



Utilising Geospatial Data to produce Dynamic Visualisations within a Web Application

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A Thesis submitted to the Faculty of Arts of Ulster University in partial fulfilment of the Bachelor of Science in Creative Technologies.

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i. ABSTRACT

This dissertation explores the upcoming innovative revolution that data visualisations and geographically spatial infographics are having within the digital era. A data-vis web application has been designed to explore & test my hypothesis suggesting 68.08% of users gained positive appeal & a stronger understanding of political, environmental & commercial data due to the interactivity & simplified visual design & structure that my project presents to web users.

The following dissertation showcases:

- Inspiration for Final Project's concept & theme of open data utilisation & its visualisation.
- Detailed step-by-step production of my project's initiation, design & coding development.
- Theoretical research & analysis utilised before, during & after my web application's production.
- User analytics of feedback to aid in the prediction of the innovative potential for visualising data.
- Summarisation of pros & cons within project to aid its future development & revolutionary aspect.

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1. INTRODUCTION

1.a. Project Description

My final project for BSc Creative Technologies involves the production of a web application that utilises geospatial data (.geojson, .kml, .csv) to produce dynamic, live visualisations. I've entitled my project 'GeoVida' derived from; **Geographical Visualiser for data**.

This will be developed within a website to provide the application a platform that is suited for user-engagement while supplying the right functionality capabilities for additional features to showcase the true potential of my application and it's desired uses for data transparency.

1.b. Project Specifications

My project will test my knowledge of web design & creative coding to a more advanced level than I have previously achieved, while utilising the skills & experiences I have previously gained from my course within discrete; Creative Coding, Web Design and Advanced Web Development modules. The project allows me to bring together the range of skills developed through these modules and apply them within one workflow hence illustrating the interdisciplinary nature of my learning.

My application itself will be coded to produce choropleth-based maps through the use of geojson.io alongside Open-source interactive, mapping software; MapBox which originated from OpenStreetMap. Dynamic features within the application's webpages will be coded via. PHP. My website U.I base design will be produced via. web-page designs created on Adobe Photoshop CS6 (.PSD) and converting them into PHP for which I will code within. HTML, CSS & JQuery are essential programming languages that provide my web structure, styling & dynamic functionality respectively. MySQL is also utilised to gain the use of User accounts, Register/Log-in sessions & tables to store data-maps produced with affiliated data e.g. title.

1.c. Research Question & Aim

My Research Statement from my proposal onwards is to provide:

"an investigation into the visual presentation of Open Data within a web browser".

The impetus for wanting to explore Open Data & Big Data was due to insights I had gained within my modules; "Issues in Contemporary Media" & "Creative Business" that showcased the rising importance of Data-sets & statistics in our society specifically for governments & businesses to aid in transparency of funds/goods while potentially highlighting a business model's pros & cons to aid in its sales & workflow.

2. PROJECT IMPLEMENTATION

2.a. Initial Proposal

I initially wrote my expectations for my final project as a business plan intended for the Innovation & Creative Enterprise modules. However, I re-drafted 'GeoVida' into a proposal for use within CRE506 & CRE507 focusing more on the project itself and it's theory & context as opposed to following the business aspect of the project. I do intend to look at developing my project into a business model after completion of my final project & thesis.

Within Creative Coding 1, I produced a Data visualisation application [Fig. 1] within Processing (JS) that incorporated the use of a live .csv file to display the current progress of participation & entry announcement of each country within Eurovision 2013: <http://www.openprocessing.org/sketch/84979>.

This was another one of initial inspirations for wishing to pursue open data visualisation, which I wanted to produce for use within a browser rather than an executable program due to accessibility & potential use of Google Analytics for statistics essential to understanding the user growth & decline alongside determining if GeoVida's U.I. works.

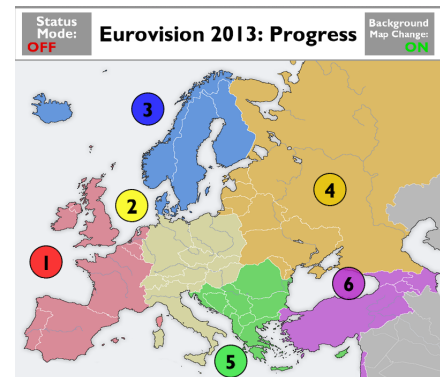


Fig. 1: CC1 Final Application: Ex. of live Geo-spatial data visualisation.

2.b. Project Set-up

Basecamp [<https://basecamp.com/2164932/>] was an essential project communication tool to plan my weekly objectives, upload content & gain feedback from lecturers regarding my project. I converted my GANTT chart [Fig. 2] from my proposal into a to-do list [Fig. 3] featured within Basecamp due to its email notification setting and ease of updating if needed.

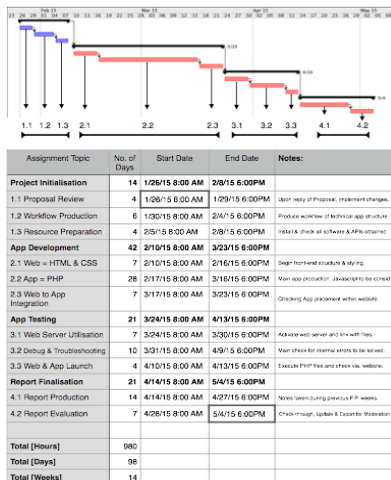


Fig. 2: Initial GANTT chart for project tasks per week.

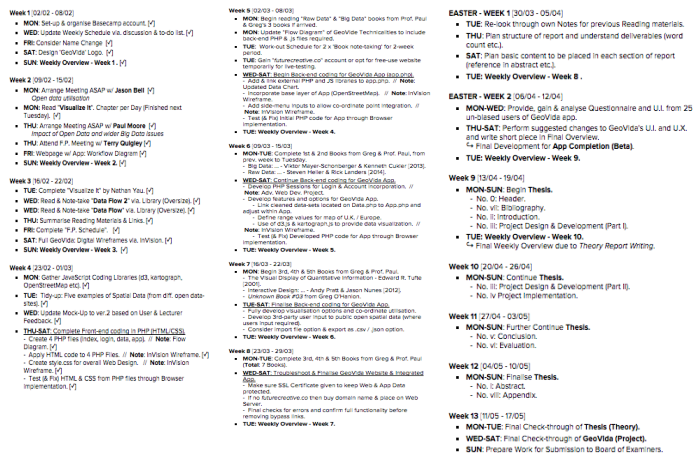


Fig. 3: Updated To-Do List featured date of completion.

2.c. Website Design

i. Logo Design

Regarding my logo's design I wanted to portray an iconographic use of colour & typography in order to gain each users' attention to my website while representing the overall goal & theme of my project to produce professional, geo-spatial data visualisation. In my initial logo design [Fig. 4] I wanted to 'visualise' earth and sea through the use of Dartmouth green [#00703C] alongside a deep, sea blue respectively.



Fig. 4: Initial Logo Design for 'GeoVida' UI.

The contrast between these two colours however divided my chosen analysts within my design feedback provided. Therefore, I removed the use of blue and finalised the logo as Fig. 5 showcases below. This more minimalist design delivers the necessary impact while clearly conveying the necessary meaning and conceptual context



Fig. 5: Finalised Logo Design for GeoVida.

Utilising 'Capitals' for the main green, heading text and 'Helvetica Neue' for the remainder while allowing the title to remain connected through the use of a horizontal line of similar stroke size to the heading font colour to transform the typography from text into a logo design.

I decided to showcase the fusion of earth & sea through the user interface by providing a sky blue background for the web-page header navigation to provide the symbolism that I am looking for while not conflicting visually on screen.

ii. Colour Scheme & Typography

Before I finalised my U.I.'s design, I wanted to use the correct colour schema & typography that exploited visual design rules to aid in the comparison & contrast between background colour & text.

Regarding colour, I was shown 'Adobe Color CC' [<https://color.adobe.com/create/color-wheel>] an online, interactive colour-rule selector tool. Due to the arrangement between sky, water & nature that I had originally intended for my U.I.'s background scheme, I realised that the Triad format of 5 colours suited my interface's design very well while providing me with technical support by knowing that the following colours can work to provide visual harmony & difference.



Fig. 6: Chosen colour scheme via. Adobe Color CC.

Utilising two greens, two blues and one red and dynamically

adjusting the colour to blend the blues & greens and contrast the red for user as a header to stand out it's content, **Fig. 6** showcases the colour scheme implemented within v.2.0 of G.U.I. Typography was chosen through online font-pairing site FontPair [<http://fontpair.co/>], after prototyping multiple different font styles together within the alpha version of my user interface within Adobe Photoshop CS6, I decided to utilise the two san-serif fonts 'Nunito' for Headings & 'Open Sans' for body, due to the function that when switched around, can continue to work

Nunito and Open Sans

All of this text is editable. Simply click anywhere in the paragraph or heading text and start typing. You can copy and paste your own content in to see what it looks like with these font combinations.

Fig. 7: GeoVida's Typography Pairing via. FontPair.co.

well together. **Fig. 7** showcases this excerpt pairing from FontPair for which I tested and decided to utilise for my web-page textual content.

I also tested these fonts' eligibility within the browser at 100%, 50% & 25% browser view and found eligibility strongly remained. After gaining these vital elements, I could now begin design on my User Interface for web-pages to aid my app's visual display.

iii. Graphical User Interface

I designed my first version of my U.I. for each web-page through Adobe Photoshop CS6 with the desire to export the .PSD's into HTML to further convert them to PHP files to code over. Issues that arose in the design showcased in **Fig.6**, **Fig.7** & **Fig.8** during feedback via. my showcase to fellow students and lecturers was "too much emphasis on heading text", "colour needed more consideration" & "edit the proportions of webpage content within its layout".

- GeoVida User-flow via. **InVision** v.1.0 - <http://invis.io/V82DN5MWT>



Fig. 8: GeoVida's G.U.I. v.1.0. - data.php.

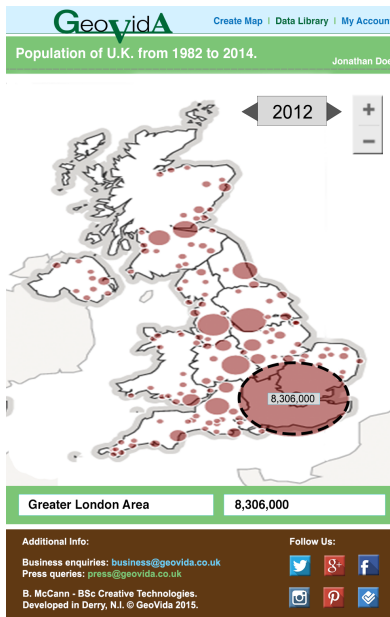


Fig. 9: GeoVida's G.U.I. v.1.0. - view.php.

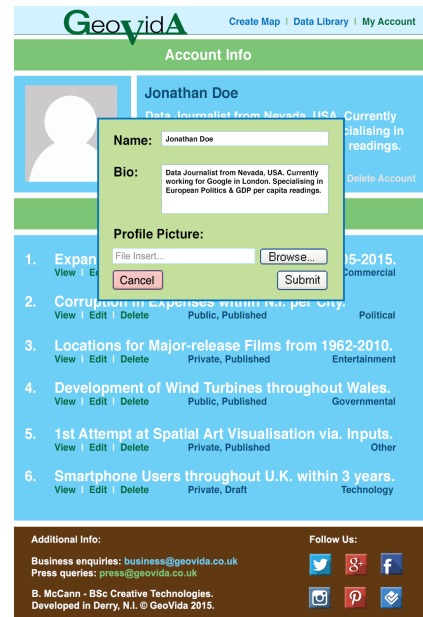


Fig. 10: GeoVida's G.U.I. v.1.0. - account.php.

Once initial feedback had been analysed and taken into account, development of design was able to be produced which can be seen in index.php's versions via **Fig. 11, Fig.12 & Fig.13.**

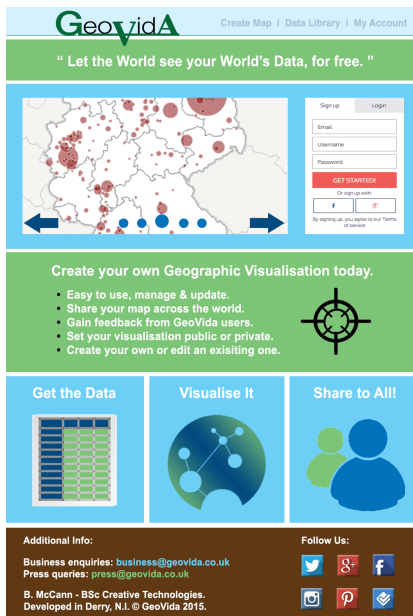


Fig. 11: GeoVida's G.U.I. v.1.0 - index.php.

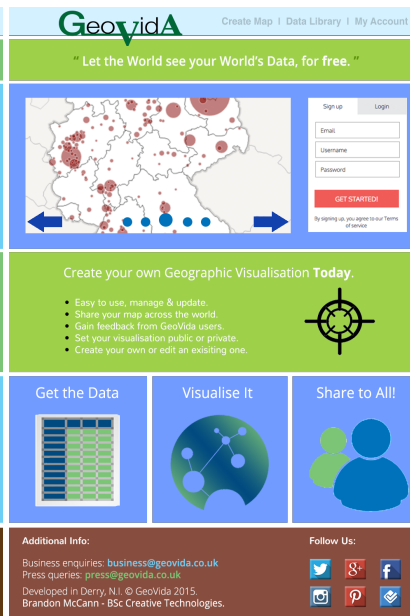


Fig. 12: GeoVida's G.U.I. v.1.5 - index.php.



Fig. 13: GeoVida's G.U.I. v.2.0 - index.php (current).

Changes from v.1.0 to v.1.5:

- Colour scheme introduced.
- Content layout re-adjusted.
- Typography: size, font, colour.
- Updated dynamic data list.

Changes from v.1.5. to v.2.0:

- Addition of a background texture.
- Removal of pixelation from inputs.
- Application: further options added.
- Updated: visualisation & footer icons.

Codecademy's homepage [<http://www.codecademy.com/>] provided inspiration to GeoVida's graphical interface of the register & log-in input forms located within index.php. I placed the image within the GUI to be removed and replaced via. code to avoid copyright or plagiarism.

During design research, I came across the following fine art piece from Ana Magai; landscape artist at Fine Art America: [<http://fineartamerica.com/featured/earth-sea-and-sky-ani-magai.html>].

The piece caught my attention as I saw a similarity to the land & earth connection that GeoVida was originally based on due to it's use of geo-spatial data. Technically, I also saw that in consideration for my triad colour scheme, I noticed the use of blue (with greens in my project) with the strong contrast of the dark maroon. I tested the image as a background texture which was successful in adding depth.



Fig. 14: Ana Magai - Earth, Sea & Sky [2009].

With all the following information gathered and applied. Version 2.0. was developed to export as the base design layer of each browser page. .PSD's were kept in case of future editing.

- GeoVida User-flow via **InVision** v.2.0 - <http://invis.io/Q72DN515X>

The main design alteration was the reinvention of my app.php's web-page design. Inspired by Wordpress's New Post design [<https://wordpress.com/post/>], To ease user interaction to it's simplest form, I divided the application into three main section tabs that can be dynamically opened alongside the header, footer that remain static and the 'upload' options placed inbetween 'app' & 'footer' as **Fig. 15** showcases with closed tabs & **Fig.16** opened.

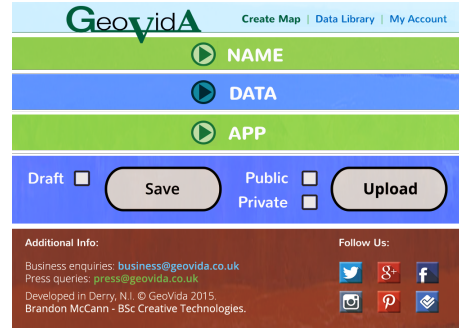


Fig. 15: GeoVida's G.U.I. v.2.0. - app.php (closed tabs).

I intend for the 'Name' tab to allow the user to select their data-set title and tag while 'Data', would be exploring the

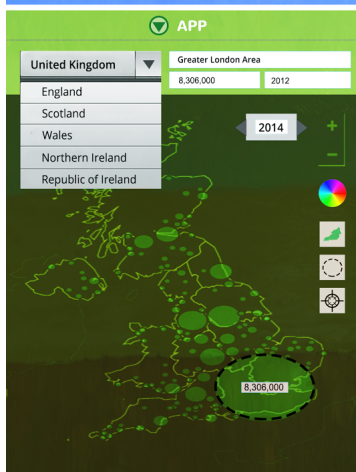
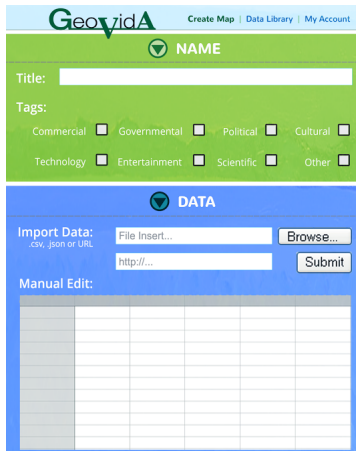


Fig. 16: GeoVida's G.U.I. v.2.0. - app.php.

option to import .geojson data to automatically produce a data visualisation that can also be manually edited to suit the user's design. I will also be looking at google spreadsheets for automatic editing onto the application itself, if this is not possible to code. Other secondary options would be to remove import and to allow the application itself to be the main platform for time-inset data visualisation from scratch with an export & share option instead.

Within the design process, I specified that the application would feature a geographic range selector, three dynamic inputs for location, number specified & year. Within the application itself, I looked at the possibility of allowing the user to select a region of the country, create their own ellipses or great geo-tags for which they can specify a name, number & year. Colour can also be stylised for each draw-input.



Fig. 17: GeoVida's G.U.I. v.2.0. - view.php.

Fig. 17 showcases the outputted result of an example data-set, where the essential details are specified. Five data-sets can appear per page with PHP-coded buttons can send user to the following 6-10 sets in data.php.

2.d. App Development

i. Front-end Coding

Once Web design has been re-evaluated and finalised. I utilised the slice tool within Photoshop CS6 to separate each web-page section that either needed linked (e.g. header navigation) or for dynamic PHP code to be placed on top (e.g. data-set list entries). Even though, this format is considered obsolete to web development, I felt it could be utilised in an efficient manner that would allow my project to gain more time from it's use as opposed to the setbacks that it would create e.g. browser zoom to distort page.

Fig. 18 & Fig. 19 showcase examples of the slice tool which I later would test in Adobe Dreamweaver CS6 followed by a MAMP Server to confirm its use within a browser. All slices are placed into a folder called 'images' and recognised by the original HTML file accompanying the slices. I would then convert the HTML to PHP for better utilisation with MySQL.

In order to provide dynamic function within the web-pages, further front-end coding had to be utilised. Within, index.php this was contributed by the use of jQuery within the visualisation preview and also the register/log-in column input tabs as **Fig. 20** showcases. Through removing the sliced images and replacing it with the code, I was able to feature them easily.

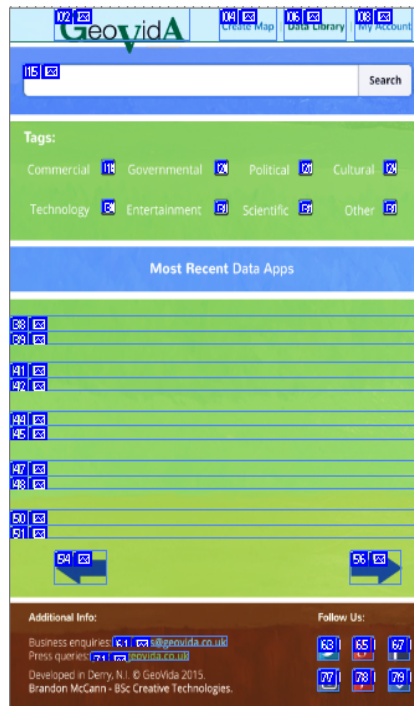


Fig. 18: GeoVida: v.2.0. - data.php (sliced).

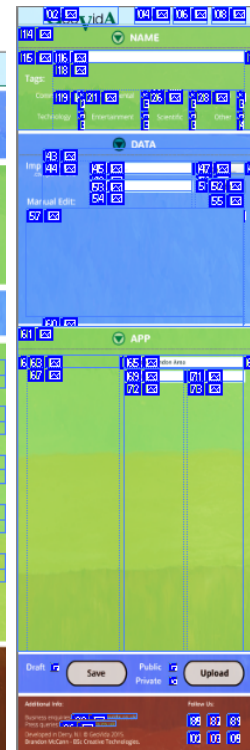


Fig. 19: GeoVida: app.php (sliced).

Image Slider was functionalised through the use of Jssor [www.jssor.com/demos/image-slider.html] which provided an updated version of jQuery's current image slider model. I felt due to options available within this version, it was more suited for my project to provide more 'life' & 'movement' to the project's static output.

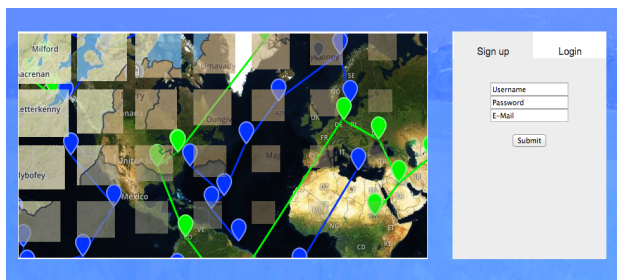


Fig. 20: GeoVida v.2.0. - jQuery ImgSlider & Tabs (index.php).

Collapsible tabs utilised within Register/ Login were embedded via. jQuery U.I. website [<http://jqueryui.com/tabs/#collapsible>]. All JQuery required absolute positioning in order to overlay the base web-page images, this resulted in my tabs being functional as I had intended from my initial inspiration from Codecademy.

Final front-end coding applied was the jQuery's **Accordion** [https://jqueryui.com/accordion/] to app.php. This allowed my application's webpage tabs to be collapsible alongside it's images & coded div's within such as the application itself. Further changes needed to be applied in order to allow the transition speed to be at a reasonable time, but once slight functionality checks were made, work could begin on GeoVida's back-end coding.



Fig. 21: GeoVida v.2.0. - app.php with jQuery Accordion.

ii. Back-end Coding

Once the main front-end coding had been applied, a hosting web server was supplied to myself via. FutureCreative [http://geovida.futurecreative.co/]. As MySQL implementation would be developed into my project, I felt it would be more appropriate to further it's real development within the hosting site itself as opposed to my previously-used MAMP server.

Early in my project's development, I developed a work-flow diagram showcasing GeoVida's U.X. Initial feedback stated that work-flow was easy to manage and any issues that arose, were highlighted & fixed with the updated user-flow diagram below [Fig. 22]:

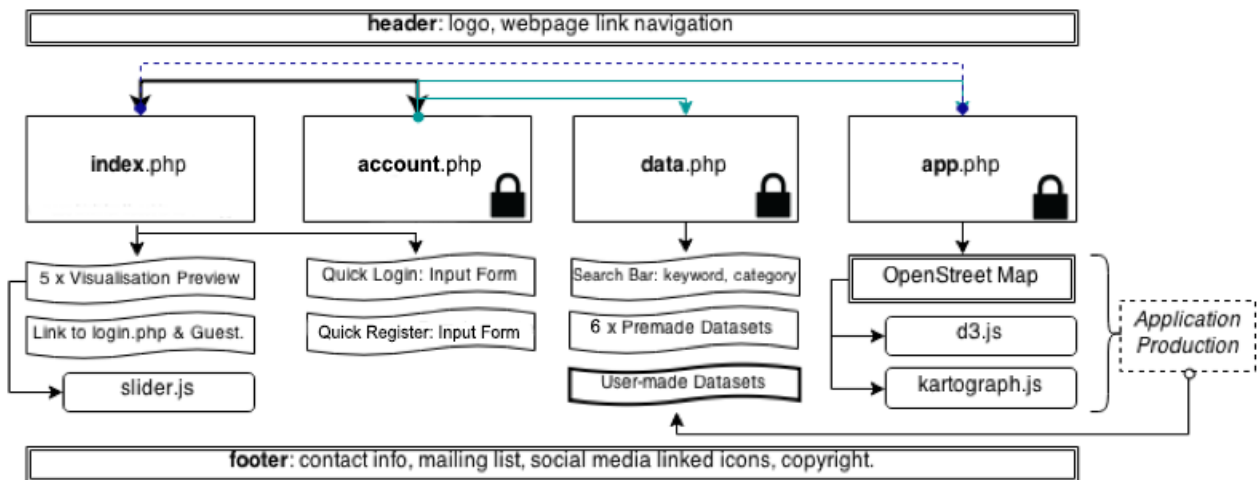


Fig. 22: Updated Work-flow diagram of GeoVida's webpage structure.

Homepage bypass links were firstly added to aid movement onto other pages during development with MySQL. Guest accounts were removed due to complexity to code & integrate to MySQL, however compromise was given by a simpler user-flow for registering & login where a guest account wouldn't be necessary due to ease of U.X within the U.I's flow.

GeoVida features five main PHP-based web-pages; index (homepage), account, data, app & view. Also featured are connect-to-db.php which provides the main initialisation code to connect the web-pages to MySQL without the need to re-write the code within each of the five main web-pages and form-process which manages the \$POST & \$GET actions such as login, create, update & delete for both users & data. By coding them as separate files, it eases the work-load of the user’s CPU which needs to be eased in order to facilitate each web-pages image-loading due to the web design’s conversion.

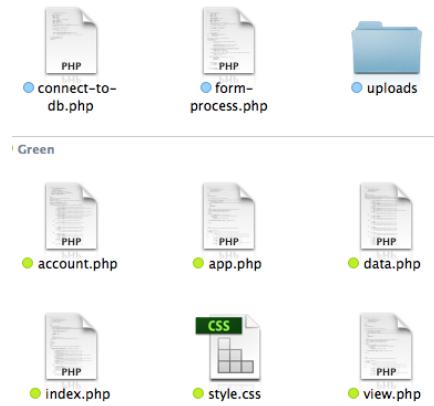


Fig. 23: Main PHP files utilised to produce GeoVida.

Through cPanel, MySQL was integrated (via. PHPMysqlAdmin), I created a database entitled brandon_geovida and inserted two tables; “users” [Fig. 24] & “data” [Fig. 25].

id	username	password	email	fullname	bio	website
43	SarahSmith1	9asew0rd	sarahsmith1@aol.com	Sarah Smith	Currently finishing my a-levels and hoping this s...	http://twitter.com/user/abc
35	GeoVida	geovida4	thegeovida@gmail.com	GeoVida	This is the official account for GeoVida. Contact...	http://geovida.futurecreative.co
71	datamatters	0444m4t5r	der_man@dm.com	Derek Manning	I'm a student with an interest in Technology-based...	mailto:der_man@dm.com
84	fohara_89	intercept	fohara_89@live.com	Frank O Hara		
88	BranMcCann	6mccann8	mccann.b@abc.co.uk	Brandon McCann	I'm a 20 year old BSc Creative Technologies studen...	http://geovida.futurecreative.co
106	andyclark	djggp	a.clark@btinternet.de	Andrew Clarkson	German data journalist. Works published on WIRED M...	http://wired.com
139	JonDoe	j0nd05	JonDoe@example.com	Jonathan Doe	Hi, I'm a data analyst from England, hoping to pro...	http://example.com/JonDoe
144	jhall1994	hrd3uyg02	jehall91@gmail.co.uk	Jenny Hall	Hoping to improve my statistics & data-vis knowled...	
150	becybaker	bb23051994	bb2846@example.co.uk	Rebecca Baker		http://pinterest.com/data
154	datavisr	passedword	staff25@bbworld.co.uk	Courtney Sturgeon	Digital Cartographer from L.A. California.	http://bbc.co.uk/world

Fig. 24: 'users' table fields & example values.

title	tag	type	description	file	date	data_id	user_id
Top 20 Smartphone utilising Countries per Capita, ...	Technology	Public	Ranking order of the 20-most smartphone advanced c...	uploads/43/datamap-tgeojson	2015-05-11 10:17:10	79	43
Ebola Outbreak - Chloropleth Mapping of Worldwide ...	Scientific	Public	News source: bbc.co.uk/wo...	uploads/43/datamap-a-geojson	2015-05-11 10:14:47	78	43
NI Railway Route between Belfast to Derry, Norther...	Governmenta	Private	First feature of a railway lin...	uploads/43/datamap-g-geojson	2015-05-11 10:13:12	77	43
Net Rate Migration as Displayed as: Pos. (0), Neutr...	Cultural	Public	Chloropleth map showcasin...	uploads/43/datamap-tu-geojson	2015-05-11 10:12:40	76	43
Randomisation of Geo-inputs (100) on Land (green) ...	Other	Public	Through the random input c...	uploads/43/random-values-geojson	2015-05-11 09:37:15	75	43
Top 20 Smartphone utilising Countries per Capita, ...	Technology	Private	Ranking order of the 20-most smartphone advanced c...	uploads/43/datamap-advanced c...	2015-05-11 09:29:20	74	43

Fig. 25: 'data' table fields & example values.

Table ‘users’ is utilised for \$POST actions; login, create & update whereas ‘data’ is utilised for create_map & delete_update_map. \$GET is utilised for delete (user) & search which queries both users & data via. “SELECT * FROM users” or “SELECT data.*, users.username FROM data” for added specification to the query.

My app was initially designed around OpenLayer 3 followed by Mapbox however it limited the aspect to design a dynamic U.I. within it & file-size uploads therefore geojson.io was utilised. As a result, I created app2.php & app3.php which I utilised for dual initial testing of the stand-alone app in different formats. These were produced to ease the clarity of the code without the sliced images & external JQuery accompaniments featured within app.php and to confirm the best application would be utilised within GeoVida in terms of functionality & U.X.

Compromises had been applied to my web application’s development including removal of profile picture incorporation, e-mail confirmation & browser download required to access base map-layers within app. This was due to the complexity of the code slowing down web-page loading and limitations within the application (via. Github & Gist) due to file-size limits.

With the following design & coding development researched & applied I could begin finalising my project, however I shall specify my theoretical research first of all, including what had been applied before Project Implementation commenced and during it’s development to finalisation.

3. THEORETICAL ANALYSIS

3.a. Open Data Utilisation

As I initiated my project as a business model, I began my research following the philosophy that “Data science is the transformation of data using mathematics and statistics into valuable insights, decisions and product.” “This is a business-centric definition.” as stated by Foreman (2013, p.xiv). Even though GeoVida’s production was centralised around practice & context as opposed to a business model, I produced my web application’s with an avenue open to develop into a potential functional business plan through the use of governmental financial support of their open data sources such as **NISRA** [<http://www.nisra.gov.uk/>] and **Data.gov.uk** [<http://data.gov.uk/>] to aid their utilisation within the application alongside the aspect of paid accounts to expand data allowance to users & businesses, following the freemium model.

In order to begin my project’s attempt at innovating open data’s use within modern society, I began with analysing the history of data-maps which led me to “Edmond Halley’s 1686 chart showing trade winds and monsoons on a world map.” noted by Tufte (1983, p.23) [**Fig. 26**].



Fig. 26: Scanned excerpt from Tufte (1983, p.23) - One of the first recorded data-maps by Edmond Halley.

Tufte continues to showcase the development of data-maps which were used throughout the 17th century as indications of deaths due to diseases common for it’s time e.g. cholera. Through this understanding of the origin of data-maps, I felt a greater understanding of the importance that data-maps can provide to the user especially when designed with simple impact & accuracy.

To further this understanding into the digital era, I observed Heller & Lander’s Raw Data: Infographic Designers’ Sketchbooks to gain a stronger understanding of the process of infographic development from paper to final design.

Kelli Anderson worked alongside Airbnb to produce an infographic of the data Airbnb had smartly gathered such as guest nights booked & a reviewed listings spatially on a world map, Heller, Landers (2014, pp. 26-31).

Having the ability to see the original sketches and the information contained within them, provides insight to the overall concept and goal of the infographic's production which is brought to life in its final design. I had not previously considered what goal I wished to produce with my application's data-vis production. Through this understanding of data's ability to impact it's viewer and the power that visualising data can do to connect & 'bring to life' statistics into a visual manner that can be understood to a greater degree than a spreadsheet, I can begin to focus on the bigger picture of data utilisation and define my end-goal for my project.

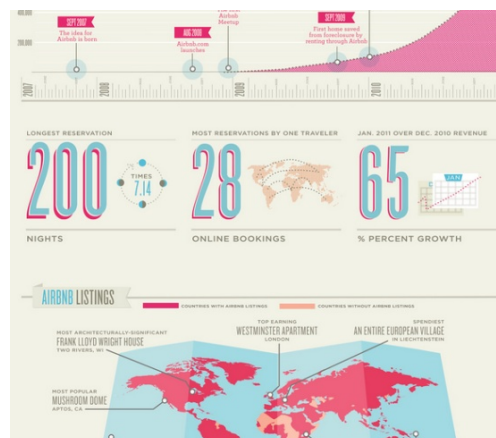


Fig. 27: Excerpt of 'Nights Booked' for Airbnb - Kelli Anderson.

One of my main inspirational readings regarding data and the prospect of its visualisation I had read was Mayer-Schönberger & Cukier's "Big Data". The book provides great level of insight on the importance data is providing such as how Big Data should be defined for its pattern & correlation as opposed to cause & effort. Mayer-Schönberger, Cukier (2013, pp. 55-59) notes that "In place of the hypothesis-driven approach, we can use a data-driven one." "Armed with sensor data, correlation analysis and similar methods can identify the specific patterns, the telltale signs that typically crop up before something breaks." They provide the example of Google utilising the pattern of search queries for flu within contained areas to predict flu-outbreaks rather than trying to understand what was the cause of the flu which doesn't provide the bigger picture on a data-vis as the pattern of flu-outbreak spread.

Data visualisations (alongside infographics) is developing its theoretical breakthrough. I intend GeoVida to showcase an innovative platform & library for geo-spatial visualisation through the production of easily-produced data visualisations that provide impact through means of correlation analysis, develop a whole new typography of data-vis as opposed to previously-used bar, pie & venn charts & provide artistic design that elevates the statistics to a new level of visual understanding.

In order to finalise my thought process to data-usage within my project I read Yau (2011, p.25) which explained the most influential digital resources I should investigate as my app's geospatial mapping software such as; "**TIGER** (www.census.gov/geo/www/tiger/)", "**OpenStreetMap** (www.openstreetmap.org)", "**Geocommons** (www.geocommons.com)" and "**Flickr Shapefiles** (www.flickr.com/services/api/)". Through research I discovered that OpenStreetMap was the correct platform, to achieve what I had set out in my practice and theory and my research led to finding which 3rd-party library of OSM, utilised in app.php.

3.b. Innovating Data Visualisation Design

With a stronger understanding of data's impact & power for innovating visualisation. I will now showcase my research towards the theoretical design of data-vis alongside info-vis.

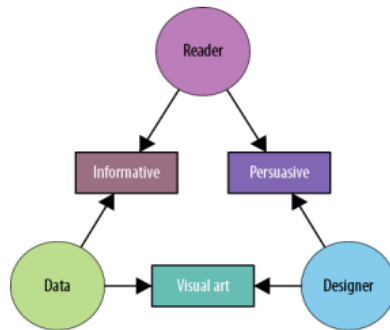


Fig. 28: "Defining Visualisation" diagram - Iliinsky, Steele.

Fig. 28 from "Designing Data Visualisations" was one of the most profound diagrams I had come across regarding how to define a visualisation. My aim to create Informative visualisations while having the aspect of a designer in producing visual art to connect users to that information.

Iliinsky, Steele (2011, p.9) discusses how "an informative visualization primarily serves the relationship between the reader and the data. It aims for a neutral presentation of the facts in such a way that will educate the reader (though not necessarily persuade)."

Through correctly choosing the right data-sets to feature within GeoVida, I intend to inspire potential users to produce similarly-based informative, effective data visualisations, continuing the progression that data utilisation is having on society and its power to inform, persuade and inspire its innovation as opposed to entertainment or personal travel based visualisations.

This led me to consider whether the complexity of my project would be a potential design downfall which Klanten (2008, p.7) answers that "Design is not just about making things simple. In fact, there is a complementary relationship between simplicity and complexity that influences design choices to produce surprising and informative data diagrams. By shaping their view on data, designers can choose to introduce a level of complexity that allows just the right amount of contrast to drive profile, focus and definition." I believe even though my project itself is produced in a complex yet structured manner that I planned my U.X.D. & U.I. to be simplified to its essential form and that the produced visualisations can denote its information visually in as few words as possible.

Klanten, Bourquin, Ehmann (2010, p.215) discuss in "Data Flow 2" how "Every map design is strongly influenced by the nature of the data. Before visualisation comes data analysis." "Maps have the ability to present, synthesize, analyse and explore the real world. Maps do this well because they only present a part of the complex reality and visualize it in an abstract way." even though "Every visualisation is an interpretation". "The ability to misinform or even tell straight lies by the means of visualisations entails a huge responsibility." noted by Klanten, Bourquin, Ehmann (2010, p.9). By encouraging GeoVida's data-mapping utilisation to remain accurately presented while accepting that statistical error & visualisation can happen and be corrected by its user or other users (via. public data-map) is how I intend to solve this issue.

Pratt, Nunes (2012, pp. 94-95) quote Jeffrey Zeldman; founder and executive creative director at Happy Cog Studios that “content precedes design. Design in the absence of content is not design, it’s decoration.” Also, “what feels natural in a living room is different from in an office or public event.” - Jennifer L. Bove, cofounder and principal, Kicker Studio; quoted by Pratt, Nunes (2012, pp.106-107). Furthering my research, these quotes showcased the importance that I prioritise my content firstly and build it around a professional design platform to highlight the data’s importance. This also made me take in consideration the technical specification for showcasing my project to external examiners for which I intend to present my work via. hosting domain on a projector as it does not limit all the functions that GeoVida will provide.

Through my experience within BSc Creative Technologies, I had learnt first-hand the importance that Usability Testing provides to any creative project as highlighted by Pratt, Nunes (pp. 28-29 & pp.18-19) respectively that “A lack of feedback is rarely a sign that you’re on the right track.” - quoted by Courtney Deakyne, director of marketing/client strategy, Sevnthsin. “Your users are continuously redesigning your user interface in real time. Users become your co-co-designers because you can’t imagine all the ways someone will actually use what you create.” - Dana Chisnell, principal research at UsabilityWorks. I utilised user feedback to finalise my U.X.D. and will do so within my project finalisation’s through the use of an online survey in order to analyse the given statistics and display within Evaluation.

To finalise my visualisation’s design aspect I watched Iliinsky (2014, ONLINE: Accessed: 06 March 2015) who stated that “the two most important considerations in visualisation” (via. @moritz_stefaner) are “position is everything” & “colour is difficult” as supported in Fig. 29.

Properties and Best Uses of Visual Encodings

Example	Encoding	Ordered	Useful values	Quantitative	Ordinal	Categorical	Relational
	position, placement	yes	infinite	Good	Good	Good	Good
1, 2, 3, A, B, C	text labels	optional (alphabetical or numbered)	infinite	Good	Good	Good	Good
	length	yes	many	Good	Good		
	size, area	yes	many	Good	Good		
	angle	yes	medium/few	Good	Good		
	pattern density	yes	few	Good	Good		
	weight, boldness	yes	few		Good		
	saturation, brightness	yes	few		Good		
	color	no	few (< 20)			Good	
	shape, icon	no	medium			Good	
	pattern texture	no	medium			Good	
	enclosure, connection	no	infinite			Good	Good
	line pattern	no	few				Good
	line endings	no	few				Good
	line weight	yes	few		Good		

Fig. 29: Iliinsky's spreadsheet defining data-vis properties.

I agree somewhat with his statement on position due to the fact it does provide the visually-easiest perception mechanism for data and it can connect with most visual properties such as: size, shape, colour etc. However, I disagree that colour is difficult to utilise for infographics as he supports his claim by stating that colour “lacks order” & “has less than 20 definable colours”. I believe use of colour shades, patterned colour schemes such as cold to warm colours can be utilised and understood instantly the severity in volume of its data especially on a geo-spatial field. However, I do accept it’s limitations in terms of accessibility.

This led me to finalise with GeoVida’s accessibility which I had analysed after further understanding that “accommodating people’s diverse needs is at the heart of any inclusive design practice.” - Kel Smith, principal, Anikto LLC via. Pratt, Nunes (2012, p.73). Accessibility was considered during U.I. design however if I had more time, I would of converted my website to a responsive web design in order to benefit more users requiring to zoom in or out of the user-interface. I am content with GeoVida’s U.I. that it won't limit the majority of users.

3.c. Applying to Practice

As with any web-based project, I begin by reviewing Duckett 's HTML and CSS: Design and Build Websites (2011). It reacquaints my knowledge of web design and the sections I had most utilised for this project were; input forms (pp.144-172) & practical information (p. 476).

N.V. Andrienko & G.L. Andrienko (1999, Vol.13, Iss. 4 p.355) discuss how “Exploratory data analysis requires highly interactive, dynamic data displays.” I believe GeoVida’s interactive functions achieve this through providing the user with an import data option to make data visualisations even easier to achieve to stylise for each user’s data-vis “interpretation”.

In order to develop my practical understanding of data-vis I read the journal article regarding Icon-image maps by Pazner, Xhang (2004, Vol.31, Iss.1, pp. 29-41) which states “graphically versatile aggregate icon constructs take several visual variables into consideration, such as color, length, width, orientation, shape, size, pattern, and texture, and thus can carry more information than conventional pixel images.” I will practically apply this through the production of choropleth maps which take into consideration, depth of colour and range of data values shown both spatially (in size & shape) and statistically (with the values present alongside).

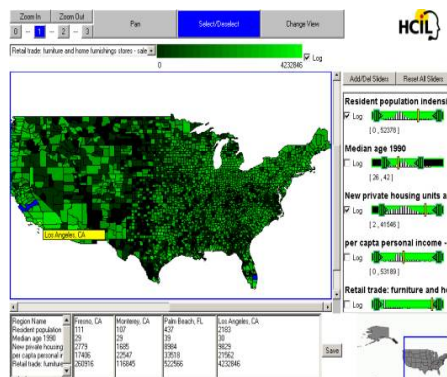


Fig. 30: Excerpt of early-dev choropleth map app via Norman.

Norman, Zhao, Shneiderman & Golub (2003, ONLINE: Accessed 23 January 2003) produced one of the first choropleth map-producing applications back twelve years ago that led the initial revolution of visualising data from the standard bar or pie chart into geo-spatial visualisations and infographics. Within their online article they discovered that “with dynamic query maps, users quickly became aware of attributes that varied in geographic directions”, this sort of instantaneous understanding of the mental process between data spreadsheets to its visualisation has helped pioneer future research into choropleth mapping.

To finalise my theoretical research at my app’s practical aspect I read Suda (2003, ONLINE: Accessed 07 March 2015) that helped provide confirmation of data formats that I had considered utilising to base my data’s visualisation from including .kml & .geojson. Suda also discusses how data-set incorporation may require converting between multiple different data file formats in order to gain the produced visualisation required. I will showcase five pre-set data samples from different housing categories to highlight this. I will also consider utilising extreme range values for both testing within my application if they can handle the volume and large range of values and also if the visualisation is not impacted by their integration.

Now having completed my theoretical research, I can now discuss GeoVida’s finalised changes and apply Usability testing & feedback to analyse the results of my findings.

4. PROJECT FINALISATION

4.a. Final Development

i. Front-end Coding

Index.php & App.php were re-designed to facilitate the change of base application to **Geojson.io** [http://geojson.io/] via. summary text being achievable in the web app (index) and removal of data's embed spreadsheet option (app).

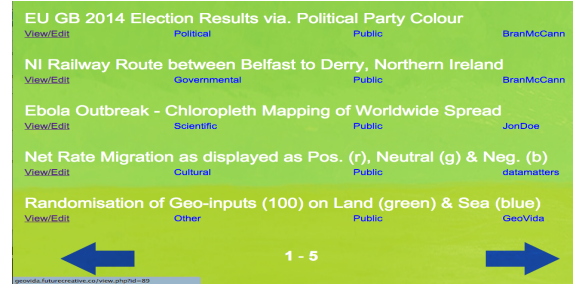


Fig. 31: PHP-integrated data-map list, limited to five most recent maps (data.php).

ii. Back-end Coding

Main PHP development was the inclusion [Fig. 34] of isset[] & LEFT JOIN used to specify and define the range of data values required for use within data.php and account.php. Also, mysql_query & variable; \$sql was developed from my 'Adv. Web Dev' module. Please note the comments within my code for full explanation of my project's coding.

```

1 <?php
2 function get_file_path_uploaded($uploadedFile, $directory, $targetFile = null, $filePattern = null, $moveFile = true, $allowDirFile = false)
3 {
4     if ($uploadedFile) {
5         throw new Exception("No file found.");
6     }
7     $error = isset($uploadedFile['error']) ? $uploadedFile['error'] : true;
8     if ($error) {
9         if ($error == 1) {
10            throw new Exception("File size exceeded, 2MB limit.");
11        }
12        if ($error == 4) {
13            if ($allowDirFile) {
14                // Don't throw error when no file is selected.
15                return;
16            } else {
17                throw new Exception("Please upload file.");
18            }
19        } else {
20            throw new Exception("Error " . $error);
21        }
22    }
23    $tempName = isset($uploadedFile['tmp_name']) ? $uploadedFile['tmp_name'] : null;
24    if ($tempName) {
25        throw new Exception("No file.");
26    }
27    $fullDirectory = __DIR__ . "/" . $directory;
28    if ($targetFile) {
29        $targetFile = $fullDirectory . $targetFile;
30    } else {
31        $targetFile = $targetFile . "-" . pathinfo($uploadedFile['name'], PATHINFO_EXTENSION);
32    }
33    if ($filePattern) {
34        if (!preg_match($filePattern, $targetFile)) {
35            throw new Exception("Invalid file.");
36        }
37    }
38    $fullTargetFile = $fullDirectory . "/" . $targetFile;
39    if ($moveFile) {
40        if (!is_dir($fullDirectory)) {
41            mkdir($fullDirectory, 0777, true);
42        }
43        if (file_exists($fullTargetFile)) {
44            unlink($fullTargetFile);
45        }
46        if (!move_uploaded_file($uploadedFile['tmp_name'], $fullTargetFile)) {
47            return $directory . "/" . $targetFile;
48        } else {
49            throw new Exception("Error on moving file.");
50        }
51    } else {
52        return $directory . "/" . $targetFile;
53    }
54 }

```

Fig. 32: Code developed from PHP.net to Local download data map.. Also provides echo if error occurs (Line 1 to 26 - form-process.php).

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Fig. 33: Utilised code to perform five data-map queries per page for data-links. (Line 216 to 225 - data.php) & (Line 282 to 291 - data.php).

```

1 <?php
2 // PHP input form for adding users. //
3 // Starts/Re-establishes the Session.
4 session_start();
5 // Connects to MySQL database. //
6 include "connect-to-db.php";
7 $loggedInUserId = isset($_SESSION["logged_in_user_id"]) ? $_SESSION["logged_in_user_id"] : 0;
8 $sql = "SELECT * FROM users, data WHERE id = " . $loggedInUserId;
9 $userResult = mysql_query($sql);
10 $userData = mysql_fetch_assoc($userResult);
11
12 $mapId = isset($_GET['id']) ? $_GET['id'] : 0;
13 $sql = "SELECT data.*, users.username FROM data -
14 * LEFT JOIN users ON users.id = data.user_id -
15 * WHERE data_id = " . $mapId
16 * AND (type = 'Public' OR (type = 'Private' AND data.user_id = " . $loggedInUserId . "))";
17
18 $mapResult = mysql_query($sql);
19 $mapData = mysql_fetch_assoc($mapResult);
20
21

```

Fig. 34: Ex. of querying specific MySQL values with range implications in place. (Line 1 to 25 - view.php).

4.b. Data Production

I produced twenty-two base map layers [e.g. Fig. 35] consisting of accumulated regions around the world to assist the user with their data-map development. Alongside, GeoVida contains eight fully produced data maps (consisting of one of each category) specified in data.php is available to inspire users to what is possible to produce within my application.

For the base-map layers, the results were gained from MapIt [http://mapit.mysociety.org] and required data cleaning to be converted from .kml to .geojson. I utilised geojson.io to produce this. N.I. - Detailed was produced into .geojson from 110 .kml files that my base app handled.

4.c. App Completion

Even though dynamic, interaction limitations were noticed with MapBox as the base app, I wanted to utilise it as the data-map viewer as it could transmit data via the server well from geojson.io and can also display Big Data examples such as my commercial map: datamap-co.geojson which contains over 10,000 inputs [Fig. 36].

Final app development consisted of my project's gained function to store user-created data maps into GeoVida's server under '/uploads' and for users to re-upload & download geojson maps while additional settings

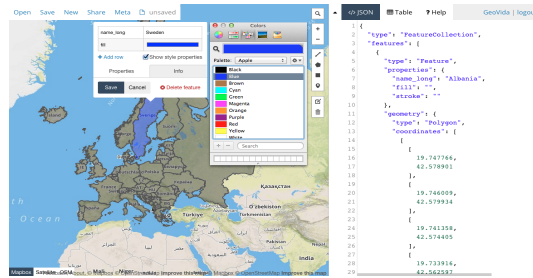


Fig. 35: Geojson.io (Base App) with inputed map-layer & pop-up input.



Fig. 36: Finalised View.php with MapBox as viewer.

were initiated to reject the same data being uploaded onto the server to help alleviate users from taking the work of other GeoVida users. Also, file size limits were employed in an attempt to reduce any server crashes potentially happening due to the server over-loading.

I however, utilised Big Data within my project to showcase its potential for GeoVida to maintain upload and extend the data possibilities to businesses & governments with Big Data.

5. EVALUATION

4.a. Project Review

Question 5 of my online survey provides users an opportunity to comment “what could be improved” with GeoVida, the following is the summarised results alongside my own feedback.

Pros:

- App U.I due to usability & interactivity.
- Data search feature via. keyword/ tag.
- Innovative platform to create and host data visualisations of mixed themes.

Cons:

- Current limitations to confirm authenticity of data-map sources.
- Accessibility limitations in font size adjustment & text to speech.

Problem:

- Lack of responsive web design due to .PNG to .PHP web conversion.

Solution:

- Accessibility considered through text enlargement & width adjustable app.

- File-size limit with FutureCreative.co due to C-Panel file maximum of 2MB.
- Upload Big Data via. File Manager for presentation of App capabilities.

4.b. User Feedback

Link to Online Survey: <https://www.surveymonkey.com/s/HHDRK9R>

To confirm my project’s research and verify my hypothesis I produced an online survey via. SurveyMonkey to analyse usability testing and feedback. I used three of the certified unbiased questions from the aforementioned website alongside two questions of mine that I asked colleagues to confirm its neutrality.

Website Feedback Template

1. How was it to navigate around the website?

Extremely easy
 Very easy
 Moderately easy
 Not so easy
 Not at all easy

2. How visually appealing is our website?

Extremely appealing
 Very appealing
 Moderately appealing
 Not so appealing
 Not at all appealing

3. Has this site made data more appealing to work with for yourself?

Definitely
 Quite a bit
 Sort of
 Not so much
 Not at all

4. How likely is it that you would recommend our website to a friend or colleague?

Not at all likely - 0 1 2 3 4 5 6 7 8 9 10 Extremely likely - 10

5. Do you have any other comments about how we can improve our website?

Fig. 37: Online Survey to gain feedback for Usability Testing.

My target audience consisted of students (college & university) between the age of 16 to 26 as I believe this demographic would be the initial driving force for governmental & business interest. Survey was supplied via. social media and feedback was provided from journalists, web designers & students.

My online survey features four multiple choice questions and one comment question for feedback. The feedback provided is as followed from 58 users:

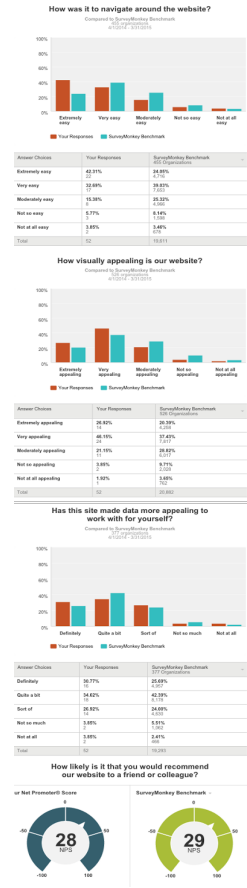


Fig. 38: Survey Analytics for GeoVida.

Question 1: How was it to navigate around the website?

Responses:

1. Extremely easy (42.31%, 22 users),
2. Very easy (32.69%, 17),
3. Moderately easy (15.38%, 8),
4. Not so easy (5.77%, 3),
5. Not at all (3.85%, 2).

Positive correlation of results, with exponential growth for the more positive options. I believe my work-flow has proved to be successful even with the limitation of responsive web design.

Question 2: How visually appealing is our website?

Responses:

1. Extremely easy (26.92%, 14),
2. Very easy (46.15%, 24),
3. Moderately easy (21.15%, 11),
4. Not so easy (3.85%, 2)
5. Not at all (1.92%, 1).

Even though responses were mainly positive, I accept the results that visual presentation of GeoVida could be improved, a fully coded website could provide this.

Question 3: Has this site made data more appealing to work with for yourself?

Responses:

1. Extremely easy (43.31%, 22 users),
2. Very easy (32.69%, 17),
3. Moderately easy (15.38%, 8),
4. Not so easy (5.77%, 3) &
5. Not at all (3.85%).

I found this the most impactful feedback as the majority of responders (92.08% out of 58 users) felt some degree of positive appeal to investigate data further with 68.08% of those answered within the top two positive options thus providing successful feedback on my hypothesis research.

Question 4: How likely is it that you would recommend our website to a friend or colleague?

Responses:

1. Promoters (9-10) = 44.83%, 24.
2. Passives (7-8) = 37.93%, 22.
3. Detractors (0-6) = 17.24%, 10.

For the time space utilised for GeoVida's production, I believe it's acceptable to have a high number of passive users, I would work on developing this through further usability testing.

Question 5: Do you have any other comments about how we can improve our website?

Responses:

- 9 Answered, 49 skipped.

Feedback were broad-ranged in improvement suggestions. More data examples was the overall suggestion followed by slight improvement to font colours against their background. I followed through on this through providing more of a font colour scheme via. CSS editing.

6. CONCLUSION

While I am overall satisfied with my final project and its development from business model to final project with practice & theory considered and explained throughout my thesis. There are a number of aspects which I would revisit if and when I decide to take it to the next level of development. These include:

- Re-design Geojson into a responsive web layout & adding e-mail confirmation (login).
- Allow users to provide feedback to other users on their visualisations via. comments.
- Re-develop **Geojson.io** into a stand-alone application to facilitate its limitations

I believe I have addressed my hypothesis & statement question and developed a platform that would encourage further user interest in the visualisation of open data. This in turn will, I hope continue the promotion of greater understanding of key national topics destined to have profound implications for both social and economic capital. For which I can support by my user feedback within my evaluation.

I hope my research & production can lead to stronger transparency of data by commercial businesses & governments that can be displayed in a format more easily understood by standard users as well as academics for use within future publications & research papers.

iii. ACKNOWLEDGEMENTS

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Finally, I wish to dedicate my undergraduate thesis to my parents; Brenda & Kieran for their undying love and for allowing me the freedom and trust to explore my own career in life.

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iv. APPENDICES

1. Project Management:

- 1.1. OpenProject.org [<https://www.openproject.org/>] - Initial GANTT chart software.
- 1.2. Basecamp [<https://basecamp.com/>] - Online project communication tool.
- 1.3. Dropbox [<https://www.dropbox.com/>] - Data storage site for project back-up.
- 1.4. Draw.io [<https://www.draw.io/>] - Online flow diagram application for use as Fig. 22.
- 1.5. InVision [<http://www.invisionapp.com/>] - Photo to G.U.I. User-flow creator.
- 1.6. MAMP.info [<https://www.mamp.info/en/>] - Initial testing server for adding PHP.

2. Online Coding Guides:

- 2.1. Jssor [<http://www.jssor.com/demos/image-slider.html>] - JQuery ImgSlider for index.php.
- 2.2. JQuery: Accordion [<http://jqueryui.com/accordion/>] - JQuery dynamic tabs for app.php.
- 2.3. w3schools [<http://www.w3schools.com/>] - HTML, CSS & PHP tutorial guide & examples.
- 2.4. PHP.net: MySQL [<http://php.net/manual/en/ref.mysql.php>] - Guide for MySQL functions.
- 2.5. d3.js [<https://github.com/mbostock/d3/wiki/Gallery>] - GitHub coded resources for d3.js.
- 2.6. MapBox [<http://www.mapbox.com/mapbox.js/api/v2.1.9/>] - Current mapping library.
- 2.7. OpenLayers 3 [<http://openlayers.org/en/v3.4.0/examples/>] - Initial map library examples.
- 2.8. Kartograph.js [<http://kartograph.org/>] - Previously researched data visualisation library.
- 2.9. Adobe Color CC [<https://color.adobe.com/>] - Online tool to define colour web schemes.
- 2.10. Fontpair.co [<http://fontpair.co/>] - Typography guide site for font-type combinations.
- 2.11. Font Squirrel [<http://www.fontsquirrel.com/>] - Typography database site used with 2.10.

3. Further Project Inspiration:

- 3.1. Andy Kirk [<https://twitter.com/visualisingdata>] - Freelance Data Visualisation Specialist.
- 3.2. Nathan Yau [<https://twitter.com/flowingdata>] - Statistics Graduate; Author of Visualize This.
- 3.3. Mike Bostock [<https://twitter.com/mbostock>] - Creator & Main Developer of d3.js.
- 3.4. Marius Watz [<https://twitter.com/mariuswatz>] - Electronic art and computational designer.
- 3.5. John Foreman [<https://twitter.com/John4man>] - Chief Data Scientist at MailChimp.com.
- 3.6. Edward Tufte [<https://twitter.com/EdwardTufte>] - Statistician; Author of The Visual Display.
- 3.7. #dataviz [<https://twitter.com/search?q=dataviz>] - Feed of upcoming data visualisations.
- 3.8. Visual.ly [<http://visual.ly/>] - Previously considered project content communication tool.
- 3.9. ManyEyes [<http://www-969.ibm.com/software/analytics/manyeyes/#/>] - Host: Infographics.
- 3.10. Visualize [<http://vizualize.tumblr.com/>] - Tumblr page: upcoming data-sets & visualisations.
- 3.11. Nicholas Feltron [<http://feltron.tumblr.com/>] - Tumblr page: collection of Feltron's data vis'.
- 3.12. Stamen [<http://stamen.com/>] - Collection of Stamen Design works: data vis & chloropleths.
- 3.13. What does SEO mean? 3 Simple SEO Rules || Article defining SEO for my application dev. [<http://www.madebymarket.com/help/ads/what-does-seo-mean.html>].
- 3.14. Be a better writer in 15 minutes || Article provided regarding effectively writing for thesis. [<http://blog.ed.ted.com/2014/05/29/be-a-better-writer-in-15-minutes-4-ted-ed-lessons-on-grammar-and-word-choice/>].
- 3.15. David McCandless - The beauty of data visualization || Effective data vis. to society. [http://www.ted.com/talks/david_mccandless_the_beauty_of_data_visualization].

4. Thesis Tools:

- 4.1. Google Scholar [<https://scholar.google.co.uk/>] - Online Journal & article search tool.
- 4.2. HarvardGenerator [<http://www.harvardgenerator.com/>] - Online reference tool via. ISBN.