will be the main area where the patient's data is shown for each of the 5 patients. Only individual patient's data will be shown and some place holder items will be in place to simulate what an actual system may look like. There are 4 other copies of this page that show different patient data, depending on what patient the user clicks on form the my patients list.

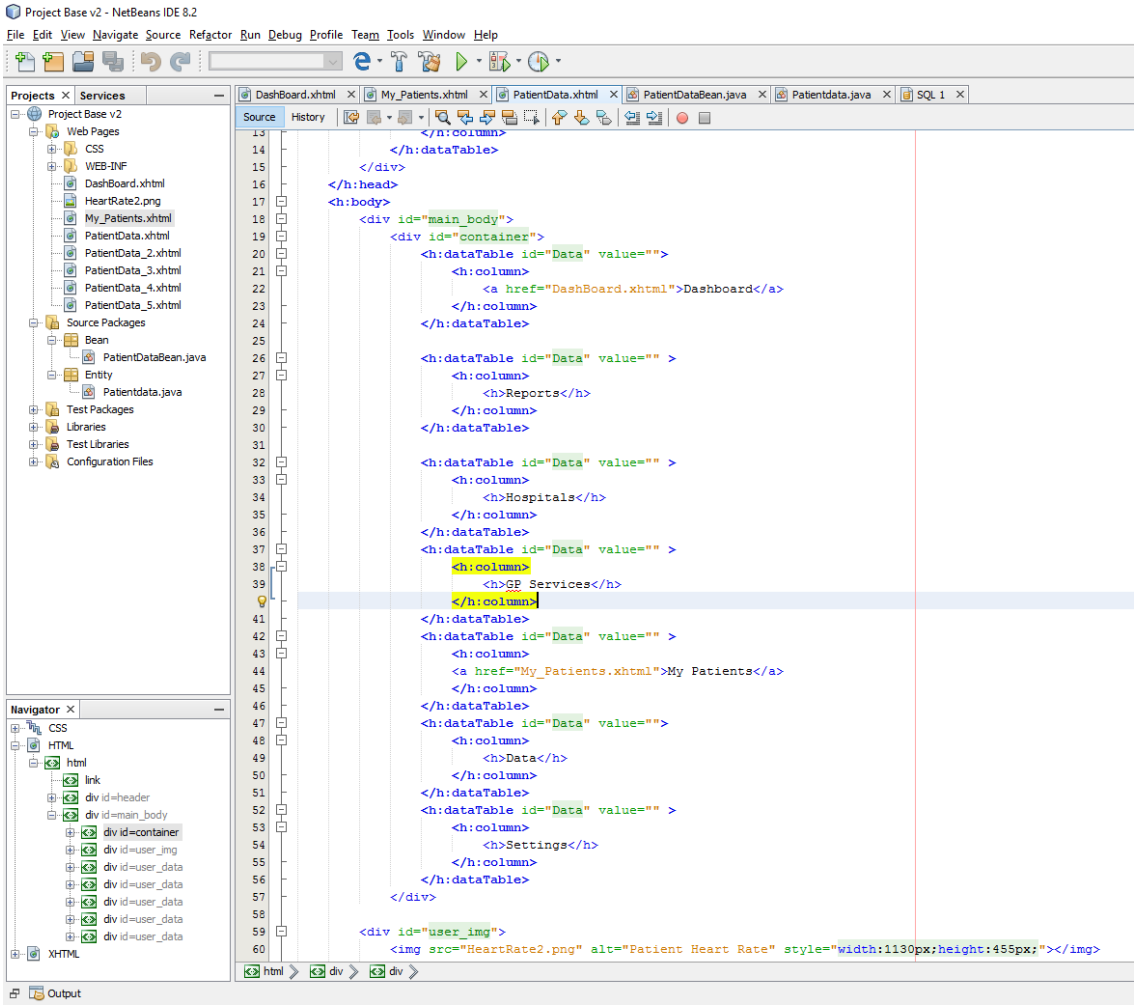
PatientData.XHTML



(Figure 20)

In the header very few things are present (Figure 21). There's the title of the page and the My account button. In more advanced system the My account button would lead you to the users details. The user could potentially change their personal details or any make queries about the system.

PatientData.XHTML



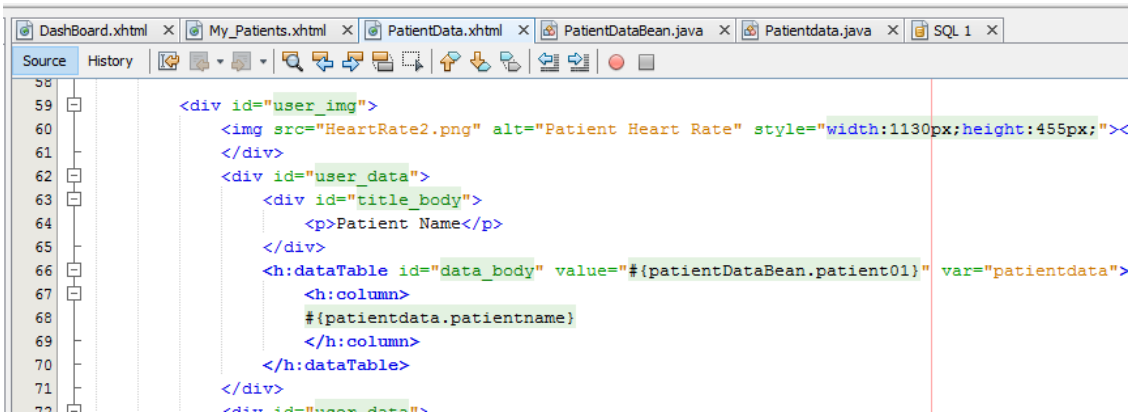
(Figure 21)

(Figure 21) There are two main parts to the body. The navigation menu on the left hand side of the page. The second part is the main page where the patient's details are shown. In (Figure 21) is the section that is the navigation bar. As you can see it's in the main body then it's in a container. This container is the main element that holds all the left hand side navigation. The dashboard link links to the main dashboard where the user is taken to when they first enter the web application. In an advanced version of the program the user would login from the main dashboard then the dashboard will load a personal overview of details that are important. But in my version the login button will directly take the user to an over view of the patients in the database. Once here the user will be able to pick what patient to look at in more detail. There is also a link to the My_patients which is an overview of the patients.

The second part of the body contains the details of the patients (Figure 22). For this I wanted something simple to show what the users may see. So all the pieces of data are in their own container boxes which has a title and underneath it has the data. The patient data is taken from the database created earlier. I have done this by using a h:datatable. I can identify the patient bean where the methods for the queries are stored in the value attribute on the h:datatable. The code used is #{patientDataBean.patient01}. the first section is identify the bean and the second part is identifying the specific method which gets all the patient data

from the database. Using Var I can add an identifier to #{patientDataBean. patient01} and that identifier being “Patientdata”, the identifier then can be used to call specific columns from the database e.g. in the piece of data showing the temperature the code #{patientdata.temperature}. The first section selecting the correct var. The second part is identify the temperature column from the database to call.

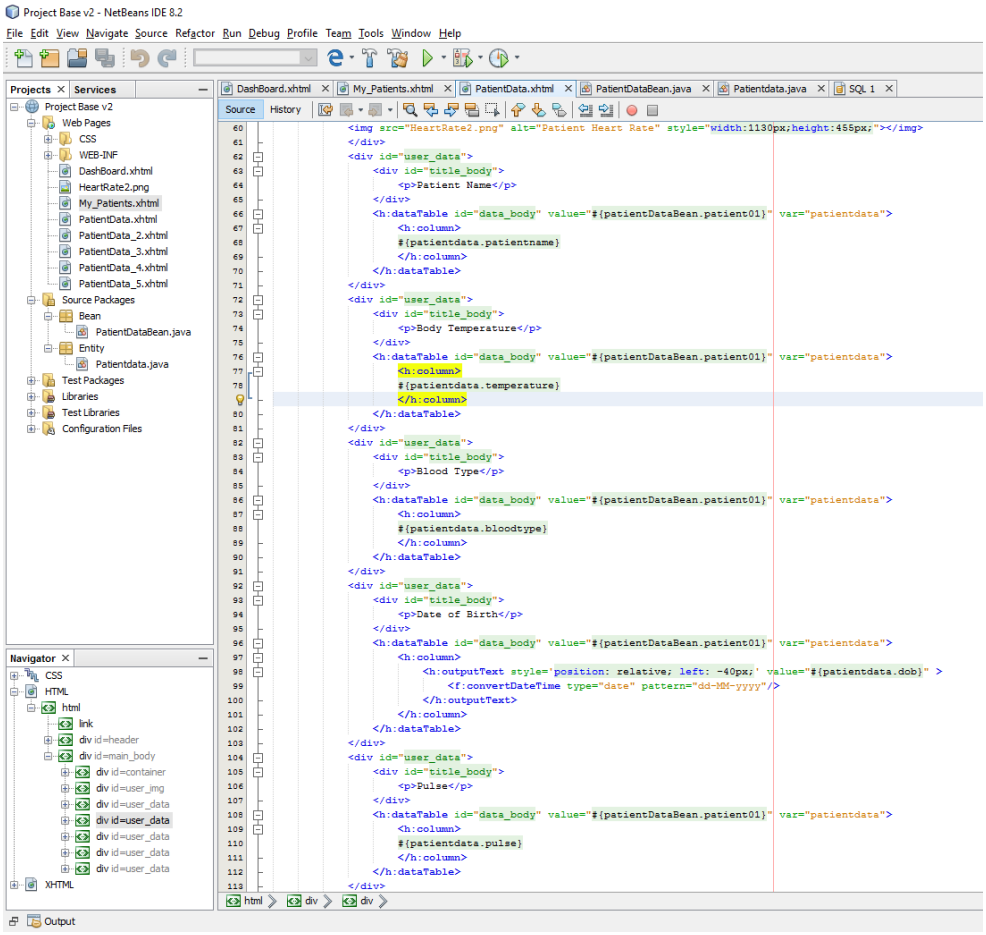
PatientData.XHTML



(Figure 22)

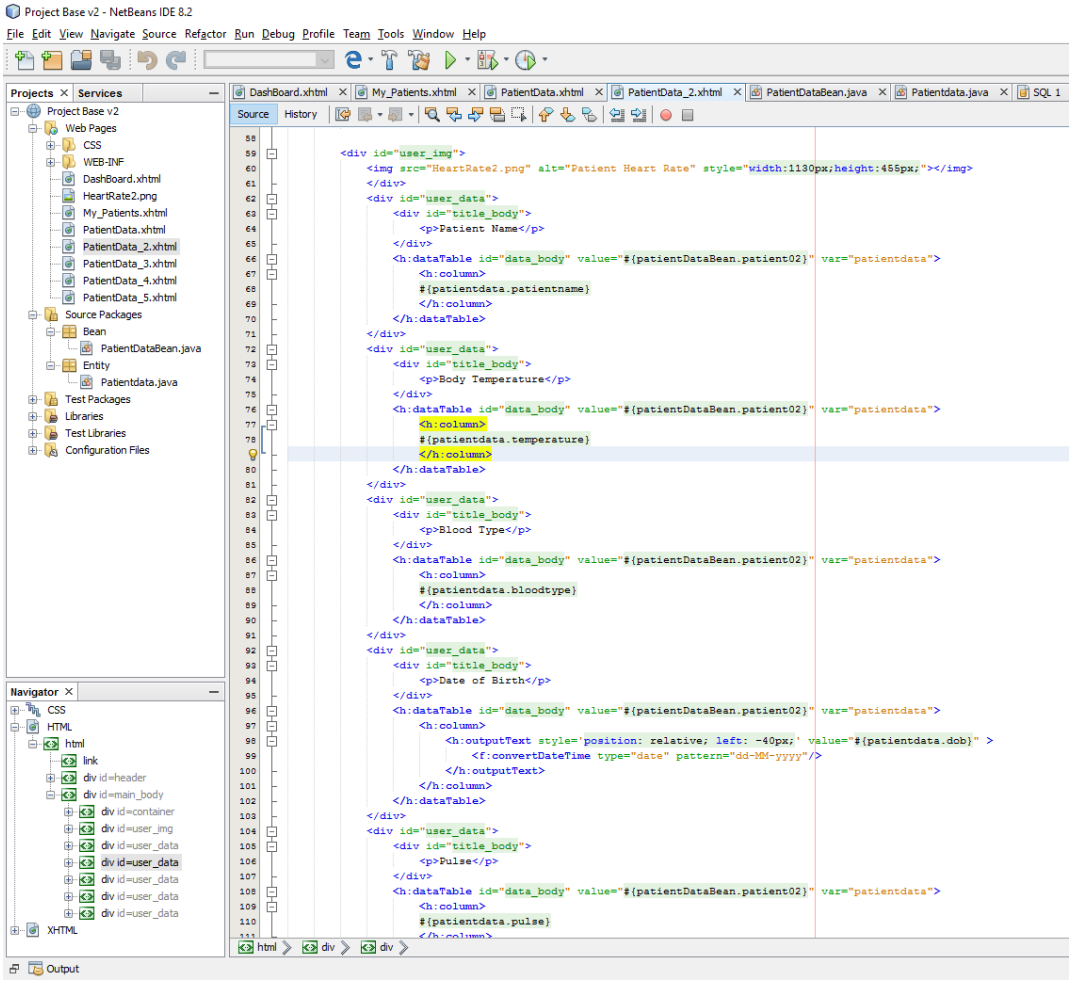
Each of them are wrapped in the user_data div. This div in the CSS provides the layout and format to each of the boxes in the main body. The user_img at the very top of the main area is just a place holder graph. This place holder graph is an image of heart rate monitor.

PatientData.XHTML



(Figure 23)

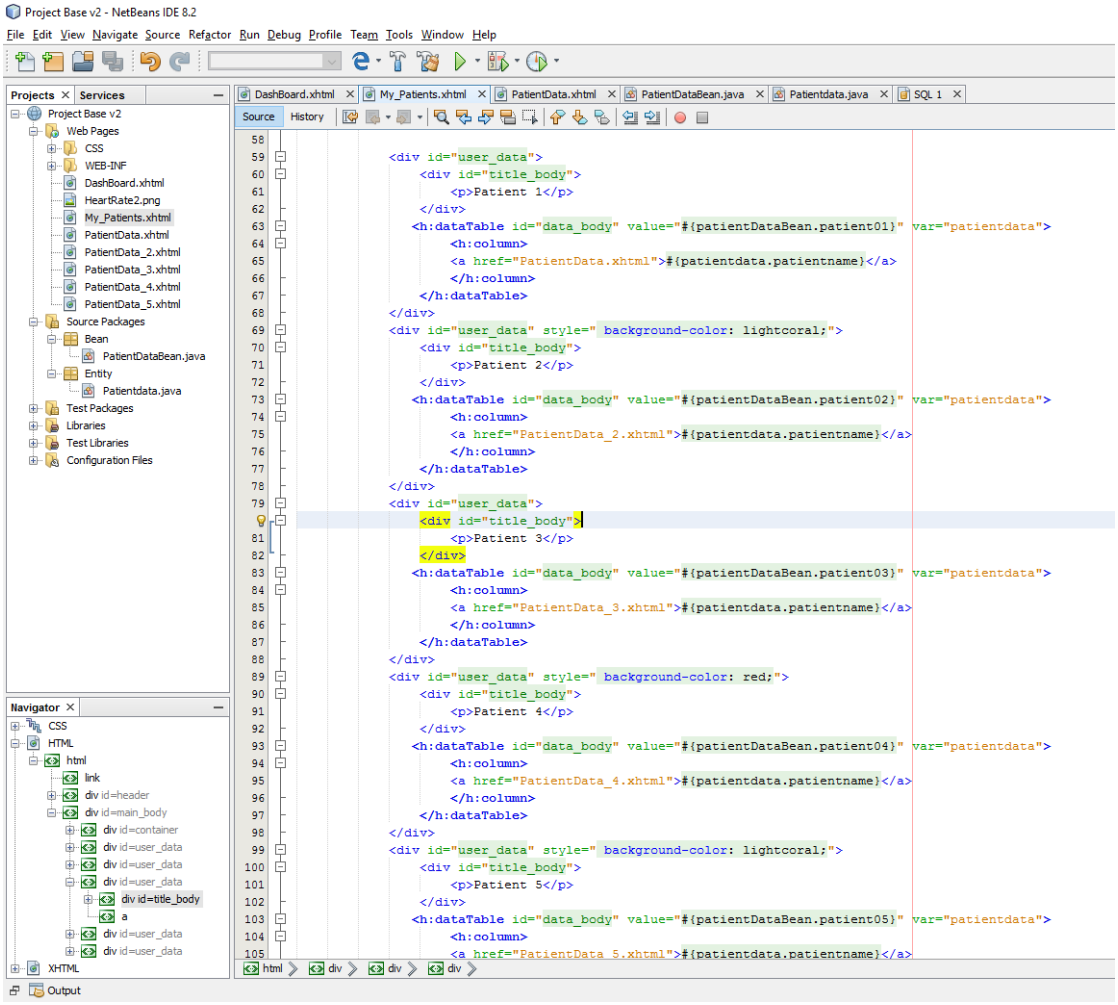
PatientData2.XHTML



(Figure 24)

(Figure 24) This image is the same as the image above but for the other patients.

My_Patients



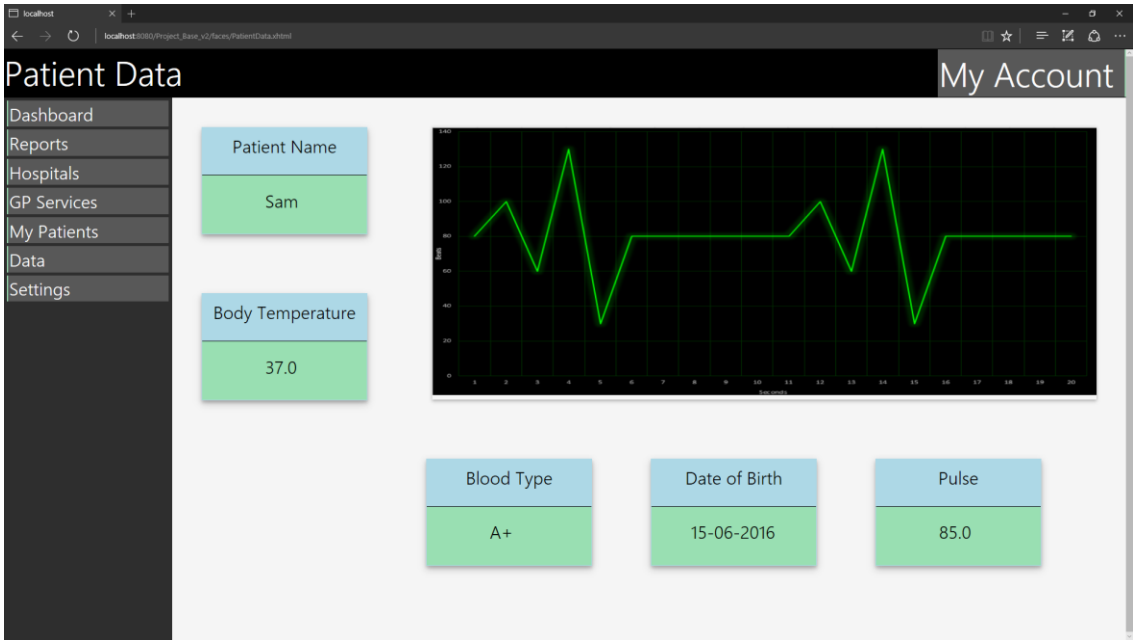
(Figure 25)

Now this is the code for the my_patients page (Figure 25). On this page the user can choose which patients data they will see first. As you can see each box has a patient number and each boxes patient number is linked to the patient number from the database. So Patient 1s box will only every get the name of patient 1 from the database. This is applied across to all patients. In a more advanced system there would only be one page and the data inside the page automatically to the correct patients data.

5.5.5 User Interface

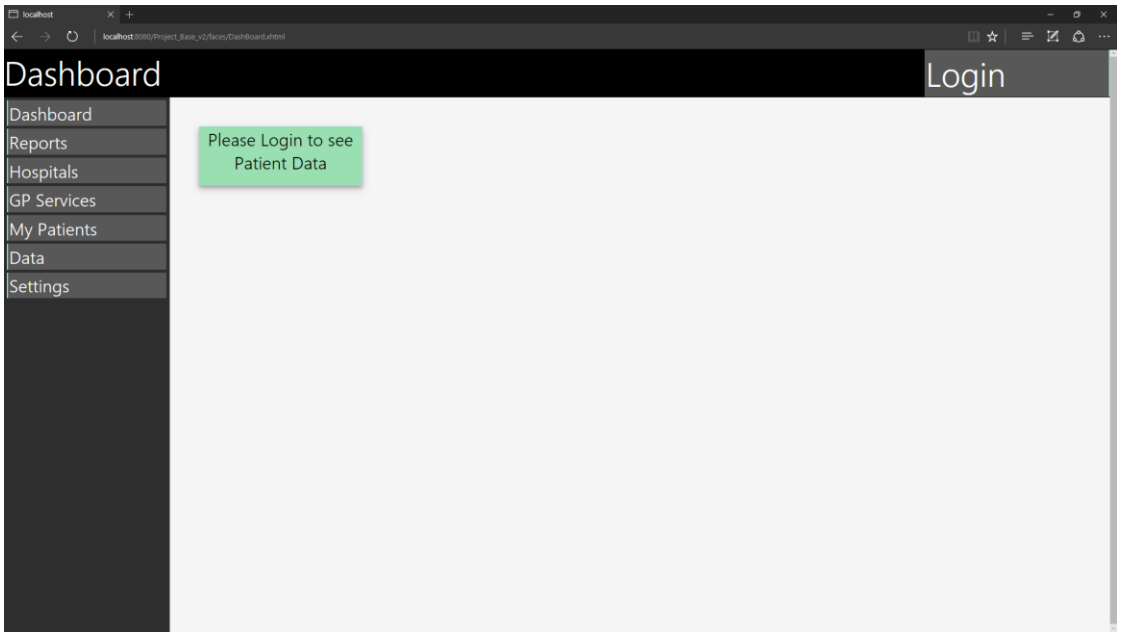
(Figure 26) Below is the main page that has been described so far. As you can see the main navigation is on the left hand side. The dashboard button is the only one that functions. In a real world system there could be more navigation buttons and other extra things that maybe useful e.g. shortcuts to certain patients or a way to generate reports. It take the user to the dashboard. Each patient data is wrapped in a box. The top part of the box shows what type of data it is and the bottom part of the box is the patient data. The placed holder graph could be a real graph in a more real world system. There would be other graphs as well that show different types of data over time e.g. Patient temperature.

Patient Data 1



(Figure 26)

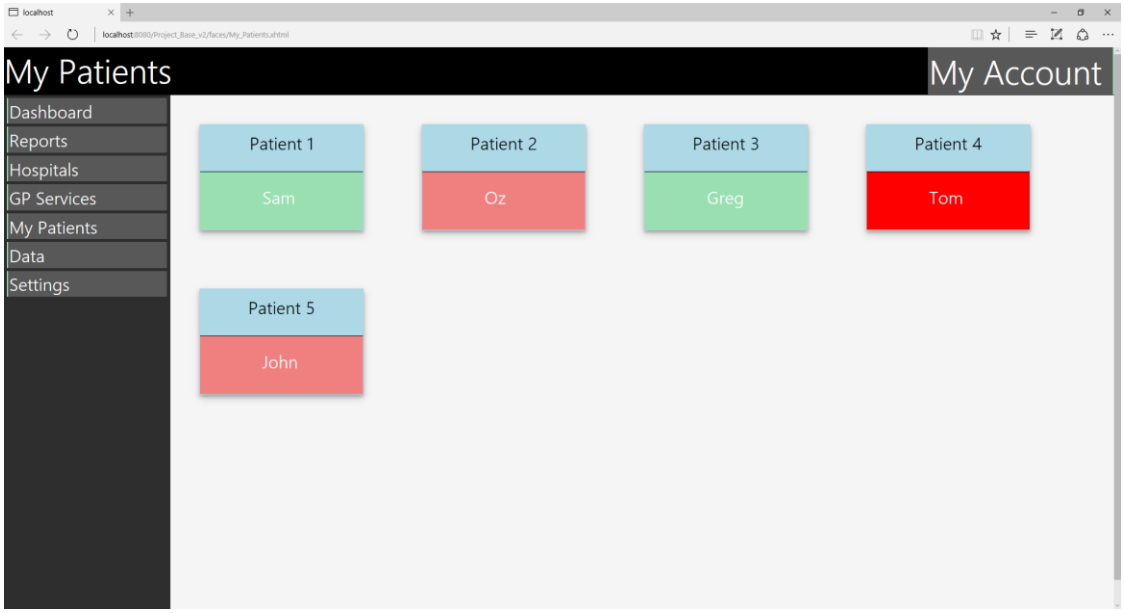
Dashboard



(Figure 27)

The dashboard is very similar to the patient's data page. The navigation is completely the same, only the main body has changed to include a message to the user to login to access the My_patient's data page. Currently the link just takes you straight to the My Patients page. In a real world system it would ask for the users login details (Figure 27).

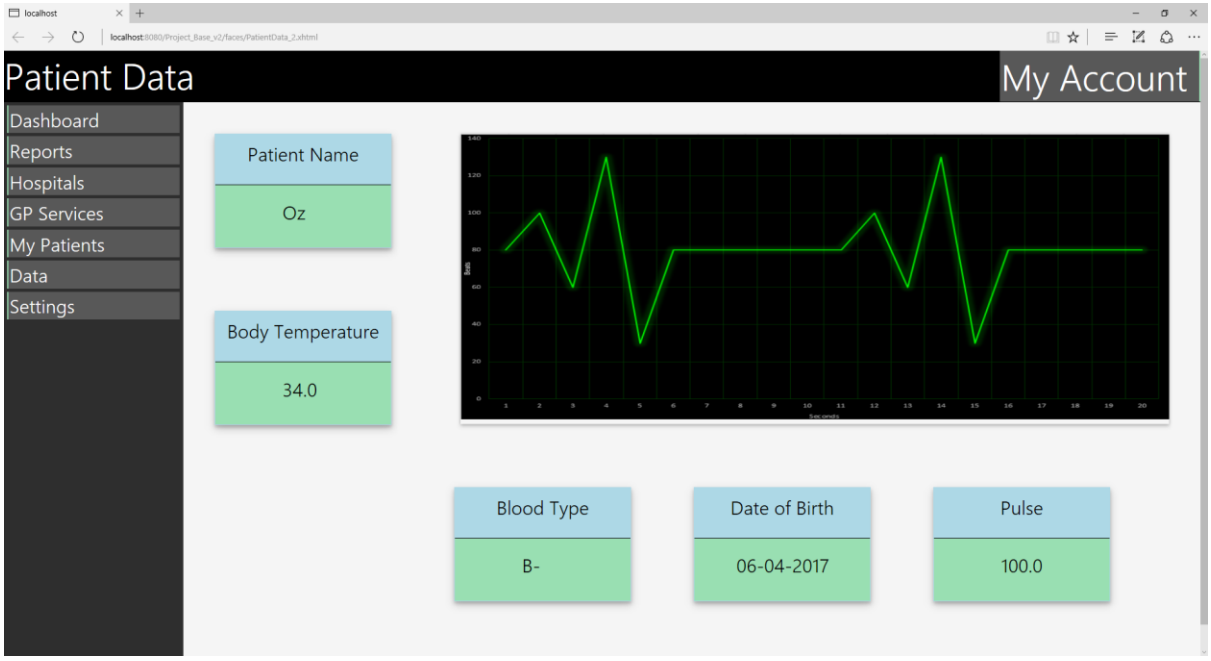
My Patients



(Figure 28)

As you can see in Figure 28 each of the patient's names are displayed under what patient number they are. The colour code means a normal patient is green, a light red patients means some abnormal activity and the solid red means that there is an emergency and must be attended to. This is just an example of what could be done, currently those colours are not using the data from the database, the colours are just a place holder.

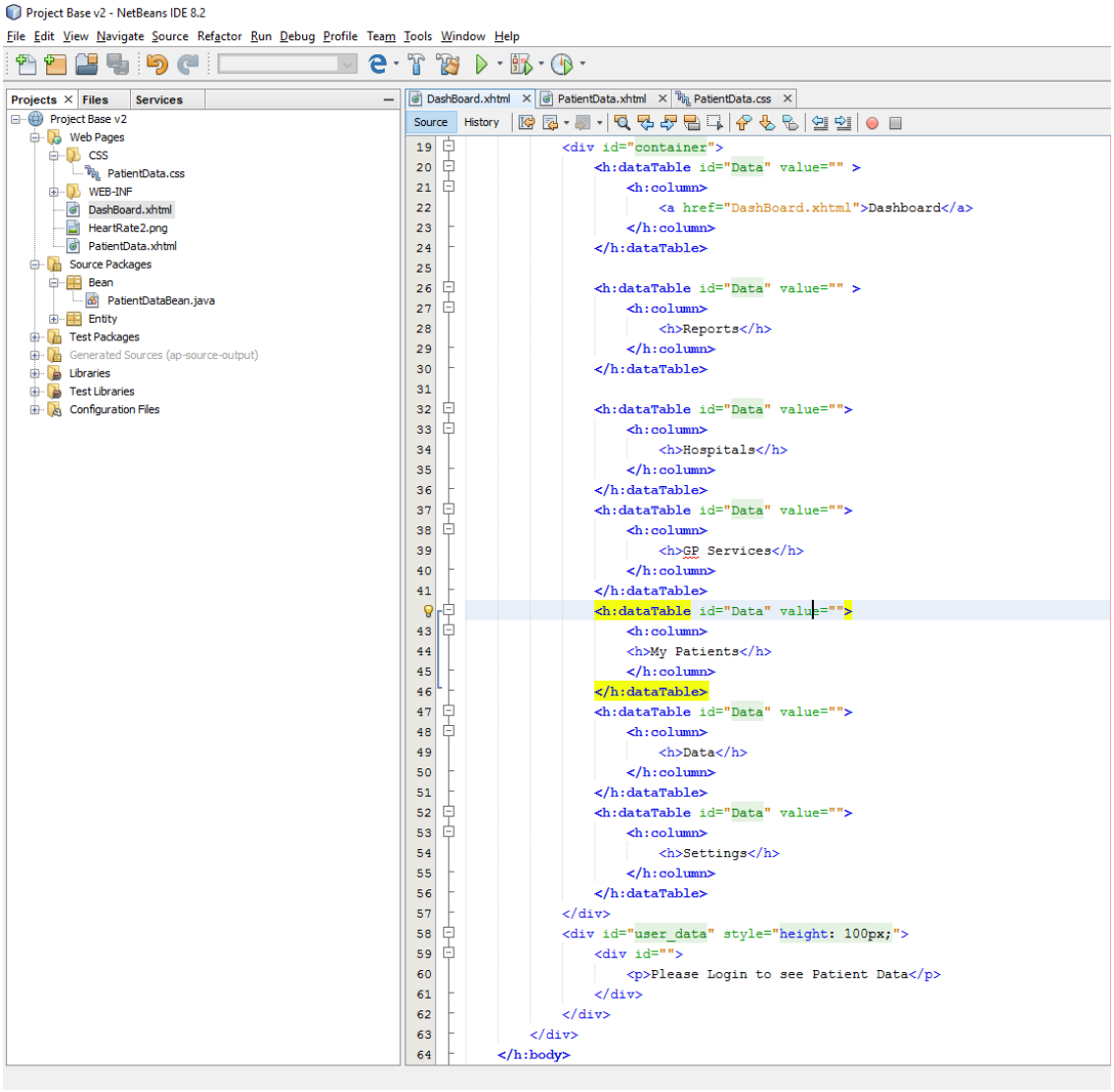
Patient Data 2



(Figure 29)

5.5.6 CSS

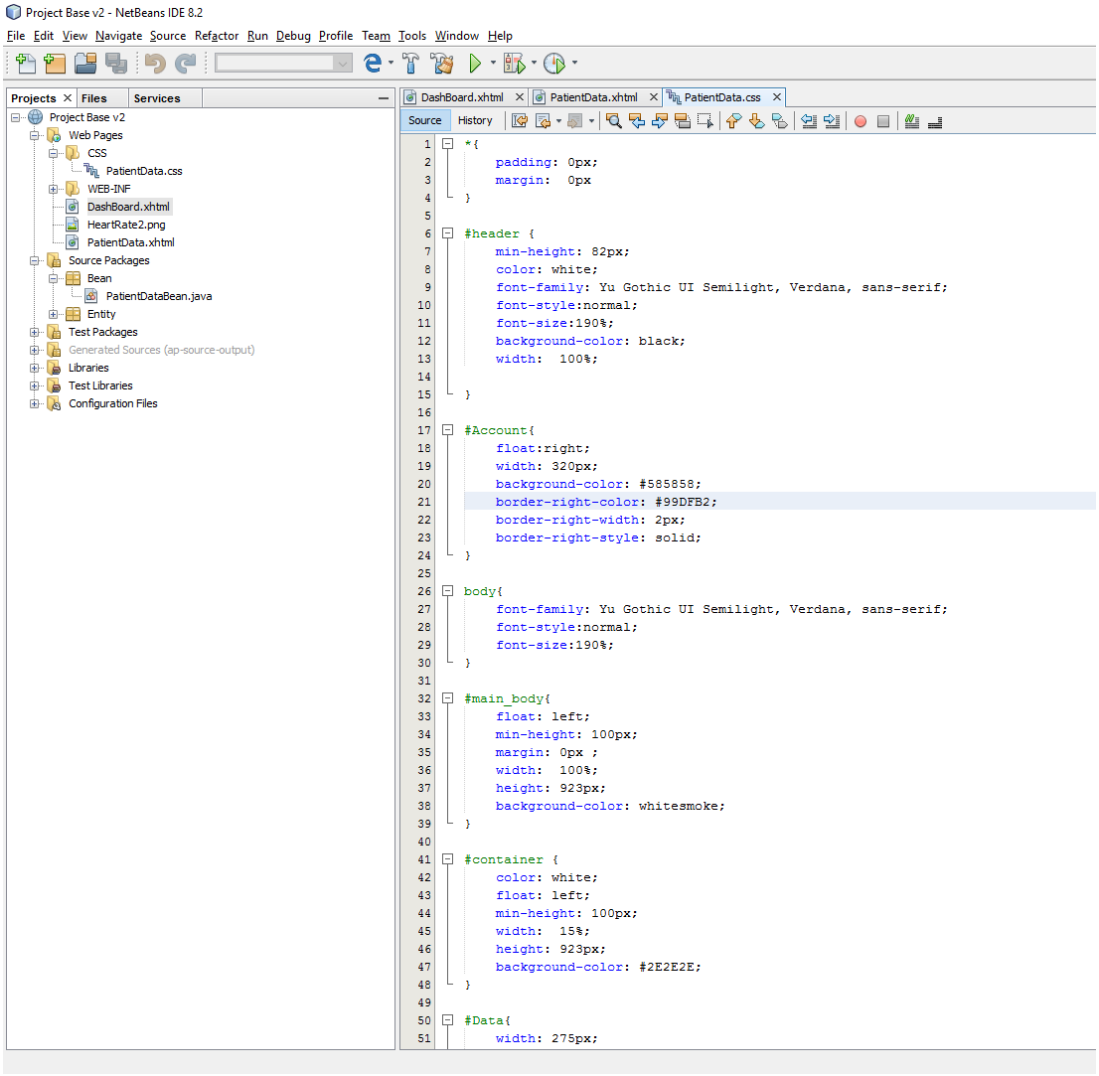
Dash board CSS



(Figure 30)

All the xhtml pages are using one CSS page which has the styles. On the first image we can see that the header, account, body, main_body, and container are all there. The #Header is the formatting for the very top of the page where the account button is and the page name is. The #Account is the element in the top right that is holding the my account/Login button. Body is the actual body and only font related things are formatted. #Main_body is a container that contains all the things in the main body such as the boxes with patient's data and the navigation bar on the left. The #container is the formatting for the left hand side navigation bar.

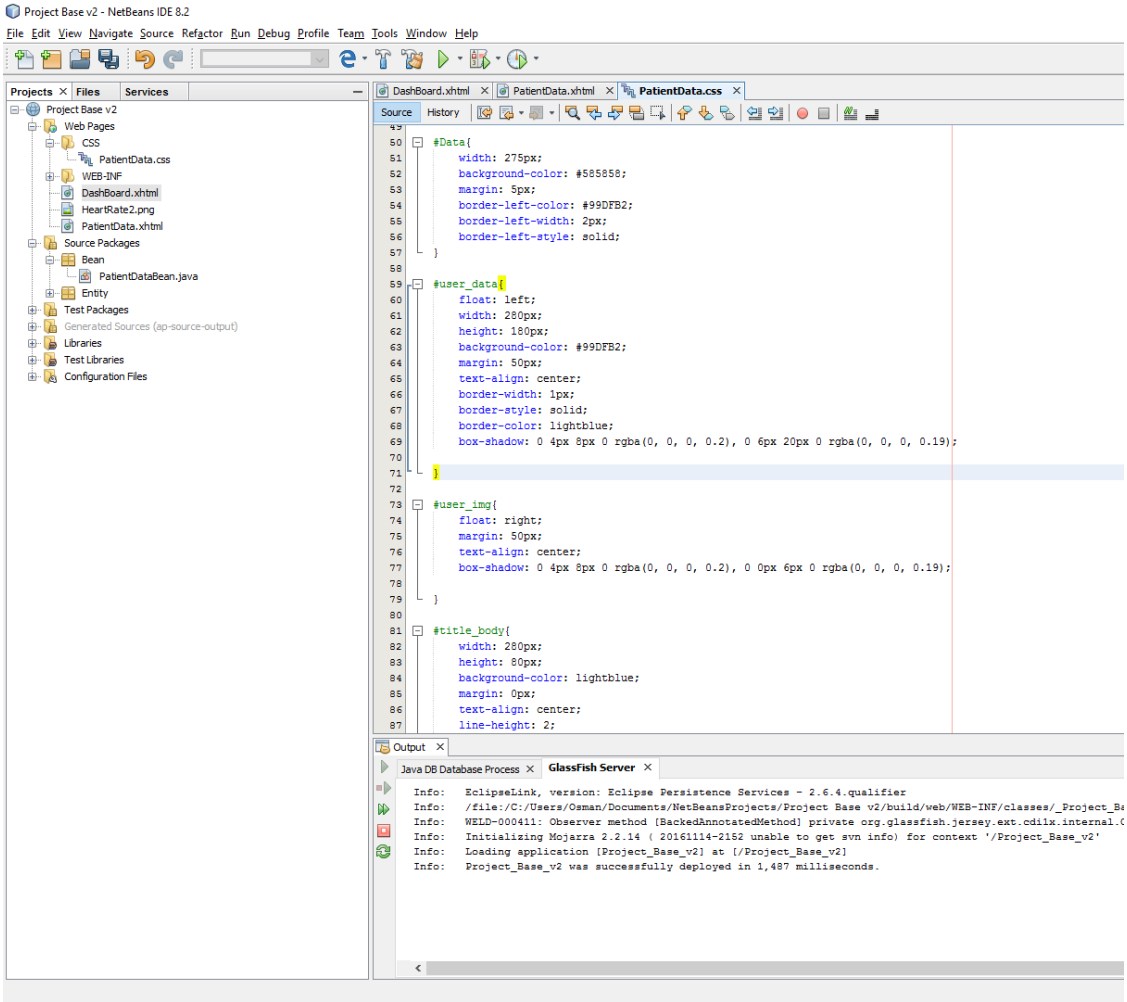
Overall CSS



(Figure 31)

Second image we have the main parts of the CSS. All these are parts of the main body where the data is being shown. We have Data, User_data, user_img, and Title_body. #Data is the formatting for each of the individual buttons in the left hand navigation menu. #User_data is the formatting for each of the individual boxes that the patients data is inside (#Title_body is and #Data_body). #User_Img is the formatting for the place holder graph. #User_data is the section where the data is being shown (Green). #Title_body is formatting for the blue section of the box.

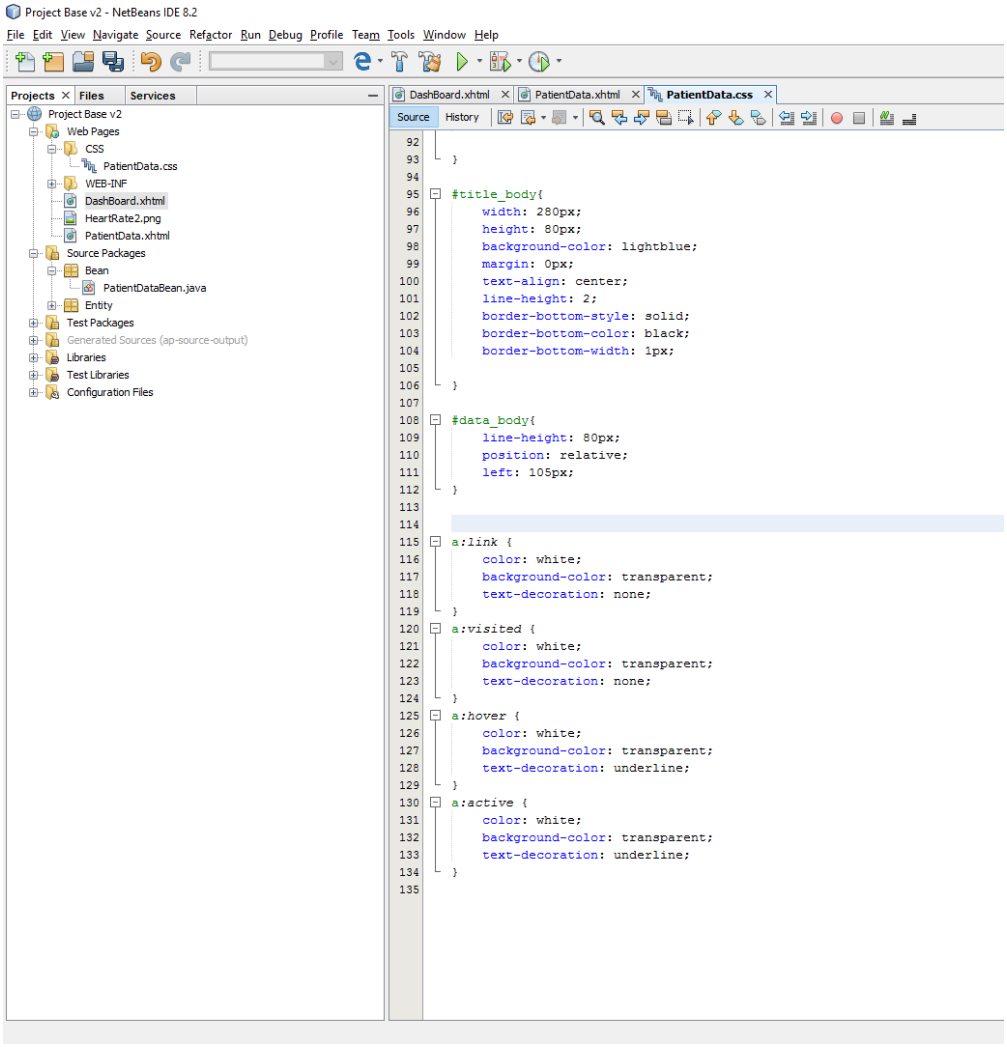
Overview CSS



(Figure 32)

In the image below you can see the data_body and the a links. A is for the links that are being use by the login button and dashboard buttons. Its keeping the button the standard colour when they are clicked on and if they have been previously been clicked. I kept it like this because it is more aesthetically pleasing to look at.

Overview CSS



(Figure 33)

5.6 Summary Development

Unfortunately I couldn't fully do everything I had stated in the design phase which was the login. The design of the program also changed during development as I found that the design I had created wasn't as good as I thought. This led me to change during the development to something I preferred more. I think this design is more modern looking and easier on the eye as well.

Chapter 6

System Evaluation

6.1 Evaluating the system

[6] This system can be compared to other similar systems to see where its faults and advantages lie. By comparing the two systems we can evaluate and test the latency, scalability and the cost of my system. The system I will be comparing it to is a cloud based platform for the ambient assisted living. This system uses very similar ideas as my system, the user can get real time updates about patient details, but they use a cloud based system so all the data is stored on the cloud and is sent through the cloud.

6.1.1 Scalability

The cloud ambient assisted living system relies on the gateway for scalability. All of the data sent has to go through the gateway to get to the cloud. This therefore limits the amount of sensors that can be connected to one gateway. In their research paper it shows that the more sensors are connected to one gateway the higher the initial response time is to the cloud system. They state that they could improve the system by having more gateways or upgrading the bandwidth and hardware (Reference this bit in document). Comparing it to my system this won't be an issue. My system doesn't use a cloud based system, it collects all the data and stores it on a local database where it can easily be accessed. The database that I am using can easily be expanded to store hundreds of more records that have more sensor readings. Because the application and the database will be on the same network the latency will be very minimal compared to a cloud based system.

6.1.2 Latency

The latency for the cloud based ambient assisted living will be much higher than my system due to the fact that that the cloud based system will have to go through more servers and gateways to get to the end than my system. On their system there are three main areas (Gateway, processing, and google app engine) where the data has to go through before getting to the end user. Where on my system the data only needs to get to the database. The database being on the same network as the web application the delay and latency will be very minimal. The processing being done on the web application side means there is no delay in-between the database and web application in sending the data.

6.1.3 Cost

My system will be cheaper than the cloud base systems. The cloud based system will have to take into consideration the cost and maintenance of running a server. Unlike my system where it's on a closed network in the hospital, and the doctor can just look at the system from his office. If my system was to be expanded so it can be used from outside the hospital/GP, then more costs would be added on such as the cloud server. Both systems will have costs associated with the sensors. If the sensors fail to work replacements will be needed and maintenance will also be needed. But because their system is based upon the patient being at home they would need to factor in travel costs to the patient for fixing sensors and such whilst my system wouldn't need that because of the patients being on site.

Chapter 7

Overall Evaluation

7.1 Overall Evaluation

Over the course of this project I have learnt many new things about the internet of things and the web of things. To begin my project I first had to understand what my topic was about. I was given a brief overview by my personal tutor but I had to do my own research as well. My tutor told me about the internet of things, the web of things, and the use of web resources which was the starting point for my research. I firstly had to analyse the current solutions and problems available already to my problem. For the beginning of my research I was sent some document by my personal tutor to look at. After I had had analysed some of the documents I went online to find more research documents about the web of things. The main things I investigated during the research phase was the web of things and how the application layer is used to communicate with a smart device and a computational system. During this phase I found about the REST api and how many systems uses this api already between smart devices and computational systems. Many of the REST apis have been modified by the organisations that are using them. This not ideal because it is harder for new smart devices to integrate easily. A more unified system will allow smart devices to be replaced easily no matter from what organisation they are from. Now it was time for me to propose my idea. During this phase of the project I found it difficult to find research papers that were relevant to the areas I was looking at such as the web of things, and specifically the application layer of the web of things. But I did find the relevant papers in the end.

In the next section I had to look at the problems first and then the requirements of the research papers. I looked at the main problems currently facing the web of things and Internet of things. After explaining the issues that I have found from the research phase and what I think the main problems are. I provided my solution with examples of how it would be in use in real world systems. After this I looked at the requirements and problems for the system I would be developing. I would provide a method how my system would be a basic example of how my solution could be used.

The next phase was development of the design of my web application and database. In this section I describe what types of methodologies exist, then what types of methodologies I will be using throughout the development of the web application. I developed diagrams of what could be implemented into the system. The diagrams shows the possibility of a login system. The login system was just a concept of what could be implemented, in the end I decided that I wouldn't be implementing it. The database designs I did use fully except for the login data table. The patient data table design worked as intended. The other designs that I made was the UI design which I didn't follow exactly but kept it similar to the original design. I decided not to follow the original design because in practice some of the placements and sizes of the items weren't ideal.

The implementation/development of the program didn't have many issues except for one issue I encountered. The main issue that I encountered was that the glassfish server system I was using had a bug which didn't let me create a connection pool, which then doesn't let me create a database. For this problem I had to use a different server system. I used Payara Server for my solution, this server system is derived from glassfish server but it is open source and is being updated. Other than this the only other problems I had was implementing a search function for the user to search through the database. Unfortunate I couldn't get this function

working, if it was the user would have been able to search by ID through the database and look at certain patient's vitals.

7.2 Future Additions

My system can be improved upon and many more features could be added. Features such as a cloud database can be added in. this would then allow the system to also be used from outside the GP/Hospital network, which can provide many benefits to doctors and nurses. Other features such as the login system can be implemented. It is also ideal to implement a system that could create report on the patients' current status. This report could be a pdf document and could easily be made by using a template and the system just adding in the relevant details of the patient.

7.3 Conclusion

Overall I think that my time management was okay during the first half of the semester. But during semester 2 due to unforeseen circumstances from my personal tutor some parts of the project was held up due to him being not available to comment on my project. The rest of the projects development went well in my opinion.

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