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MODELING MEDIATED URBAN SPACE THROUGH GEO LOCATED SOCIAL MICROBLOGGING

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Abstract
This paper explores the hybrid nature of mediated urban space in the contemporary city, consisting of architectural spaces interlinked with the digital; situated and networked. We suggest an alternative way of looking into the city, using digitally augmented methods beyond the traditionally established ones in urban design and spatial analysis. Taking the physical space as a starting point, we apply an eco-systemic model to investigate mediated urban forces in the city of London. We identify the implications for the city through mapping, visualization and analysis of geo-located social micro blogging in the form of Twitter data.

The discussion of this project is mainly concentrated on the results of time based patterns on geo-located Twitter flows and urban conditions, outlining initial observations about the city and its digital apparatus. By exploring how technology mediates sociality through Twitter channels and the creation of potentially new social representation forms, the project outlines the influence of those mechanisms on social, cultural and political life of cities.

1 Introduction
The globalized world is experiencing a paradigm shift in the socio-political spectrum. New technologies and social media materialize the inexorable and rapid flow of information throughout the world. Happenings like the Arab Spring in Northern African countries as well as the Occupy Movement in western metropolis' show how these new information platforms interlink and connect our world. They all became feasible through the constant flow of information through social networking media.

From global to city scale, new media and ubiquitous computing play also a significant role in today's urban environment. The city generates increasing amounts of data on various platforms including digital and physical, mobile and social, via data sources such as Twitter, Google Maps and Facebook. Technological innovations form a digital layer over the city's physical topography, containing rich data-sets for urban social life correlating the inhabitants' behavior to the physical

space. In this respect, we need to understand how pervasive technologies interrelate and interweave with the built environment.

In an urban environment, augmented by pervasive computing systems, the interaction space depends on the characteristics of the technologies, the architecture in which they are embedded or through which they move, and the particular events in which people are engaged (Fatah gen. Schieck et al, 2011). Although, it's well understood that the architectural spatial configuration gives rise to movement and encounter patterns directly impacting social life (Hillier and Hanson, 1984), there is a lack of understanding of how the contemporary city is impacted by the advent of mobile and pervasive technologies. To comprehend the augmented urban and digital landscape of a city, we need to expand and adapt our understanding and practice of urban design by looking at the urban environment as an integrated system mediating both the built environment and pervasive systems (Fatah gen Schieck et al, 2008).

With the advent of pervasive technologies a dialogue and a symbiotic relationship is being formed through digital mediums embedded within public space. The progression of modern mobile technologies such as smart phones, encourage pervasive devices, not just portable but personal into our everyday lives, give place for a new type of interaction (Fatah gen Schieck et al, 2011). Computers are no longer just objects, but consist of situations (McCullough, 2004) - in this respect location increasingly matters (Gordon and de Souza e Silva, 2011).

To give people easy access to information received from the generated data in a more understandable way, visualizations are a very common way to communicate relationships. The Center for Advanced Spatial Analysis (CASA) at UCL or MIT's SENSEable City Lab, use different techniques and visualization-methods, in order to make relations of data visible and clearly understandable. Calabrese and Ratti use in their project "Real-time Rome" (Calabrese and Ratti, 2006) a combination of data provided, from multiple sources of the local cell phone provider for Rome, and the GPS locations of local taxis and cabs to plot mobility.

In the research reported in this paper we map, visualize and examine interaction spaces generated by mobile digital devices carried by people in the cityscape. We focus on technologically mediated social interactions within public space, when Social network platforms like "Twitter" are used.

1.1 Measuring A-spatiality

Sharing thoughts, opinions, news and information on actual happenings, is a part of human nature. In that sense, there has always been an a-spatiality, an un-measurable spatial impact of events and social interaction within the urban space. The introduction of digital technologies in combination with location based social media offers the ability to measure the a-spatial social tendencies of the community in relation to location.

Common data visualization is being used in relation to urban space – there is a strong affinity to the usage of location, in terms of distance, proximity and time. However, current approaches lack in-depth research that look into the content of the messages send, relating to the physical environment, which would offer insight to the a-spatial properties.

Following, the description and methodology of this project is unveiled, in which the visualization and mapping of time based activities in the city of London take place. The main focus of this exercise is the definition of geo-located sensitive word search that explores the relationship between the content of tweets, the behaviors and interactions of individuals, afforded by the events taking place in public space.

2 Methodology: data collection and visualization

The research relies on a time-based data package, received from the Center for Advanced Spatial Analysis at UCL containing tweet information for the duration over a 7-day week period in spring 2010.

2.1 Input

The data package [.json – file type] contains >94.000 tweets with:

- geo located in the metropolitan area of London
- time frame: 28.04.2010 – 04.05.2010

Tweet Structure / Information available from Dataset:
ID, Twitter-post, Twitter ID, date, name, link, page, Twitter geo-location, language, profile, Google-

*393466,"Just confirmed oral sex is not biblically wrong. @kinkyshankly is a legend.",
"13195121602" ,"2010-05-01 15:55:40","Demoooo (Ademola Adewole)",
http://twitter.com/Demoooo/statuses/ 13195121602
,"http://twitter.com/Demoooo","","en",
"http://a1.twimg.com/profile_images/858866392/dagrin_normal.jpg","ÜT:51.608482,
-0.144936","Just confirmed oral sex is not biblically wrong. @kinkyshankly is a
legend.","web",51.608482 -0.144936"*

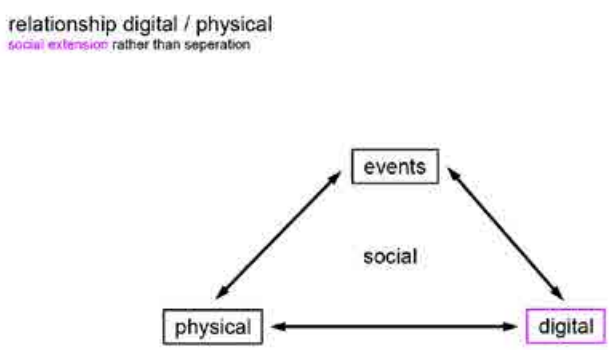
location, content, source, parsed geo-locations.

Figure 1. Tweet Content Example

2.2 Investigating the relationship from physical to digital / spatial to a-spatial

To go beyond general time-space research and for further investigations on physical-digital relations, an additional layer had to be installed, representing the physical environment in opposition to the Twitter dataset. An event always has a physical relation to the built environment and time - it happens in a real space over a certain "defined" period of time. Different events attract different peer groups and contain different time/space schemes, regarding the period and opening hours, which follows a top-down approach. Thirty events, happening within the given timeframe and based in the metropolitan area of London, have been selected and categorized in five sub-groups, relying on event information – including football, theatre, concerts, exhibitions and festivals.

The digital layer of the Twitter dataset and the physical layer of events form the basis for further development. Both share time/space information, in terms of geographical location, opening hours and tweet times.



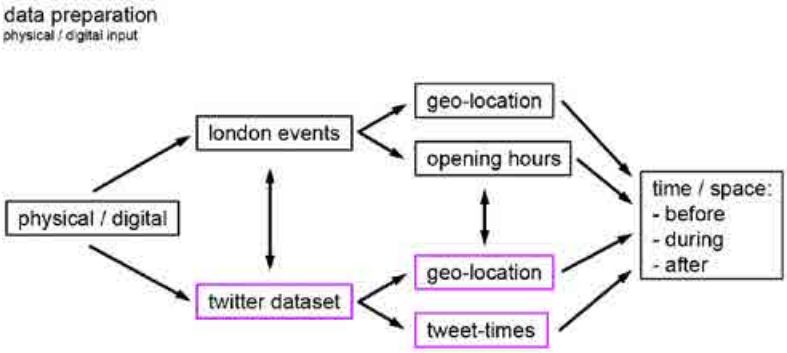


Figure 2. Relationship between digital/physical
Figure 3. Data preparation for comparison of digital/physical data

2.3 Introducing filters

In order to compare the digital with the physical layer, it was necessary to develop a method that investigates similarities in time/space and the tweet content level. For further development – which can be compared to a filtering process – different kinds of selectors (filters) have been introduced, depending on the investigation stage.

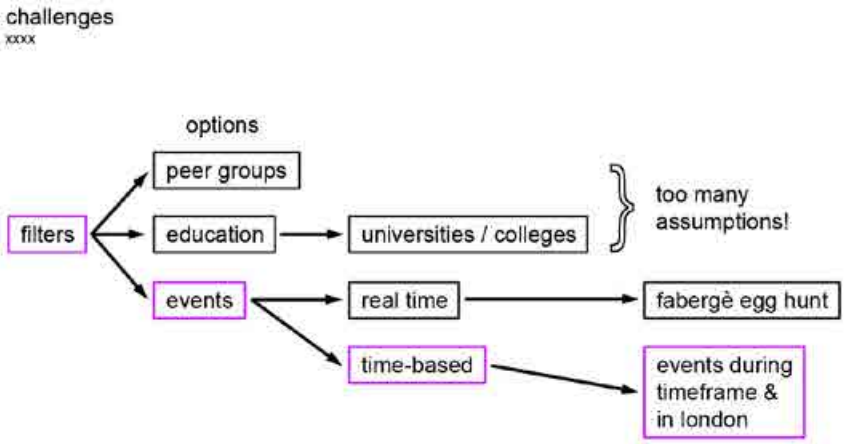


Figure 4. Filter Development, introducing events with geo-location and opening-hours as first Filter-Set

2.4 Visualization interface

Below we illustrate the visualization interface:

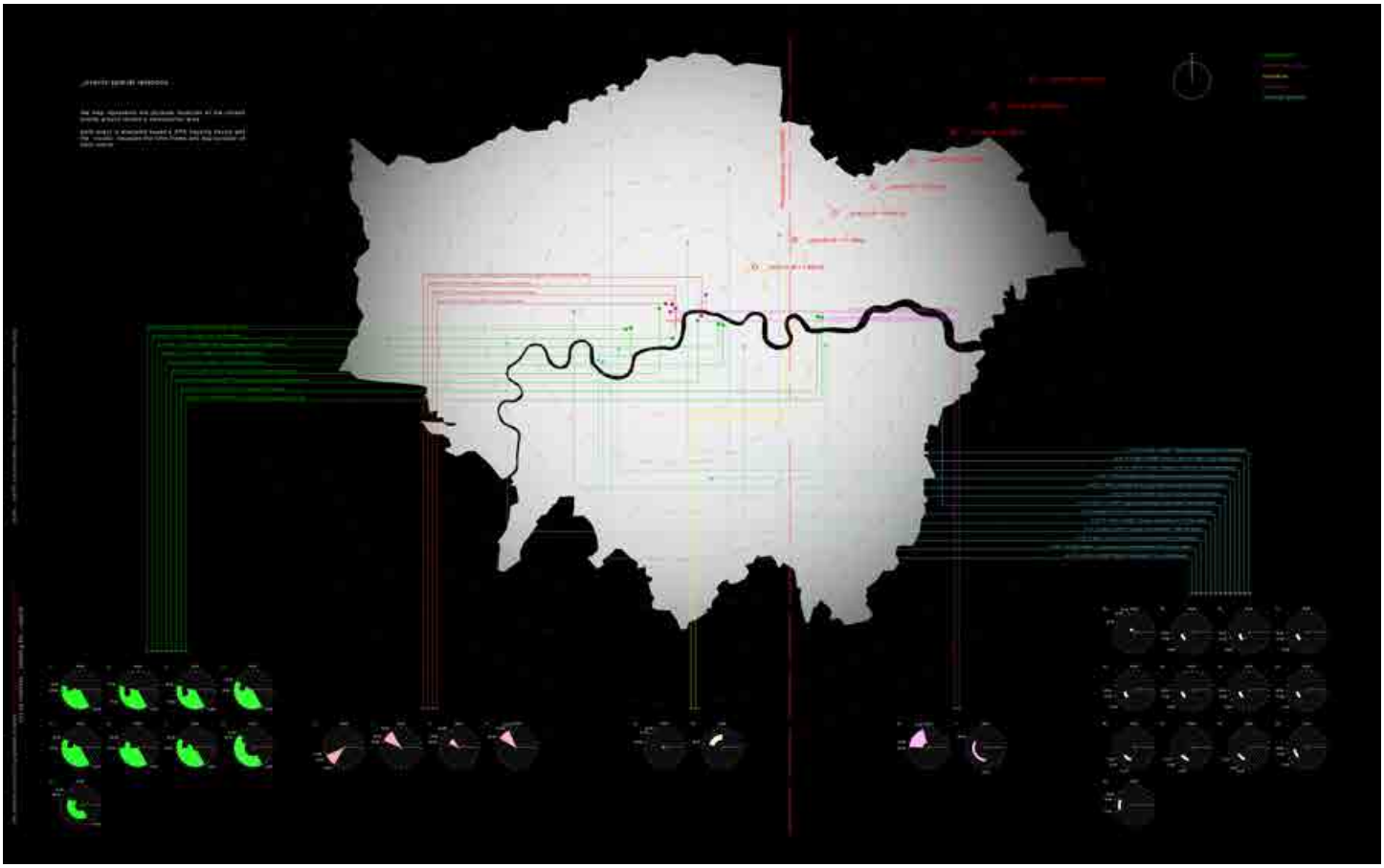


Figure 5. Showing events during the investigated timeframe within the metropolitan area of London, including opening hours and geo-location

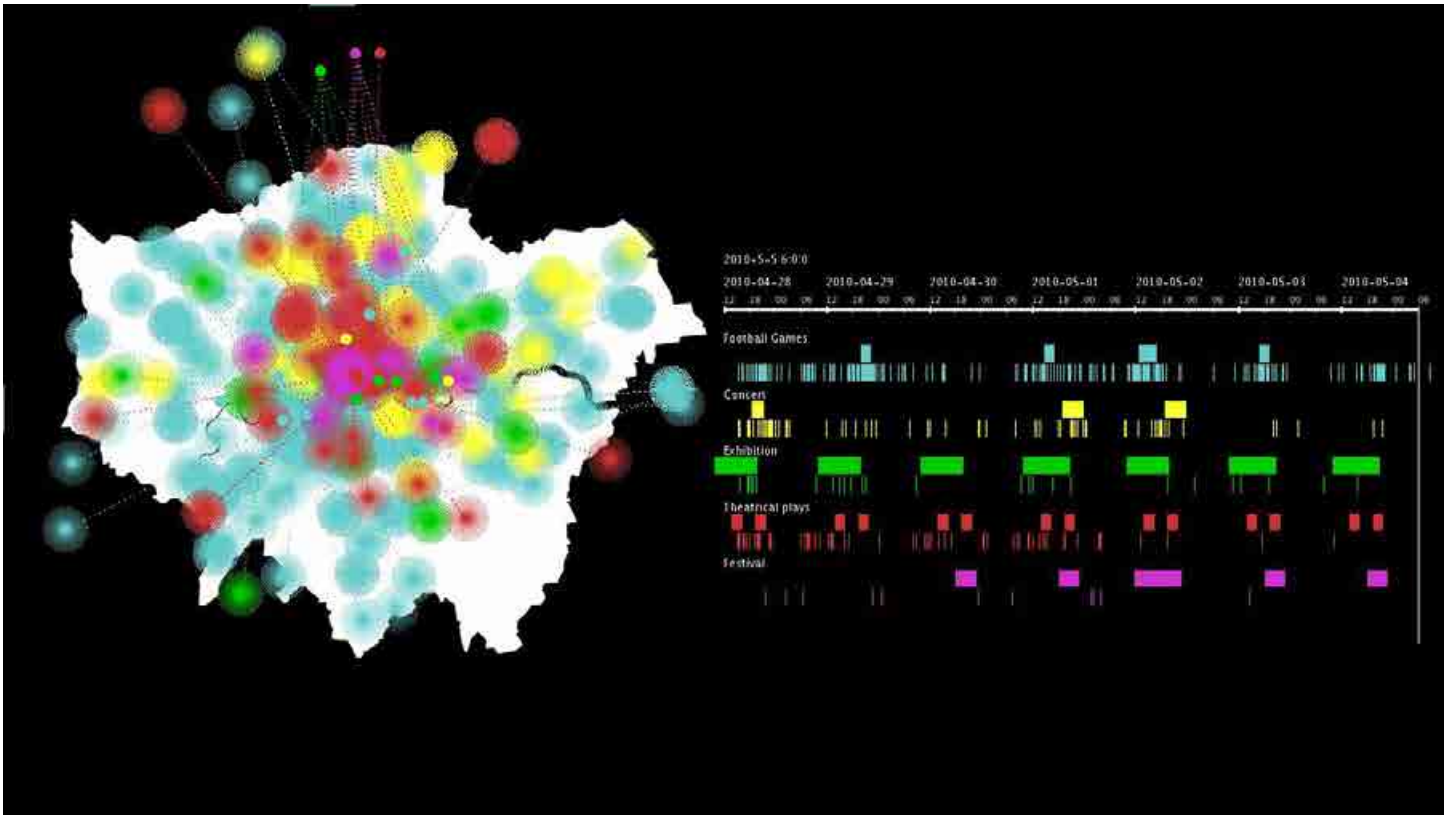


Figure 6. Visualization of Twitter activities in relation to the events: Map, left side, showing geo-located tweet activity by fading dots within London. Right side, the tweet activity is shown along a timeline, containing exact opening hours of the events.

3 Data Analysis and Discussion

3.1 Filter Development

Step 1 – based on time/date and location

As a first step, the received Twitter dataset gets visualized based on geo-location and time/date – information acting as filters. There is no difference to existing visualizations dealing with the same topic ('Twitter vs. Flickr' Eric Fisher, 'GoodMorning' blprnt.blg) The outcome shows every one of the >94.000 tweets, contained in the dataset, categorized and colored. They appear and fade on the map at the exact time and date shown on the timeline, on the exact geo-location within London. As a landmark and orientation-point the river Thames is included on the map. There is no further research of the tweet content relationships to a physical component at this point.

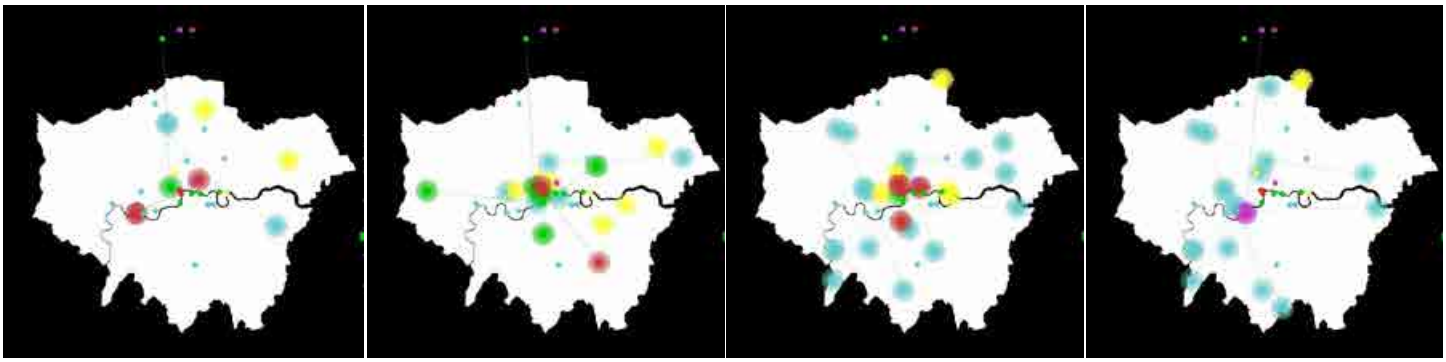
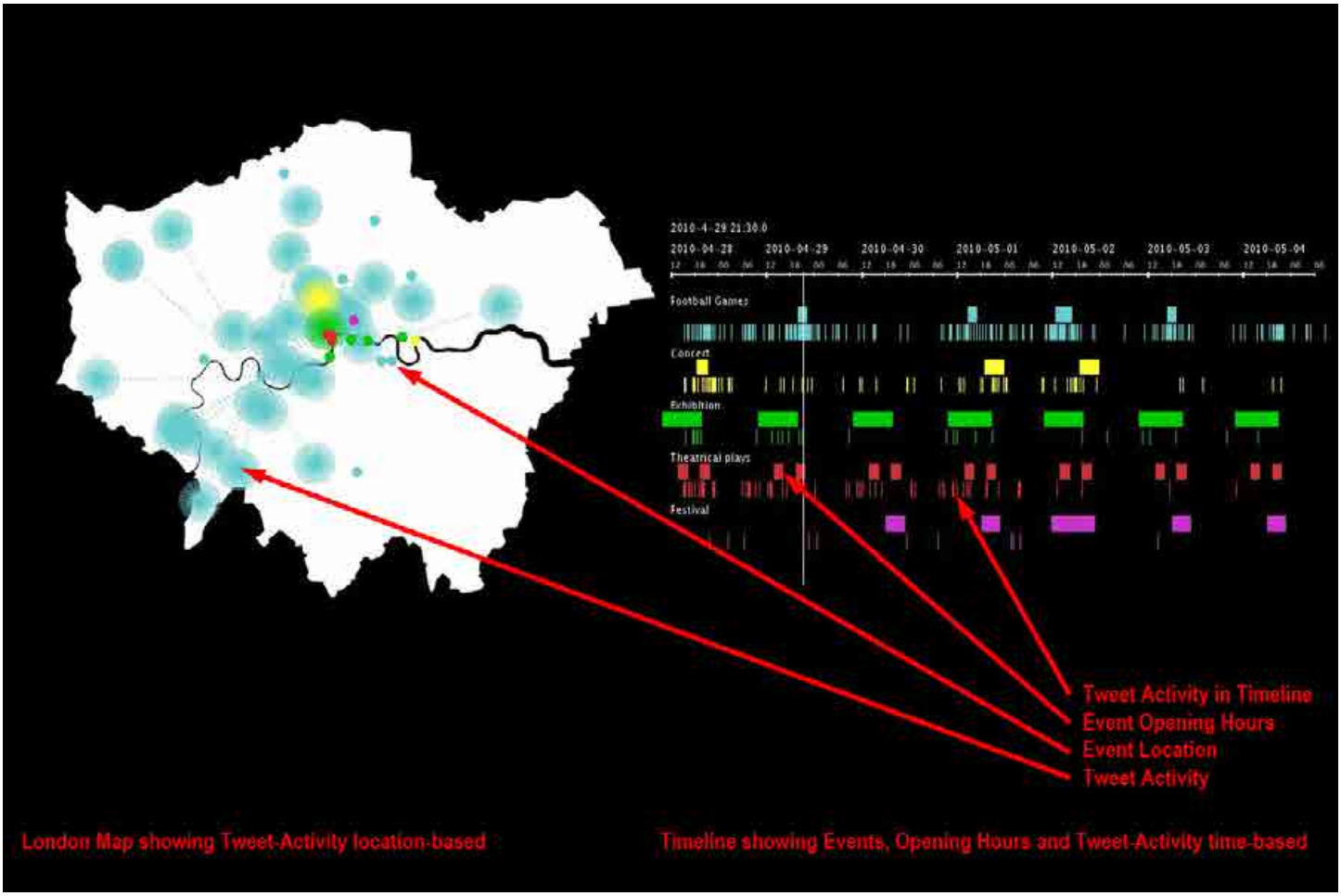


Figure 7 (Above). The map of London showing the river Thames. Step 1 — Sequence showing every tweet categorized per hour: blue — football games; yellow — concerts; green — exhibitions; red — theatrical plays; magenta — festivals

Figure 8 (Below). All twitter activities of the whole week superimposed on the map. Weekly tweet-activity: colour indicate: blue — football games; yellow — concerts; green — exhibitions; red — theatrical plays; magenta — festivals



Step 2 – installment of additional filters on tweet content information

To find additional information that can be used to investigate space/time relations, the research focuses on tweet content in relation to the ongoing events. The filter uses sensitive words, as event names and the event categorization, establishing a link between the tweets and the events. Every one of the five categories is visualized separately to give a detailed insight of the spatial and a-spatial parameter. The outcome is a representation of tweets related to events separately, defined by their categorization. A line links the tweets and the related event. The visualization patterns demonstrate the relations among tweet times and spreading, compared to the event and its related audience. A significant alteration is visible among the one-off events, like concerts and weekly events, like football; presumably, something dialing mostly with locality and the repetition of the event. Those having closer connection to the city, develop a stronger relationship with the local audience. Football supporters for example, conceive the game as part of their everyday life, not just the match day, creating the sense of large a-spatial effect.

Figure 9. Step 2 — Sequences showing event categories individually per hour during the timeframe (from top to bottom): concerts, exhibitions, festivals, football games, theatrical plays

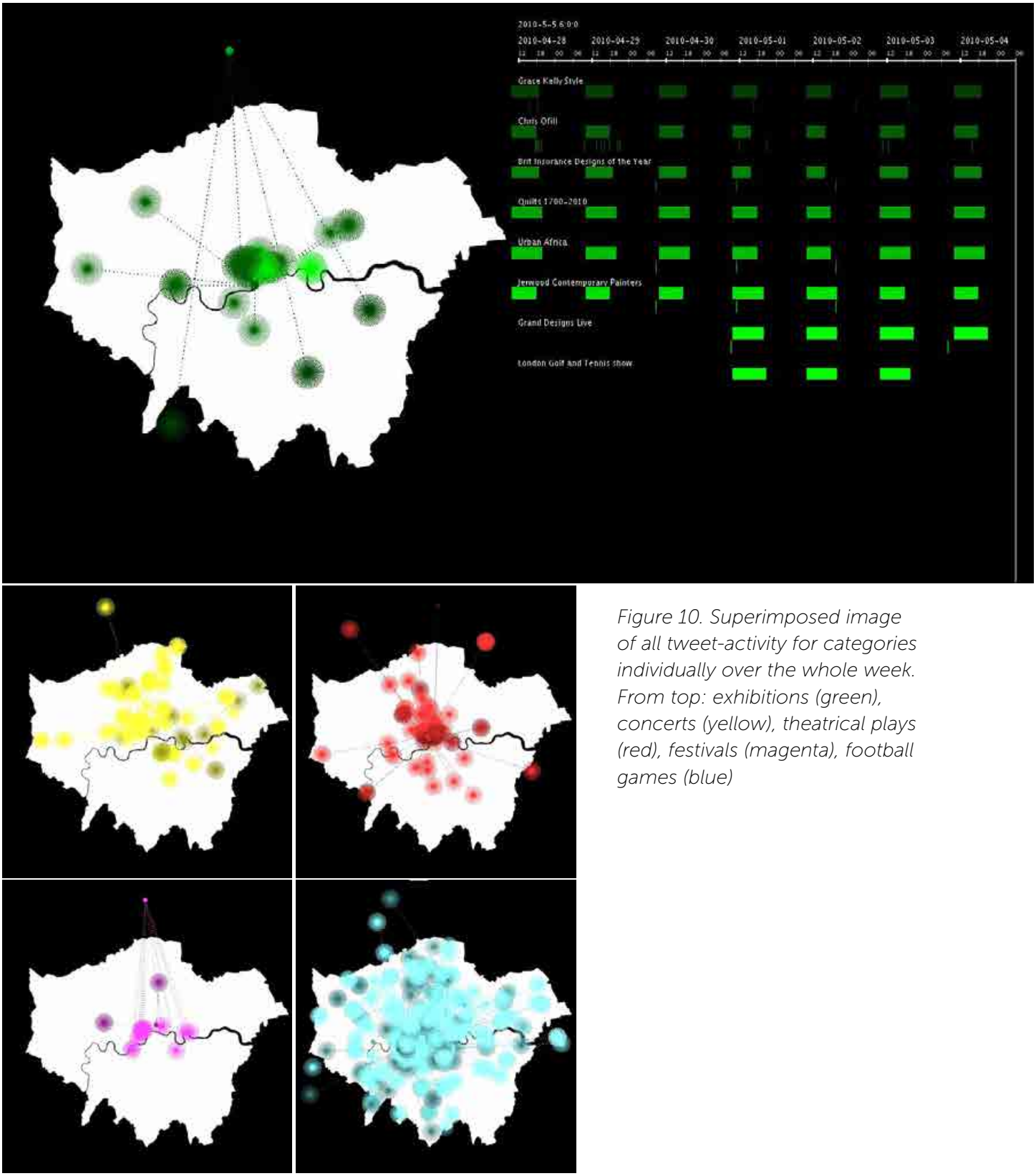


Figure 10. Superimposed image of all tweet-activity for categories individually over the whole week. From top: exhibitions (green), concerts (yellow), theatrical plays (red), festivals (magenta), football games (blue)

Step 3 – additional filter, selecting tweets only about the event itself
Processing furthermore, a differentiation was necessary in terms of outputs, resulting to a minimized amount of events; three football games and one concert.

A closer look at the outcome of step 2 makes visible that there is no differentiation between the tweet and the selected topic (sensitive word), revealing difficulties on the word-tracking dependence on event's name. That resulted to a blurred output, giving a false image of the generated outcome. For example the word "Hair", referring to an event, gave back different types of tweets results, not all of them related to the type or the nature of the event. In other cases, like "Arsenal", the delivered output was more precise.

Base on those facts and to investigate in more detail the relations between the physical event and the tweet, a manual selection of the messages was necessary. Only tweets related to the events were selected and shown in final the visualization. The outcome of stage 3 shows a precise visualization of tweets traffic for the four chosen events (figure 13) in connection to space and time. The emerging patterns unveil a representation of peer group dependence on tweet behavior, related to the location and time of the event.

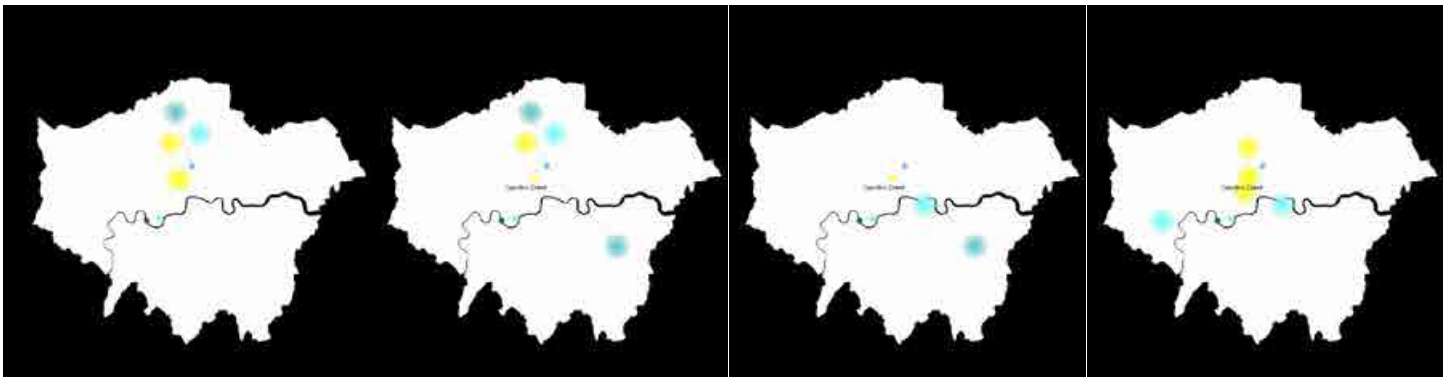


Figure 11. A sequence showing selected events of the categories: concerts (yellow) and football games (blue)

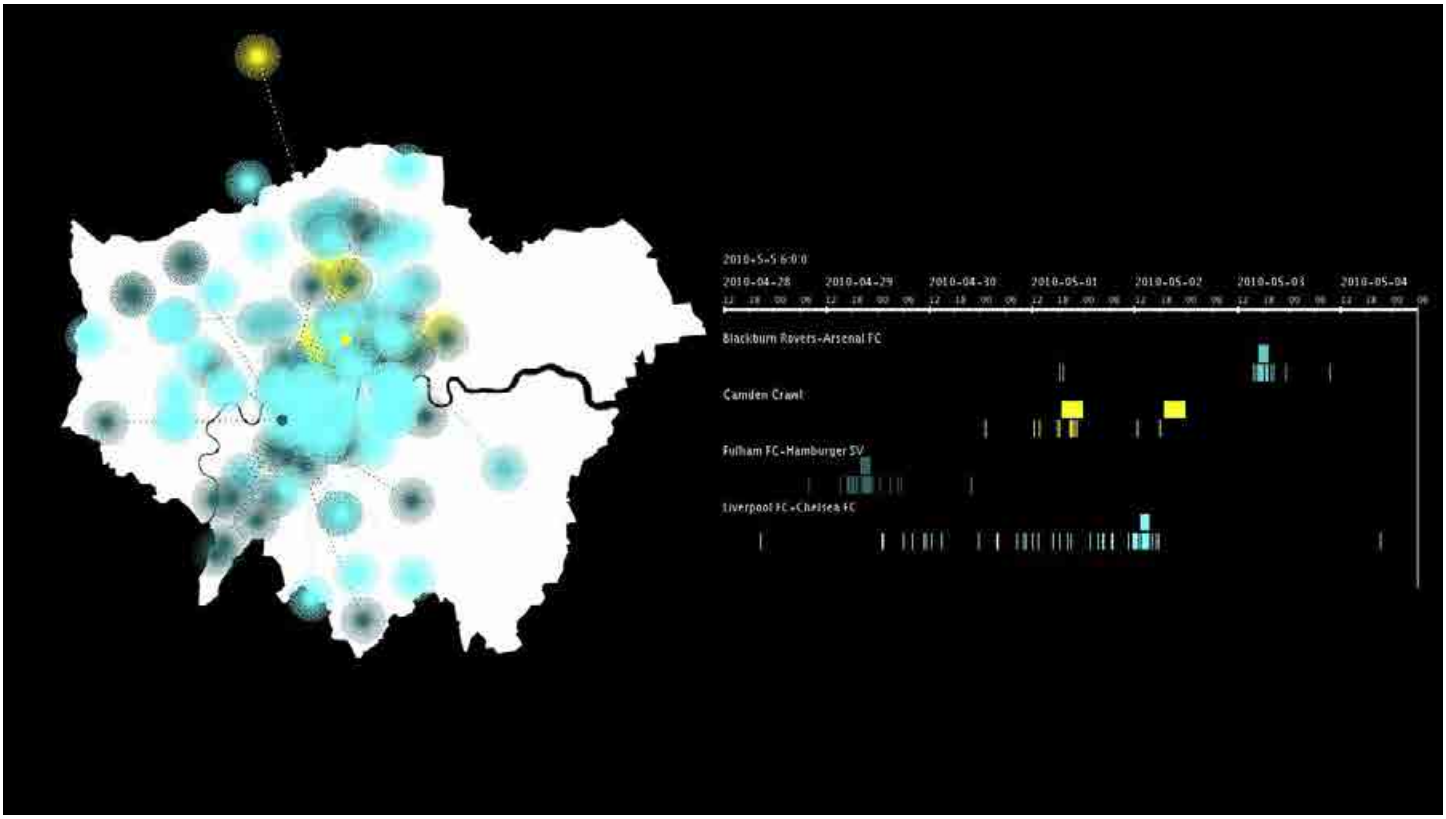
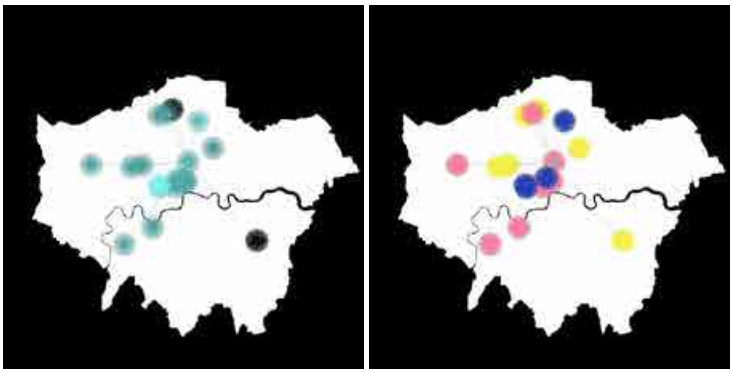


Figure 12. Superimposed image of weekly tweet-activity for the events:
Blackburn Rovers – Arsenal FC
Camden Crawl
Fulham FC – Hamburger SV
Liverpool FC – Chelsea FC

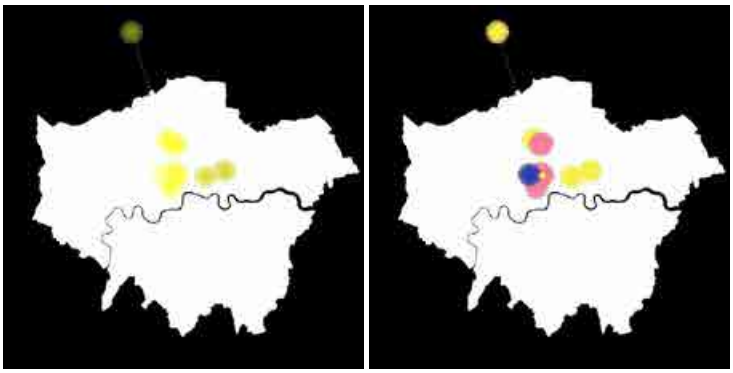
3.2 Focus on tweet time in relation to the event: before — during — after

In this stage, the research focuses on the tweet's temporal properties in relation to the event and the given time frame over 7 days. The visualization on the left shows the tweet duration over the whole week and gives output for the period people are talking about a certain event. Depending on the color code shown under the map, tweets appear darker when sent earlier and brighter when sent later during the week. It is difficult to differentiate in this visualization if a tweet was sent before, during or after the event. Further investigations in terms of tweet time, divide the sent messages in three sub-groups depending on being sent before, during or after the event, is shown on the right side. The color code marks tweets sent before as yellow, during as red and after in blue.

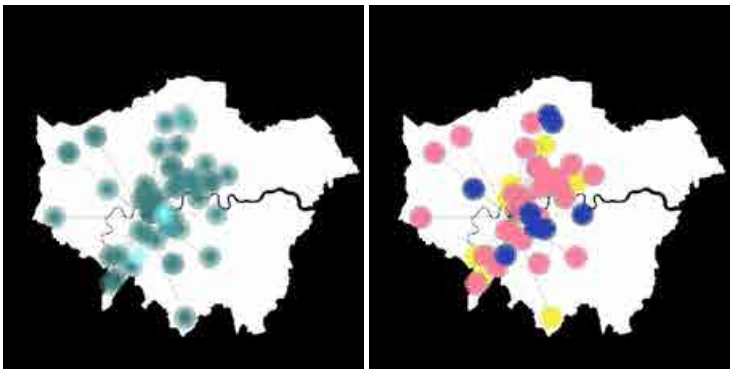
The output of the research shows that Twitter is mostly used before an event and barely afterwards. Therefore it can be assumed that anticipation is a major factor in a Tweeter's behavior. On the other hand, sharing experiences after an event doesn't generate a lot of tweet traffic, as shown at the graphs. Figure 15 below shows tweets for the selected four events, in relation to the time.



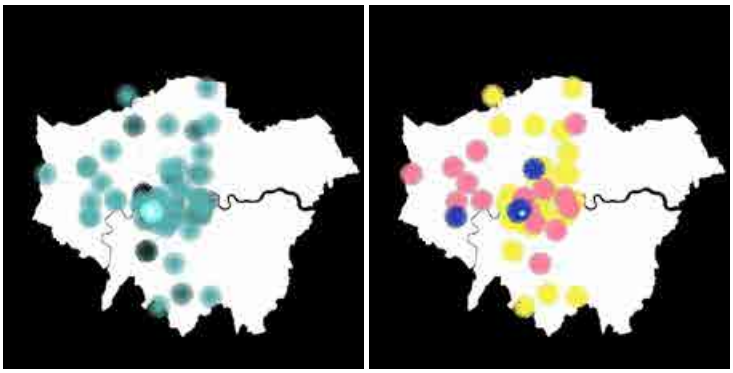
Blackburn Rovers – Arsenal FC



Camden Crawl



Fulham FC – Hamburger SV



Liverpool FC – Chelsea FC

Figure 13. Outcome, showing tweets for the selected four events, in relation to the time throughout the week (left) and the relation to the opening hours of the event – tweet sent before / during / after (right)

There has always been a "back-and-forth" between the research method and the development of the data output, based on the filtering stages. The analysis and methodology related to the spatial/ a-spatial relationships had to be refined several times during the process, bringing up limitations of the used technique. For example, by tracking sensitive words, it is not possible to identify Twitter-patterns of the same user, or following his path through the urban fabric by sensing his tweets and geo-location. Using other technology, like Bluetooth, would be more precise as revealed in other investigations (Chronis A., et al. 2010 and Fatah gen. Schieck, 2008). Also it's not possible, using this method, to differentiate hash-tags (tags marked with "#" at the beginning of a word, which group tweets of different topics) from words used in the tweet content. Furthermore, based on time limitations the project method was unable to include a computational-based solution for the filtering of step 3, where human syntax and semantics brought up "unsolvable" challenges.

Based on the above, the project must be seen as a first step towards a deeper investigation on behavior-patterns, dealing with the spatial / a-spatial relationships of events within the urban environment. While developing the research in order to answer the original question, new questions opened up, as well as new possible input that can be added to the research itself.

In terms of the filtering system, the biggest disadvantage of the used method is the fact that the final stage uses manpower to come to a result. An application of a powerful algorithm, like a neural-network, would be the next step to focus on, which can handle the large amount of data. Furthermore the question arises, whether the third filtering stage is actually necessary or if, by comparing it with the second stage in detail, the same patterns would result. Nonetheless, this can be conceived only as a fragment of a larger and most detailed study that can evaluate in a deeper level the knowledge gained by this process, at that specific stage.

4 Conclusion

The framework stated above represents a selection of twitter data referring to a 7 day period of information gathering and the extraction of results based on a staged filtering process. Following each step of this extensive research, the study stands as an intermediate point of pure visualization and pattern representation. The idea of working both ways to achieve the best possible result addressed issues that had to be solved and provided deeper knowledge and understanding of the mechanisms needed for data processing. The outcome was an intriguing concept of various types of events, contained within urban space (London metropolitan area) restrained by the amount of information (tweets) received in the same location. The emerged patterns define a relationship among physical and digital space, reinterpreting the notion of the city perceived only as a physical frontier.

The dynamics of digital interface in relation to the built environment can be seen as the major aspect of this project. The various patterns of geo-located tweets outlined a clear image of the different types of events, the location and the time-scape momentum that can be identified. Nonetheless, limitations exist in processes like that, where the basic filtering process can overcome the syntax, but not the semantics of written word. It is imperative to note that word recognition is not enough to extract complex information from human language and a more powerful algorithm is needed with a steep learning curve over written word. For future work we focus therefore on the development and installment of an algorithm in order to have better insight on the topic.

With a rapidly grown demand on new technologies that overlay the physical with the digital, the urban environment will have to adapt and interact with the node of the users. Recent examples verify this statement, where people share information (US presidential elections), create social movements (Arab Sprint, Occupy Movement) and even more influence decision making policies (election, legislations, protests etc). Augmented technologies play an important role on the shaping of cities, not only in terms of accessing digital space, but also in defining networks. Location based services create an invisible layer within the urban realm, containing a rich dataset of geo located opinions, emotions and detailed information of the city and its inhabitants. With the cityscape exceeding the known boundaries, the person's location inside the urban fabric is becoming the core theme for technologies and analytical methods of the future. In this respect we need to understand the relationship of global information to local situations: This project is an initial step to investigate this relationship by exploring spatial – temporal patterns among the physical and digital network.

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