Project Title: Night on Earth

Project Members:

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Word Count: 5823

Project Output	**Output Description**
Project Output Files	Zip File on Moodle / Zip File download link emailed to duncan.a.smith@ucl.ac.uk
Presentation Slides	Powerpoint included in Output Files
Project Website	https://casagroupproject.github.io/ https://github.com/casagroupproject/casagroupproject.github.io

Night on Earth

1. Themes and Motivation

1.1 Project Overview

Under the theme of ‘The Pulse of the City’, the presented interactive visualisation Night on Earth focuses on the current issues of light pollution and human well-being from both a global and the city-wide perspective. We imagine pulse as the rhythmical interaction of light, darkness and social network activity by exploring the effect of natural and anthropogenic light sources on sleep quality and digital well-being. The idea is delivered through an immersive web-based experience developed through the extensive languages of JavaScript, Three.js, WebGL and Processing.js, it aims to provoke the users’ reflection on the global night pollution and our daily well-being in an exploratory environment.

1.2 Inspiration and Justification

Night on earth (Jim Jarmusch, 1991)

Written and directed by Jim Jarmusch, Night on Earth is a film made of 5 vignettes about the interaction of the taxi driver and their customers in five different cities (Los Angeles, New York, Rome, Paris and Helsinki) during the same night. It uses a parallel storytelling to explore different city cultures by focusing on the temporary bond in a taxi ride. The film sends a strong message that each city has their own pulse, and how it is amplified through the lens of night. Inspired by this idea, our visualisation project adopts the film title and also samples a collection of diverse cities, aiming to further extend the discussion of the urban humanity and city night culture through the interactive storytelling.

How we are losing the night (BBC, 2017)

‘How we are losing the night’ is a media campaign initialised by BBC Science and environment to discuss the global issue of light pollution and its associated effects on global ecology and human behavior. It suggests that the artificially lit area in the earth is increasing more than 2% annually since 2012, which leads to an increasing loss of night in growing countries (Gill, 2017). Since developing countries like India and developed nations such as the UK and the United States are facing the same problem, and the excessive artificial light can disturb human’s sleep and health, nocturnal animal and seasonal patterns, researchers claim greater efforts should be given to improve the worldwide light pollution (Schernhammer and Stone, 2011). In this presented project, we would like to focus on the sleep well-being as one key factor and explore the interaction of light pollution and human well-being to raise the attention and reflection to the environmental issue.

2. Datasets and Statistical Analysis

In this coursework, we choose six cities based on cultural and geographic diversity to explore the relationship between light and human well-being. For this purpose, we group the data into two categories: data relating to light sources and data relating to human activity. We further subdivide the light data into data about anthropological light sources and data about natural light sources. The dataset 'Globe at Night', covering the human-caused light sources, contains crowd-sourced data indicating global light pollution. The entire data can be downloaded online[1]. The metric used to describe light pollution is the Limiting Magnitude (LM), a value ranging from zero to seven, where seven indicates a completely clear sky. Some readings also include a Sky Quality Meter (SQM) reading: In this case, the sky brightness is measured with a professional device, where a larger value indicates a clearer sky. The Globe at Night is a program of the National Optical Astronomy Observatory, the national center for ground-based nighttime astronomy in the United States, operated by the Association of Universities for Research in Astronomy (AURA). For the purpose of this coursework, we only focus on the data from 2017, with a total of 15,382 observations from around the world (Figure 1).

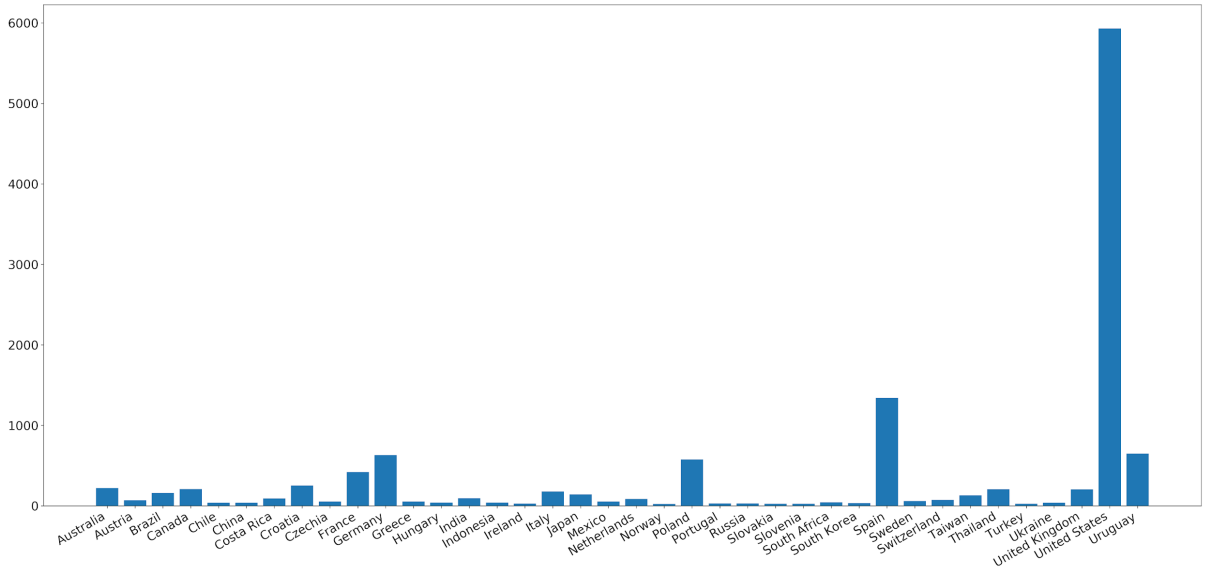


Figure 1. Number of readings per country

[1] Globe at Night project: https://www.globeatnight.org/maps.php

As a secondary source, we use NASA night-time satellite imagery from the NASA Suomi Mission in 2012 for each city[2]. The data can be downloaded as geo positioned raster images from the NASA Worldviewer application (Figure 2). Natural sources of light, that is the sunrise and sunset times for each city, can be obtained from various sources online[3].

Figure 2. 3 NASA images

We subdivide the human activity data into social network activity and reading on the human metabolism. Our source for social network activity data is Twitter. As our focus is on well-being related to sleep behavior, we limit our search to Tweets that contain the keyword 'sleep' in the predominant language of each city. Using the official Twitter API[4] and R, we obtained 13,838 tweets in total from April 6 to April 11, including the content of the tweet, the time and a location (Figure 3). In addition, those tweets are analysed based on their emotion by using the R sentimental analysis package.

[2] NASA imagery: https://worldview.earthdata.nasa.gov
[3] Night and Day data: http://aa.usno.navy.mil/data/docs/Dur_OneYear.php/
[4] Official Twitter API: https://apps.twitter.com/

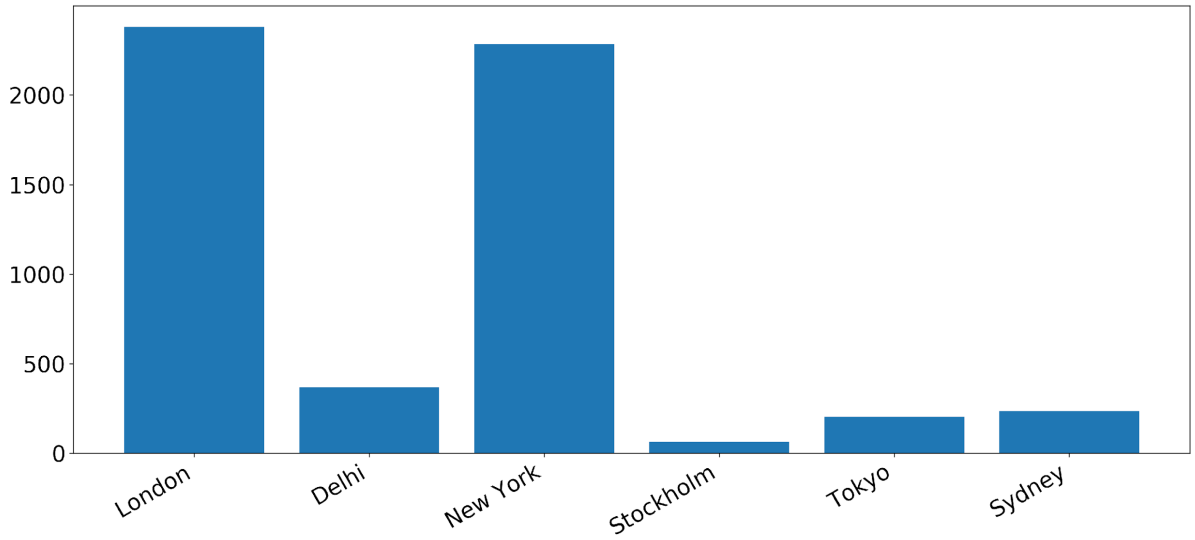


Figure 3. Tweet counts per city

The data about body activity is obtained from the Department of Psychology at the Boise State University[5]. It contains 336 readings each for systolic and diastolic blood pressure as well as heart rate including a timestamp of a 47-year old male over seven consecutive days (Figure 4).

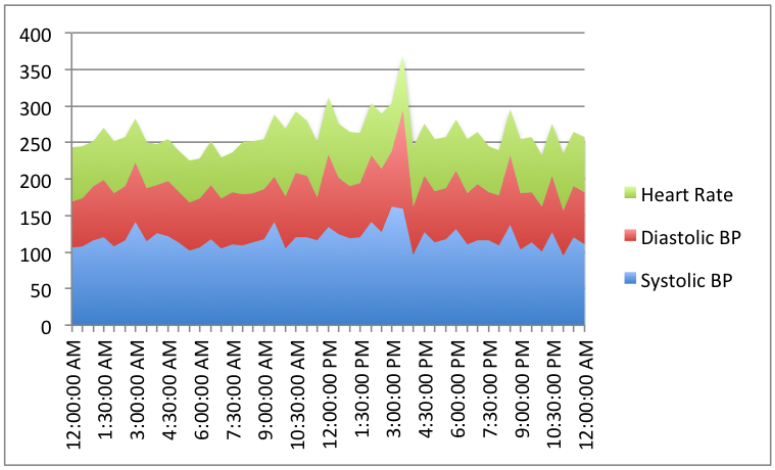


*Figure SEQ Figure * ARABIC 4. Metabolism Readings from a Monday*

3. Methodology and Implementation

3.1 Website Architecture

A flat website hierarchy is adopted for organising the visualisation contents. Starting at the top with a pre-loader page and a single homepage with the global LM data, the website has two sub-layers visualising the Tweets, light and Circadian data

[5] http://www.circadian.org/data

respectively (Figure 5). Benefiting from this simple and intuitive structure, the contents are more discoverable without being buried under multiple intervening pages, thus helping users better follow the interactive storytelling about light and human wellbeing (Whitenton, 2013). Each page is well-linked to the parent and child element, ensuring a strong accessibility to switch between different contents.

The content design and data type in each layer are also coherent from the chosen theme with a logical consistency. The introduction page has a universe-stimulated background with the button linking to the globe view on the homepage. Through the navigation link on the homepage, users can zoom into 6 specific cities to get more detailed information. After that, further insights about the Circadian clock of the human body are provided in the last layer. Therefore, following the natural consequences of the webpage organization, user can easily experience the visualised journey from universe to earth, from city to citizen, which serve as an inner clue for the informative storytelling. The first subpage uses the Bootstrap[6] frame work to set up the two column grid. Bootstrap is a very popular HTML, CSS, and JS framework for developing responsive, mobile first projects on the web.

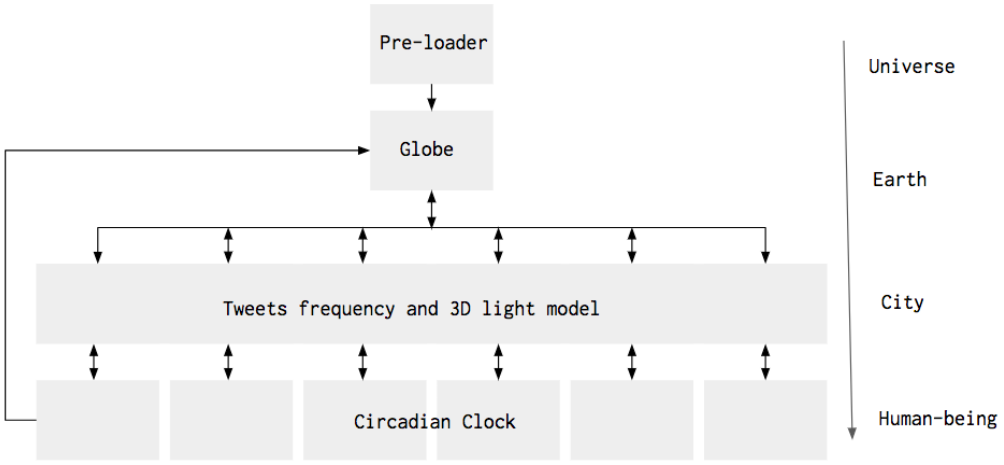


Figure 5. Website structure

3.2 Introduction Page and Globe Splash

Both the pre-loader and homepage sections are built through the web development language JavaScript with the collective libraries of JQuery, Three.Js and WebGL. It gives a practical solution to create an interactive 3D view on the client side with great accessibility.

In the pre-loader page, an immersive universe environment is created as the animated background by using the particle system to visualise the floating stars. A

[6] BootStrap official website: https://getbootstrap.com/

mouse event allows the user to change the background orientation when moving around the mouse. This interaction is implemented by mapping the 3D camera position (x, y, z-axis) with the dynamic mouse location from the user input. A typewriter effect is created for presenting the text content of the project's objective for giving the visitors the idea overview.

After clicking the lightbulb button, the user lands on the homepage started with a globe splash animation (Figure 6). The spinning globe visualises the LM data with a range from 0 to 7, where a bigger number indicates a clearer sky view and comparatively lower light pollution. The 3D earth and its associated animation are rendered out in real-time on the webpage, and coded based on the Google WebGL globe experiment[7]. All the elements (earth globe, pin, marker) are created by Three.js geometry and encapsulated to the globe object system following the concept of object-oriented programming. All the animation effects are achieved based on the time-related functions including 'setTimeOut( )' and 'setInterval( )' methods, which helps generate the dynamic interaction between camera viewpoint and real-time frame count on the user side. To deal with the bias and error in the crowdsourcing LM dataset, the raw limited magnitude data is firstly screened through static plots in Python for potential outliers and patterns. The data in the same country are then aggregated together for an average value. Since all the value entries are projected to the globe based on their geo coordinates, the GoogleMap API is used to regenerate the latitude and longitude information for each recorded country. The processed data set is finally stored in a JSON-style list and passed to the key functions of 'addPin( )' and 'addMarker( )' for the globe-based data visualisation. A circle-style navigation button is added on the left side of the globe, where user can choose to explore more information details about the six specific cities. The pop-up effect of the city selection is achieved by a combined use of JavaScript and CSS, which changes the 'div' element style dynamically based on the user mouse event.

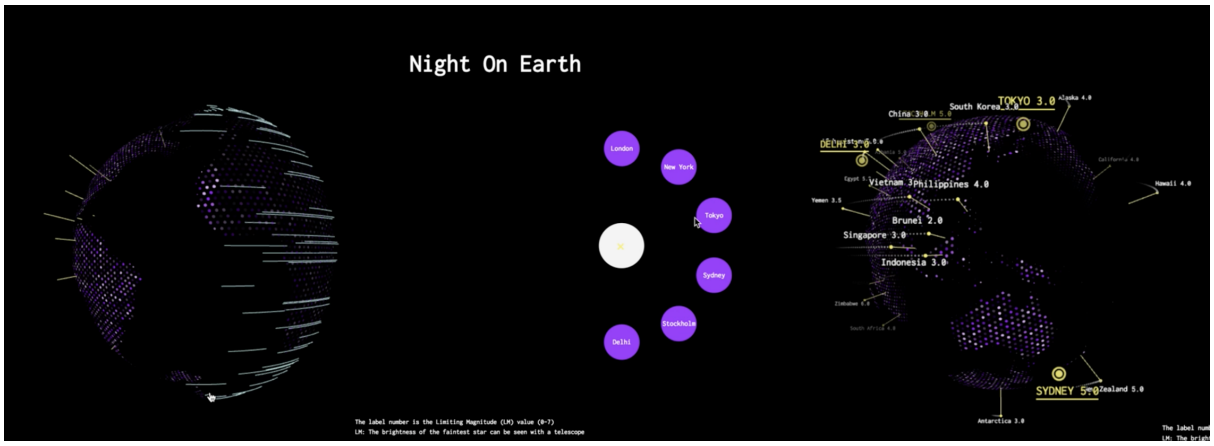


Figure 6. Splash animation and globe visualisation

[7] Google WebGL globe experiment: https://experiments.withgoogle.com/chrome/globe

The above implementations successfully implement the extensive web development and data visualisation skills, from the raw data processing to the front-end engineering. The use of ThreeJs[8] and WebGL presents a strong 3D visual effect to immerse users in the informative storytelling. A responsive design is implemented to adapt to different window sizes and mobile devices, at the same time great attention is also paid to optimise the web usability. While the pre-loader page uses an animated effect to introduce the website concept in an artistic way, it also serves as a buffer to load all the JS libraries in advance to ensure a better user experience. However, one limitation is that the use of the 3D globe can only show half of the global LM data on the user view at one time, which does not allow a completed view for the worldwide comparison. Also, the interactive button may cause confusion to specific users who are more comfortable with a more intuitive UI design.

3.3 Light Landscapes

The purpose of the light landscapes is to visualise different patterns of light pollution across different cities and to enable the user to explore those patterns by making the 3D diagrams interactive. The idea was inspired by the city density diagrams from the LSE Cities programme [9]. In the web framework, the landscapes are part of a one-page city overview that displays key data about light pollution and Twitter data for each city. We downloaded a satellite image from the NASA Suomi Mission of 150 by 150 pixel for each city and its surrounding area, which translates to an area of 750km by 750km. The large area that extends well beyond the official city borders was chosen because earlier tests with smaller bounding boxes resulted in no visible pattern. With a small bounding box, the light intensity was equally spread across the image for very large cities like Delhi. With a larger bounding box, the difference between city and rural areas is made visible. The 3D object based on the image data was procedurally generated in Unity 3D using a custom C# script. The script loads the image and turns it into black and white image with pixel values ranging from 0 to 255, where 0 is black. These pixel values are stored in an array. The voxel effect is created by pushing a primitive cube (a built-in object in Unity3D) 150 times along the x-axis and the y-axis. For each cube, the pixel value from the stored array including a scaling factor is assigned as cube height. Other options were tested, such as the height map terrain generation in Unity 3D that creates a similar effect and does not require any custom scripting (Figure 7).

[8] Three.JS library: http://threejs.org

[9] Density diagrams: https://lsecities.net/media/objects/articles/measuring-density/en-gb/

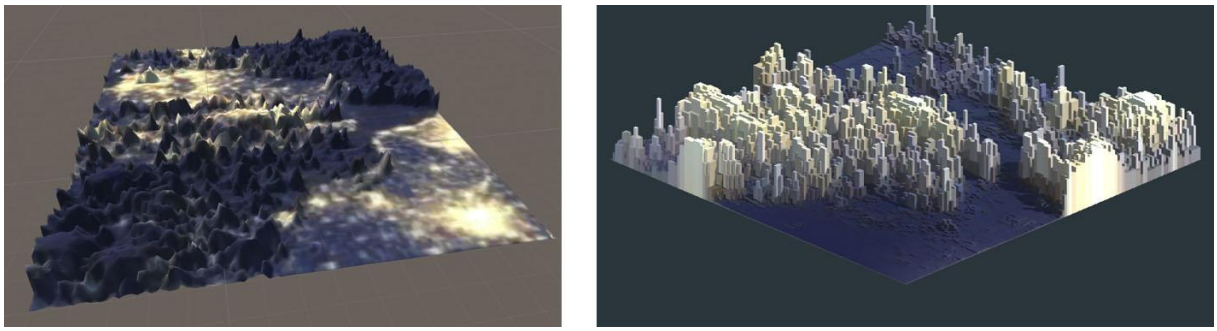


Figure 7. Unity tests (terrain height map and custom script)

The advantage of using built-in functionalities to generate the landscape is that exporting becomes easier. However, the visual effect is less compelling. We therefore chose the custom procedural generation in C#. To export the C# script in runtime, several Editor scripts from the Unity Asset Store were downloaded and tested. The only working script is an asset named ‘obj scene exporter’ that is able to export the script as .obj format, a common 3D format, in runtime. However, the texture was lost in the process and the resulting .obj had a size of roughly 22MB, which is too large to display in a web browser. We were able to decrease the size by 50% by converting the .obj to a binary .stl by using the 3D software Rhinoceros.

Several parts of the project, such as the globe and the light landscapes made extensive use of the Threejs library. Threejs is a JavaScript library used to create and display 3D graphics in a web browser. It is built on top of WebGL, another library for 3D graphics, but is known to be more accessible for beginners in computer graphics. Even though Threejs might look complex at first, it would take much more code to achieve the same goal in pure WebGL, mostly because WebGL requires the user to set up their own rendering engine. Threejs supplies prefab renderers. It also allows creating geometries as well as loading in external geometries: While the globe was generated within Threejs, the light landscapes are loaded in as .stl files using a specific loading function called ‘STLLoader()’. Displaying a single 3d model is relatively easy: The key Threejs elements needed to display a 3d geometry in a web browser are a scene, a camera and a renderer. The scene is the area we define to locate the 3d objects, the camera sets up the view and the renderer is in charge of displaying the content. For the purpose of this coursework, we chose to work with WebGL renderers only. By directly accessing the GPU (Graphics Processing Unit), the WebGL renderer outperforms than other renderers by several orders of magnitude. Despite the simple setup, loading and rendering six different 3D models proved to be a challenge. After trying out several different methods, we decided to load all objects in a loop, where each scene element, the HTML DOM container the scene element is attached to and the camera are dynamically generated within JavaScript. Each scene has its individual controls to move, zoom and rotate. Only one renderer is instantiated outside of the loop, rendering all six scenes at the same time. Similarly to the overall web framework, each HTML scene container is

responsive: the ‘updateSize()’ functions makes sure that when the screen is resized, the renderer re-renders the scene according to the new dimensions (Figure 8).

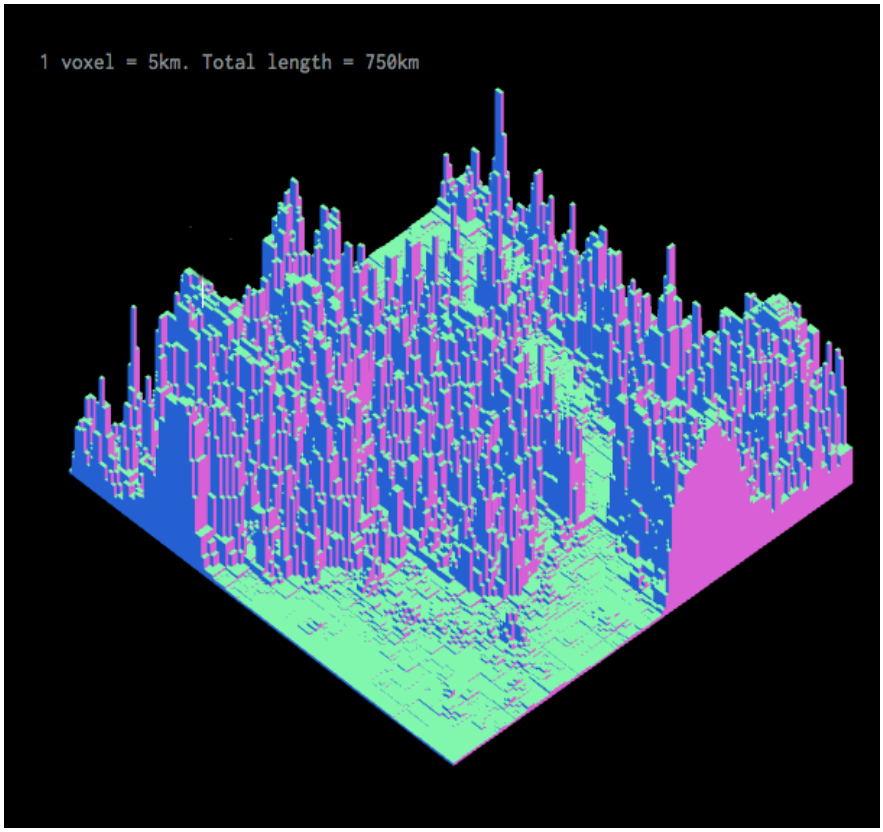


Figure 8. Example Three.js viewport (London)

To create the summary statistics that are embedded in the webpage text, the pixel values of a black and white image for each city were extracted with the Python Imaging Library (PIL) in Python (Table 1). For each pixel, the value ranges from 0 to 255, where 0 is black. The image analysis shows that Delhi reaches the highest mean pixel value and therefore the highest overall brightness. However, the high standard deviance for London and New York, the second and third brightest cities, indicates that the light sources in these two cities are much more condensed.

Table 1	**London**	**Delhi**	**New York**	**Stockholm**	**Tokyo**	**Sydney**
Pixel count	22500	22500	22500	22500	22500	22500
mean	48	53	42	13	23	10
std	61	45	63	25	47	19
min	0	0	0	0	0	0
max	255	255	255	251	255	255

3.4 Night and Day Twitter Dashboard

The Tweet frequency chart and the day and night dashboard are trying to show the number of Tweets containing the word "sleep" in the local language (‘sleep Tweets’). We gathered data for different times of the day with different coordinates based on the city. The length of daytime and nighttime in the graph visualises the relationship between the length of dark and the quality of people’s sleeping. In this case, we decided to implement a dynamic 2D graph in order to show the sleep Tweets data and the length of night time in different city separately. In addition, we make a comparison for all six cities compiled in one graph.

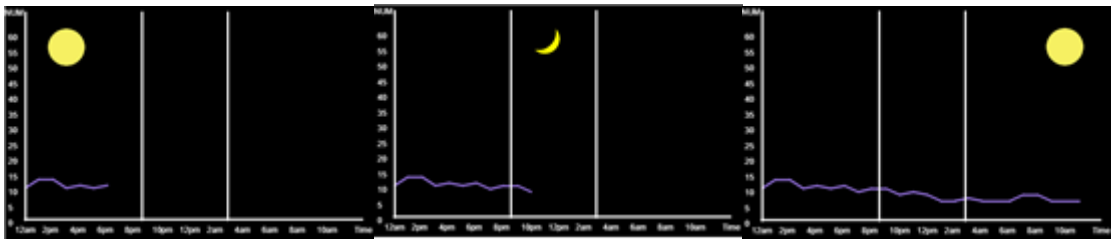


Figure 9. The first graph shows in the dashboard

Figure 9 displays three example screenshots of one instance in the Tweets frequency chart of Tokyo. The animated line is moving at a frame rate of 10. The x-axis of the chart is the time of the day and the y-axis is the number of sleep Tweets sent. We set 12am in the middle of the graph because we want to draw the users attention on the night time. The sun and moon icon on top of the graph indicates night and day time. The two vertical lines in the middle of the graph give an additional indication on whether it is night or day in each city. In order to give the user a quick overview, we compile the number of Tweets for working hours (9am to 5pm) and resting hours (5pm to 9am) in an average in the text above the graph.

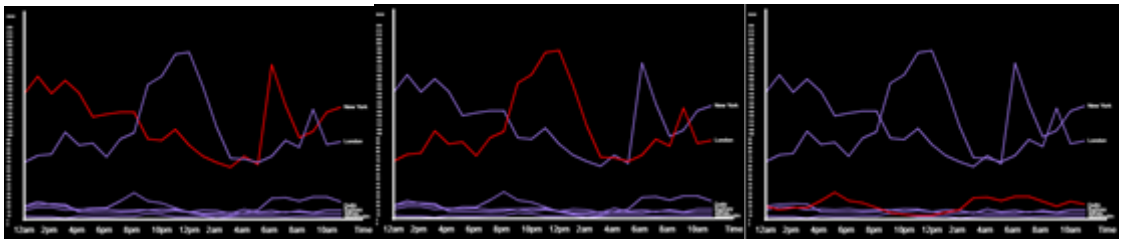


Figure 10. Aggregated comparison of six city

Figure 10 is the step 2 in the dashboard New York, London, and Delhi. The red line indicates the city we want to show in the first step. By creating an aggregated graph, we can compare each city’s Tweet counts regarding the theme of sleep.

3.4.1 Tools Used

The data collected from Twitter API is raw data, so it is necessary to extensively clean it. Python is a wonderful tool for data cleaning: we use the Python library

Pandas to do the data cleaning, calculate the average and create a new data file for sleep Tweets. Processing is a useful visualisation tool. Processing is based on Java and it is usually used to draw graphs or create artistic pieces of code. In order to upload the processing (.pde) file to our website, we use a tool called Processing.js. Processing.js is a friendly alternative for Processing users who are not familiar with Javascript. However, in some cases it is not suitable to use Processing.js, as certain functions, such as 'loadtable()', do not exist. In addition, if you want to visualise a huge amounts of data, Processing.js is not an ideal choice because large tables have to be stored within the processing sketch. Since the Tweets data and the day and night time data is relatively small, Processing.js is a sensible choice. The data can simply be stored in an array within the sketch.

3.4.2 Technical Implementation

We use two global values to make the graph easier to rescale: g and y. Every coordinate and size is increased g times. Therefore, whenever we want to zoom in or zoom out the dashboard, we only need to change the variable "g". "y" is used to change the scale of the y-axis and it represents the interval of 1 Sleep tweet. It can be seen in the graphs that the data of London and New York is several times larger than the other cities. When we visualise the data of London and New York, we make it easier to see by reducing the interval of each number.

The variable "k" and "i" are two very important global variables representing time. To make the graph moving, we let i=i+1 and k=k+1. In order to convert different steps and make an infinite loop for the website, we create a timeline: In each different time zone, Processing will draw the different parts of the dashboard.

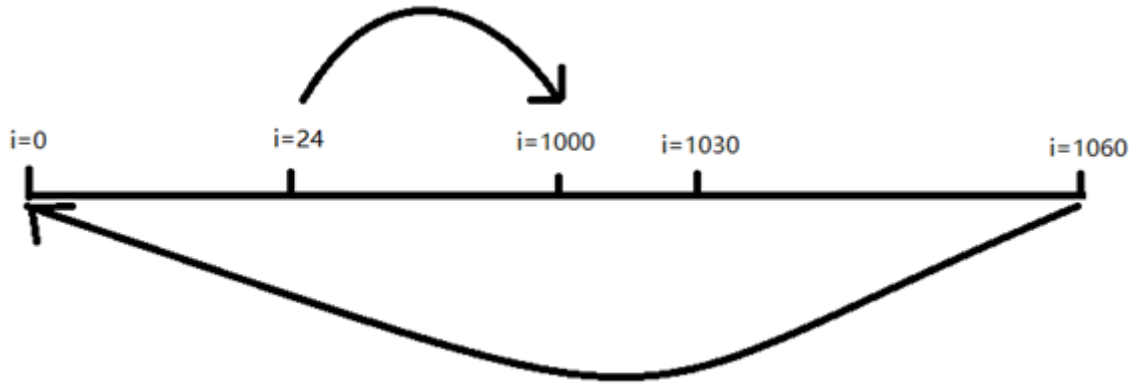


Figure 11. The timeline

As we can see, when the "i" is equal to a number, it can jump to the time zone we want it to. Theoretically speaking, this allows us visualise as much data as we want, and we can also create some buttons to select the timezone we want "i" to be.

In addition, we create two variables for the sun and moon icon: "dt" and "nt", when nt<k<dt, the moon shows up, otherwise, a sun will be drawn. During the conversion process, we use a rectangle with the background color to cover the last sun or moon.

During the data analysis, we discovered that people in New York and London like to talk about sleep at night. They send large amounts of sleep Tweets. In addition, these two cities have a high level of light pollution at night in the city center. Stockholm is the only city which does not have decreased brightness during the night in summer due to its high latitude. Strangely, only few people talk about sleep in Stockholm in summer. Our explanation is that sunlight does not affect people's sleep behaviours.

3.5 Circadian Clock

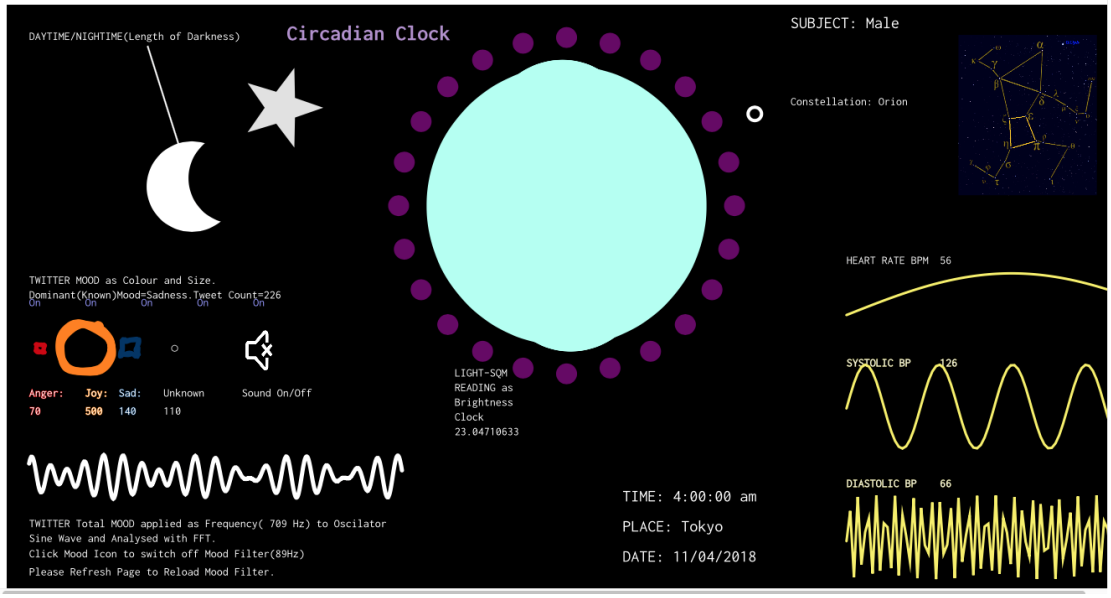


Figure 12. Circadian clock

3.5.1 Aims

Using the idea of clocks and time seemed to be a good way of fusing and giving life to the themes highlighted in the Group Project Theses and Motivation. In exploring rhythmical interaction a stop-watch acts as an objective gauge and central point of reference with which to compare the movement of the participating thematic actors(Light, Twitter, Pulse Rate, Night Time). The clock is also a fitting motif for the idea of sleep well-being (or, for some, the increasing lack of it) in the unrelenting, paced slipstream of the modern, urban environment.

The image of clocks ticking and a sense of accompanying anxiety might appeal and engage those already sympathetic to the idea of sleep well-being but also might pester or trigger a latent interest in other members of our demographic target group.

These might be good ways to employ an effective visualisation, for instance a web or media campaign raising awareness for light pollution (or at least Modern Living) and its possible role in mutating the natural Circadian clock cycles that mankind has developed over millennia (Chepesiuk, 2009).

To the aim of thematic engagement we also sought to incorporate two other relevant ideas: that of the representation of time in the urban environment (Lynch, 1972) and the possibility of urban design as envelopes or flows of information (Benjamin and Yang, 2011).

We sought to explore the Lynchian idea of looking at representing time in different and innovative ways as seen in the urban fabric. This might help create an Urban Environment that is more in tune with the different individuals that it encapsulates.

Having decided on Processing and, as a Web Based Project, the contemporary emerging JavaScript platform P5.JS, it seemed natural to refer to Daniel Shiffman's *Nature of Code* (2012) and its focus on representing natural, physical forces in programming code. In particular the chapter on oscillation and its expounding of waves and pendulums seemed types of movement that should be involved in the Sketch.

We thought of time in terms of phases rather than ordinal clicks, and hoped we might even explore time and timed events as synchronous and multi dimensional entities. A dashboard might allow the user to experience different ideas simultaneously and allow us to investigate different forms and senses to receive these forms: colour, shape, size, touch, smell and sound. These are the ideas that are raised in Lynch's *What Time is this Place*? (1972). We wanted to fuse the different elements of the theses and explore how they were all fundamentally related and how movement in one or a group of actors might promote movement in the other subjects/themes featured in this scenario.

3.5.2 Data

We focused on preparing the London dataset with a realistic and statistically relevant data. We applied a rough and ready mixture of SQL Server AVG and MEDIAN aggregate functions to populate NULL values from the London X and Y Coordinate data extract(MEDIAN is a bit trickier to apply to GROUP BY queries). For the other cities we used the Excel Random Between Function generating random values within real data ranges seen in the data. Ideally, we would have obtained Circadian data for subjects from the same time and place as the Light and Twitter datasets. Recently, the Fit Bit Company (Kosecki, 2018) released anonymous analysis of the sleep data generated by its large number of users. We might have harvested sleep data from the team members from the 11/04/2018 though time constraints did not allow. Night and Day times were obtained as sunrise and sunset for the dates and locations (although not all) in question from data.gov.uk.

3.5.3 Prototype Code

All code and code ideas were borrowed from P5.JS website, the Open Processing WebSite, the Processing Modules from this course, Daniel Shiffman's Nature of Code Course and from the CASA Introduction to Programming Module from 2017.

Further time might have spent on producing more efficient, intelligent and elegant code. Notably the responsiveness of the code in diverse platforms and screen sizes suffered. Originally rapidly developed on an 1920 by 1080 Imac, not enough use was made of dynamic Width and Height P5 constants. A rushed working version was produced to work reasonably well on a 13.3 Inch MacBook with Safari (also Chrome) at 1280 by 800. In the rush to get a functioning suggestive prototype off the ground several, code and data reliability elements suffered.

3.5.4 Technical Implementation and Challenges

Each element will be discussed by moving through each clock component on the Screen (clockwise).

Star Constellations: Star Constellations are included in the Globe At Night data, LM (increasingly seen as subjective and unreliable) values use visibility of cyclical Star Constellations for that time and place as the reference point for measuring extent of visibility. Ideally this would be a data driven component and use astronomically correct images.

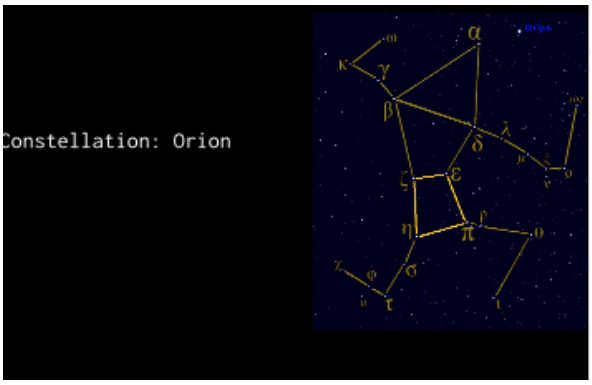


Figure 13. Loading the Constellation data for our Time and Place

Vital Life Signs: Frequency is a measure of the number of waves over time. amplitude is the strength or maximum disturbance of a wave measure. As regards the P5.js tools readily available, pulse might best be measured in terms of frequency and blood pressure in terms of amplitude. The clumsy wave response (mm/HG or millimetres of mercury) used for the diastolic pressure add in (bottom of the 3 waves) was opted for in order to perk up that part of the dashboard. In fact, throughout the sketch, a variety of questionable code treatments were used to highlight differences and variance (division or multiplication of response variables) whilst keeping

approximate ratios in frame but using artistic license to create a general impression rather than a specific calculation.

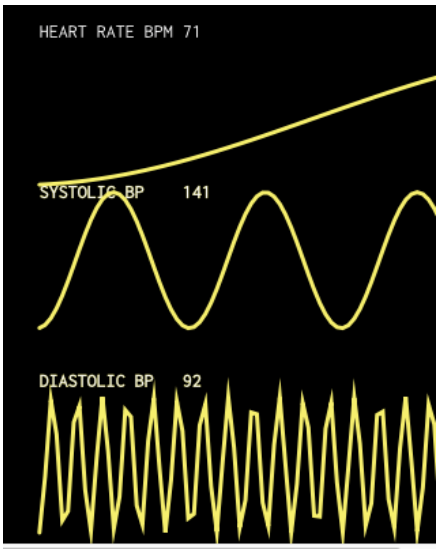


Figure 14. Vital Life Signs rendered using wave frequency and amplitude

Brightness Clock: The brightness clock might have benefitted from the employ of a different color range, perhaps using the design principles that underlie the color schema in the widely used Bortle Light Scale. However it could be said to succeed as a soothing point of focus for both the themes explored and the at times noisy overall dashboard effect of the sketch.

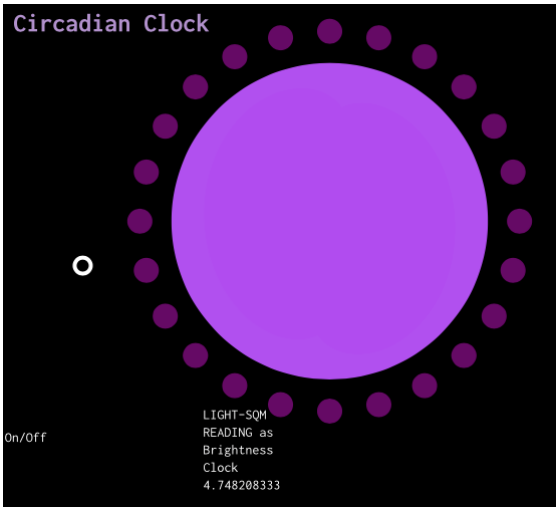


Figure 15. Circadian Motif used to explore Light SQM Readings

Audio Treatment and Analysis: Buttons have been included to switch the mood filter on and off and to switch the audio off completely. Ideally, different filter and EQ treatments would have been used to represent different mood prevalence in the aggregate Tweet stream of data (i.e. different channels for different types of mood).

Aural cues can be seen to be effective in conveying this aspect of the data (dominant emotional flavours of the aggregate Twitter count), and free up visual “information channels” in the visualisation, allowing for a less cluttered and direct data analysis experience.

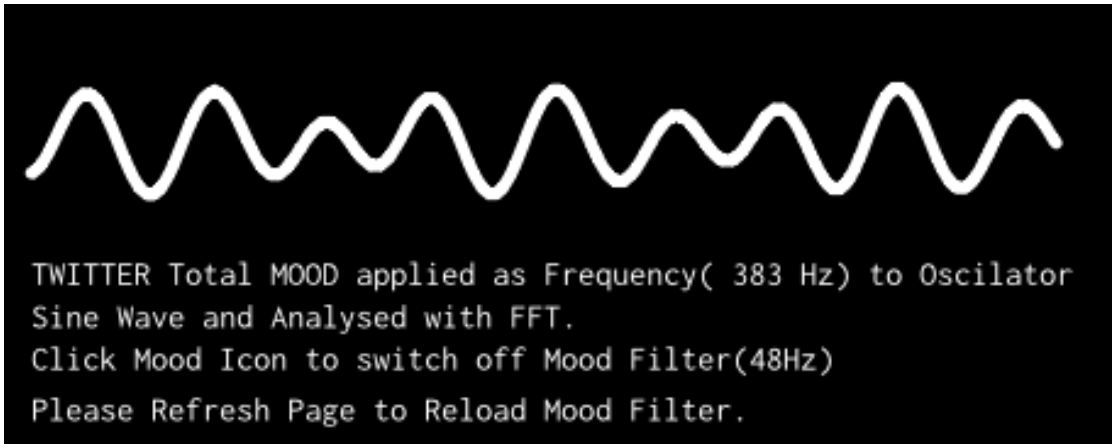


Figure 16. FFT and Oscillator Tools from the P5 Audio Library

Figure 17. Color and Size of Twitter Sentiment Analysis, applied as user controls for the Audio Tool

Night and Day Gauge: This might have been applied as a sketch control used to fast forward the user into night and day sections of the day. The star map component might also be used in this way and developed further to allow the user to configure the data being viewed or “played” with.

Figure 18. Using the P5.JS Code Examples Star Function

3.5.5 Some Observations

Whilst bearing firmly in mind the numerical and analytical limitations of our chosen data sets and motivation, some patterns and relationships are nevertheless discernible and could be built on with further analysis and visual exploration.

Circadian Spikes: Our male subject experienced expected observations in heart rate and blood pressure during parts of the day and week, according to what we know and expect in Circadian studies of human body cycles (Duffy, 2009). However there was an interesting one-off spike mid week late in the afternoon, which saw the highest levels of all three indicators recorded during that week. This might have been a visit to the gym or an unforeseen bout of physical exercise or even an episode of emotional stress, or a technical glitch.

General Light Pollution observations: Using London specific groupings of the data produced increases in visibility late at night (where data existed for London). However using AVG values of the aggregate GAN dataset brought atypically low values throughout the others, with outliers and nulls clearly skewing the data.

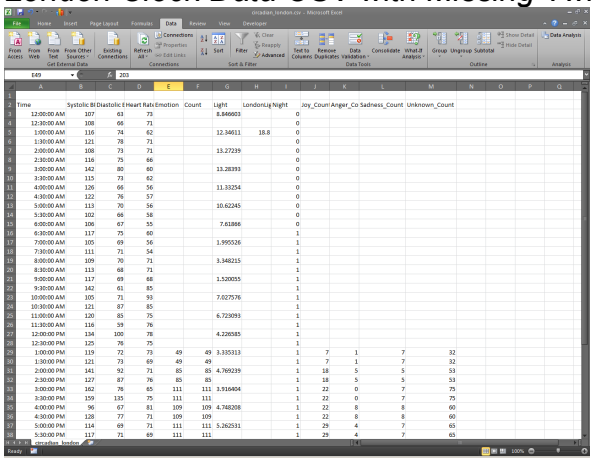
General Twitter Observations: Joyful Tweets increase as the evening proceeds, highlighting the socialized grounding (possibly bias) of these introspections and insights into human thoughts and feelings. There are a large number of unknown category Tweets in the sentiment analysis, and polarity strength increases as the day proceeds and the Twitter consciousness gets underway and becomes more defined and in rhythm with typical social behavioural norms (e.g. excited Tweeters greeting free time and the night time and seeking to be part of the night society reflected with positive outlooks or Tweets on life).

The synchronicity of some of these patterns are possibly apparent in the visualisation as is, and could be developed on and highlighted in future iterations.

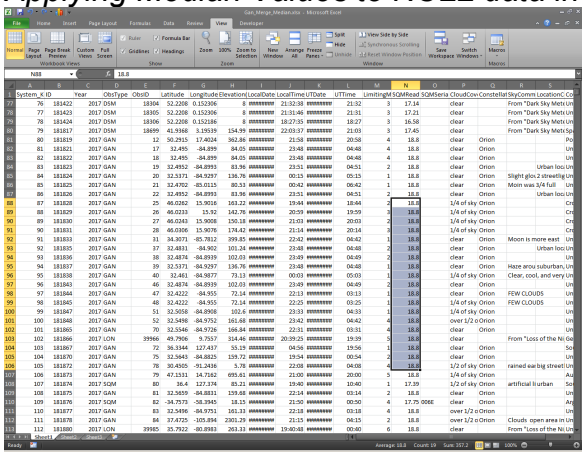
One potential direction for this experimental exercise might be in allowing Users to plug their own data into the Sketch(from their own harvested data from “Smart Wearables” or “Personal Health Monitor Devices” and from public repositories related to a particular Locations and times).

3.5.6 Further Data Preparations for the Clock Sketch

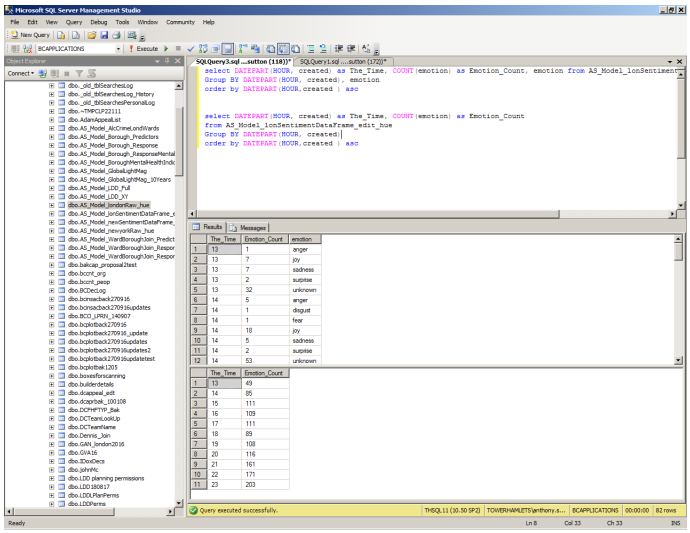
London Clock Data CSV with Missing Twitter and GAN Data



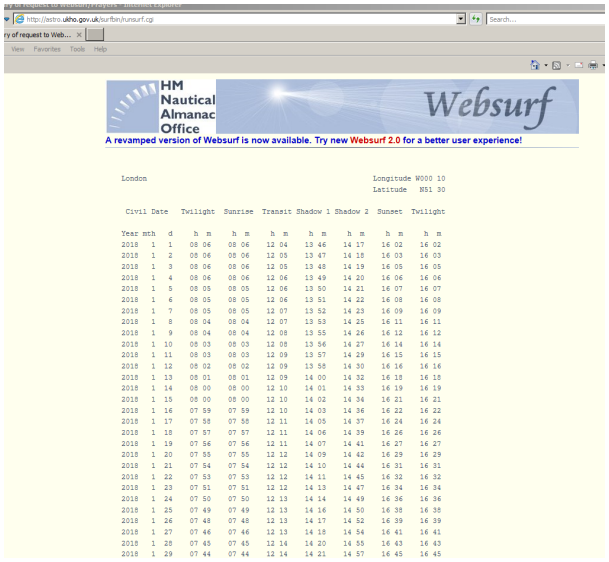
Applying Median Values to NULL data in the GAN dataset



Applying MEDIAN and AVG Values to Hourly Groupings with SQL Server



Verifying Length of Darkness data with Sunrise and Sunset times data from HM Nautical Almanac Office website



4. Conclusion

4.1 Summary

From the project outset it was agreed that we wanted to produce an experience that was immersive, personalized and that raised awareness on the underlying narrative of the chosen research motivation question.

4.1.1 Exploratory vs. Analytical

A major part of the project's overall narrative is to be found in looking for interesting but approximate/relative relationships between the constituent themes: rhythm, light/darkness, social network activity, natural or un-natural light, sleep well-being and insomnia. The various streams overlap and come to life in the thematic treatment of the key unifying story elements of Sleep and Night, which we have tried

to present in all the visualisations in fairly equal measure and to explore and unfold for the audience in a cohesive and interesting way.

4.1.2 Mix of Tools

The group have been flexible in exploring multiple platforms to achieve this aim including allowing the website an important role in drawing the user in and yet further in to the story to make core elements of the motivational question readily available for deeper inspection.

This is reflected in the consistent and evocative Art Direction led by Shu and Mel and which goes some way in conveying the mood and direction of the piece.

Shu's Global Visualisation gives the piece a geographically located emphasis, in keeping with the creative touchstone of Jarmusch's *Night on Earth* Film. Indeed, aspects of the whimsical but tenderly existential mood of the film could be seen in the creative decisions made and the personalities carried through into each individual's visualisation.

4.1.2 Theme Juxtaposition

Mel and James' Three JS rendering of their work in a juxtaposed fashion highlights the Group's willingness to collaborate effectively in pursuit of the common goal.

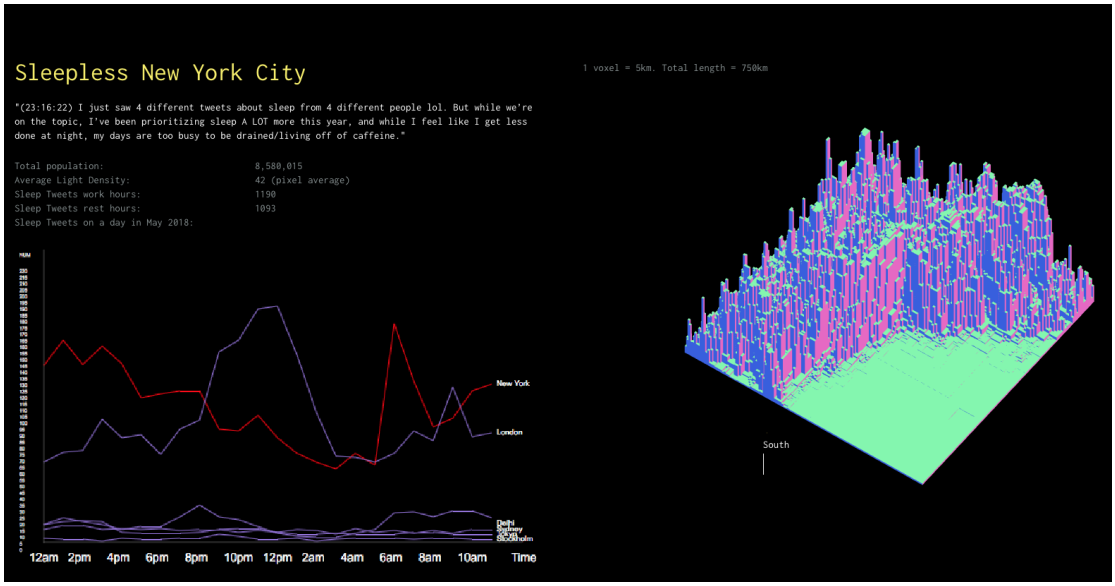


Figure 19. Combining Individual Vizualisations

4.1.3 Theme Drill Down

James' graph and statistically-driven visualisation (tailored to fit in with the soft character of the whole website) allows for a drilling down into the themes in a complementary way.

Similarly Mel's Unity Model presented a large amount of data in an immersive manner, and would provide a vast extensively explorable domain for the data narrative, outside of the website experience.

The Clock Sketch could have been more aesthetically pleasing, and clever in an algorithmic way or work a bit more like the Flickr flow visualisation as below (Figure 20). However, it does draw together all of the themes and provides some food for thought for the end user whilst ticking the box as regards immersion and rhythmical interaction.

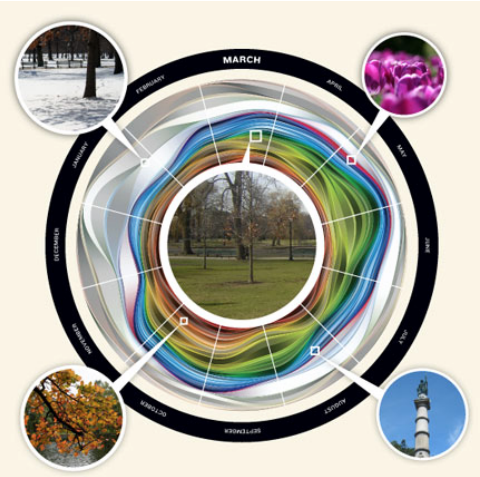


Figure 20. Flickr Seasonal Clock

4.2 Lessons Learned

The group made extensive use of the collaborative working area, documenting progress, sharing sources of artistic inspiration, reference documents and maintaining prototype, code, and data libraries in a well organised and hierarchical Google drive implementation.

It was also a good learning experience in terms of time management, in tailoring a loosely agile project methodology and in gaining familiarisation with some of the challenges that one can encounter when working on a creative project in a group setting. As individuals we tried to find a common focus and used initiative in locating areas of specialisation that work best for the group project as a whole, and which did not get in the way of the narrative and thematic direction.
As such, the group project is hopefully to some degree a total experience and the sum of its parts. We hoped to deliver a set of connected visualisations which

conveyed something of the essence of night time (and the quiet time that precedes sleep and dreams) and that is tactile, personable/approachable and that investigated issues of human relevance (the science of light pollution, sleep well-being).

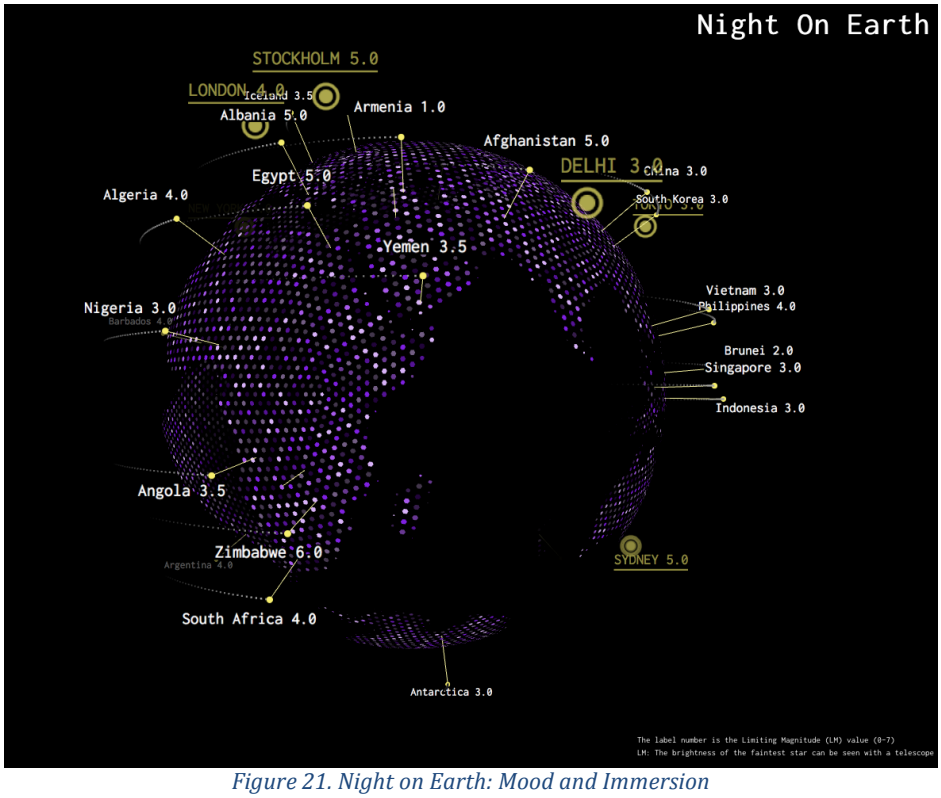


Figure 21. Night on Earth: Mood and Immersion

4.3 Further Extension

Although we visually achieved the aims we set to ourselves, there is still space of improvement for further enhancing the user experience. Firstly, we plan to further improve the cross-platform experience and better tailor it to different platforms and digital devices of varied screen sizes. It currently works reasonably well in most web browsers. However, in the mobile view, the subpage with the city overview can get stuck in the 3D model part, and it may be not easy for certain users to slide through the city overview quickly. Secondly, we are planning to improve the audio effects of the website in order to maximise the cinematic experience by adding more interactive sound elements, in particular in the pre-loading section. Thirdly, we intend to collect more data from the different social networking applications, such as Instagram, Foursquare and Facebook. We believe that by extending our data sources to broader and more objective datasets, further scientific insights will be gained about the relationship between light, city and well-being in a rigorous manner.

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Contribution Table

Task Name	Major Contributors	Additional Contributors	Relevant Chapters in Report
Concept Development	All team members		1
Thematic Treatment	Shu	All team members	1, All Chapters
Website Development	Shu	Melanie	3
Data preparation and integration	Melanie, Shu	Anthony, Pei	2
Visualisation 1	Shu		3
Visualisation 2	Melanie		3
Visualisation 3	James		3
Visualisation 4	Anthony		3
Summary	Anthony		4
Further Extension	Pei		4
Report Compilation	All team members		
Collaborative Working Tools and Project Mgmt	All team members		