GPX VisRev

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ABSTRACT

GPX VisRev is a website based on HTML, CSS and JS/jQuery where a user can upload up to 5 GPX track files and display them on a map. The site also displays a graph of the changes in elevation and speed with respect to time during the track and provides a pie chart of the distance travelled uphill, downhill or on a flat surface. Some basic statistics are also provided such as the average speed, total distance and time.

The site also features accessibility options such as the possibility to choose font, font size, font weight, dark mode. GPX VisRev is also optimised to be used with screen readers for the visually impaired.

INTRODUCTION

The task was assigned as a part of the Interactive Systems course at University of Glasgow. Our team had to design a user-friendly website to visualize GPX data provided by the user in three distinct ways. Based on the given sample GPX files, we assumed that the user data will display a running or cycling path the user went on. We developed user personas to get a rough idea of the types of users who would be interested in visualizing their tracks, and we aimed to design the page with their needs in mind. We agreed that we should display the route itself as it would be the most visually pleasing and informative feature. Later, we decided that all our users would be keen to get statistics about the track's details (changes in elevation, distance, time), and their performance (speed). Our goal was to show these in a visually pleasing and informative manner, hence we attempted to choose data visualization tools (graphs, pie charts) accordingly. Finally, we also wanted to introduce added interaction to the site in the form of being able to upload multiple tracks and "fly" to and from them.

The layout was created so that the map is the key component. We assumed that the reader would be reading left to right therefore we designed the website with a "Z" flow[1] in mind. The colors assisted with this by keeping the top darker and the buttons were designed to be relatively large and close to each other. We chose blue colors to be dominant as for the calming effect they tend to have[2] . Finally, for enhanced user experience, the page was optimized for all display sizes and for the visually impaired (color blind, blind)[3]

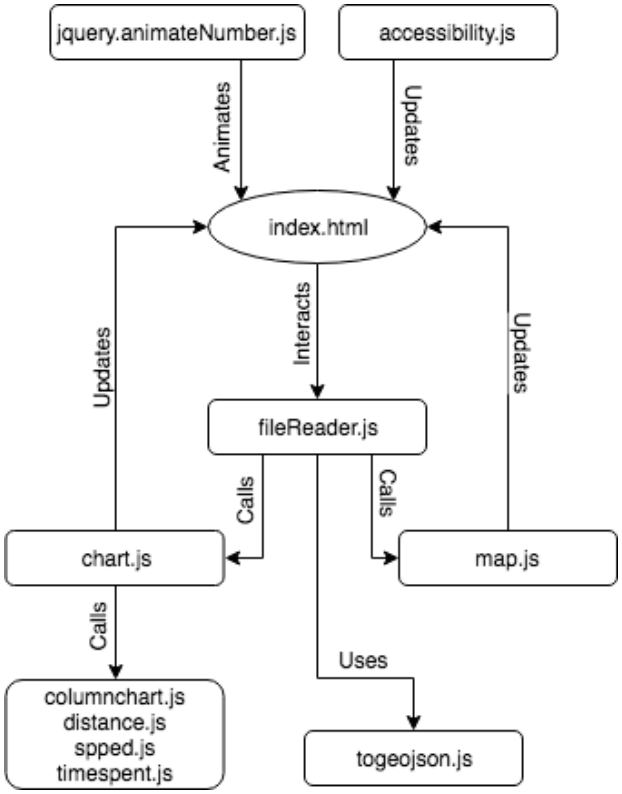
PROJECT CONCEPT

The original idea was to implement a JavaScript based interactive web app, incorporating the WRLD 3D API as our map, since we had some previous experience with this API, and found it aesthetically pleasing. The attached user personas reflect this. However, after our initial setup of the project we realized that unfortunately, contrary to what the name would let you believe, the API doesn't include the mapping of the entire world.

After brainstorming ideas, we arrived at the conclusion of having a map as the key component displaying the route and various metrics about the selected path. That led to calculating the total distance and time, average speed, and to give a more objective (and feature-rich) overview of these metrics we decided to display information regarding the elevation changes. To show a (usually negative) correlation between speed and the slope of the path we created a graph to display this. The reason why the graph is at the top is due to a simple reasoning. The common user reads top to bottom meaning that at some point the user will land on the map which is reasonably big and interactive. Having the graph at a smaller height compared to the map meant we could risk overlooking. The height of the graph couldn't be changed because that would defeat the purpose of having the map as the key component. Be it long-distance running or cycling, the distance going uphill/downhill is significant in terms of energy needed from the participant. We decided to display this information in a pie chart, which would naturally emphasize the ratio between them. The Average Speed and Total Distance are color coded based on a scale we display below it showing, what we assume to be a reasonably high or small distance/speed. The page was divided left to right into ¾ and ¼. The main reason was because the map and the graph displaying the elevation + speed had to be the biggest to display the data nicely, as we deemed these the two most useful tools for the user. Everything was aligned by imaginary horizontal lines and padding was set to a naturally pleasant center of the given imaginary column or row.

Implementation

After abandoning the WRLD 3D API, we have decided to use MapBox due to its generous free API cap, and well documented JS API. MapBox also provides the ability to customize the styling of the map down to each street, which can be very useful in achieving a unique look for our app. Below is a graph representing the architecture in which our JS files interact with each other and the main index.html.



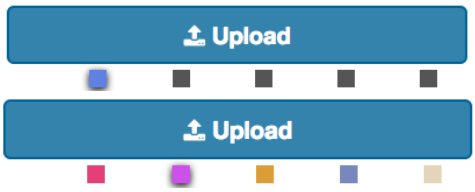
The system runs entirely on the front end, with no backend required, this made it easier to manage, since only a file reader needed to be implemented. However, the drawback is that the user cannot store their previous routes, data. After selecting an uncorrupted .gpx file, the main computations, and data visualization begins.

Parsing

We parse the file using the togeojson JavaScript library, which is under MIT License. After the filereader reads in the .gpx as a string, we call the method imported from togeojson to convert it into useable form. By parsing to Geojson the plotting with MapBox becomes trivial, as it has integrated Geojson support. The distance is calculated by iterating through the coordinates and using this function on the latitudes and longitudes. Average speed is calculated by dividing the sum of the distances between measured points and the sum of the intervals and are then displayed with a counter animation. Elevation measurements are parsed through and depending on the difference subsequent measured points, the distances are counted as going uphill, downhill or horizontally, and then displayed in a pie chart using the canvasJS library. Similarly, "instantaneous" speed and elevation is calculated between measure points and plotted on a graph as two y axes with respect to time (x axis). For displaying the graph, we used the canvasJS library again.

Showing multiple tracks

We have decided to allow 5 routes in each instance, since any more would make the route traversal quite cumbersome, but any less would be quite limiting for the user. The way this is tracked is by displaying colored boxes, as more routes are uploaded the boxes take up the color of the route, gray boxes mean empty datasets. The user can change between the uploaded datasets, with a simple button, and the current viewed box gets a shadow to present the current viewed path.



After a new file is uploaded, or the next track is requested, the map camera flies to the new view, a track is drawn, and the charts, statistics are updated. The way we handle correct track view is by calculating a box based on the corner datapoints, this way the entire tracks fit into the view. After 5 files are uploaded, the user is prompted when he tries to upload, notifying that previous track will be overwritten.

Accessibility Features

To make the webpage accessible to wider audience, we have included accessibility options in it. These include options to choose a font, font size, font weight as well as a dark mode for uses during night or for people with vision problems. Our users can choose from three different fonts: Arial - default, Comic - which is more readable for dyslexic people and the Monospace Font – where all the letters have the same width. The users can also adjust the size of text on the page. There are three options for this and offer the default size, large size and and huge size. Thanks to these settings, people do not have to zoom in, and they can just use this feature to make the app usable on screens of various sizes. To suit needs of a larger audience, we have also included one more option to make text more visible. There is one more option for them and that is the font weight – users can convert all the text to bold font, making it thicker and easier to read for visually impaired. Finally, we have also implemented an option to turn on dark mode, which inverts colours and makes context of the app readable in dark environment.

Peer Assessment

We received feedback about our initial documentation of the webpage from two groups. The feedback we received from one group was a generic message, that the documentation is a bit vague, needs more details, but the user personas and scenarios are detailed enough to optimise our webpage for them. The other feedback praised the user personas and the description of key features, but pointed out label the axes (speed, distance) and their measurement units on the charts. They also suggested to center the right items on the page.

The peer assessment was a crucial point in our project. The feedback we received provided us with new perspectives on our project, pinpointed weaknesses and allowed us to design the functionality of our web page to satisfy a wider range of audience.

EVALUATION

Given the scope of the project and given time limit, we opted for a structured interview using a survey with the help of Google Forms.

The participants were informed about

- their rights to withdraw
- the fact that their responses are anonymized
- the surveyors' contact details

And then explicitly stated that they agree to take part in the user study.

The participants were then asked to explore GPX VisRev:

They uploaded gpx files, experimented with the flying to the next track function and examined the visualisations, and then started to fill in the survey.

We did allow some semi-structured elements in this user study, e.g. in case a participant wanted to ask questions about a specific feature or suggested additional features to implement during the user study.

The survey to be completed can be found on this link.

Structure

The structure of the survey was the following:

The first two questions were meant to provide feedback (on a Likert-scale) about the overall impression GPX VisRev left in its examiners, in particular, we wanted to measure how easy/difficult participants found it to navigate through the page, and how visually pleasing they found it in general.

After that, we asked participants to rate the ease of use the various features of the web page on a Likert-scale. We then asked them to explain what they found most difficult to use and how it could be improved

Following usability, we turned our attention to the visual appeal of the data visualisation tools:

- Plotting the track on the map
- The graph plotting speed and elevation with respect to time
- The summary statistics showing average speed, total distance, and distances traveled uphill, downhill or horizontally

We asked users to rate these on a Likert-scale, and then asked qualitative questions about their most and least preferred features (and thus indirectly getting and ordinal representation of their preferences).

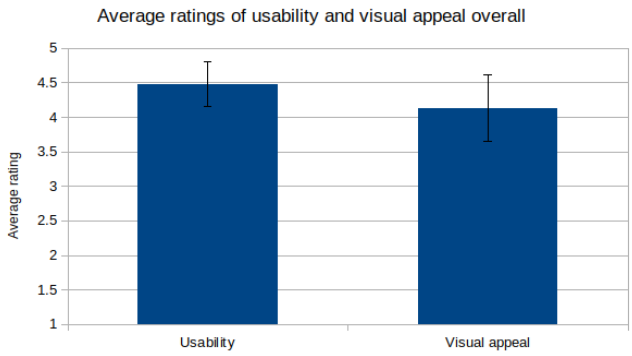
Moving on, we wanted to explore how users perceive the performance of the data visualisation tools of GPX VisRev in portraying information about the uploaded gpx files in a similar vein to the previous questions.

Finally, we wanted to get a sense of the potential of the web app by asking users to rate the likeliness of them recommending it to their friends. We ended the survey by asking the user for a new feature to implement, any other remarks that he/she would like to share with us.

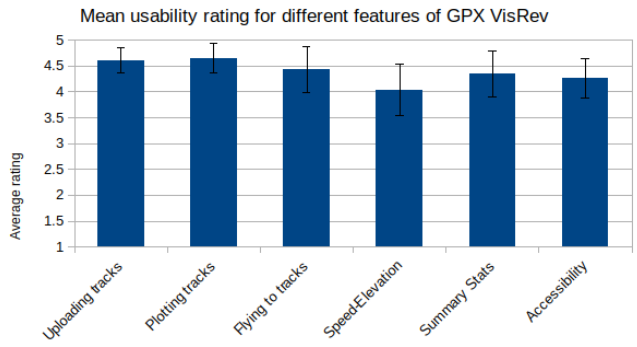
23 people participated in our user study. It should be noted that the population sample was mostly male Computer Science students of European descent; hence it is not at a representative sample of the wider population. We present the results of our user study below, having removed N/A or otherwise not very useful responses from the charts.

Results

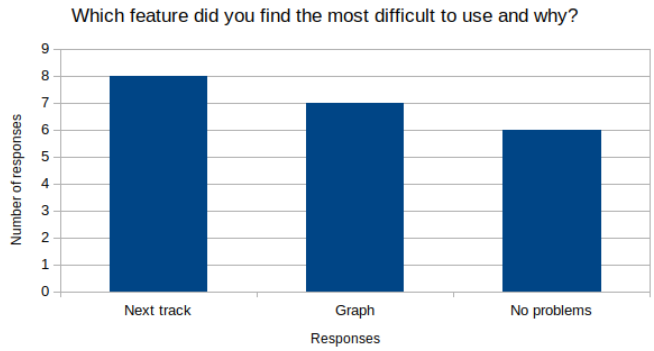
Average usability and visual appeal overall



The mean score for the usability of the web page is 4.48 with a standard deviation of 0.66. The mean score for the overall visual appeal of GPX VisRev was slightly lower, 4.13, with a standard deviation of 0.97, clearly indicating a wider spread of (lower) values.



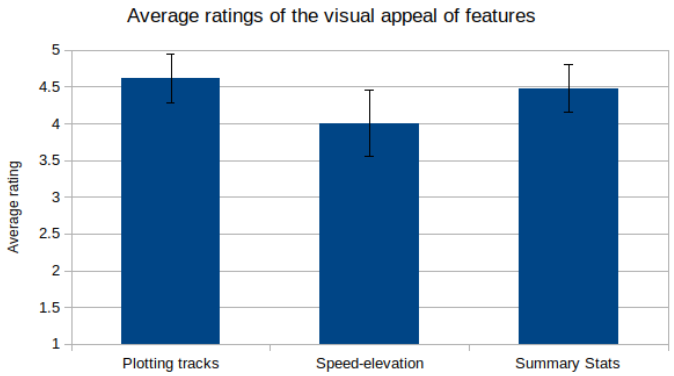
When asked about the usability of the individual features of the web page, ”Uploading and plotting” tracks achieved very high mean values with low standard deviation (4.61, 4.65 and 0.5, 0.58 respectively). The features: ”Flying to tracks”, the ”Summary statistics” and ”Accessibility” achieved lower means with greater standard deviation (4.43,4.35, 4.26 and 0.9, 0.88, 0.76). The graph depicting speed and elevation received the lowest mean with greatest standard deviation: 4.04 and 0.98, respectively.



Qualititative Questions Regarding Usability

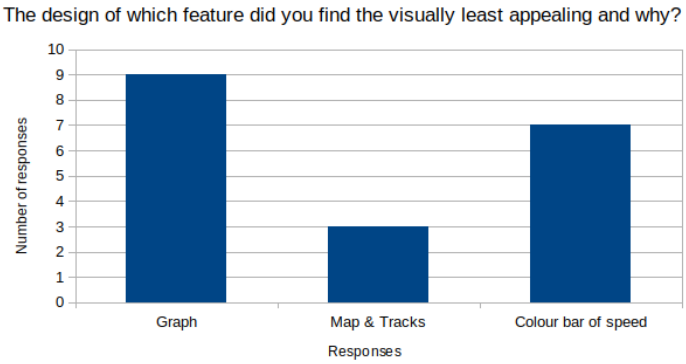
Approximately the same number of participants found the “Next Track” button and the Graph plot above the map difficult to use.
Seven participants found the “Next Track” button confusing, since it appeared on the map upon loading it, but did not give any feedback to the user until two or more tracks had been uploaded.
Another seven participants pointed out that the graph plotting Elevation and Speed is too small, difficult to make out what points on the graph represent. To the latter, five participants suggested increasing the size of the graph and possibly decreasing the size of the map, and one suggested the option to zoom in to the graph. Regarding the ”Next Track” button, two participants pointed out that it should be hidden (or greyed out), until two tracks are uploaded. Others suggested ”better guidance” and increasing the squares with more vivid colours that depict the newly added tracks.

Visual appeal of individual features



The mean and standard deviation of Plotting tracks on the map and Summary Statistics did not differ considerably (4.61, 0.66 and 4,48, 0.66 respecively), however, the Graph depicting Speed and Elevation received an average of 4 points with a standard deviation of 0.9.

Qualitative questions about the visual appeal of individual features

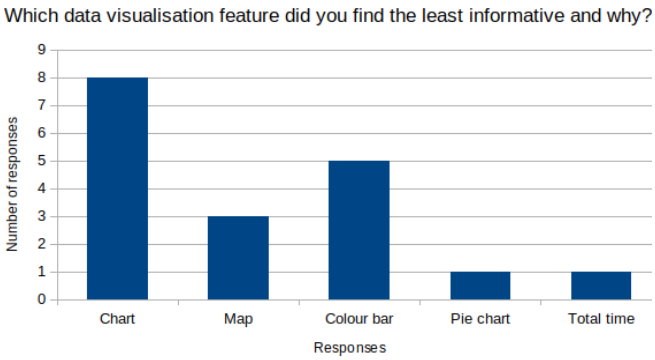


When asked about which features are the most visually pleasing, more than half of the participants chose the Pie chart, seven chose the map and only three the graph, indicating a clear order of preference. When the participants were asked about the least visually pleasing feature: nine of them chose the speed-elevation graph, stating that it is not only difficult to use but also visually unpleasant to cramp so much data into such a small area. Seven participants found the colour bar depicting speed and distance the least appealing: stating either confusion or aesthetic doubts. Three participants mentioned that the design of the squares indicating uploaded tracks could be improved.

The amount of information conveyed in individual features

The mean and standard deviation of the informativeness of the data visualisation tools was remarkably similar to their visual appeal: plotting tracks (4.61,0.65), speed-elevation graph (3.95, 1.06), summary statistics (4.65, 0.57).

Qualitative questions about how informative individual features are



Similarly to the question about visual appeal, the largest number of participants considered the speed-elevation plot and colour bar features portraying the least amount of information. The reasons given were also largely repetitions of previous answers, which suggests either a very strong connection between informativeness and visual appeal, or the effect of user fatigue.

Potential and additional remarks

To the question of how likely they would recommend the webpage to their friends (on a 1-10 scale), participants answered with **a mean of 8.43 and 1.28 standard deviation**.

When asked about new features participants would add, we received a wide array of answers and excellent ideas, which could be grouped as follows: Five participants suggested more control over **uploading tracks and navigating between them**, e.g. the ability to remove and uploaded track, to go back to the previous, be able to upload multiple tracks at once, etc. Five participants suggested **more charts**, e.g. cadence, heart rate, average elevation, calories burnt. Four participants suggested **design changes**, such as adding night mode or a footer. Two participants suggested having a **connection between the speed-elevation graph** and the plot: as we hover over either one, a small point could indicate the location on the other feature. Two participants suggested indicating the start and end point of the track on the map, and a further two suggested **comparing tracks** on the same route but different run, or categorising trainings by sport discipline. To the last optional question, most responses were compliments, however four participants mentioned that there should be **more accessibility options,** e.g. alt text in html to make it work with screen reader as well as colorblind mode.

DISCUSSION

The immediate conclusion to draw is certainly about the speed and elevation graph. Approximately half of the participants found it too small and cramped with data, and suggested increasing its size, while decreasing the size of the map. However, a decent amount of people chose the map as the most visually appealing and informative part of the web page, hence we need to find a middle ground, an acceptable compromise for both groups. This could be a basis for an excellent A/B testing study, however for the purposes of the demonstration, we will increase the size of the chart slightly.

Another realization is that the button “Next Track” is confusing for the first-time visitor until more than one tracks had been uploaded. This criticism is completely justified, and we decided to hide the button until the user uploaded at least two tracks. An excellent suggestion was adding the dark mode feature for accessibility, which was implemented shortly after the user study. A significant number of participants were confused by the color bar indicating average speed. We could mitigate this problem by personalising the extreme values of distance and speed and changing the colour scheme to colours with greater contrast (e.g. green for slow, red for fast).

As for further features to implement, based on the responses of our participants, interaction between the plotted track and the graph seems like a reasonable step: this would increase the popularity of both features, it would provide more information about the track as well as generate better user experience due to enhanced interaction. The way we imagine this is that if a user hovers over the elevation-speed graph or the plotted track, we would indicate the position on the other feature. Another frequently requested feature candidate is to make it possible for users to switch between tracks by clicking on the squares depicting the uploaded tracks.

CONCLUSION

The result was a successful webpage that visualised data retrieved from gpx files uploaded by users and provides basic error handling on the most common errors such as wrong or corrupt input file. GPX VisRev provides a graphically simple yet pleasing design and layout, and the data displayed was found informative according to our user study. There is still room for improvement however in terms of additional features and making the existing ones more interactive.

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