Zooming Into Edinburgh

Color Illustration of The City

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Abstract

Social media dataset with massive social data, are often used to analyze social patterns. Opposed to only analyzing numbers (such as date, location indication) or words (such as tags), how could colors and “internal” metadata of user-generated photos be used to present a specific place and time? Since user-generated photos with subjective identification of objects can present a place diversely, will visualization of thousand of geo-tagged photos release common views or generate “collective memories” that different people will unconsciously share a similar memories for a specific place and time? This paper will explore the visualization methods for using user-generation photos collected from Flickr that is firmly embedded in a culture of connectivity, discuss “collective memories” in Edinburgh based on user-generated photos and explore color patterns for this city.

Key words: image data visualization, user-generated photos, collective memories, color pattern.

NOTE : Productions of image data visualization are available at : https://g130800038.github.io

All original codes and files are available at :

https://github.com/g130800038/g130800038.github.io

Introduction

Social media now are widely used to share personal experience and record daily routine. Photo-sharing site such as Flickr originally regarded as a photo repository has grown into a social network site with a constantly evolving database (Cox et al., 2008). Millions of user-generated photos and content are shared on the platform and metadata of these individual photographs are automatically (such as upload dates, locations) or manually (such as tags) linked. The constantly updated images from individual enrich the dataset where a collective and joint perspective on the world will gradually generate through the accumulation (Dijck, 2010). Construction of these connection has enable the platform connect common views of the world in a spatio-temporal scale and gives imaginations and potentials to trace social and cultural activities.

Launched in 2004, Flickr is lauded by some researchers for a visual archive where a large number of user-generated photos naturally lead to a “collective memory” (Ibid.) on past events. Flickr has its own search function with advanced options. Most information comes from tags, members or groups, enabling users to look for images related to particular topics and periods. Over twelve years construction, Flickr has become a prevalent database with many application programming interfaces (APIs) constructed. Many APIs developed by academics are used, for instance, to explore advanced search engines for photo recognition, while some applications work towards analyzing the intensity of relations between users for purpose of exploring social interaction (Mislove et al., 2008).

Unlike many investigations of social media data visualization that applies classic data visualization techniques (such as pie chart, timelines, network diagrams, etc.) and reveal patterns in standard metadata (such as image tags), Nadav Hochman and Lev Manovich (2013) have proposed that globally photo shared media and metadata,such as Instagram and Flickr, can be explored to study patterns on multiple scales - not only focusing on massive social data aggregated in space and

time, for instance, visualizations of movement of users in a city over a long period of time, but reading of local features and cultural events through images sets and their content. In other words, a large number of photos generated by individuals are indeed useful media to translate daily happenings and analyze shared view for a specific feature and event.

In contrast with a more classic approach in social network study, this project do not discuss a hypothesis or start with predetermined problems, but rather implement an visual exploration on two aspects, moving from an overview of color pattern of Edinburgh in cyclical time, to a mosaic visualization about “collective memories” in the city in terms of different color ranges. As previously suggested by Dijck’s study, Flickr indeed offers a “collective experiences and memories” on social events and culture. In the part of literature review, this project will discuss how a large number of connectively user-generated photos captured in a specific time and place can construct an “imaged data community” (Hochman and Tifentale, 2014). Then this paper will address on how to collect, visualize and explore the production of such “collective memories” with the media platform in ways that reveal its uniqueness as a culture archive and

Finally this project will execute the method of exploring a multi-scale reading, combining “distant reading” (Jänicke, 2015) of patterns with “close reading” (Ibid.) of particular photograph, which is appropriate for the social and color presentation of user-generated photos in Edinburgh. By applying a variety of visualization techniques, including polar pilot, montages, mosaic photography and some created graphic designs, the project shows how category volumes, spatial coordinates and visual feature (such as color) of Flickr photos over time can tell individuals’ stories and present their “collective memories”.

Literature Review

Introduction

Computer science researchers, analyzing large sets of data, typically generate patterns for social and cultural activities. Many Social media datasets with a large number of social data, such as Twitter, Facebook, YouTube, Instagram and Flickr, are used to study through this standard approach (Zheng and Hong, 2012). Although many research papers visualize large data sets in spatio-temporal scale, for instance, based on Twitter's activity to study people's movements during a long period of time across the world (Fischer, 2010), they sacrificed detailed individual information from dataset. This project, instead, is not only going to visualize thousands of individual photographs for color patterns, but also zoom into "internal" metadata of individual photos, for instance "close reading" of image content, to find "collective memories". There are several research papers addressing on visualization of geo-tagged photo collections and two specific areas particularly relevant.

Spatio-temporal images applications

The first related research area is analyses of satellite-based photograph applications, such as Google street view, location-based or event-based image applications, such as Foursquare. By comparing these two kinds of geographic visualizations, the features of user-generated images are worthy of discussing due to their subjective identification of objects. The most significant difference between satellite trajectories and user-generated photo datasets is in the way the data records are generated: satellite images lack semantic meaning and background information, for instance, images of Google street view or Google Earth are too objective or plain when depicting an area, while geo-tagged images captured by diversely individual people describe a place with more eye-catching objects and emotions.

Inherent characters of geo-tagged image

There are two kinds of metadata can be addressed about user-generated photos on social media: the automatic and manual annotation of images with “external” metadata (such as updated time, location, or textual tags created by users), and with “internal” metadata that is interpreted and passed by images’ contents itself.

These individual “external” visual metadata, on the one hand, are used to record and depict personal routine, on the other hand, are incorporated by social media platform for connecting relations among users or items. Text (such as tags, name of objects) or numbers (such as date, location indications) are not inclined to express an image (as an indexical sign) but rather to link it with all other images that share data similarity.

“Internal” metadata, instead, refers subjective identification of objects in an image. An object or place is likely to be presented diversely even in a same time because of different angles and focuses operated by users. On the other hand, when considering filter function of processing photos, personal preference and emotion will have significant effects on the final production of photographs updated on social media platform. When analyzing atmosphere (emotion) of an image, color and brightness are two very important indications (Cai, 2014). By adjusting hues, contrast, lightness or other color attribution, each intended filter operation evokes a distinctive “feel” replacing or re-creating the message delivered by an image. By this means, when taking a picture in a specific place and time, individuals are likely to use a filter to it to suggest a different atmosphere that they believe is the most common or suitable.

Imaged data communities

Big data (Li, 2016) is extremely helpful with gathering quantitative information about new trends,

behaviors and preferences, while thick data (Alles, 2014) is qualitative information that provides insights into the everyday emotional lives of consumers. In term of digital humanities, Presner (2014) proposed an ideal state about HyperCities by mapping thick data (or thick mapping):

“Imagine a digital narrative crisscrossing place and time, starting with the date and location of your birth. The narrative grows, fragments, and connects many places and times together, as your life unfolds and as you tell your story. Any event in your life can be geo- and time-located, and each event connects with innumerable other events in your life and the lives of others. Everyone’s life story intersects with countless others at every moment, creating ever denser webs that document the complexity of the human experience. Every story matters, every voice can be heard, every event—no matter how big or how small — can be captured. ”

Today, internet-based mapping applications, such as Google Earth, have brought the analytic methods of Geographic Information Systems (GIS) to public in general and are altering the approach people process, visualize, explore, and access geographic information. Although idea of a memorable and narrative archival of thick data over human beings is quite unrealistic, it is quite inspired for mapping user-generated photos that may not present external reality, but attempt to reflect memories and lives of individuals. Because user-generated photos are highly related to people’s life and provide personal views, experiences and memories of specific place or objects during that period of time, mappings of these user-generated data (photographs) can be considered as a set of trajectories of a group of users or as spatio-temporal events and useful to emerge or highlight places of interest. By visualizing hundreds and thousands of these geo-tagged images that has similar content or same tags, “collective memories” are probably revealed and a digital “imaged community” are likely to be generated.

Algorithmic analysis

The second area is algorithmic analysis for large image sets, in other words, what kind of metadata is supposed to be used as analytical elements. By examining text tags and geo-spatial visual data created by users of popular social network, such as Instagram and Flickr, some studies provide algorithms of using metadata to carry out comparison of behavioral patterns of different user communities on geo-tagged photo data (Jaffe, et al., 2006; Simon, et al., 2007); or estimate ecological phenomena analyzing spatio-temporal photos (Haipeng, et al., 2012). There are also studies exploiting the visual quality of photos perceived by humans, and introducing a methodology for ranking and classifying photos in terms of “attractiveness” (San Pedro and Siersdorfer, 2009). Besides, some academics emphasize on exploring “internal” metadata of images. Study of Carl Doersch and Saurabh Singh (2012) seeks to automatically find most distinctive visual elements of a given large repository of geo-tagged images for a certain geo-spatial area. In a digital thought facility project called selfieCity (Manovich, 2014), researchers generate a unique dataset compiled thousands of selfies images of several city from Instagram by manually verifying distinctive elements, such as eye, nose, mouth and gender, then visualizes the degrees of different emotional expressions.

Existing studies also cover a lot about spatio-temporal researches by using social media image data, including analysis of people’s behavior and action using geo-tagged photo collections in Flickr and Panoramio (Kisilevich, 2010); visualization of large sets of Instagram photos to offer social and cultural insight of people for a specific place and time (Hochman and Manovich, 2013). In paper, Utilizing Social Media to Understand the Dynamics of A City, Justin Cranshaw (2012) discuss how to depict a dynamic city for tracing social and place proximities by gathering check-in data from social networks. Foursquare is a typical application, applying these theories, that gives a good example how user-generated photos are used to show defined areas. However, these check-in data (displayed on Foursquare) may cause bias of sight view, especial for famous scenic spots,

because they ignore the clustering of images (distant reading) and do not show a pattern for that place in a specific time.

In order to exercise “close” reading, “distant” reading as well as perform a good transition between these two scales when processing high-dimensional and large data set, this paper will discuss researches conducted by Stefan Jänicke (2015) , Helmut Doleisch (2003), and Allen R. Martin and Matthew O. Ward (1995).

Jänicke (2015) and his team members focus their research field on visualization of distant and close reading of textual data in the digital humanities. They presented an overview of the last ten years of relevant researches and concluded that:

Close reading

“Close reading means reading to uncover layers of meaning that lead to deep comprehension.” in another word, close reading emphasize a detailed exploration of a text message, including the analysis of (1) individuals, events, and ideas, their development and interaction, (2) used words and phrases, (3) text structure and style, and (4) argument patterns.

Compared to digital text, images, similarly, may also have potential to apply these analysis models: (1) individual stories, events, (2) used textual tags and description, (3) atmosphere created by users, for instance, filtered colors.

Distant reading

While close reading enables users to read the source text without affecting its structure, distant reading addresses on creating an abstract view by “shifting from observing textual content to

visualizing global features of a single or of multiple text(s)" (Ibid.). By this definition, thousands of user-generated photographs could probably generate prominent atmospheres and "collective memories" about one place or object at a specific time (or a period of time), with the inherent "external" spatio-temporal metadata.

"Focus + context" framework

Combination of both "close" and "distant" reading means to enable visualizations to interactively drill down to particular portions of the data from patterns of global features. In term of using images as metadata, the interactive switch may references to "focus + context" framework that presents a clear method for "flexible and interactive specification of high-dimensional and/or complex features in simulation data" (Doleisch, 2003).

When visualization aims at supporting the analysis of high-dimensional and big data set, "feature-based" (Ibid.) approaches are quite helpful to decrease the number of data that is displayed at each instance of time, and guide to data areas where users are intended to see interactively. Specifically, high-dimensional data should be "brushed" or selected for interactive exploration (Martin and Ward, 1995), which means a subset of the large "feature-based" data set is needed to be viewed for a specific interest, for instance, in focus, using a brush-like interface element. Besides, a wide range of large data set should be specified in hierarchical layers for a fast and flexible analysis (Doleisch, 2003). Doleisch classified a sketch of the "feature-based" structure based on the different key components: the feature specification itself (root), feature sets (level 1), features (level 2) and feature characteristics (level 3).

Summary and implication

"Share your photos. Watch the world" is the motto written on Flickr. Because the platform assembles

millions of user-generated photos on its database that visibly and invisibly links users activities and their image content, it has potential to bespeak an on-going process of picturing, narrating, symbolizing and recording a set of relation between individual photographs.

Dijck's previous work (2010) proposes Flickr is firmly embedded in a culture of connectivity based on its interface design by discussing three assumptions: sharing views, experiences, and memories. To understand these definitions with Flickr's functions and features can facilitate the subsequent work on grasping and visualizing image data that is related to connective memory or "culture heritage". While many research papers address on aggregation of a large number of spatio-temporal data for studying trend or pattern of social activities, this project follows individual "stories" rather than only society by adopting the idea of "thick mapping" proposed by Todd Presner, David Shepard (2014) in their book, Hypercities Thick Mapping in the Digital Humanities. In this book, they generate concept of HyperCities and Thick Mapping, discussing a possibility of telling stories, of narrating places based on spatio-temporal search, which fit well for the purpose of this project.

Methodology

In order to perform thick visualization and analyze the data sets, several data processing techniques and computational methods are need to be discussed and specified to this project. Visualization of high-dimensional and large data sets in computer programs has to consider its flexibility and interaction. When aiming at the analysis of such large datasets, “feature-based” approaches (Doleisch et al., 2003) are usually helpful to control the number of data displayed at each time and specify interesting areas of the data. On the other hand, this project not only expects to present visual patterns but focus on individual “stores” inside images, it must be viewed closely by users. Stefan Jänicke and Greta Franzini (2015), who presented an overview of the last ten years of studies on visualizations that support close and distant reading of textual data in the digital humanities, inspires a good point that digital photo data also has a potential to be analyzed as the similar way. In order to fulfill “distant reading” of patterns with “close reading” of particular artifacts, ideas of “brushing” (Martin and Ward, 1995) and “focus + context” Deleisch (2003) provide a valuable framework to exercise.

Feature-based geo-tagged images dataset

API methods

Flickr allows users access to its metadata so that they can develop programs or services based on Flickr resources. The dataset, including necessary image metadata, is collected from Flickr’s publicly available APIs. Two of these API methods are relevant to apply spatio-temporal analysis for this project: flickr.photos.search, which returns a list of user-generated photos matching some criteria; flickr.groups.pools.getPhotos, which returns a list of pool photos for a given group. The photo search method provides an efficient approach to widely search and collect geo-tagged image sets by filtering metadata such as tags, location and time, while the formation of groups offers specific

spaces for many-to-many contacts. Groups on Flickr are formed based on social or thematic principles: they may be assembled on something or someone (such as photographs of Edinburgh, landscapes, festivals, etc). For instance, 5.2 thousand of photographs with 296 members have been generated into a group that was initiated in 2009 for sharing photographs of Edinburgh Festivals. However, these two methods will only return standard information of photo list from Flickr metadata, some of the photo information should be filtered and added based on later requirement.

Processing image “internal” data

Backstage program of this project is based on Python, a widely used dynamic, interpreted language, including a large and comprehensive standard library. The Python Imaging Library (PIL) provides extensive file format support and fairly powerful image processing capabilities and functionality, including point (pixel) operations, filtering with a set of built-in convolution kernels, and color space conversions. Except for resizing images and converting formats in consistent, some important indications of “internal” metadata of images, such as average RGB, hue, brightness, can be calculated by their grabbing Uniform Resource Identifier (URL) and processed in Python. In selfieCity (Manovich, 2014), they filtered the “internal” metadata by hiring several Amazon’s Mechanical Turk works to manually verify single selfie from their age, gender and expression. This project, instead, is using average color to present “feel” of individual photos and atmosphere of group of images.

Brushing high-dimensional, large dataset

The framework “focus + context” allows several “features-based” data to be hierarchically described by brushing multiple dimensions. Dataset of this project follows this organization and contains 1) basic information, includes location and time of images; 2) user created tags; 3) color attributions of images. When visualization and interaction required, these data

can be assembled with each other and present different interest of specification.

According to Doleisch's research, using feature-based data fast and flexibly, a hierarchy of dataset should be constructed: the feature specification itself (root), feature sets (level 1), features (level 2) and feature characteristics (level 3). In this project, the structure is much simple and straightforward: 1) the root is closely to the dataset acquired from Flickr APIs with added color attributions. 2) When focusing one feature set, all the other feature sets are inactive at that time, for instance, changing the translucency of group of images. Feature sets thereby can be used to interactively switch focus and context. 3) Photograph, itself, is feature characteristics. When mouse over on a specific image, the corresponding "external" metadata will showed up; When zooming into a photograph, users can see any inside details of image content.

Graphic Layouts

Cyclical time

Visualization layouts, such as pie, bar chart, histogram and tree map are often used to analyze multi-dimensional data, while this project will adapt some of the features and place user-generated photos based on different aspects of the data and layout algorithms to present visualization in attractive and revealing ways.

Inspired by Henri Lefebvre's rhythm analysis and his temporal understanding of time and space (2004), linear and cyclical time that divide cultures into two major ways of understanding time could be introduced when designing layout for spatio-temporal photographs in Flickr. However, this project will only address on cyclical time that addresses the diachronic order of multiple individual photographs, in order to fulfill the purpose that visualizing "collective memories" of user-generated photographs.

Histogram and polar plot

Histogram is one of the most suitable graphic layouts to present the diachronic order of all user-generated photos in a specific place during a period of time. For example, an image montage could distribute all geo-tagged images from a period of time based on their average brightness or average hue, thus revealing a dominant feature in term of color preferences that might indicate a shared views or “collective memories” by individuals (See Figure 2 and 3).

Besides, structure of polar plot also shares the similarity with cyclical time. Because cyclical time emphasize that live is repeatable, time moves in endless loops and reminiscent of the cycles of the seasons. When visualized, cyclical time indicates that social events and activities happen periodically. The polar plot enables the visual production to potentially repeat itself infinitely and present the historic collection of memories. For instance, this project use radial (polar plot) visualizations to distribute user-generated photos along a circle using dates when photos were taken, and value of mean hue. One parameter controls the angle (position along the perimeter); another parameter controls the radius (how far a photo is from the center). The polar plot (radial) finally organizes all spatio-temporal images from different years in a similar pattern respectively, revealing that user-generated photos share a similar “collective memories” on events and activities during that period (See Figure 1, and 4).

Mosaic Photography

In order to give a interesting reading for local feature and explore “collective memories” for different color ranges in Edinburgh, this project is also going to practice mosaic photography that is one large (target) image made out of hundreds and thousands of tiny (tiles) images that share data similarity. To achieve this, two Python-based functions are need to be defined: 1) Divide the target image into multiple blocks and calculate the average color of each block; 2) Loop the tiles library

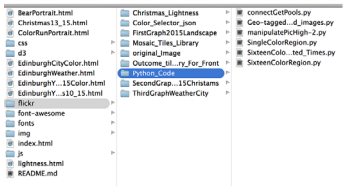
collected from Flickr’s API, match tile image to blocks of target images through average RGB. The mosaic photography will give users a very clear view about context. Besides, different color ranges will be regarded as interface indications that subgroups these user-generated photos and gives information implying atmospheres and “collective memories”(See Figure 5 and 6).

Execution and Findings

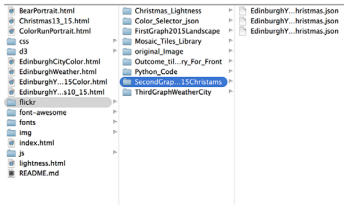
Data Collection and Dataset

The dataset is composed of user-generated photos' color attributions, such as average color, hue and brightness, processed by Python and the initial metadata that was collected based on two Flickr APIs, flickr.photos.search, and flickr.groups.pools.getPhotos. Although this web-based project does not use Structured Query Language, such as MySQLi, to manage data held in a relational database, it uses D3, a JavaScript library, to manipulate data directly from JavaScript Object Notation (Json) files returned by Flickr APIs. Therefore, two essential steps for executing data visualization are: 1) Using Python to acquire information of user-generated photos from Flickr by filtering update time, location and tags, while processing color attributions of photos by calling their URL links and eliminating unqualified data, such as, image with pure black or white color (caused by invalid URL links). Then the valid dataset will be return as a Json file stored in the local desktop. 2) Using D3 JavaScript to call the Json file (data

Python executing root



Returend Json File root



Metadata in the Json File

Visualization Display

Overview of Edinburgh Color Distribution

The radial (polar) plot visualization (Figure 1) shows 2,610 user-generated photos taken in 2015 with user-created tags, "beautiful" and "sight", which aims to give an overview of Edinburgh's color

pattern and most memorable scenic spots during that period. Photo's distance from the center (radius) corresponds to its mean hue; photo's angle (i.e. the position along the perimeter) corresponds to its time stamp. By looking at the color pattern from this graphic layout, users can roughly generate a perspective that most of user-generated photos meet in two hue ranges, from 0 to 90 (red to yellow) and from 200 to 260 (cyan to blue), while hue ranges from 60 to 150 (yellow to green) become more prevalent in June, July and August when temperature goes up. When zooming into user-generated photos to have a close reading of images' content, it is noticed that people's view about "beautiful" and "sight" most referred to several places, The Author's Seat, Calton Hill, Portobello Beach, The Forth Bridge, Edinburgh Castle, the Royal Mile and Princess street, while The Author's Seat was the most salient one.

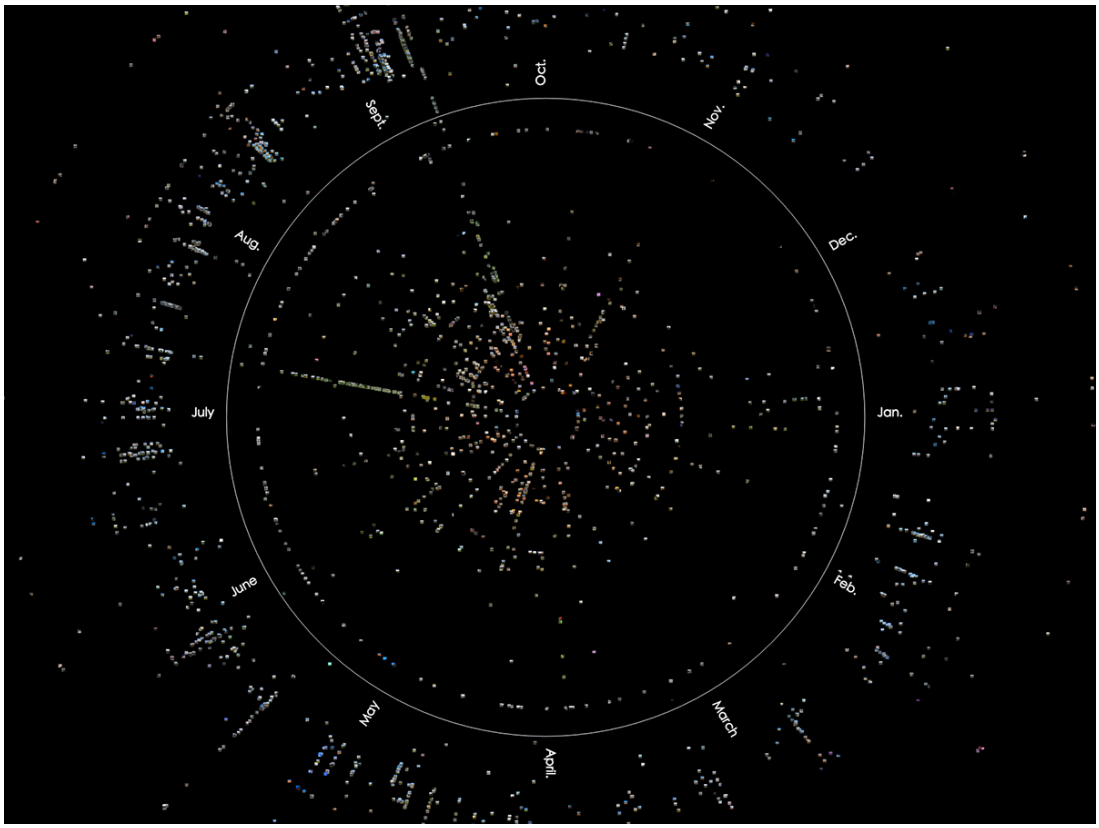


Figure 1 : This polar plot layout shows color pattern of 2,610 user-generated photos filtered with user-created tags "beautiful" and "sight" from Flickr APIs. Photo's distance from the center (radius) corresponds to its mean hue; photo's angle (i.e. the position along the perimeter) corresponds to its time stamp.

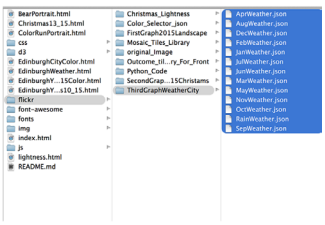
Edinburgh Presented in Cyclical Time

According to Lefebvre (2014) and Hochman (2013), cyclical time indicates that social events and activities happen periodically, which “shows the historic process of collective social, visual production that potentially repeats itself infinitely”. The polar plot and histogram (montage) visualizations showed below are presentations of cyclical time in Edinburgh, while the mosaic photography is used to explore user’s “collective memories” for different color ranges of Edinburgh.

Edinburgh Annually Events

Edinburgh is the world's leading festival city, with 12 major annual festivals bringing talents from more than a third of the world's countries to streets and stages. The most popular festivals including International Science Festival, Hidden Door Festival, International Festival, Edinburgh Festival Carnival, Edinburgh Festival Fringe and The Royal Edinburgh Military Tattoo, are organized annually from April to August respectively. Datasets of this visualization (Figure 2) were collected separately based on different filter commands, for instance, data for the August category was filtered by a user-created tag, “festival”, and dates (such as between "08-31 23:59:59" and "08-01 00:00:00"). Different “feature-based” data are stored in different Json file. The twelve circle buttons are used to control animation of their corresponding feature set. By calling Json files separately, the interaction for each feature set become more convenient to apply. For instance, when clicking the first button, only the January feature set will be invoked, while other feature sets will remain as context of the visualization.

Feature sets root



Dates metadata

Related tags metadata

Compared to the overview of Edinburgh's color distribution, this graphic layout presents a closer reading about "collective memories" of Edinburgh's Festival as well as specific domestic features, such as food, Christmas Market, in category volumes. Inspired by the project selfieCity, the appearance of this layout combines the feature of histogram and information of Edinburgh's monthly average temperature in the past five years. The horizontal categories corresponds to twelve month, the highest volume in each category corresponds to the average high temperature in that month.

Although category volumes and the context of this visualization do not give a clear color pattern for Edinburgh, they identify some features by organizing user-generated photos. By give a close reading to user-generated photos from April to August, we could see the most identified feature inside is "people". Owners of these photos use specific figure or group of figures to refer their memories in the festival and tag these photos as "festival". Specifically, performers, dancers and musicians are regarded as the representatives to the community in festival events. The abstract word "festival" therefore could be visualized as concrete characters based on collective views from these user-generated photos.

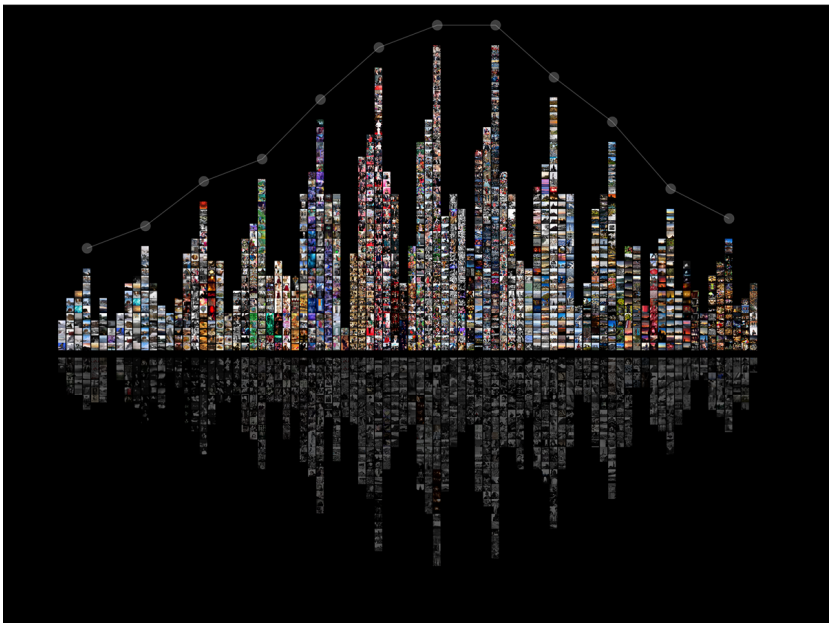


Figure 2 :

This visualization layout shows Edinburgh's Festival as well as specific domestic features, such as food, Christmas Market, in category volumes.

The horizontal categories correspond to twelve month, the highest volume in each category corresponds to the average high temperature in that month.

Dominate Color of Edinburgh in Christmas

This image montage (Figure 3) enables users to see 2694 user-generated photos related to Christmas of Edinburgh in 2013, 2014 and 2015. All of these photos are organized by their color lightness from 0 to 1 (left to right). The lower color montage gives an overview of average RGB of all user-generated photos. The three circles with different level of orange-brown color represent dark part, middle part, and bright part of the whole photo collection respectively.

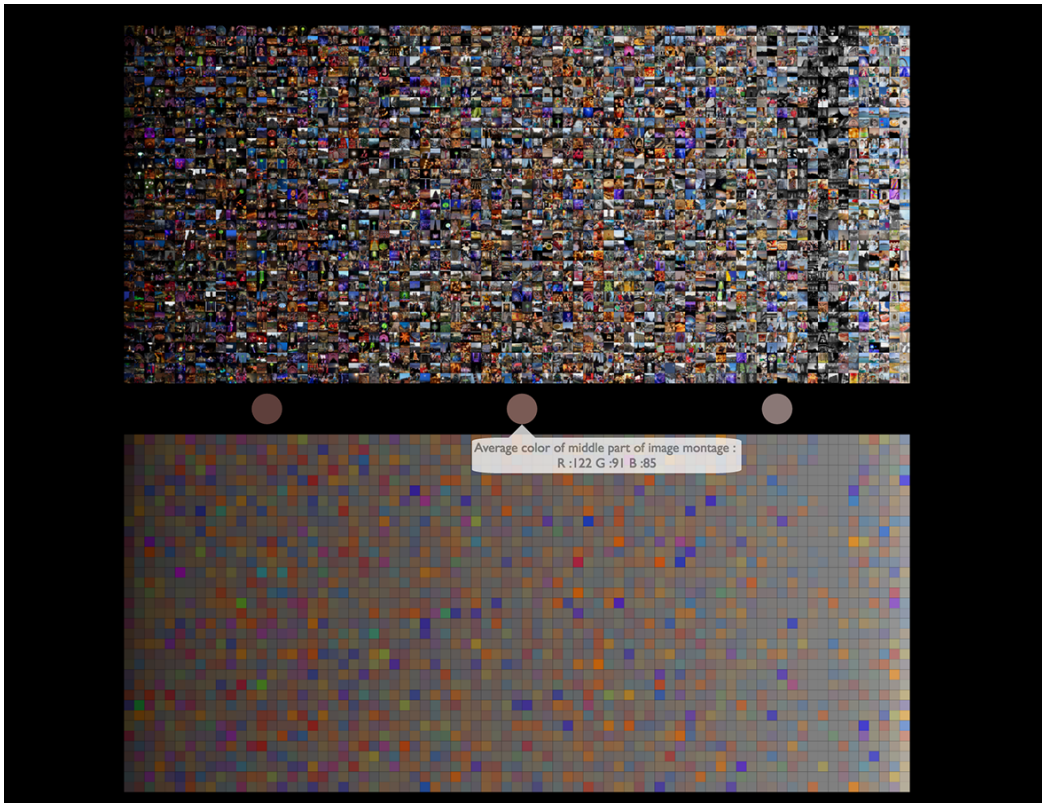


Figure 3 : This polar plot layout shows color pattern of 2,694 user-generated photos filtered with user-created tag "Christmas" from Flickr APIs.All of these photos are organized by their color lightness from 0 to 1 (left to right). The lower color montage gives an overview of average RGB of all user-generated photos. The three circles with different level of orange-brown color represent dark part, middle part, and bright part of the whole photo collection respectively.

Although user-generated photos are not organized based on time stamp, the visualization layout indeed indicates the different atmospheres between nighttime and daytime. By zooming into the photo collection, most of photos are taken for recording activities hold in The Princess Street and The Royal Mile during the nighttime, leaving a feel that most of people gathered together to

celebrate Christmas and enjoyed the specific annually activities – amusement park and the Christmas market. However, during the daytime, photos are much more dispersive around Edinburgh. These photos are more about self-portrait and family portrait in different places.

Besides, the average color of three different lightness areas is between orange and brown. By examining features of Edinburgh, such as its classic architectures, road and mountains, we could see their colors are also quite close to orange-brown. Thus, it could be proposed that the “collective memories” about Edinburgh’s dominant color in December is orange-brown, and the most memorable areas are amusement park and the Christmas market in The Princess Street

.

In order to further discuss the conclusion that the dominant color of Edinburgh in December is orange-brown, this project uses another polar plot visualization (Figure 4) that explores 5000 user-generated photos in December of Edinburgh, with 1200, 1300, 2500 photos in 2013, 2014, and 2015 respectively. This visualization enables users to view user-generated photos in different days by selecting different feature set interactively. The corresponding results of three years will be separately showed on the left user interface part, which gives a clear comparison about daily memories of people in December of three different years.

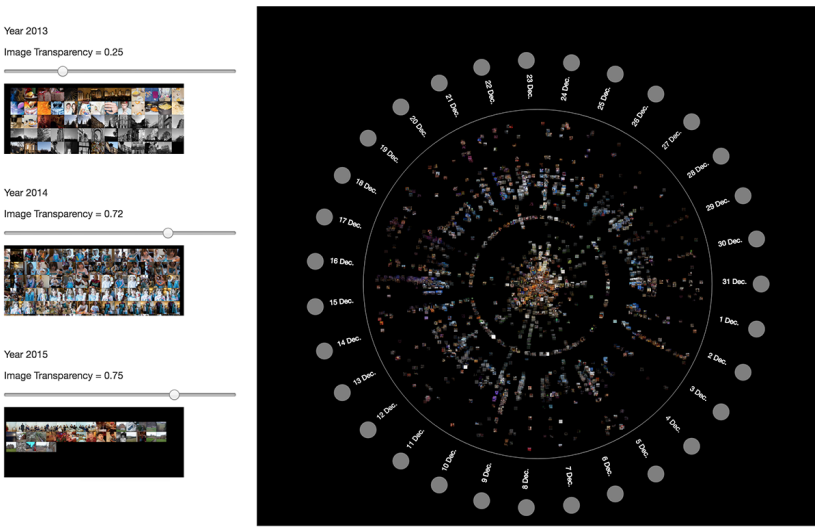


Figure 4 :

This polar plot visualization shows 5000 user-generated photos in December of Edinburgh, with 1200, 1300, 2500 photos in 2013, 2014, and 2015 respectively.

Photo’s distance from the center (radius) corresponds to its mean hue; photo’s angle (i.e. the position along the perimeter) corresponds to its time stamp.

By adjusting the opacity attribution, users could see the color pattern in each year clearly. The three patterns all show a feature that most of user-generated photos gather in hue range of 0 to 60, releasing the same conclusion that orange-brown is the dominant color of Edinburgh in December. By close reading these user-generated photos day by day, users could also see most of photos are captured for Christmas market and amusement park, which gives the same perspective that Christmas market and amusement park are the most prevalent activities in December.

Mosaic Photography

Except for using graphic layout to visualize and analyze the color patterns and features in Edinburgh, mosaic photography is also a revealing way to address specific feature based on its color attribution. The essential points of this idea are 1) to select a typical and high-quality photograph as target image that presents a specific object or place; 2) then to use thousands of related tiles images to match the pixels of the target image. Because a target image could be visually divided by several color areas where the corresponding user-generated photos are going to fill, users could easily see “collective memories” of certain color after the mosaic photography is produced. In order to achieve the mosaic photography, several important steps are need addressing:

Divide Target Image

First step is to divide the target image into multiple blocks with equal width and height, then calculate the average color of each block and store them in an array list.

Collection of tiles library

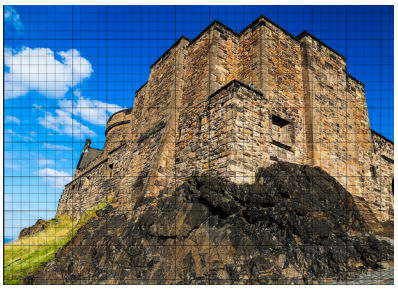
Second step is to collect a large and related dataset from Flickr’s APIs in order to satisfy all color ranges, and then calculate average color of each tiles image.

Match tile images

Third step is to loop data in the tiles library and match user-generated photo for each block of the

target image. The specific approaches of this step will be discussed as below. 1) Compare the average RGB in predefined pixels of the block to the average RGB in each tile in the tile library, calculating the distance between the two (the distance is the square root of the two corresponding RGB triplets). 2) Select the tile image that has minimal distance. 3) Resize the tile image at a given resolution, and place it in the mosaic at the position corresponding to the position of the block in the target image.

Target Image *Match process* *Mosaic production*

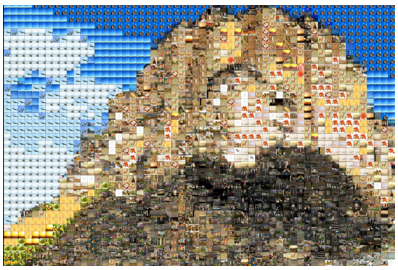


```
def matchRGB(current_rgb, json):
    r = current_rgb[0]
    g = current_rgb[1]
    b = current_rgb[2]
    dis = 9999999999999
    tile_now = None

    for tile in json:
        tile_r = tile[u'color'][0]
        tile_g = tile[u'color'][1]
        tile_b = tile[u'color'][2]
        r_delta = (r - tile_r)**2
        g_delta = (g - tile_g)**2
        b_delta = (b - tile_b)**2
        dist_now = math.sqrt(r_delta + g_delta + b_delta)

        if dist_now < dis:
            tile_now = tile
            dis = dist_now
        else:
            pass

    return tile_now
```



Improvement

The output mosaics are not that satisfying by applying the above methods either due to the insufficient tiles set or imprecise calculation on average color (See figure). In order to improve the quality of output mosaics, we could either lessen the block size or make the match more precise. Because lessen the block size of target image will burden the browser for loading too many tiles images, this project prefers to address on the latter method. Firstly, we need to divide each block of the target image into 4 x 4 sub-blocks and store their average color in a multi-dimensional array list. Secondly we also divide 4 x 4 blocks for tiles images and store each block's average color. Thirdly, we compare average RGB of sub-blocks (1 to 16) with color array list of each tiles image one by one and pick the tiles image that is most matched.

Production and reflection of mosaic photography

This project selects two target images, portrait of bear captured in Edinburgh zoo and portrait of a participant in 2016 color run event, to produce mosaic photography. These two images are distinctive in color ranges with the first one presenting a darker version and the second one presenting a brighter and colorful version. Although it is expected that different filled color areas will show a diversity of objects for a specific color, the result is quite disappointing. Both of two mosaic productions are filled quite accurately, but some of tile images are used too many times, resulting a terrible illustration of “collective memory” for that color range, such as purple, grey in the production of color run event. There are a few color ranges, such as green, cyan and blue, giving a relative better view about “collective memory”. For instance, the blue range is mostly filled by photos with coast, sky and shows diversity in some degree. Although some codes have been written to limit the times of using a singe image, the output is quite bad due to unqualified matches of tiles image.

Figure 5 :

Mosaic production with dark color ranges.

Photograph was capture in Edinburgh zoo

Figure 6 :

Mosaic production with light color ranges.

Photograph was captured in 2016 color run event,

Conclusion

This paper integrates methods from digital humanities, and data visualization studies to explore color patterns of Edinburgh based on user-generated photos collected from Flickr that is firmly embedded in a culture of connectivity. This paper start with analysis of the idea of “thick mapping” and Flickr’s spatio-temporal images with “external” and “internal” metadata, proposing that thousands of user-generated photos can be used to present “collective memories” in a specific place and time or generate an “imaged community”. Then this paper explores the ways in which we can visualize and explore the visual content of social media data on a variety of scales. By studying the “focus + context” framework and method of “brushing”, this paper discusses how large and high-dimensional datasets can be processed and generates that visualization of feature-based and geo-tagged images can combines “distant reading” of patterns with “close reading” of particular artifacts. In the execution, this paper uses graphic layouts that combine histogram (montage) and polar plot to analyze colors of Edinburgh and present the city in cyclical time. Though the visualization of Edinburgh Annually Events, this paper generates that performers, dancers and musicians are regarded as the representatives to the community in festival events, while visualization of Christmas in Edinburgh suggests that dominate color of Edinburgh in Christmas is orange-brown and the most memorable activities are amusement park and Christmas market during that period. Finally, this paper discusses the possibility of using mosaic photography to address specific feature and explore “collective memories” for specific color range in Edinburgh, although the outcomes of mosaic productions are not revealing so far.

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