# Section 3 – Development

## Version 1

Version 1 represents the initial work done on this project before I added the project to GitHub. In reality this was more than one version but since it was pre GitHub I have no changelog or history about it. The project was fairly well developed by this point, consisting of 13 pages 3 helper scripts. This version was also using the old front end system, before I moved to bootstrap and the new design. This meant that adding new pages took a lot of time as each element needed its own custom CSS.

This also meant that the website wasn’t responsive. This means that all the styling on the website was designed for one screen size and resolution. Whist it was still useable on some similar or bigger screen resolutions, the overall user experience was pretty poor and the website didn’t look very good. After this release I learnt about bootstrap, a responsive front-end web framework that seemed to provide everything I needed.

Version 1 had quite a bit functionality, although most of the codebase has been re-written in more recent commits as my knowledge and understanding of PHP increased. You could create accounts, log in, ask questions, see questions in a table and view individual questions. Although heavily edited and refactored, all of these files exist in the most recent version to date.

Below is an analysis of the notable code used in version 1:

**account.php:**

First the script specifies the doctype of the page as html, and initiates a new PHP session by calling the session\_start() function. It then includes the connect.php script, which is used in the early versions of the program to connect to the database. Next it creates a new MySQLi connection object called $connection by using the connect() function from connect.php.

The script then checks if a user is logged in or not, by checking the value of the SESSION variable ‘username’. If this variable is not set, then no user is logged in and the script displays a link to the ‘Sign up / Login’ page on the header. If it is then a user is logged and it displays a link to the ‘My account’ page. It then displays the rest of the header links.

The same check is then done again later on in the script, displaying a ‘Log out’ link if a user is logged in or a ‘Sign up / Login’ link if not.

This is the code for a blank template page under the old system, and is used for all pages that were undeveloped.

**admin.php:**

First the script performs a similar check to the username SESSION variable check in the previous script, except on this page the script isn’t just checking that the variable has been set, but comparing the value of the variable to a hardcoded constant. This is to only allow one user with one username to access this page. If this check fails, the page redirects back to the homepage instantly. It does this by calling the built in header() function, using a String consisting of ‘Location:’, and the URL of the homepage at this time.

However, if this check succeeds, the script displays an HTML form where the user can enter an IP address to block. This is a POST form and it redirects to the processipblock.php script when the submitted.

**ask.php:**

This page starts off using the blank page template used by account.php, with additional features like a basic HTML form with inputs for the question title and question body. As with admin.php, this is a POST form, and redirects to processquestion.php.

**downloadquestions.php**:

Possibly the most complex PHP script in the entire project, and one that’s relatively unchanged since its addition in version 1, except for some minor bug fixes, the purpose of this script is to download and filters the questions from the database in accordance with the filters specified by the dropdown on questions.php. These are then outputted in a format readable by a JavaScript script running on questions.php in order to populate the questions table.

This script starts off the same way as all the others in this version, starting a PHP session and including the connect.php script in order to create a connection object. Then, as database connectivity is vital for this script to function, it then checks to see if the connection as established successfully. If this check fails, then the script will exit with an error.

Providing a connection was successfully established to the database, the script gets the type of filter from the URL. The script then prepares a MySQL query for each filter. The ‘top’ and ‘new’ filters are the easiest, as all the filtering and sorting are all done in the MySQL queries as you can sort by columns and order in ascending and descending order.

However, the ‘hot’ filter is much more complicated than the others, and cannot be filtered by a simple MySQL query. It then creates two empty arrays, $scoreArray and $array. Then, it iterates through the $result array. A $points variable is created and set equal to the number of votes question currently being iterated over has (given by $row[“votes”]). A variable called $order is also created. The value of $order is given by (loge(max(abs($points), 1, 10). Then, if the $points variable is bigger than 0, A variable called $sign is created and set to equal 1. If the $points variable is smaller than 0, A variable called $sign is created and set to equal -1. If neither of the two above conditions are met, a variable called $sign is created and set to equal 0.

Then, a variable called $seconds is created and set to the Unix time when the question was asked - the constant 1516221943 (Wednesday, 17 January 2018 20:45:43, the date the system was first implemented). Another variable, $score, is also created, and assigned the value of ($order + $sign \* $seconds / 45000) rounded to 7 decimal places. The rounding is done using the build in method round(). It then pushes $score to the $scoreArray array, and pushes a new array composed of $score, $row[“title”], $row[“id”] and $row[“votes”] to the $array array.

Then, after all the returned questions have been processed, it sorts the array by a user defined order as defined in the sortOrder() function. The function to sort an array by a custom sorting function is provided by the build in method usort().

Then, the contents of $array are outputted in a format that can be read by the scripts running on question.php.

**index.php:**

This is the script for the homepage of the website in version 1. It’s also based off the blank page template, but with a lot of modifications including logging details about the user into the database.

The logging at the top of the script works by collecting the user’s IP Address, the current time and the current date, and inserting them into a ‘visits’ table in the database. The script does not attempt to log anything if it cannot establish a connection to the database in order to prevent errors.

There is also a footer at the bottom of the page which renders status icons for both the website and database, for development purposes.

**logout.php:**

This script logs the user out of the website by wiping the ‘username’ SESSION variable and redirecting the user back to the homepage. This is the simplest script in this version of the project and remains relatively unchanged throughout subsequent versions.

**processipblock.php:**

The process\*.php scripts in this project appear in every single version and are used to process form data and interface with the database.

This script takes the form data from admin.php and uses an INSERT INTO MySQL query to insert the user’s IP address and the date into the database, providing a connection to be established to the database.

**processlogin.php:**

As with processipblock.php, this is a backend script that runs after a specific form has been submitted. This script is runs after a user clicks ‘log in’ and is used to validate their credentials either log them in or produce an error message depending on the username/password combination they enter in the form. These fields are sent as POST data and are received by the script by assigning $username and $password to the value of $\_POST[‘username’] and $\_POST[‘password’] respectively.

As always, first the script checks that it can establish a connection to the database, exiting with an error message if not. Then it gets the username and password that the user entered as described above and creates a new MySQL query to select the ‘id’ and ‘password’ attribute from the ‘users’ table from the record where the ‘username’ attribute matched the username that the user entered on the previous page. It then runs the query and stores the result.

If there is a result from this query, then the username entered must be a valid username stored in the database because the mysqli\_query function returns null if no data is returned. Therefore the script next compares the result returned from the database against null. If the result is not null then the script continues, but if it is then the user doesn’t exist and the script exists with an error message telling the user that their username does not exist.

Providing the username exists, the script then creates an associative array of the data returned from the database. It then uses this array to get the encrypted password hash returned from the database, and uses the build in function ‘password\_verify()’ using the hash returned from the database and the password the user entered as the parameters. If this returns true then the password matches the hash and the login details the user entered are correct. The user can then be logged in and the page redirects back to the homepage.

However if this function returns false then the user entered the wrong password and the script displays an error message and a button to try again.

**processquestion.php:**

This is the backend script that uploads a question to the database. As well as simply adding the question to the database, this script does some minor processing in the form of checking if all the fields contains data (using the same process as described in the above script) and checking if the user has been blocked.

Providing the checks pass without issue, the script uploads the question fields into the database.

**processsignup.php:**

This is the script that is ran from the signup form on signup.php. First it collects all the POST data from the form, then it performs the same series of checks as the scripts above, plus some more specialised checks for its specific purpose. Theses checks involve validating the email address and checking that the username has not already been taken.

Validating the email address is only done primitively at this stage. I use the built in strpos function which is used to return the position of a substring in a String. However, it can be used to return true/false if no comparison operator is used. Therefore I used this function, on the username variable to check if it contained an “@” symbol. This method is improved in later versions because this would validate “@” as a valid email, which it isn’t.

Checking if the username is already taken however, is a more complex task. To do this, I create a MySQL query to select only the username attribute (to save processing time and bandwidth) from the database from whichever record has a username value of the username sent from the signup form. Then I use the built in function mysqli\_num\_rows to get the number of rows returned from the database. If this is less than 1 (0) then the username is unique and the user can be created, However if not then the username has already been used and the script returns and error.

Providing the username is unique, the script create the user by adding a new record to the database with all the data entered in the form. At this stage I haven’t implemented password hashing, so this is less secure. Adding the record to the database is again done with a simple MySQL query.

**qa.php:**

qa.php is the homepage for the questions section of the site – the most important of the three. The page is mostly built from static HTML but when the page loads, it calls on a JavaScript function called Download() with “hot” as the parameter. This function is used to asynchronously download, filter, process and display questions from the database. The parameter specifies which filter to use. I’ll discuss how this function works in the section for filterQuestion.js. On qa.php there is a table with no entries. This is where the downloaded questions appear. The purpose of calling the function as soon as the page has loaded is so that questions can be on the screen before the user changes any filters.

There is a dropdown menu above the table. This is used to filter the questions and whenever a user changes the filter the JavaScript script asynchronously downloads the questions for that filter. This doesn’t require a page reload which gives my website an advantage over websites like StackOverflow and reddit which do require a page reload. I believe that this greatly enhances user experience.

**question.php:**

question.php is the page that displays a question loaded from the database. There are a lot of functions in this script so I moved most of them to an external class called questionFuncs and included them in the top using the PHP ‘include’ statement. This is used provide access to all the functions in the class as if they were declared in the same page, but with the extra benefits of being able to use the functions from any class (by including the class) and keeping the page (made from predominantly HTML) clean.

When the page has loaded, the page calls a JavaScript function called SetHeight(). I’ll talk about how this function works in the section for this page. The purpose of this function is to apply a quick fix for the height of the question vote arrows which were always slightly and inexplicably out of position.

Most of this page is composed of HTML markup for the structure of the page, but the main functionality consists of a PHP function used to download the question from the database based on the URL parameter, and some more PHP used to display the correct colour voting arrows depending on the way the user has (or hasn’t) voted on the specific question.

The function for downloading and outputting the question works by getting the ID of the question from the URL, then querying the database to select all the attributes for the question with that ID. It then outputs the attributes along with some HTML markup and styling.

The function for displaying the different types of voting arrows works by calling on several of the functions stored in questionFuncs.php. First it checks if the user is logged in by checking if the ‘username’ SESSION variable is empty or not.

Assuming the user is logged in, it next uses the UsrVoted function from questionFuncs.php to check if the user has voted on the question or not. This function takes three parameters: the user’s id (from $\_SESSION[“id”]), the question id (from $\_GET[“id”]) and a reference to the MySQL connection. This returns true if the user has voted on the question or false if they haven’t.

If the user has voted on the question, the script next checks which way the user has voted, using the Upvoted function from questionFuncs.php. This function takes the same three parameters as UsrVoted and returns true if the use has voted the question up, and false if the user has voted the question down. It uses this return value to draw the correct colour arrows.

If the user has not voted on the question, or the user isn’t logged in, the script draws the standard grey arrows used to represent no votes cast.

**questionFuncs.php:**

questionFuncs.php is a script used mainly by question.php in order to make the mainly markup based script easier to read and understand. This script isn’t designed to be accessed by the web browser, and consists entirely of several function definitions.

The first function defined in questionFuncs.php is called UsrVoted, and takes three parameters: the user’s id (from $\_SESSION[“id”]), the question id (from $\_GET[“id”]) and a reference to the MySQL connection. The function executes a MySQL query to check if the user has voted on a question or not. This is a SELECT query which selects the `id` attribute (the smallest data to collect about a record) from the `votes` table where the user id attribute (`uID`) is equal to the $id parameter and the question if attribute (`qID`) is equal to the $qID parameter.

It then uses the mysqli\_num\_rows function on the data returned from the query to check how many rows have been returned from the database. Due to the nature of the database and the query, the number of rows will only every be 1 or 0, 1 representing the user having voted on the question, and 0 representing the user not having voted on the question.

The second and final function in this file in this version is called Upvoted, and is used to determine which way a user that has voted on a question (represented by their user id and question id) has voted. This function takes the same three parameters as the previous function: the user’s id (from $\_SESSION[“id”]), the question id (from $\_GET[“id”]) and a reference to the MySQL connection.

**filterQuestions.js:**

The first JavaScript script in this release, filterQuestions.js is used to download, process, filter and output questions from the database. It consists of two functions: Download() and Output(), and is in the style of a typical (but very simple) async JavaScript script.

The first function, Download, takes one parameter: the type of question to download from the database (an integer inclusively from 0-2). This function is called when questions.php is loaded, and is used to prepare and send an asynchronous GET request used to download the questions from the database.

First, it makes a new XMLHttpRequest object, and sets the URL target. This URL is the downloadquestions.php script (for interfacing with the database and downloading the data) with a URL parameter called type, set to the value of the type parameter passed into the Download function. The function next checks to see if there is any errors creating the XMLHttpRequest object, outputting an error message if there are.

Providing there are no errors, the function sets the onreadystatechange attribute of the XMLHttpRequest to the Output function, specifies the XMLHttpRequest as a GET request and sends it, initiating the asynchronous download.

The second function, Output, takes no parameters, and is known as a callback function. This means that the function is passed into another function as an argument, and called from that function. In this case, Ouptut is an asynchronous callback from the XMLHttpRequest object. This means that it’s only executed once an action has finished executing. The purpose of this function is to collect the downloaded questions when they have finished being downloaded, and then output them into the HTML table on questions.php.

First, the script checks to see if the XMLHttpRequest has finished, and that there were no errors, outputting error messages if not. Assuming both theses conditions are passed, the function stores the output of the request, then creates an array of the response by splitting the response by “<br/>” (a line break in HTML). Each question in the response takes up three elements in the array. The function then loops over the HTML table and deletes all the non-header rows.

Then, the function iterates over the response array using a for loop, incrementing by 3 each time. For each iteration, the function creates HTML elements for each of the parts of the table (table row, table data, links, paragraphs and text nodes) and assembles them all together. It then creates and sets the attributes for certain elements including custom CSS, adding classes and id’s, and setting link locations. After all this is finished, it adds a new table row to the table, representing one downloaded question. It does the same in the following iterations for the rest of the questions fetched from the database.

Finally, the function adds some padding in the form of 3 leading spaces to the number of votes for each question.

**questionHeightFix.js:**

This is a simple JavaScript script used to set the height of the votes div to the same height as the question-container div. It does this by getting the raw CSS height of the question-container div using the window.getComputedStyle function, and then adding a new height attribute to the votes div and setting it equal to the value returned from the window.getComputerStyle().height.

**signup.php:**

This page is entirely comprised from HTML and CSS and used as the front-end for the signup/login system. It consists of 2 HTML forms, one for login and one for signup.

**\*.css:**  
The last 6 files in version 1 of NullPointerException are all stylesheets. These are used in the earliest versions of my project to add all the styling to the website, however just like the files only consisting of HTML, they are long and not suited to a detailed explanation.

### Notes about version 1:

* Writing custom stylesheets for each page was time consuming and didn’t produce good results
* Too much code was written in one version making it hard to document
* No comments in this version means documenting and maintaining it was harder than it should have been
* This version was pre version control which made it harder to revert any mistakes

Version 1 was the biggest version added to the project and contained all the code the entire project is based on. I made lots of mistakes in this early version of the project mainly in terms of the tools and processes I used. However, it provides a good starting point for the rest of the project to follow from.

## Version 2

Version 2 of NullPointerException can also be referred to as rewrite 1. Over the course of my project I rewrote and redesigned the site between 3 and 4 times. This came from bad planning and I regret it because it cost me a lot of time, however the effect on the project was definitely worth it.

Version 2 was when I redesigned the entire site, using a CSS framework called bootstrap to do most of the heavy lifting. The front-end of the site hasn’t changed at all since this redesign and I feel that it makes the site much more user friendly, which was one of my personal success criteria.

This version is made up from merging the front-end-design branch into the master branch. front-end-redesign was a git branch I made for converting the entire site to run on bootstrap. This process involved removing the stylesheet links from a page, replacing the custom classes and id’s with bootstrap classes, and linking the bootstrap CSS and JS.

I also added two new pages to the site: tutorial.php and python3.php. tutorial.php is the landing page for the tutorial section of the website, and python3.php is the landing page for the Python 3 tutorials. Both of these pages are entirely written in HTML + bootstrap.

All the changes in this version are markup changes and adding/removing CSS classes, neither of which are suited to a write-up in the same style as the version one PHP scripts so I’ve linked the git diffs which show all the changes in this version.

<https://github.com/OliRadlett/NullPointerException/commit/b0e8f8d133e447bb5acccc9c7c6994e7d2bb70c0>

## Version 3

Version 3 was mainly bug fixes and adding some smaller features. When I first started my project I decided to split the development into 4 main blocks: the core site, the q&a system, the careers system and the tutorial zone. This allowed me to organise my time to finish one section before starting another – an approach which I mainly stuck to throughout the project and found very beneficial. Most of the work done in version 3 was to the core site, including adding favicons, a small JavaScript script to change to a more mobile friendly logo if viewed on a phone, bugfixing and other minor improvements.

Notable changes are shown below:

**logo-fix.js:**

A new script in this version, logo-fix.js is used to change the logo above the menu bar to a more narrow varient when the site viewed on a mobile device. This is because the desktop version of the logo is wider than the width of some phones in portrait mode. The script works by creating a function called checkLogo() which compares the width of the browser (from window.innerWidth) with a constant value of 576. This value was chosen because it was the size of the window that the styling broke using the old image. If the window width is smaller than 576 then the script changes the src attribute of the image element to the relative path of the mobile logo. If not the script does the same but uses the path for the desktop logo.

The script sets this function to run after two browser events: window.onload and window.onresize. window.onload is fired when the page has finished loading, and window.onresize is fired every time the browser window changes size.

**\*.php:**

All php scripts had the following added to the top of them:

session\_start();

include connect.php;

The first of these two lines are used to connect the script to the PHP session in order to access SESSION\_ cookies and data. This must be the first line in the PHP script in order to work properly.

The second line is used to include the connect.php script. This is where the functions to connect to the database are located, and is stored in a separate file and included to avoid writing the same duplicate code in every script. This line allows every script to connect and interact with the database.

**\*-OLD.php:**

Any file with the -OLD prefix was removed from the repository. -OLD files were the origin files from version one before the first rewrite. I kept them until this point because I wasn’t fluent enough in git to trust myself to delete files and be able to recover them if necessary but by version 3 I felt comfortable to remove them.

## Version 4

Version 4 was re-write number 2. Whilst the first rewrite was focused on the front end, version 4 focused on the back-end. I mainly focused on breaking down all the large JavaScript and PHP scripts down into smaller functions, using a weird mix of procedural programming with lots of functions which I now regret. However, this is one of the many things I learnt while doing this project and did help make the project more modular and easier to develop/maintain (in the short term).

Notable changes are shown below:

**header.html:**

A new file in this version, header.html contains the markup and bootstrap classes for the header shown at the top of every page on the website. This includes the logo and the menu bar with the links to all the pages, as well as linking a JavaScript script used to add the “active” bootstrap class to the menu bar link for whichever page is currently being shown. The theory behind this file is to remove duplicate code wherever possible, and all this code (with minor differences) was written in on every page which added to load times (before the browser caches it) and made the PHP scripts harder to read and maintain. It was always my intention to move this code to an external file but up until version 4 I didn’t realise that PHP’s include expression could work with non-PHP files, and what the behaviour of including markup would be. Luckily it simply writes out the contents of the HTML document to the browser at the point of the script where the include expression is located.

**addActive.js:**

addActive.js is a small script used to add the “active” bootstrap class to the header link for the page that the user is on. This used to be hardcoded to the header for each individual page, but since moving the header to one universal file, this approach no longer works. The script gets the current URL and uses it to determine which page the user is on. It then adds the active bootstrap class to the header link element for the correct page.

An interesting side effect of this script is that it stops any window.onload events from firing as they are taken up by this script. I deal with this by providing a space at the bottom of the main function in addActive.js for calling page specific onload functions.

All other changes in this version are minor bug fixes and structure changes to make the solution more modular and easier to read.

Version 4 was quite a time consuming version to write even though it didn’t further the state of the project much. However, the backend changes implemented in this version helped speed up the development of future versions. Another unexpected benefit of making a more modular solution is that it’s easier to document and write up. This is because all the changes are now in their own functions rather than spread out all over multiple files.

## Version 5

Version 5 added a new feature for searching questions, the initial commenting system, a “404” page, along with several enhancements and bug fixes. This is the most new features added in a single version since the initial upload of the project to GitHub.

One minor change that had a decent impact on the scalability of the project was adding the String “LIMIT 10” to the MySQL queries on qa.php. This does exactly what you’d expect – limits the number of results that can be returned from the database to 10. This saves on database processing power, and saves on network requests from the computer to the server and back again. I made this change because the page started to look silly when the database had over 10 questions in (during testing), and limiting the query was a much better solution that only displaying 10 for the reasons mentions above.

A potential fix to an irritating bug I discovered after version 4 – where session variables seemingly randomly disappeared mid-session – was the function session\_write\_close(). I make a call to this function after any session functions and just before any calls to the header() function. This function is used to save the state of the session, which normally happens anyway, but when session function were used in conjunction with setting the headers to redirect the user, it started causing errors. Adding session\_write\_close() seemed to fix this behaviour.

Full details of script specific changes are below:

**downloadquestions.php:**

Added “LIMIT 10” to all three of the MySQL queries on the downloadquestions.php. This is used to reduce load on the database server and to limit bandwidth used between the database server and the users computer. This was a very quick fix that provided very good improvements.

**downloadsearchq.php:**

A new file added in this version, downloadsearchq.php is the search system’s equivalent to downloadquestions.php. Its purpose is to search the database for questions based off a provided query and output the results in a format that the JavaScript script that initiates the search and receives the results can understand.

The script works by first getting the search query from a URL parameter, then preparing a MySQL query to search the database, using the “LIKE” keyword. “LIKE” in MySQL works by only returning records that match a certain pattern. The pattern I’m using for NullPointerException is “%{$q}%”. Whist this seems confusing at first, its actually quite simple. The % signs are used to represent any number (including zero) characters – meaning that the main patter can occur anywhere within the record. The {$q} section of the pattern represents the PHP variable $q, which is used to store the search query the user entered.

The rest of the script simply executes the query, and outputs it in the form expected by the JavaScript script initiating the search.

**filterSearchQuestions.js:**

Another new script in this version, this script is an almost identical copy of filterQuestions.js and is used for initiating searches and outputting the results. Most of the code in this file has already been explained in version 1.

One issue with this script is that it involves duplicate code – something I always to try to avoid while programming. However, at this stage of development I was behind my personal schedule for this project – partly due to the complete re-writes. This means that I was prepared to use the quick fix of duplicating a JavaScript file and changing some of the functions at this stage, instead of combining the two similar scripts into one universal multi-use master script. However I hope to fix this in a future release.

**questionFuncs.php:**

I added three more functions in questionFuncs.php in this version: GetComments, Comment and getUserID. As their names suggests, these functions are all part of the new comment system which was added in this version. These are helper functions added in this separate file to keep the main questions.php file free from clutter.

The first, GetComments, takes two parameters: $qID (an integer representing the question id in the database), and $connection (a reference to the MySQLi connection object). This function is used to return all the comments that have been made about a specific question. This is a very simple function because it relies on a second new function in this class for most of the heavy lifting. GetComments works by preparing a simple MySQL function for select all the comments from the database that have the question id attribute equal to the one provided in an argument to the function. Then it iterates over all the results returned and calls the Comment function for every result.

The Comment function is used to output a comment returned from the database. It takes two parameters: $row (An associative array comprised of one result row returned from the database) and $connection (a reference to the MySQLi connection object). It then uses the echo expression to output HTML content onto the page containing a mixture of elements, bootstrap classes and PHP variables. This, combined with some custom CSS, outputs a comment onto the question page.

The final function is not part of the new comment system, but is more of a quality of life improvement. Its called getUserID and it takes two parameters: $connection (a reference to the MySQLi connection object), and $username (A String containing a username to return the id of). The function simple queries the database to return the user id attribute for the user with the username matching the username parameter passed into the function. It then returns that value.

**processcomment.php:**

The final new (non-markup) file in this version, processcomment.php – the back-end system for posting a new comment for a question. The script starts off by connecting to the database, getting the attributes for the database from the URL, POST data, SESSION data, and the build in time() function (used for returning the current UNIX timestamp). It then checks the user hasn’t been banned from the database, and if not it uploads it into the database (assuming that the comment body is not empty).

Version 5 was a large release with new features which work well and some small big fixes and minor improvements. It showed some more of the benefits of the modular design I’ve been employing by having a separate script for functions relating to the questions. It was quite an easy version to develop as the new features simply needed programming, before they could be slotted in – again thanks to the modular approach I’ve been using during development so far.

The rest of the work in this version was on bug fixing and minor improvements.