User Modelling in Search for People with Autism

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Abstract

This project report presents my research and the development of a prototype web application to assist users with Autism when they search the web. The system has modelled user interactions with the search process into a user profile for this category of users, integrating insights from the core features of autism into the model. The system is integrated with an infra-red, motion controlled, user interface component to assist users with Autism during search. The project provides insights into how search can be improved for users with Autism.

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Contents

Abbreviations

API	Application Programming Interface
AQ	Autism Quotient
ASD	Autism Spectrum Disorder
DSM	Diagnostic and Statistical Manual
GCS	Google Custom Search
HCI	Human Computer Interaction
HTTP	Hypertext Transfer Protocol
JSON	JavaScript Object Notation
IDE	Integrated Development Environment
KWIC	Key Word In Context
LEAP	LEAP Motion Controller
REST	Representational state transfer
RIFT	Oculus Rift Virtual Reality Head Mounted Display
TDD	Test Driven Development
UI	User Interface
UX	User Experience
VR	Virtual Reality

Definitions

Autism	Autism is amongst the most common neuro-developmental condition and it is currently estimated that 1/68 children meet criteria for Autism Spectrum [5]. Autism is five times more common amongst boys than girls (1/42 boys, and 1/189 girls). According to the Diagnostic and Statistical Manual (2013), Autism is characterised by persistent and early deficits in reciprocal social interaction and repetitive behaviours. Individuals vary from high functioning to low functioning (along a spectrum), with behaviours emerging around 2 to 3 years of age.
Stereotyped User Model	Stereotyped user models infer characteristics about a user from data gathered from other users within that distinct subset. They can be built quickly using clusters of characteristics of groups of individuals.

Search Engine Measures

Precision

The field of information retrieval defines precision as the fraction of retrieved documents that are relevant to the query.

$$Precision = \frac{|(relevant\ documents) \wedge (retrieved\ documents)|}{|(retrieved\ documents)|}$$

Recall

The field of information retrieval defines recall as the fraction of relevant documents that are retrieved by the search query.

$$Recall = \frac{|(relevant\ documents) \wedge (retrieved\ documents)|}{|(relevant\ documents)|}$$

1 Introduction

This project report presents the development and evaluation of a prototype web-browser based application to assist users with Autism when they search the web. The application is hereafter referred to as Jellibeans [1]. Jellibeans utilises gesture and hand movement data recorded using the Leap Motion Controller (LEAP).

In programmatic terms, Jellibeans is designed to implement a research-guided user model in search. The development of this user model consisted of iterations of the 'research, development, test, evaluate' lifecycle. I conducted research to identify the preferences within search, and the differences in user queries formed by individuals with Autism, by conducting surveys and collecting and analysing search behaviour patterns from people with and without Autism. Using these data I built a set of features into search, to guide the user through forming a more complete search query. Development and evaluation included the implementation and testing of the features, and further implementation and revision of the software to enhance the search process and the precision of the search engine for the users' intended search query.

Jellibeans integrates a motion controlled user interface (UI) using the LEAP motion controller. The interface is very dynamic as opposed to static, and can hold users' attention for longer periods of time. In the past, users with Autism have struggled to maintain their attention to sift through the large number of search results. In line with the attention difficulties individuals with Autism face, Jellibeans has been designed to reduce the amount of text on the search results page, presenting only 3 results per page, instead of the default 10.

Despite Autism being amongst the most common neuro-developmental condition (1/68 children meet criteria for Autism Spectrum [5]), no user model has yet been developed for Autism within Search. In the current project, I describe my efforts to build a user model within search for individuals with Autism.

1.1 Background Research

According to the Diagnostic and Statistical Manual [5], Autism is characterised by persistent and early deficits in reciprocal social interaction, so interaction with computers is prominent in this group. It is also well established that individuals with Autism are more engaged when using technology that is receptive and interactive (e.g., games, responsive consoles, motion controlled devices) compared to technology that is not [14]. This project will combine interactive, motion recognition hardware with search to also improve the UI (user interface) of search for individuals with Autism.

[1] Jellibeans are a rainbow of colours, different sizes and shades, and the name represents the difference in style of processing of individuals with ASD.

Research has shown that people with Autism are less context-sensitive and prefer a more detail-focused processing style [19]. There is good reason to postulate then, that web-search queries are formed very differently to the typical population. Generally speaking, individuals with Autism prefer, and are more likely to engage in an item-specific, or detailed processing style, resulting in web-search queries that are more likely formed of single-order associations. In addition to a detailed, item-specific processing style, individuals with Autism are also less likely to engage in a contextual processing style. For example in a search for 'Guitar', a contextual style of processing would imply an awareness that the word is related to 'Piano', but also that both words are hierarchically related to 'Instrument'. In day to day life, a major factor determining the effectiveness of working-memory (the transient holding and processing of information for updating, learning and comprehension), and the amount and quality of information that an individual can recall and enter into the web-search, is greatly influenced by the number of cues that are available at the time. For example, if presented with a list of 50 items to remember, you are more likely to remember that I presented 'Zebra' if I tell you that I presented an animal. This type of 'cued' recall can be used to bolster recall of information for people with Autism, and is a technique that will be applied in the current project.

1.2 The Problems with Current Web-Search

The Internet is one of the largest resources of information. Search engines allow users to collate hundreds of links on a single topic, using only a few words or phrases. The typical user sorts the returned results into 'relevant' or 'irrelevant' categories, flexibly shifting (mentally) between one result and the next, to determine the relevance of each page returned by the search engine. Search allows the user to assimilate the information on the page into their knowledge and is an important learning tool. For people with Autism, the requirement is no different, however, current search is not adequate. A large body of research has shown that 'mental shifts' are a known area of weakness for people with Autism [9]. The information is therefore harder to assimilate or learn, and judging the relevance of each document becomes near impossible. One successful therapeutic technique to increase the assimilation of information for individuals with Autism is to present it in clearer, smaller amounts [25]. This technique avoids overwhelming individuals, and although less information is presented as a whole, whatever is presented to the user becomes 'digestible' and ultimately, the information as a whole becomes more understandable.

One of the first aims of the current project was to build a synthesis of three leading search engines, to ensure the best possible results were retrieved by Jellibeans and presented to the user. The first stage was to therefore build the combination search engine and test the results on a user group with Autism. The goal of the research was to understand if the synthesis of the search engines enhanced search experience (in other words were users happy with the combination search), or, whether the results introduced redundancies or oddities in the results (some users may not use a certain search engine because they do not find the results helpful).

Search queries usually fall into one of three broad categories [10]. 'Do' queries which characterise transactions between the user and the search engine, for example when the user wants to do something such as *buy a plane ticket*, *listen to a song* or, *download a screensaver*. 'Know' type queries, which are informational in nature, usually covering a broad topic, for example, the *name of a band* or *restaurant in London*, *trucks*, or *Colorado*. The third broad category is 'Go' type queries, which are navigational in nature, for example, searching for a particular home page on the web, *YouTube* or *American Airlines*. There are also many stages to the search process [10]. After identifying the information need, the user must formulate a search query. The user must browse through results once the query has been entered into a search engine. The whole process can be repeated if the user is not satisfied.

1. Experience the need for an answer, solution, or piece of information.
2. Formulate that need in a string of words and phrases, also known as 'the query'.
3. Enter the query into a search engine.
4. Browse through the results for a match.
5. Click on a result
6. Scan for a solution, or a link to that solution.
7. If unsatisfied, return to the search results and browse for another link or ...
8. Perform a new search with refinements to the query

1.3 Design Patterns for Web Applications

Search engines like Google apply strong reduction techniques to navigation of the web. For example, one common way this reduction pattern is implemented is by assuming the behaviour of the current user is similar to the behaviour of other users in similar situations. This is often seen in recommendation engines, e.g., Amazon. The principle applied by Google is to 'make it easy' for the user [15], by assuming that users form search queries similarly, and returning similar results to those users.

As we have seen in the introduction, users with Autism behave in different ways to typical users when navigating search. Users with Autism do not use the same key phrases when looking for documents with several attributes, i.e., queries that would be best formulated using several iterations of search, or multiple search parameters. This leads to an ineffective search; one that requires users to sift through results which are in large-part irrelevant, and a bad user experience. Parametric search queries allow users to define parameters in an increasingly logical and structured way. As an example, consider the experience of searching for flights to a particular holiday destination, or for a person. This requires high cognitive 'load' (remembering and manipulating arrival, departure, destination, timings, airlines, seat preferences etc.) so searches are often structured using fixed options (see Figure 1).

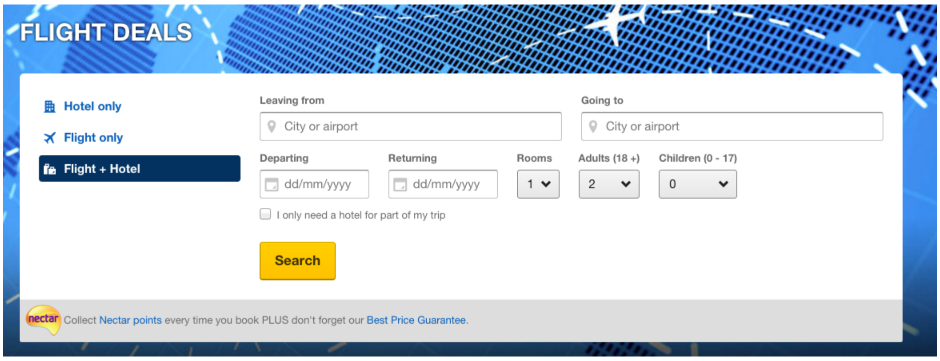


Figure 1: Expedia Parametric Search Example

For typical users, parametric search is more structured, and in some circumstances seems more natural than a free keyword search. It makes search queries easier to formulate in situations where there is a high cognitive load. We can apply this idea to web search for people with Autism, by asking them to enter criteria that can be applied to subgroups of search queries. Parametric search can assist the user with capturing the search parameters that are useful for a query it does not ultimately reduce the number of search results returned; the possibility of a large result set is most definitely true. However, when used in addition to the original search query itself, the parametric search will refine the user's search results in line with their search query, ultimately leading to a higher precision for the search engine. One of the aims of the study is to reduce the amount of textual information on the webpage presented to the user, so the solution implemented here tries to find a balance between these two aims.

1.4 Motion controllers

Individuals with Autism have poor attention [3]. The static 2-dimensional interface of many current search engines is unlikely to maintain adequate (sustained) interest levels. Individuals (and especially teenagers) with Autism spend a substantial amount of their time using computers, web, portable or console devices [24], as they find these more stimulating and attention-grabbing. For these individuals, computer-based technologies provide a stable, consistent learning environment that can be customized [21]. Furthermore, motion recognition devices can be programmed to make consistent responses to environmental triggers. These controlled and interactive environments have shown promise for improving social communication skills and reducing repetitive behaviours [11]. For the current project a motion-controlled learning environment will be bolstered to improve attention within search for people with autism.

Figure 2: Envisioned UI component for the project [12].

1.5 Summary

As search can be compartmentalised into 'Do', 'Know' and 'Go' type queries, it provides a natural way to tackle the issue of simplifying the search process for people with Autism. Users first identify the type of search they would like to carry out, the search engine can better phrase a question to guide the user through their informational demand. Each stage of the search process described above, can be better tailored towards providing a concrete and unambiguous experience for the user with Autism, and reducing the amount of text on the page. When using Jellibeans query formulation, the user will be assisted through the process of formulating a search query (much like a parametric search engine form for example when you buy a car, you fill out many criteria which must be simultaneously searched for). Concretely phrased questions will be aided by suggestions that appear laterally on the page. These suggestions can be added into the search query without the need to type them in, just by using natural hand movements, tracked by the LEAP motion controller. The suggestions also serve as cues for the user, and to simplify the search process for them. The UI component will make the whole experience more interactive and the search engine more receptive to user input. The process of forming an search query thus becomes more tightly defined compared to the current systems for web search, the process will be more predictable, and the size of the result-set will be adapted towards users with Autism.

1.6 Aims for Jellibeans

The goal of the project is to build a prototype search tool that assists users with Autism search and navigate the web. These prototype features will be tested on a group of users

with Autism. The final product will be integrated within a motion-controlled environment. The prototype will be modified accordingly in line with the outcome of several stages of user research.
The core features of Jellibeans are:

1. To implement and test a combination search web application that synthesises the results from three of the largest and most popular engines; Google, Bing and Yahoo [20].

2. The design and implementation of a user model of Autism to filter user search results. This will be a *stereotyped* model, i.e., some characteristics of the model will be based upon the user's demographic data, other characteristics will be inferred from the Autism subset of users for an explanation of the different types of user models.)

3. To Present Words In their Context; returning query terms in context, within small snippets (not verbally-overloaded).

4. Prioritisation of results which have first-order semantic relations to the query words i.e., they appear in matched context to the search query.

5. Motion controlled UI (see Figure 2).

2 Project Trailer

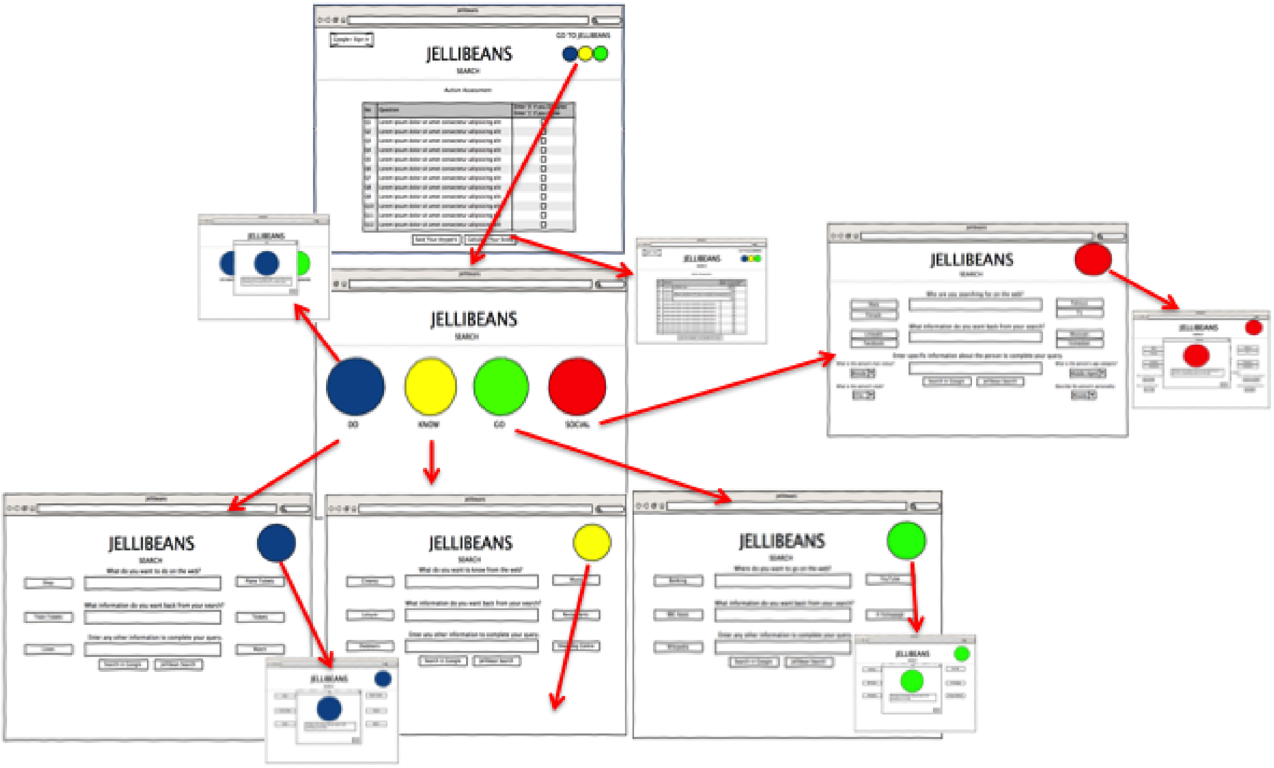


Figure 3: Wireframe Sketches for Jellibeans User Flow

2.1 Description of What Jellibeans Does

1. Jellibeans is a web-browser based application to assist users with Autism when they search the web. Jellibeans can be found at http://esha.mseth.co.

2. Jellibeans utilises a *stereotyped* user model of Autism for Web Search. The features of the model were determined following analyses of survey responses gathered from individuals with Autism or a high occurrence of autism-like symptoms. The survey was administered online using a web-based survey engine [26], and focused on identifying the differences in user search query generation for people with autism (see Figure 3).

3. Following the insights gathered from the first set of research findings above, Jellibeans employed a parametric-like search, and include suggestions to guide the user towards forming succinct and accurate search queries.

4. Jellibeans was integrated with Google+, to allow the user to sign in and have their profile picture and name displayed, enhancing the feel of a personalised search engine.

5. Jellibeans allows users to get feedback on the level of their autism-like symptoms. The Autism Quotient [1], a scientifically validated screening tool for autism spectrum disorders will feature on the Jellibean homepage, and users can retrieve their score and save their responses for each question to a local file for their reference (the file is formatted for Microsoft Excel).

6. Jellibeans prioritises and displays the three highest precision search results for users. The goal of Jellibeans is to increase precision of the search results that are returned. Recall of the engine is sacrificed in line with the demands of the user model, to have less textual information on the page.

7. Jellibeans reduces the amount of text on the webpage by having results display on a modal (a hovering display panel on the page) which can be easily closed, and re-opened to display results (see Figure 4).

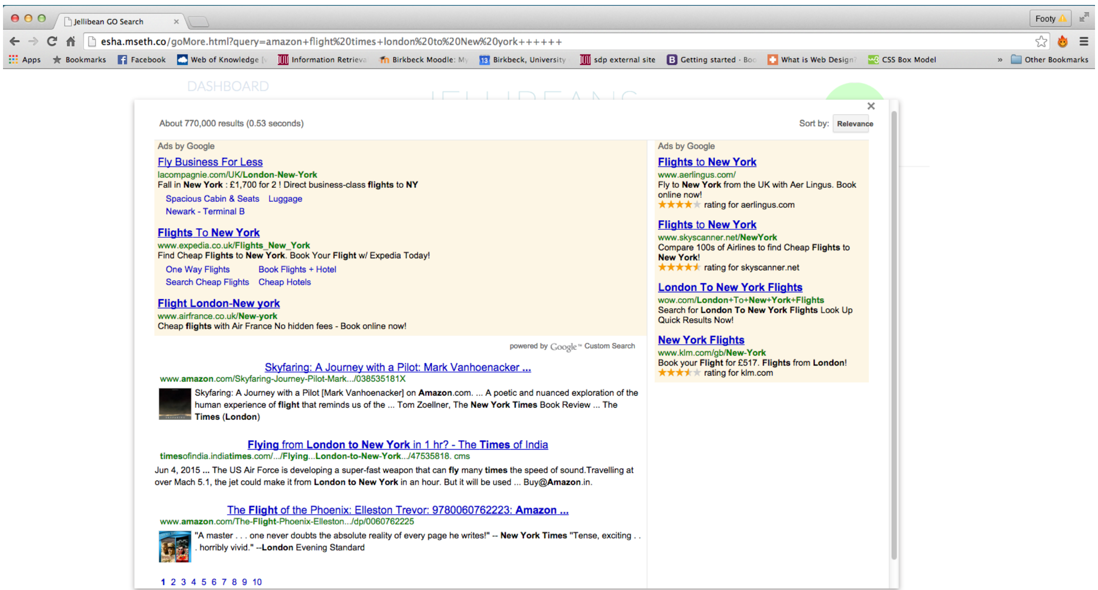


Figure 4: Top 3 results are presented back to users in a modal to reduce information on the page. The modal can easily be closed and reopened.

8. Due to the nature of the parametric search, and the reduction in number of search

results displayed, the results from Jellibeans are more likely to be a direct semantic relation to the search query. This makes the selection of that result by the search engine more transparent to the user.

9. Integration of the web application with a motion controlled user interface, the LEAP controller.

3 Product Specification

Major dependencies and How I plan on tackling the problem to meet my requirements. The core features for Jellibeans are to implement and test for suitability within an environment for users with Autism are:

1. A combination search engine.
   A combination search engine that will synthesise the search results from three engines, Google, Bing and Yahoo. The aim of this feature is to increase recall of the engine.

2. User Testing.
   To test the combination search engine with a sample of users with Autism, and typically developing individuals to ensure that the combination search engine enhances search experience without introducing redundancies. To understand more about the likes, dislikes and preferences of user's self-selected search engines.

3. User Research.
   Research and develop iterations of a *stereotyped* user model of Autism within Search.

4. Retriving Google+ Data.
   To integrate the user model and Jellibeans with Google+, to enhancing the feel of a personalised search engine.

5. Assessment of the User's Autistic Traits.
   To develop a diagnostic assessment page for Jellibeans based on a Psychological assessment, the Autism Quotient [1]. Jellibeans will review and assess autistic-like traits or characteristics, so that users can be aware of, and save a copy of their diagnostic information.

6. Assisting the User to Break Down their Search Query.
   To allow the user to navigate Jellibeans to break down their search query into smaller manageable questions to ask, i.e., breaking the query up into 'Do', 'Know', 'Go', 'Social' questions.

7. Parametric Search Process.
   To provide a parametric search process, and reduce ambiguity of forming a search query for users with Autism.

8. Jellibean Suggestions and Assitance.
   To provide suggestions or cues for users to assist them with forming a search query, and to help ease some users need of a 'perfect' search query.

9. Prioritising Search Results and Minimising Text Displayed to User.
   Jellibeans will prioritise and display the three highest ranking search results for users. The overall goal of this feature is to reduce the amount of text on the page, to minimise the chance of overwhelming users and to retain as high precision of the search results as possible.

10. User Testing.
    To test the *stereotyped* user model embedded within Jellibeans on a sample of individuals with Autism and gather feedback.

11. Motion Controlled User Interface.
    Jellibeans will utilise a motion controlled UI to enhance the search experience for individuals with Autism by making it more receptive and interactive, and to maintain the user's attention for longer.

12. User Testing.
    To gather feedback from a sample of individuals with Autism who have used Jellibeans, and present the findings in the Evaluation and Conclusions (see Section 9).

4 Software Architecture

4.1 Design Patterns

1. Builder Design Pattern.
   For Jellibeans to successfully create the user's query string, http GET requests were used to extract parameters from the URL. The Builder Design pattern was used to achieve this. Once the parameters from the URL are retrieved, Jellibeans builds them into the user's search query string. The search query string can then be passed to the JavaScript methods in the relevant class (dependent upon the user's search behaviours), parsed into the correct format, before a POST request is then made to the Jellibeans Custom Search Engine to process the request.

2. Chain of responsibility Pattern.
   Because there are many behaviours that the user can perform before their query string is formulated and ready to be posted to the search engine, the software also makes use of the Chain of responsibility pattern where at each stage the user's query is passed along a chain, with added functionality and methods depending on what the behaviour of the user was.

3. Adapter Pattern.

I accessed the user's Google+ profile data (name and profile picture) and presented these on the Jellibeans homepage. I then used the Adapter design pattern to build my own functionality onto the existing profile. For example, to present the user's Autism Quotient score, and to guide the user through forming their search query.

These patterns reduced coupling between the classes and the query, so it was chosen because it follows programming best practice.

4.2 Use Case Diagram

The main use cases which are required by the Jellibeans application are:
A SHORT DESCRIPTION WILL GO HERE.

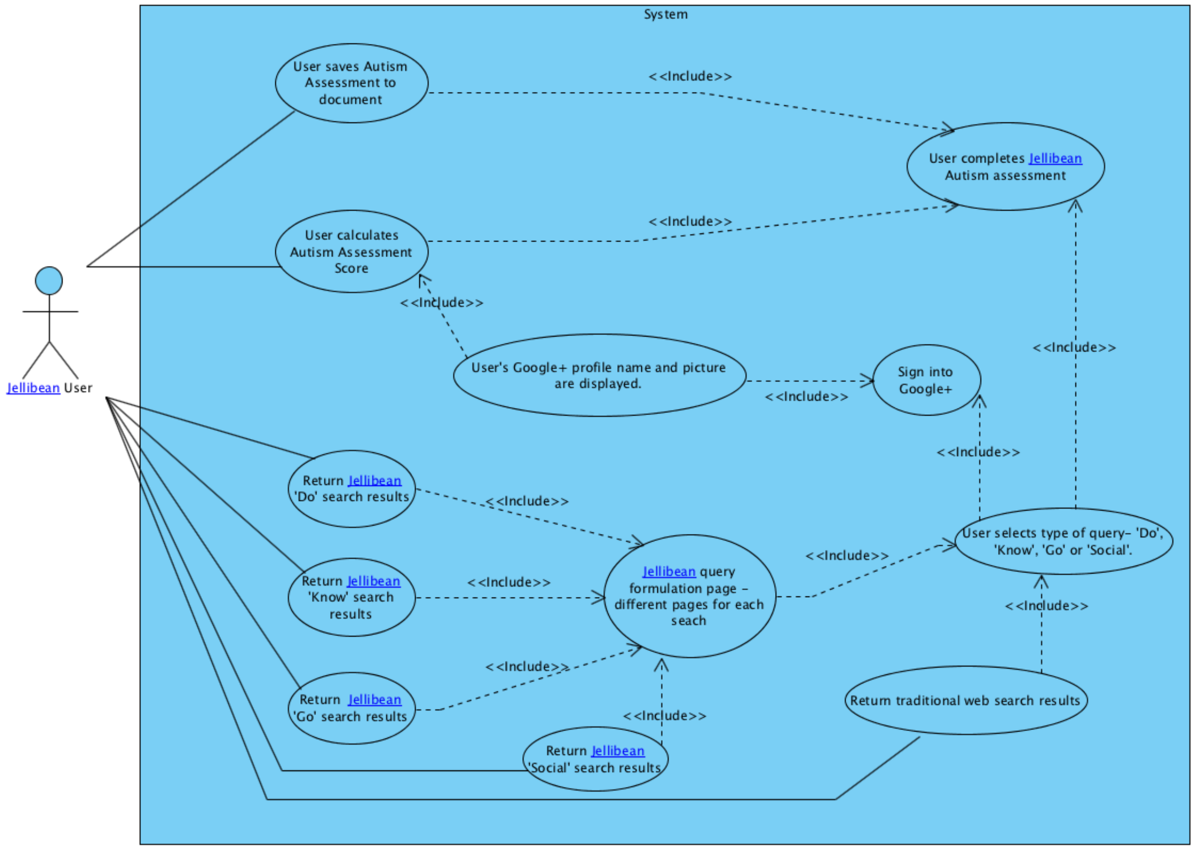


Figure 5: Jellibean Feature Uses and High Level UML Use Case Diagram

4.3 Class Diagram

A SHORT DESCRIPTION WILL GO HERE.

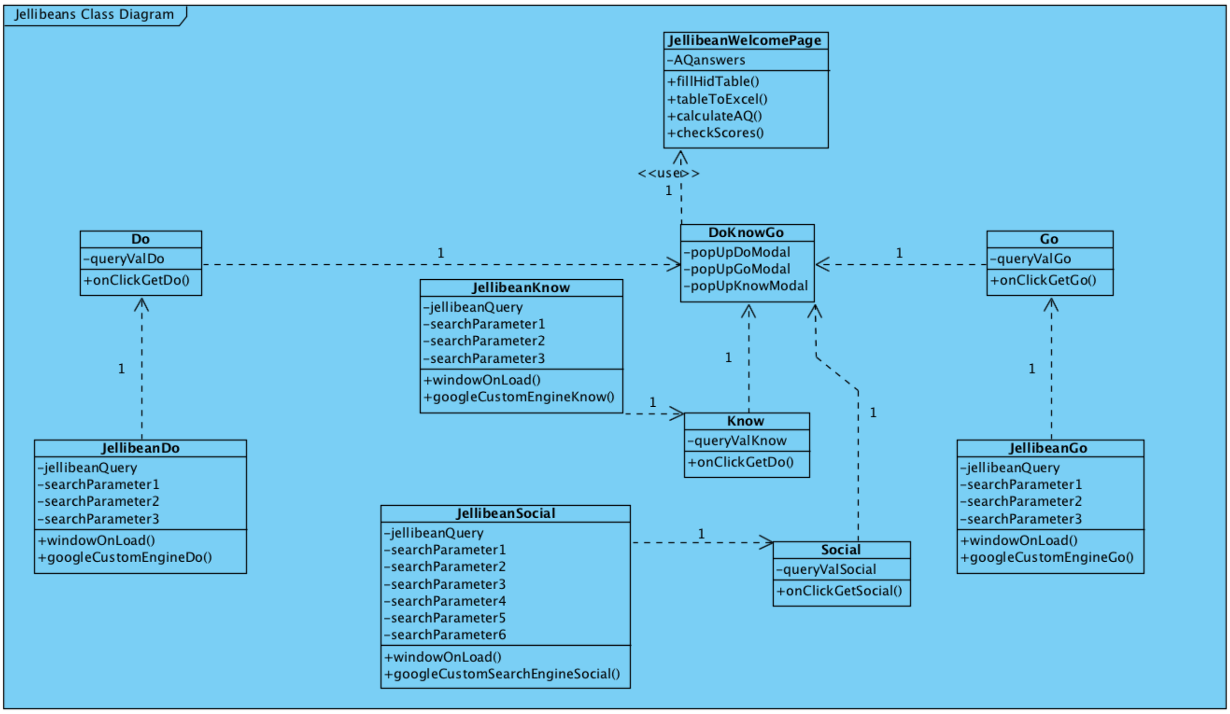


Figure 6: Jellibean High Level UML Class Diagram of Jellibeans

5 Implementation

5.1 Synthesis of Search Results From Different Engines.

For search results returned by Google, the Custom Search API was used in line with the Google terms of service, that is that ‘screen scraping’, or copying the data directly from the website is prohibited. The Google Custom Search API is a RESTful API with a single method called list. The API method used was GET, and the response data is returned as a JSON type. The response consists of (1) the actual search result, (2) metadata for search like number of results, alternative search queries, and (3) custom search engine metadata.

5.2 JSoup API

For Bing and Yahoo search results, JSoup (a Java HTML parser) was used to identify the links from the resulting query. The JSoup HTML parser was considered more efficient for retrieving search results, as it could be used to complete the task from both search engines, using a slightly different href element filter for each. JSoup also has advantages over html parsing. It contains a class representing a list of nodes called ‘Elements’, which implements Iterable to iterate over a list in an enhanced for loop.

5.3 Java

To test the combined output from the three search engines with a group of users, and gather their feedback on the results, I developed a Java Applet to run the programme (see Figure 7). The search results from the Java Applet were written to a text file.

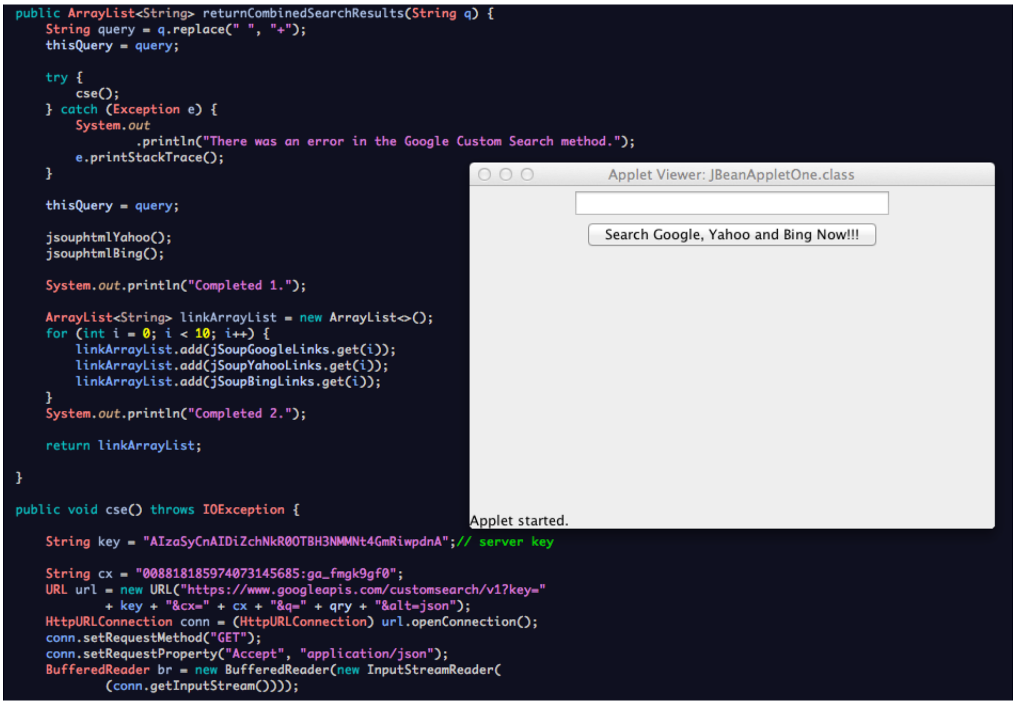


Figure 7: Applet Built to User Test the Combination Search Engine.

Java was chosen for development of 'to be tested' packages of features (e.g., the combination search engine). The developer for the project was most proficient with Java, and could quickly develop prototypes for user testing.

5.4 JavaScript

JavaScript is commonly used in HTML as it can run locally in a browser (rather than remote server). The Google+ API provided good documentation for using JavaScript. Furthermore the JavaScript code could be easily embedded into the Jellibean HTML code to interact with the Document Object Model (DOM) of the page. The browser was able to respond to user demand quickly, which made Jellibeans more responsive. JavaScript was used in this way to return the aboutMe profile information from Google+ to the user.

JavaScript was also used to calculate the user's Autism Quotient, display the score in the browser, and to save the user's responses to a local Excel file on the users computer so that they can access the data at a later stage.

5.5 HTTP: Client and Server Set-up

The Hypertext Transfer Protocol (HTTP) enables communications between web-browsers (clients) and the server (the computer that hosts Jellibeans) using a request-response protocol. Jellibeans was deployed in textbfnginx (pronounded 'engine x') HTTP web server, and digitalocean.com was used to host the web servers, so that it was ready to be used remotely by users (and for me to gather feedback easily). When the user submits a HTTP request to the server that hosts Jellibeans, it responds with the appropriate behaviour to the client so that the user can formulate their search query and retrieve the results from their search.

Jellibeans can be viewed at http://esha.mseth.co.

5.6 HTML

HyperText Markup Language (HTML 5) was used to create the webpages for Jellibeans, so that the web browser could render the wesite.

5.6.1 Bootstrap and CSS

For front-end development and to style the Jellibean web pages I used the Bootstrap framework [2] for it's clear styles, good design and ease of use for the current project. I included my own Cascading Style Sheet (css file) where I needed extra styling beyond what the Bootstrap framework could offer.

5.7 LEAP Motion Detector and LEAP SDK

The LEAP motion controller is a light-weight, portable device that detects user motions using infra-red light. The LEAP has accurate timing, and works well with the combinatorial configuration of senses (sight, hearing and touch). As this is a tool to be used with individuals with Autism, who have increased sensitivity to touch, the LEAP is the perfect choice as there is no additional sensations to the users body. The LEAP is affordable for users to integrate with search at home, and currently retails for about £60.

5.8 LeapStrap for the LEAP Motion Controller

The LeapStrap SDK was used to integrate the LEAP into the web broswer. LeapStrap is a HTML5 front-end framework for websites, and gives them fill LEAP motion functionality.

6 Software Development Process

6.1 Core Feature 1: Research and Data Collection for a Combination Search Engine using Google, Yahoo and Bing.

To implement the combination search engine I used three API's provided by Google, Bing and Yahoo, namely, the Google Custom Search API, Yahoo BOSS Java API and Bing Search API.

To get started with the Google Custom Search API, I created a project called *Jellibeans* in the Google Developers Console, and an OAuth 2.0 Client ID. I obtained a Consumer Key and Secret to use the API, and used these in the application code to access the Google Custom Search Engine (see Figure 8).

```
public class GoogleCustomSearchApiApplet {

    String qry = null;
    public ArrayList<String> jSoupGoogleLinks = new ArrayList<>();

    public void cse() throws IOException {

        String key = "AIzaSyCnAIDiZchNkR0OTBH3NMMNt4GmRiwpdnA";// server key

        String cx = "008818185974073145685:ga_fmgk9gf0";
        URL url = new URL("https://www.googleapis.com/customsearch/v1?key="
                + key + "&cx=" + cx + "&q=" + qry + "&alt=json");
        HttpURLConnection conn = (HttpURLConnection) url.openConnection();
        conn.setRequestMethod("GET");
        conn.setRequestProperty("Accept", "application/json");
        BufferedReader br = new BufferedReader(new InputStreamReader(
                (conn.getInputStream())));

        String output;
        while ((output = br.readLine()) != null) {

            if (output.contains("\"link\": \"")) {
                String link = output.substring(output.indexOf("\"link\": \"")
                        + ("\"link\": \"").length(), output.indexOf("\","));
                jSoupGoogleLinks.add(link.toString());
            }
        }
        conn.disconnect();
    }
```

Figure 8: Jellibean Applet Combination Search Engine

Following that I also registered my JavaScript origins within the console to access the Google+ API, and redirected URIs so that once users Sign-In using their Google+ login credentials they will be redirected to Jellibeans (or http://esha.mseth.co). This was done because I wanted users to be able to sign in and access their google profile from Jellibeans (see Figure 9), giving the user the feel of a more personalised search experience.

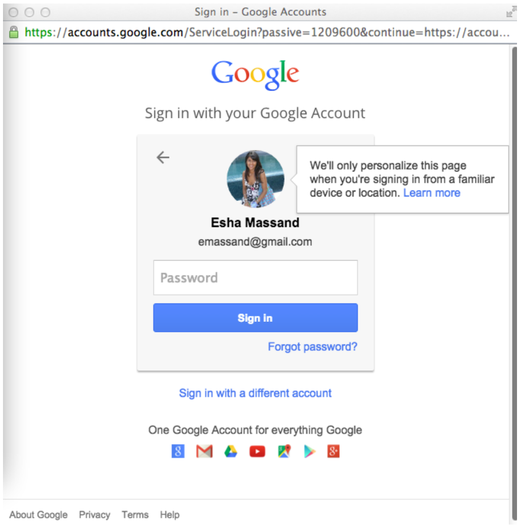


Figure 9: Google Sign In Pop-Up.

Following a similar protocol for Yahoo and Bing Search API's, I created projects in the Yahoo Developers Network, and Microsoft Azure Marketplace, and purchased an API Consumer Keys and Secrets (needed to use the APIs).

6.1.1 Web Scraping

As Web Scraping for Bing and Yahoo search (using the JSoup API) was an option, and it quickly became a preferred choice because of the flexibility/manipulation of the results if they were returned using the same API rather than two different ones. Web-Scraping is against terms of service set out by Google, however (see section 5.3 of Figure 10). Furthermore, the web-links that were returned using web-scraping on any Google results pages were erroneous and incomplete.

5. Use of the Services by you

5.1 In order to access certain Services, you may be required to provide information about yourself (such as identification or contact details) as part of the registration process for the Service, or as part of your continued use of the Services. You agree that any registration information you give to Google will always be accurate, correct and up to date.

5.2 You agree to use the Services only for purposes that are permitted by (a) the Terms and (b) any applicable law, regulation or generally accepted practices or guidelines in the relevant jurisdictions (including any laws regarding the export of data or software to and from the United States or other relevant countries).

5.3 You agree not to access (or attempt to access) any of the Services by any means other than through the interface that is provided by Google, unless you have been specifically allowed to do so in a separate agreement with Google. You specifically agree not to access (or attempt to access) any of the Services through any automated means (including use of scripts or web crawlers) and shall ensure that you comply with the instructions set out in any robots.txt file present on the Services.

5.4 You agree that you will not engage in any activity that interferes with or disrupts the Services (or the servers and networks which are connected to the Services).

5.5 Unless you have been specifically permitted to do so in a separate agreement with Google, you agree that you will not reproduce, duplicate, copy, sell, trade or resell the Services for any purpose.

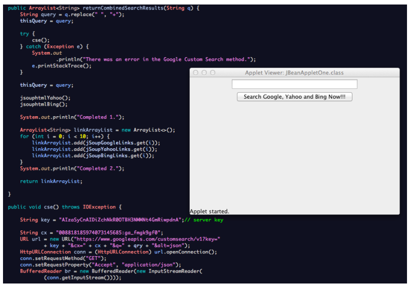
5.6 You agree that you are solely responsible for (and that Google has no responsibility to you or to any third party for) any breach of your obligations under the Terms and for the consequences (including any loss or damage which Google may suffer) of any such breach.

Figure 10: Google Terms of Service

I used the Jsoup API [18], which is a Java-written API for HTML. The library provides methods to conveniently extract data using DOM (Data Object Model) and CSS (Cascading Style Sheet) methods.

The combined Google, Yahoo and Bing results were integrated these into a Java Applet that runs in Eclipse Luna IDE (see Figure 11). The program ran so that the user could enter a search query and the results would be presneted back to them for inspection. The top 10 links, from each search engine were presented to users. Results were ranked prior to presentation, such that result 1 from Google was followed by result 1 from Yahoo, and that was followed by result 1 from Bing. Then results 2 from Google, Yahoo and Bing were presented and so on, until the 30 links were produced (top 10 links for a search from each search engine), in ranked order from the three search engines.

(a) JSoup HTML Parser.



(b) Integration with Google Custom Search to Produce the Complete Query Results.

Figure 11: (a) JSoup HTML Parsers for Yahoo and Bing. (b) JSoup HTML Parsers working with Google Custom Search API in Java Applet for User Testing.

6.1.2 User Research and Testing of Core Feature 1

To test the integrated combined search engine, 10 participants took part in a study to evaluate the quality of it's output. The participants were selected because they scored highly (above 30, where 32 is threshold for Autism Spectrum Disorder with a 79% sensitivity) on a 50-item screening measure of Autism-like tratis (the Autism Quotient [1]), and these individuals were thought to be most suited to test the current system.

The range of scores for the AQ is 0 to 50 with high scores indicating increased likelihood of autism-like traits. A score under 21 is a low to average result (many women average around 15 and men around 17). A score of 22-25 indicates autistic tendencies slightly above the population average. A score above 26 gives a borderline indication of high functioning autism, or Aspergers. A score above 30 suggests a likelihood of Aspergers syndrome or autism (sensitivity of test measure = 79% [1]).For the purposes of this study, individuals with scores equal to, and above 30 were interpreted as having 'autistic-like traits'.

Results from 10 pre-determined search queries were presented to the 10 participants and they were asked to comment on the search results that had been returned, and to choose three out of the links returned that they would follow up with. They were also asked to observe if anything was odd about the results returned. The responses from the 10 users were analysed to determine whether a combination search would be an enhancement in Jellibean Search, or whether it would introduce redundancy in the search results.

Somewhat non-surprisingly (given the statistics of most preferred search engines (Google's unique monthly visitors: 1,100,000,000 and query volume: 64.5% ; Bing: 350,000,000, 12.8%; and Yahoo!: 300,000,000, 64.5% ([7] [20])), the results revealed Bing Search was favoured the least, and Google results the most, with Yahoo falling somewhere in between. Out of the 30 responses participants indicated to follow up with (3 per participant), 21 were Google results, 3 were Yahoo, and 1 was Bing and 5 results overlapped between Google and Yahoo. Four participants commented specifically, that the Bing results were distracting rather than helpful.

Given these findings from the user group, it was decided to continue using the Google results, but to drop the results from Yahoo and Bing, in line with the aim of the project as a whole, that is, to improve returned search results for users with Autism.

6.2 Core Feature 2: Building a User Model of Autism.

To identify the features of the user model to build, I ran a study to collect example search queries on a set of informational needs from 37 participants. The participants were asked to give examples of search queries they would use to, for example, identify the name of a song they had heard (given the lyrics), or the name of a breed of a dog they had seen (given a picture of the dog). There were in total 10 search queries; the study was distributed widely via Surveymonkey.com [26] and can be seen in the Appendix 10.1. All participants were also asked to complete the Autism Spectrum Quotient 50-item questionnaire see Appendix 10.2. The participants responses are analysed and reported back to surveymonkey.

Participants were divided into two groups; low AQ scorers (scores below 30), and high AQ scorers (scores equal to and above 30). There were 30 low AQ scorers and 7 high AQ scorers.

6.2.1 Differences in Search Queries Between Users With and Without Autistic-like traits.

I conducted a qualitative analysis on the search query strings from both low and high AQ scorers.

To confirm the results from the user testing of Core Feature 1, participants were asked to indicate which search engine they commonly use, and in both groups, Google was the prefered search engine by far, with all participants reporting that they used Google as a first choice. No one in the current sample used Yahoo or Bing.

The low AQ scorer responses were analysed together to establish a baseline answer. This was generated using a frequency criterion of 40% i.e., if 12 out of 30 respondents or more generated the same portion of a query string given an informational need, it was included in the model below. If two responses were equally as common, both are reported in the model. Data was discarded when a response indicated that the participant would do an image search, as this was not the aim of the survey. The results from the frequency analysis are presented below.

1. You hear a song on the radio with the lyrics, 'Look at your children', and you want to download it. What would you type into search on your favourite search engine to find out what song it was?
   Look at your children song.
   Look at your children lyrics.

2. You've lost touch with an old school friend (you went to St. Mary's School). What key words/queries would you use to find them?
   St. Mary's School Year of X.

3. How would you identify what this is using a search engine (pretend you don't know what it is called). What key words/queries would you use?
   Star shaped brown plant.

4. How would you find out the name of this famous person using a search engine? What key words/queries would you use?
   Brown hair famous young women.

5. How would you identify what breed this animal is using a search engine? What key words/queries would you use?
   Small dog fluffy breed.

6. Your friend and you can't agree on how Thandie Newton pronounces her first name. How would you resolve this using a search engine?
   Thandie Newton pronunciation.

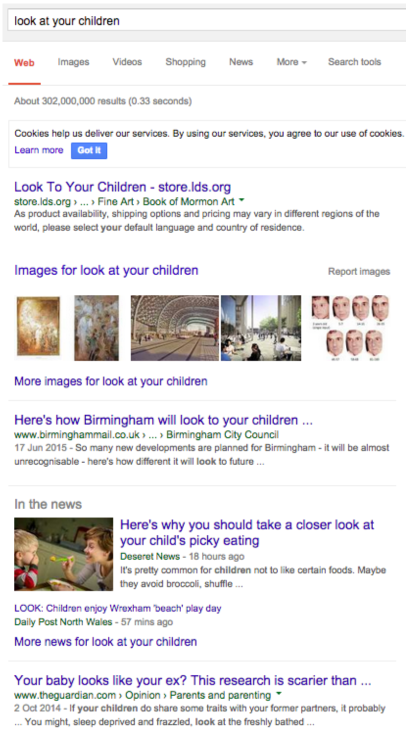
7. What would you search for to identify this pattern's name, and which country it originates from?
   Repeating square maze pattern border.

8. How would you search for delay's relating to your (imminent) flight to Paris?
   Flight number, carrier, Paris, airport, flight time.

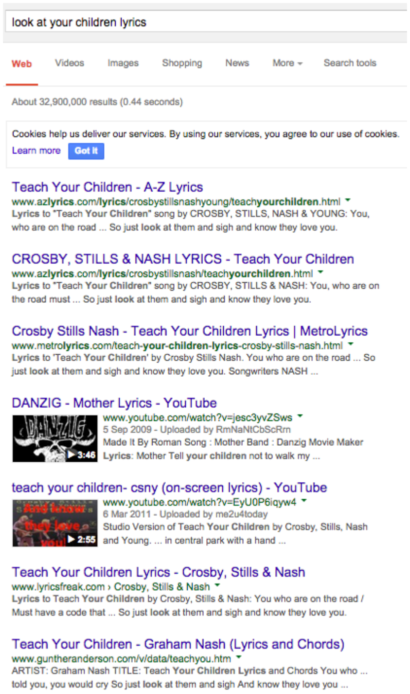
The following observations were made for the users in the high AQ group:

1. There were an increased number of incompletely-formed queries. In the high AQ group, participants were more likely to miss off words in the query string. For example, when analysing the results from query 1 above, 2 out of 7 respondents in

the high AQ group did not put ‘lyrics’ or ‘song’ in the search query when searching for the lyrics “Look at your children”. When these search strings are entered into Google, the results are very different (see Figure 12). A larger number of results are returned to the incomplete query (302,000,000 compared to 32,900,000). In this instance, the high AQ user group were presented with results that have a lower precision, i.e., more irrelevant information that they must sift through to find the answer to their search query.



(a) Incomplete query results.



(b) Complete query results.

Figure 12: High and low AQ scorers both formed search queries accurately, however there was an increased tendency to omit the word “lyrics” in the high AQ group resulting in very different search results.

2. Although many high AQ scorers’ formed query strings well, there was increased use of idiosyncratic words in the query strings that were formulated. This is in line with previous research that suggests that people with autism organise information in more subjective and individual ways [4]. For example, referring to the picture of the dog as ‘yorkie pooh’(not listed in frequency index), ‘aeroplane’ (frequency of 8254 words per million) instead of plane (frequency of 33900 words per million) or flight (29535 words per million) , ‘miniature’ (less than 4973 words per million) instead of small (185463 words per million). The idiosyncratic nature of the words is cap-

tured by their lower frequency of use in the English language. Search engines use term frequency to determine if a document is relevant to the users search query. If the frequency of words used to form search queries differs between low and high AQ scorers, so will the rankings of the returned search results.

3. One individual of the 7 individuals in the high AQ group demonstrated ambiguous use of third-person pronouns, which is characteristic of some individuals with Autism [22]. This includes using first names. This is particularly detrimental to search engine query strings because the use of names disrupts the term frequency - inverse document frequency weighting [27] of the search query and subsequently the results returned to the user.

4. For questions that were 'social' in nature (e.g., featuring a face of a famous woman), 2 out of 7 individuals in the high AQ group indicated that these were types of queries that they would not normally be interested in, and so "wouldn't bother asking it". For these queries, it was more common for individuals in the high AQ group to include information in their search query string that was extraneous to the search question itself, compared to the low AQ group. For example, in query 4 above (which asked respondents to indicate how they would identify a famous person), 2 high AQ scorers included information about the woman's earring. Inevitably this 'dilutes' the search query and results in reduced precision for the search engine.

6.3 Core Features 3 and 4: Jellibeans – Transforming the User Query.

Given the set of observations in the data reported above, the aims were to 'transform' queries made by individuals in the high AQ group to queries more similar to the low AQ group. The search engines already handle some of the observations from high AQ scorer queries. For example, the use of pronouns ('I' and 'You') is already taken care of with the use of stop words. The aim of the project is to therefore address issues that result in the search query string being misleading, and returning differnt results to low AQ scorer search queries. The rule engine is a concrete and operationalised framework, for a theoretically-grounded stereotyped user model of autism within search.

Jellibeans works to address multiple observations made during the data collection stage, so the order in which the observations are tackled in the user model is not linear. As a general rule, changes will take the form of 'add on' questions that aim to structure the individuals search query logically, so that key search terms are not dropped. A structured query formation will assist the user with less idiosyncratic search queries.

Building upon the reserach discussed in the introduction [10], that search can be compartmentatlised into three broad categories (Do's, Know's and Go's), and, to address the observation of idiosyncrasy (point 2 above in the current research), Jellibeans will prompt the user to categorise their search query into one of 3 possible types of queries, a 'Do', 'Know' or, 'Go'. 'Do' queries are when they want to do something on the web like, buy a cinema ticket. 'Know' queries for when they want to know something from the web like, what time the cinema closes. And, 'Go' queries when they want to go somewhere specific on the web like the cinema homepage. Jellibeans will integrate a fourth subtype of query – the 'Social' query, especially for the user group in question. 'Social' queries are for when their search is about something social; a person, or group of people. Social queries have additional functionality beyond the Do, Know and Go query pages, to reflect the additional difficulties individuals with Autism have when formulating Social search queries on the web.

Each type of query will be associated with a different colour, and once the user has selected that type of query, this colour will be prominent on the page throughout their search, to serve as a visual reminder of the task. This works to reduce the **working memory load** for the user, and to serve as a **goal-directed cue**. Two things we know are difficult for people with Autism are maintenance of information in working memory, and goal-directed tasks involving a high demand on Executive Functioning (Executive functions (also known as cognitive control and supervisory attentional system) is an umbrella term for the management (regulation, control) of cognitive processes, including working memory, reasoning, task flexibility, and problem solving as well as planning and execution [8].)

The Jellibeans 'Social' query applies particularly to the user group in question, and has hints and suggestions added into search to assist the user when forming their query. The cues take the form of suggestions, that the user may select if helpful for their search, and to improve search results that are returned from Jellibeans.

To address observation 1, that user queries were often submitted when incomplete, suggestions as well as drop down menus have been implemented on each search page. Users can click on suggestions, and select from the menus if they want the keyword to be added to their search. Individuals with Autism have an uneven cognitive profile, where verbal ability is usually lower than performance skill [6], the cues will assist users who have particular word-finding difficulties.

Once the user has pressed 'Jellibean Search', and requested their search results be returned, Jellibeans collates all information the user has entered into the search boxes, as well as any suggestions, and options from drop down menu's that were selected to be included in the search. To achieve a good precision and specificity, Jellibeans implemented 'AND' boolean operators between each input of the parametric search. This resulted in increased precision and a drop in recall for Jellibeans. The results are then presented to the user, with the exact phrase that was searched for. This means that the user can clearly see their final search query, and rather than a 'black-box' system, Jellibeans also works to train the user for the long-term about specific ways to improve their personal search query strings.

Because the current research identified that user's with Autism formed search queries were particularly incomplete for socially-grounded informational needs, extra functionality has been added to the 'Social' query page. For example, if the user has indicated that they are searching for a famous person, they will be prompted for descriptions about that famous person's personality, character age bracket, and physical descriptions amongst other attributes. These features work to ensure that for this type of query, where users with Autism have most difficulty, that user search queries are more complete than they otherwise would have been (see Figure 13).

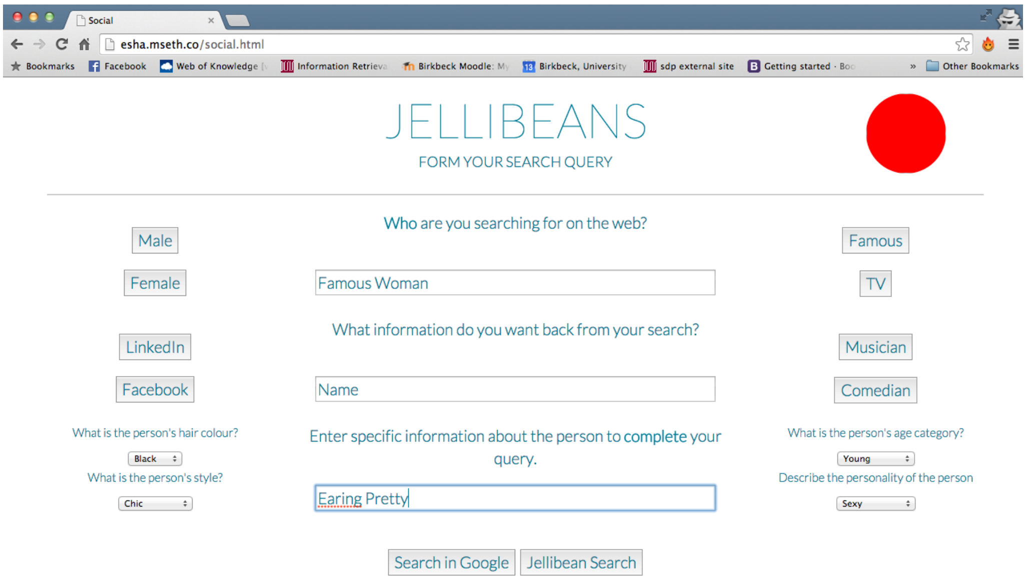
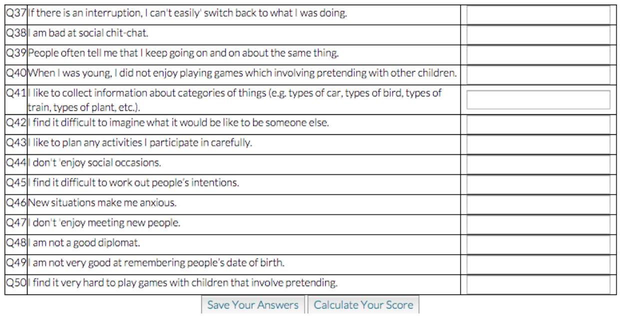


Figure 13: Example of User's Social Search in Jellibeans.

The Autism Quotient score and all 50 of the responses from the user will be stored locally to an Excel file, if the user chooses, by selecting the 'Save Your Answers' button on the Jellibean Homepage (see Figure 16).



Q37	If there is an interruption, I can't easily' switch back to what I was doing.	
Q38	I am bad at social chit-chat.	
Q39	People often tell me that I keep going on and on about the same thing.	
Q40	When I was young, I did not enjoy playing games which involving pretending with other children.	
Q41	I like to collect information about categories of things (e.g. types of car, types of bird, types of train, types of plant, etc.).	
Q42	I find it difficult to imagine what it would be like to be someone else.	
Q43	I like to plan any activities I participate in carefully.	
Q44	I don't 'enjoy social occasions.	
Q45	I find it difficult to work out people's intentions.	
Q46	New situations make me anxious.	
Q47	I don't 'enjoy meeting new people.	
Q48	I am not a good diplomat.	
Q49	I am not very good at remembering people's date of birth.	
Q50	I find it very hard to play games with children that involve pretending.	

Save Your Answers | Calculate Your Score

Figure 14: Example of User's Social Search in Jellibeans.

The user can also choose 'Calculate Your Score' which returns the score as an alert to the page

To further address Core Feature 3 of Jellibeans, that is, that results should be returned to the user in smaller snippets rather than large sets of text, I modified the Jellibeans Custom Search Engine to select the 3 highest ranked (precision) results, and to present these back to the user on the first page of their search. The 3 top results are presented on a floating modal[2], so that the user has the option to close and reopen the results very easily, without having to redo the search itself (see Figure 4).

6.4 Core Feature 5: Integration with a Motion Controlled Interface.

The selection process for which hardware to integrate with Jellibeans considered the timing of the device, the 'volume', the applicability to real-world environments and the affordability for users.

Jellibeans is integrated with the LEAP Motion Controller Hardware (see Figure 15). The LEAP has good timing because it polls frames at a constant rate to keep to timining of accurate movement, which is important for user experience. It is very easy to use, and only requires a short calibration period, and is very non-invasive and has a low sensory experience (sensory experiences are not tolerated well by individuals with Autism). The cognitive demand that is required to operate the LEAP is low, and given the web search task is a highly cognitive task, this is a real benefit for the user.

[2]A modal is a feature in the Bootstrap Framework, see Section **??**

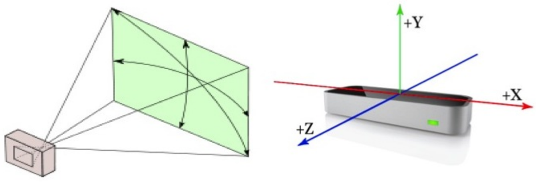
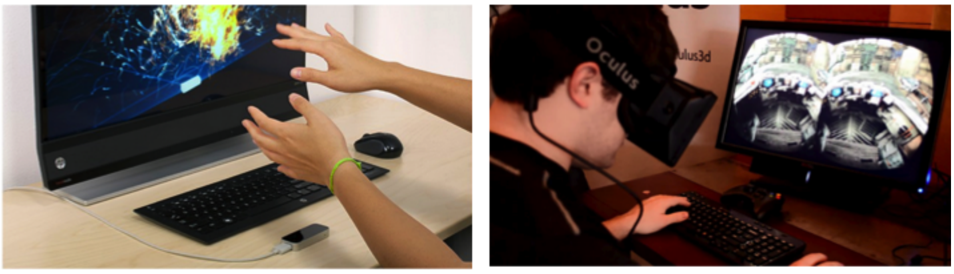


Figure 15: The LEAP controller, with 150 degree view [12].

The LEAP will recognize and track hands, fingers, finger-like tools, positions, motions and gestures using infrared light and optical sensors along the cartesian coordinate system. The controller has a 150-degree field of view, and operates in a range of 1 inch to 2 feet.

Each of our senses operates with a different lag time. Hearing has the fastest sense-to-cognition/understanding, and surprisingly, sight – the slowest. If the device interferes with the processing of the sense, it will confuse the combinatorial configuration of the senses, leading to misunderstandings in the meaning and a worse user experience. The LEAP does not have the best cognitive lag time compared to other devices such as the Oculus VR Rift, but it is a completely non-invasive device in comparison (see Figure **??**), so was considered a better option for the current user group.



LEAP reference: http://edition.cnn.com/2013/07/22/tech/gaming-gadgets/leap-motion-controller-review/

Oculus VR Rift reference: https://www.maxxor.com/blog/past-future-oculus-rift/

Figure 16: Comparison of the invasivness of the Oculus VR Rift and LEAP motion controller.

I also took into consideration the way in which the device manifests actions into behaviours. That is, how does the user engage behaviourally within the environment using the device? The LEAP was considered very realistic in terms of the behaviours the user uses when operating the device, and how these transtition into real-world environments.

6.4.1 Using LEAP in the IDE.

The code that tracked frames from the LEAP used the `Frames` class, to track detected motion. I created frames by calling `Controller.frame()`. The following code was used to implement a forward poking pointing motion to control mouse clicks. I ran the code to check how well it worked in Eclipse IDE (see https://youtu.be/ikfiul_JPBk for a video of the LEAP working in my IDE).

```
Controller JellibeanController = new Controller();
Frame jellibeanFrame = JellibeanController.frame();

Robot jellibeanRobot = new Robot();

if(jellibeanFrame.fingers.get(arg0).tipVelocity.get(2)>75)//if finger moves forward past a threshold velocity {

        jellibeanRobot(InputEvent.BUTTON1_DOWN_MASK);
        Thread.sleep(200);
        jellibeanRobot(InputEvent.BUTTON1_DOWN_MASK);

        }
```

Figure 17: Pointing and Poke Motion Used to Control Mouse Clicks.

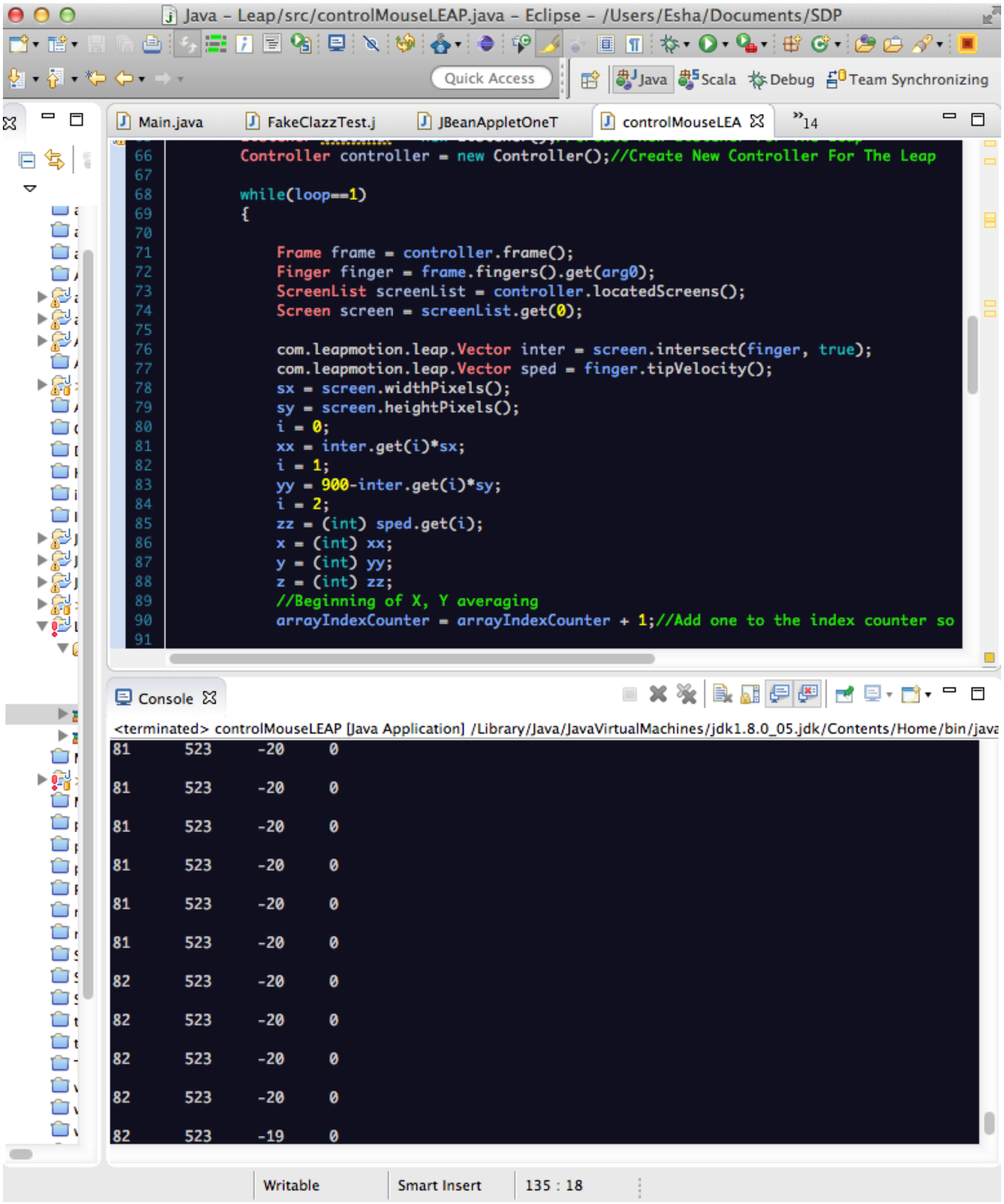


Figure 18: Code to Display Polling of Frame Data from the LEAP.

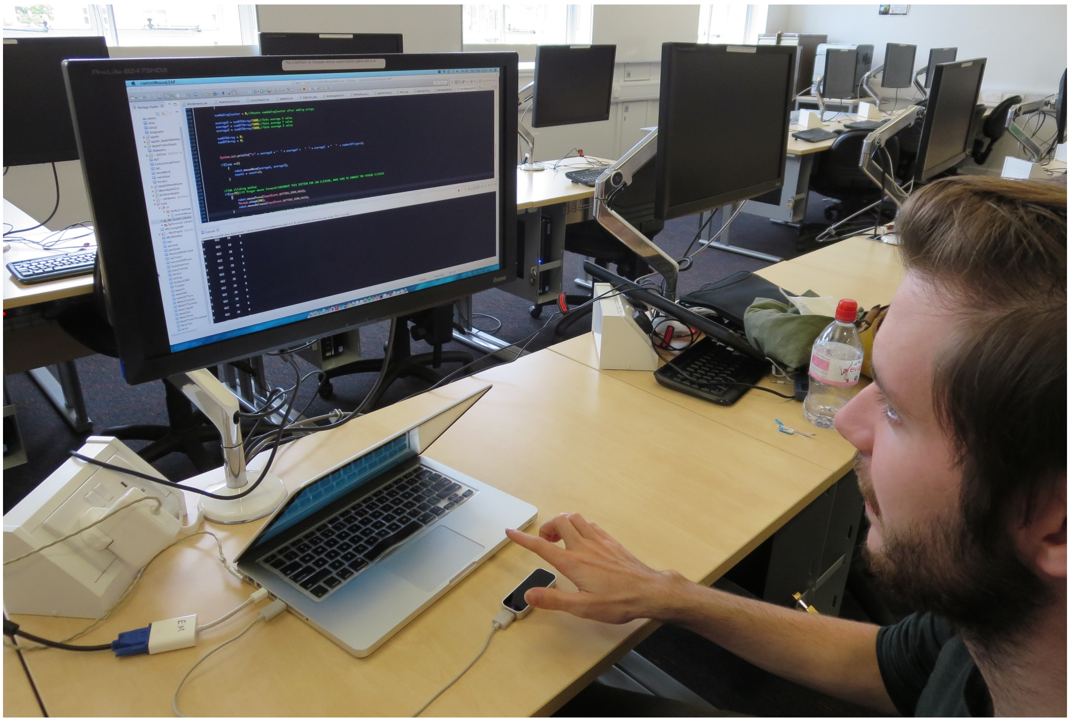


Figure 19: Using the LEAP to Control the Cursor in the IDE.

6.4.2 Using LeapStrap in the Web-browser.

To use the LEAP in a web-browser I used LeapStrap [13], which is built on top of Bootrap and was easy to integrate into the project.

```
In the head section of the HTML page:
<!-- Include Leapstrap CSS -->
        <link rel="stylesheet" href="//wilkesalex.github.io/leapstrap/dist/css/leapstrap.css" />
<!-- Include jQuery -->
        <script src="//ajax.googleapis.com/ajax/libs/jquery/1.10.2/jquery.min.js" ></script>
<!-- Include Leap -->
        <script src="//js.leapmotion.com/0.3.0-beta3/leap.js"></script>
<!-- Include Leapstrap JS -->
        <script src="//wilkesalex.github.io/leapstrap/dist/js/leapstrap.js"></script>

Before the closing </body> tag:
<!-- Init Leap, Set all "a" interactive, use 1 Leap cursor/finger -->
        <script>LeapManager.init({interactiveSelector:"a",maxCursors:1});</script>

And, every element must be assigned to the class "leap-interactive":
        <a class="leap-interactive" href="#">Click me with Leap!</a>
```

Figure 20: LeapStrap Code Used to Implement the LEAP Motion Controller in the Browser.

Once the LEAP was enabled for Jellibeans I was able to test the application with users to gather feedback.

6.4.3 Using the LEAP with Jellibeans.

Figure 21: User Forming A Jellibean Search Query with LEAP Using Both Hands.

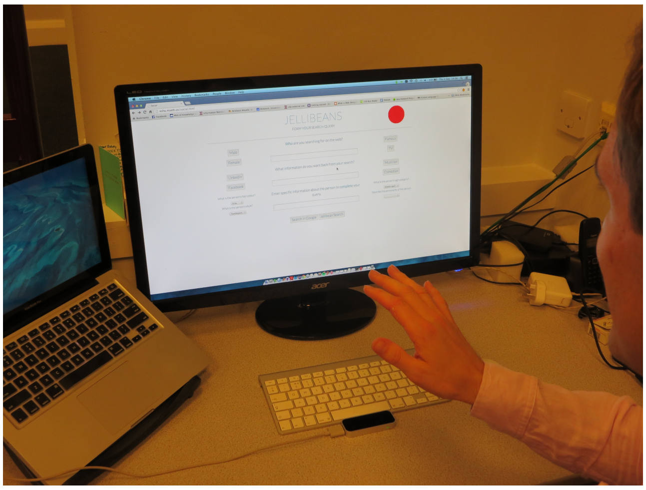


Figure 22: User Forming A Jellibean Search Query with LEAP Using One Hand.

6.4.4 Evaluation of the LEAP Motion Controller in Jellibeans.

The LEAP motion controller is an impressive device that uses infra-red light to embed the users (phantom) hands onto the screen. It is a novel, portable and 'at home' technology, and because of the portable nature of the device, it is one that has been introduced to laptops. The LEAP offers a recalibration process if the controller is persistently jumpy, which is good because jumpy movements and mannerisms could be an issue for some of the users in the current user group. The device will recalibrate if there are discontinuities or aberrations in the tracking data in certain field of view, or in poor tracking ranges.

The LEAP does however miss small hand movements, and also very large ones (outside of the 150 degree angle along the y axis (see Figure 15)). The LEAP also neglects to track the bottom left and right-most corners of the screen. I have tried to take this into consideration when designing Jellibeans, so that the user does not need to reach to the corners of the screen.

7 Software Testing

I used Behaviour Driven Development (BDD) to test the integration of my HTML, CSS and JavaScript code. The testing process consisted of development, test, make modifications, test (and so on) until the behaviour of the website was what I intended.

The JavaScript Console was used for testing JavaScript code. [16], I also used JSfiddle [17] to ensure the code contained no bugs, and was particularly good for seeing how the JavaScript code integrated with the HTML code and CSS.

JUnit was used to test the Combination Search Engine and the LEAP motion controller methods, which were written using Java. Unit testing was completed, at the method level.

8 User Verification and User Testing

Five high AQ scorers were called back from the previous research study for one-to-one interviews and a combined focus group. During the interview, individuals were given the same user search queries as previously, and for each search that was implemented, users were asked to comment on whether it enhanced, or took away from their search experience, and from their satisfaction with the search results. Users were asked to comment on:

1. Whether the colour coding for each category of search was helpful.
2. Whether they liked the parametric search style of Jellibeans

3. Whether they felt Jellibeans ‘narrowed’ the scope for irrelevant detail.
4. If they would choose Jellibeans over other search engines, for example, Google, and why.
5. The speed and efficiency of search with Jellibeans
6. Their thought on search results.
7. The integration of Jellibeans with the LEAP motion controller.

8.1 The Positives

All 5 users verified that the ‘Dashboard’ colour coding was helpful (see Figure 24), and liked that the colour of the chosen type of search remained on screen for its duration.

Figure 23: Colour coding on Jellibean dashboard.

The modals (floating window reminders) for each of the colour themes were useful for all new users, as they were originally unfamiliar with the colours. The associations for all user groups, including users with Autism, were quick to learn, these were single link visual (rather than verbal) associations.

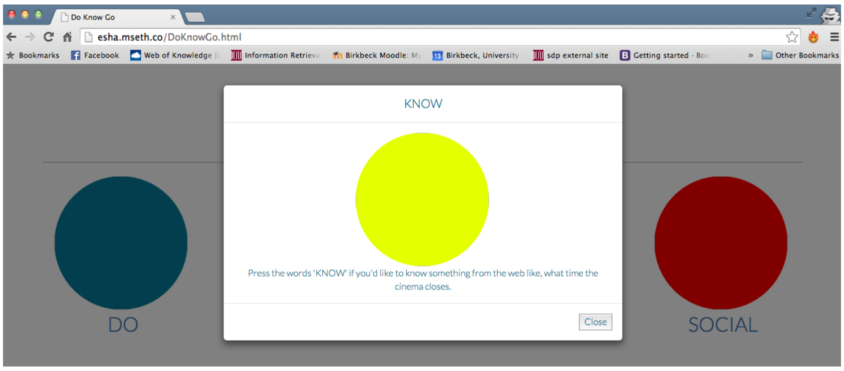


Figure 24: Modals Assist New Users To Lean the Colour Associations.

Four out of 5 participants agreed that one of the major positives of Jellibeans was that unlike Google, users did not receive back hundreds and thousands of mostly irrelevant results. Jellibeans held their interest for longer because of the reduced number of results that users had to sift through. Testing also revealed that the parametric search style meant that they did not need to try and remember all the key words to search for, rather the cues helped them remember points they would have missed otherwise.

A common comment (3 out of 5 users) was the time/reward payoff from completing a detailed search form. Users agreed that although they would spend more time formulating their search query, they were likely to save time that would usually be spent sifting through search results. These participants indicated that they would use Jellibeans over other search engines if continued use on other queries also showed such benefit.

All users positively commented on the reduced number of search results presented (top 3). The amount of textual information that was presented back on the results page is significantly reduced in Jellibeans.

During the focus group one user with high functioning Autism described that the direct questions (e.g., 'What do you want to do on the web?'), with suggestions ('Shop', 'Watch', 'Listen'), was useful when he was "at a total blank". He disclosed that often his need for perfectionism and sameness could have him staring at a blank screen until he came up with the 'perfect' query. However, the suggestions were helpful for him to get started, and so his experience was that the queries were completed faster than usual.

8.2 The Negatives

Two users however, had considerations about the 'missing' results from their search and commented that for them, 3 results were too few and perhaps 5 or 6 results would have been a better choice. It must be said that these individuals were amongst the lowest AQ scorers, suggesting that the amount of text individuals with Autism find optimal is a function of the severity of Autism traits in that individual.

One participant commented that the suggestions that appear on the sides of the 'Do', 'Know', 'Go' and 'Social' pages were not user-specific (see Figure 25). He suggested implementing something that is user-centred, user-driven, or, trending, rather than static.

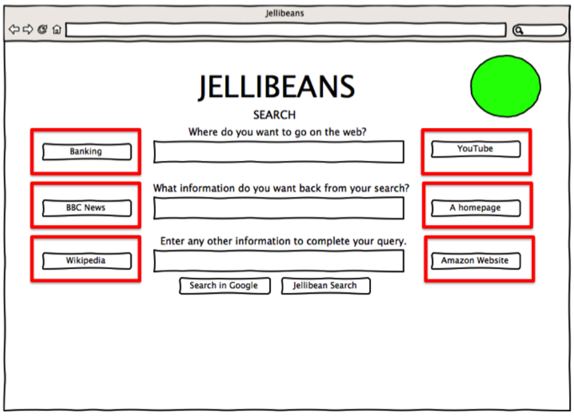


Figure 25: Suggestions on Jellibeans 'Go' page for users to help with search query formulation (suggestions are highlighted in red).

However, one of the characteristics of Autism is restricted and repetitive behaviours, and an aims of the current project was to reduce the restricted and repetitive nature of search queries for people with Autism. In other words, this comment was suggesting that Jellibeans was achieving the aim it had set out to do.

Nevertheless, one future direction for Jellibeans in order to achieve a balance between user-specific suggestions but not restricted interests, is to include a recommendation system that changes often enough for them not to be repetitive, but still within a range of possible interests for that individual.

8.3 The Neutrals

Users agreed during the focus group that with Jellibeans the time/reward payoff is really only apparent, over and beyond a traditional search engine, when the search query is complex. For example, if users are searching for something they have yet to identify, i.e., something ambiguous. To overcome this criticism, Jellibeans includes a 'Search in Google' option, so that if users know what they are searching for, they have the option to run the search outside Jellibeans.

9 Evaluation and Discussion.

The final section summarises the project as a whole A critical evaluation by the student, emphasising strong points and weak points lessons learnt design decisions which, looking back, would be made differently ways in which the project could be improved or extended etc. recommendations for the project You can also describe possible future work in the area of your project
Robots Apache Lucene Sandboxes JavaScript html can't access third party pages Yahoo and Bing was easier and faster to do html scraping
How does it compare to the original specification This work has successfully completed aims XXX
The final section summarises the project as a whole
A critical evaluation by the student, emphasising
strong points and weak points
lessons learnt
design decisions which, looking back, would be made differently
ways in which the project could be improved or extended etc.
recommendations for the project
You can also describe possible future work in the area of your project

9.1 Signals of Quality Content

I will test and evaluate the system. Testing will involve assessing the reliability and robustness of Jellibeans; the ease of its interaction; boundary conditions; ease of use; does it fulfil the aims of the project. Evaluation of the system will include comparisons to existing search engines; assessing how this idea can be implemented to tailor an existing systems; assessing how well the system does compared to existing systems on a set of criteria that are only relevant to the user group in question (a collective measure of user happiness). Evaluation will also include quantitative metrics such as Recall, Precision, and False Negative/Positive rates.
Apache Solr

9.2 Future Directions

A future direction for Jellibeans would be to use an API or library for word frequencies in the written English language, which could be integrated with a thesaurus. This type of API requires significant research into the natural language processing of written (rather than spoken) English text. These frequency data could have been used to replace infrequent words in queries formed by individuals with Autism with more frequent words to suggest alternatives for the user. Of course this product would not be scalable, and only apply to users with a particular dialect. This is because word frequency is considerably variable across, and even within a language (e.g., consider South-West England compared to the North of England).

Another future direction for Jellibeans would be to implement current trending searches, which could be a contributing factor in the future for why users choose other search engines over Jellibeans.

Individuals with Autism have increased comorbidity with Attention Hyperactivity Disorder (ADHD), and Colour Blindness, and so these can be taken into account for future iterations of Jellibeans. For example, the colours used for Jellibeans are in the RGB colour scheme, but these could be replaced with gradients or patterns so that individuals with colour blindness can also also benefit.

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10 Appendices

10.1 Search Query Survey

Search Behaviours

Welcome to My Survey

We are trying to understand more about how people with autism, or autistic tendencies, and people without autism search the web.

For the search queries below please indicate what search terms you would use to search the web.
There are no right or wrong answers.
Some of the searches do not have an answer but please tell us how you would go about trying to search for the answer.
If you would do many iterations of search, please indicate that below. Start with the one you are most likely to try.
Please indicate as much as you can about your search process as possible. Use as much space as you need.

There are 10 questions here and this should take approximately 20 minutes or less.
The second part asks you to complete an online questionnaire and report back the score on this sheet.

If you have any questions you can contact e.massand@bbk.ac.uk.

Next

Search Behaviours

An Example Question

EXAMPLE QUESTION:
You saw a man reading the paper today (you don't know which paper it was), and the headline was vaguely about a new discovery about the solar system. What would you type into search on your favourite search engine to find out about the story?

EXAMPLE ANSWER:
I could start by searching, 'solar system and discovery and news and today'.
If that doesn't work I could search, 'todays paper and solar system', or if I don't find my answer there I could search 'news' and manually /visually sift the page for relevant info.

Prev Next

Search Behaviours

1.

What browser do you usually use? (Google Chrome, Internet Explorer, Safari, Firefox ...)

and

What search engine do you usually use? (Google, Bing, Yahoo ...)

Prev Next

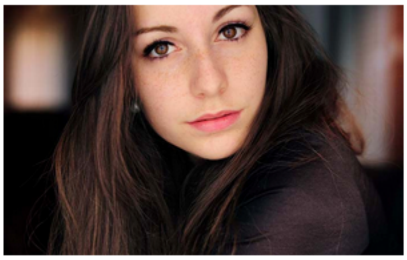
Search Behaviours

2. You hear a song on the radio with the lyrics, "Look at your children", and you want to download it. What would you type into search on your favourite search engine to find out what song it was?

3. You've lost touch with an old school friend (you went to St. Mary's School). What key words/queries would you use to find them?

4. 

How would you identify what this is using a search engine (pretend you don't know what it is called). What key words/queries would you use?

5. 

How would you find out the name of this famous person using a search engine? What key words/queries would you use?

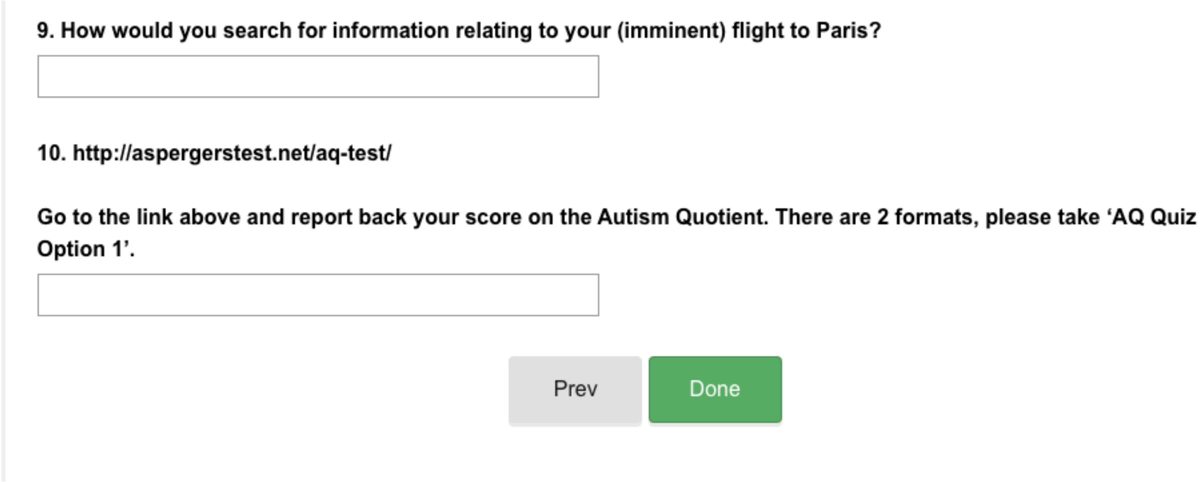
6. Two repeats shown

What would you search for to identify this pattern's name, and which country it originates from?

7. 

How would you identify what breed this dog is using a search engine? What key words/queries would you use

8. Your friend and you can't agree on how Thandie Newton pronounces her first name. How would you resolve this using a search engine?



9. How would you search for information relating to your (imminent) flight to Paris?

10. http://aspergerstest.net/aq-test/

Go to the link above and report back your score on the Autism Quotient. There are 2 formats, please take 'AQ Quiz Option 1'.

Prev Done

Figure 26: Search Query Survey on Surveymonkey.com [26]

10.2 Questions on the Autism Spectrum Quotient [1]

Participants are asked to read each statement very carefully and rate how strongly they agree or disagree with the statement (Strongly Disagree, Slightly Disagree, Slightly Agree, or, Strongly Agree).

I prefer to do things with others rather than on my own.
I prefer to do things the same way over and over again.
If I try to imagine something, I find it very easy to create a picture in my mind.
I frequently get so strongly absorbed in one thing that I lose sight of other things.
I often notice small sounds when others do not.
I usually notice car number plates or similar strings of information.
Other people frequently tell me that what Ive said is impolite, even though I think it is polite.
When I'm reading a story, I can easily imagine what the characters might look like.
I am fascinated by dates.
In a social group, I can easily keep track of several different peoples conversations.
I find social situations easy.
I tend to notice details that others do not.
I would rather go to a library than a party.
I find making up stories easy.
I find myself drawn more strongly to people than to things.
I tend to have very strong interests which I get upset about if I can't pursue.
I enjoy social chit-chat.
When I talk, it isn't always easy for others to get a word in edgeways.
I am fascinated by numbers.
When I'm reading a story, I find it difficult to work out the characters' intentions.
I don't particularly enjoy reading fiction.
I find it hard to make new friends.
I notice patterns in things all the time.
I would rather go to the theatre than a museum.
It does not upset me if my daily routine is disturbed.
I frequently find that I don't know how to keep a conversation going.
I find it easy to read between the lines when someone is talking to me.
I usually concentrate more on the whole picture, rather than the small details.
I am not very good at remembering phone numbers.
I dont usually notice small changes in a situation, or a persons appearance.
I know how to tell if someone listening to me is getting bored.
I find it easy to do more than one thing at once.
When I talk on the phone, I'm not sure when it's my turn to speak.
I enjoy doing things spontaneously.
I am often the last to understand the point of a joke.
I find it easy to work out what someone is thinking or feeling just by looking at their

face.
If there is an interruption, I can switch back to what I was doing very quickly.
I am good at social chit-chat.
People often tell me that I keep going on and on about the same thing.
When I was young, I used to enjoy playing games involving pretending with other children.
I like to collect information about categories of things (e.g. types of car, types of bird, types of train, types of plant, etc.).
I find it difficult to imagine what it would be like to be someone else.
I like to plan any activities I participate in carefully.
I enjoy social occasions.
I find it difficult to work out people's intentions.
New situations make me anxious.
I enjoy meeting new people.
I am a good diplomat.
I am not very good at remembering people's date of birth.
I find it very easy to play games with children that involve pretending.