Using VGI for analyzing activities and emotions of locals and tourists

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Abstract

Volunteered geographic information and especially photo platforms such us Flickr serve increasingly as base data in science since they provide subjective information, related to space and generated by an immense amount of people. The presented study makes use of Flickr data of the city of Dresden (Germany) for extracting emotions related to a place, for distinguishing between tourists and locals and for a comparative analysis. Results indicate differences between these two user groups regarding the concentration/dispersion of photos and emotions, their temporal distribution as well as lexical differences hinting at distinct activities.

Keywords: volunteered geographic information, emotional cartography, affect analysis, user groups

1   Introduction and Motivation

Volunteered geographic information (VGI) provide heterogeneous information about the user who generated those information and about the user's environment. This makes VGI being a data source for miscellaneous fields in research and application. For instance, space-related emotions can be extracted [7] which enable also temporal analyses [8]. Furthermore VGI allows to distinguish users into user groups, e.g. into tourists and locals by analysing the data they produced over time. The presented work combines the three aforenamed scopes to gain insight into the activities as well as the behaviour of locals compared to tourists and into the way they sense a place, also from a temporal point of view. These investigations have been carried out for the study area of Dresden (Germany) using Flickr data.

The presented study illustrates the eclectic complexity of VGI which enables the extraction of miscellaneous information about the user in space and time. Categorizing users into user groups for analyzing their behavior can replace (or at least complement) laborious empirical surveys, like in this case in tourism business.

2   Related work

VGI enables the extraction of tourism-related information using for instance travel blogs, tourism-related rating platforms like TripAdvisor[1] or photo platforms. Especially the photo platform Flickr[2] is particularly appropriate as a data source for the aforementioned purpose since photos of places can be uploaded, georeferenced and described. Additionally the photo metadata provide further information like the time stamp of a photo or information about the user (e.g. user location). Thus sightseeing hotspots, travel trajectories, temporal patterns etc. can be extracted from Flickr data [2, 5, 6, 12, 13, 14, 16, 17, 19]. By analysing the photo metadata, users can be determined as tourists or residents at a particular place. [5] compares the differences between photos taken by tourists and by residents. Eric Fischer created an interactive map showing photo locations of locals and tourists worldwide[3]. However no methical description about this approach is existing. [10] investigates the localness of Flickr data and figures out that 50% of Flickr users contribute local information and 47% of the Flickr photos are taken within a 100 km radius around the user's home location. The presented study focuses on the differences between tourists and locals regarding not only the concentration/dispersion and temporal distribution of photos but also of emotions as well as lexical differences hinting at distinct activities.

3   Data basis and data preparation

For gathering emotional information, emotions need to be structured. In psychology different approaches for structuring emotions exist. Dimensional approaches try to reduce affective states to a few dimensions. Thus each emotion can be described as a combination of different severities of those dimensions. We are working with the model proposed by [15] involving the two dimensions valence and arousal which can be described as ranging from positive/pleasing to negative/displeasing and from arousing/intense to unarousing/numbing (see Figure 1a). With the help of these two dimensions it is possible to locate emotions within valence-arousal-space. For instance joy is a very positive emotion with high arousal whereas anger also has a high arousal but a negative valence.
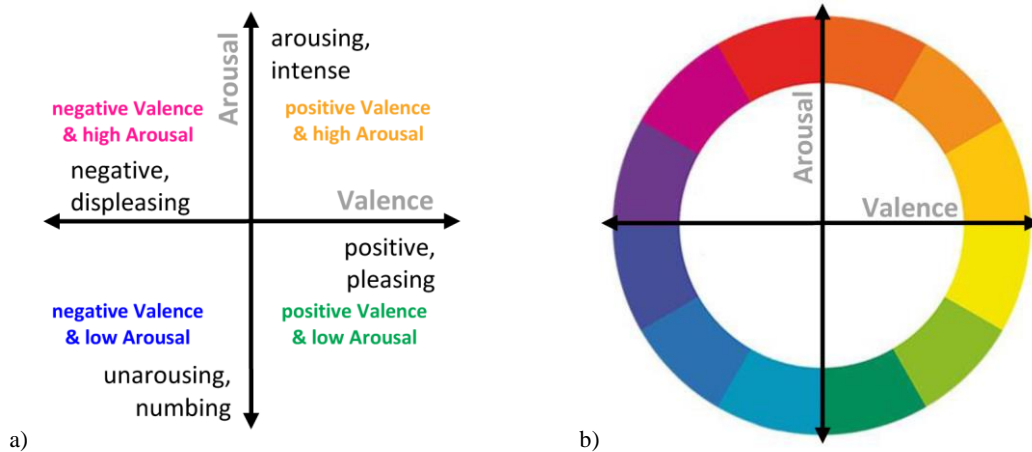
Our approach applies several methods of natural language processing to words that are contained in the title, description

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Figure 1: a) Two-dimensional structure of emotions according to [15],
b) Adaption of color wheel after [11] into valence-arousal-space

a)　　　　　　　　　　　　　　　　　　　　　b)

and tags of georeferenced Flickr photos. All words are matched with two emotional word lists: ANEW (Affective Norms for English Words [1]) and BAWL-R (Berlin Affective Word List Reloaded [18]) comprise English and respectively German words that are weighted with a valence and an arousal value and reflect affective connotations [9] and thus represent emotions. Each matched word is stored together with its emotional values from ANEW or BAWL-R and with the coordinates of the particular photo. Within this extraction approach, various grammatical issues are considered, like negations of words or amplifications. Procedures were developed for modifying the emotional values of the affected word, for example for inverting or intensifying them [7].

We applied this algorithm for extracting georeferenced emotions from photo metadata to a dataset of 48,286 Flickr photos of Dresden (Germany) from 2,684 users covering a period starting at the launch date of Flickr (February 2004) until 2015-06-15. The data were requested with the Flickr REST API. 122,140 emotions have been detected.

In the following the users of the used Flickr dataset shall be distinguished into tourists and locals. We define tourists as visitors of a place (a city, in our case), whereas locals are persons who gained deep and diverse knowledge of this place, i.e. inhabitants but also many-times-visitors. Thus it is a smooth transition between those two user groups, nevertheless we need to set hard thresholds for a distinction.

For determining users as tourists or locals of Dresden, the statement of each user about the user location in the Flickr metadata was used for assigning a user to one of the following groups: 'local', 'tourist' or 'possibly local' (e.g. in the case of 'Germany' as the user location which does not exclude Dresden). For the latter group, the time difference between the first and last photo taken in Dresden was calculated for each user. If all photos were taken within 30 days, the user is assumed to be a tourist. If the time difference is bigger than 30 days, the user is supposed to be a local. The 30-days-threshold was chosen according to [6]. Users who uploaded several pictures of Dresden with exactly the same time stamp were considered as tourists too. In the end there are still some users remaining that can be determined neither as tourists nor as locals because they uploaded only one picture. Finally 20% of all users are locals of Dresden, 63% are tourists and for 17% an assignment was not possible.

4 Data analysis and visualization

For analysing the emotional data, valence-arousal-space is subdivided into four quadrants which are combinations of positive/negative valence and high/low arousal (see Figure 1a). In order to visualise the data in an intuitively accessible way, one colour is assigned to each quadrant based on emotional associations and connotations of these colours and will be applied for visualisation repeatedly in the following. High arousal is generally related to warm colours like red, orange or yellow. Therefore shades of red are chosen for high arousal as red is the most emotional colour signifying passion, anger, love and strength [20]. Negative connotations of red are danger and devil, thus a bluish red is applied to the quadrant of negative valence & high arousal. The quadrant of positive valence & high arousal is assigned to the energetic colour orange, which positive associations are warmth, cheerfulness and brightness. Low arousal is rather represented by cold colours, e.g. green or blue. Green is chosen for the quadrant of positive valence & low arousal since positive connotations of green include calm, peace and health. The quadrant of negative valence & low arousal is represented by blue because its negative connotations are depression, sadness and introversion [4]. The explained colour assignment can be realized by fitting the colour wheel of Itten [11] into valence-arousal-space (see Figure 1b).

In the following the prepared data will be analyzed for differences between tourists and locals regarding quantitative and spatial differences (for both emotions and photos) as well as lexical differences.
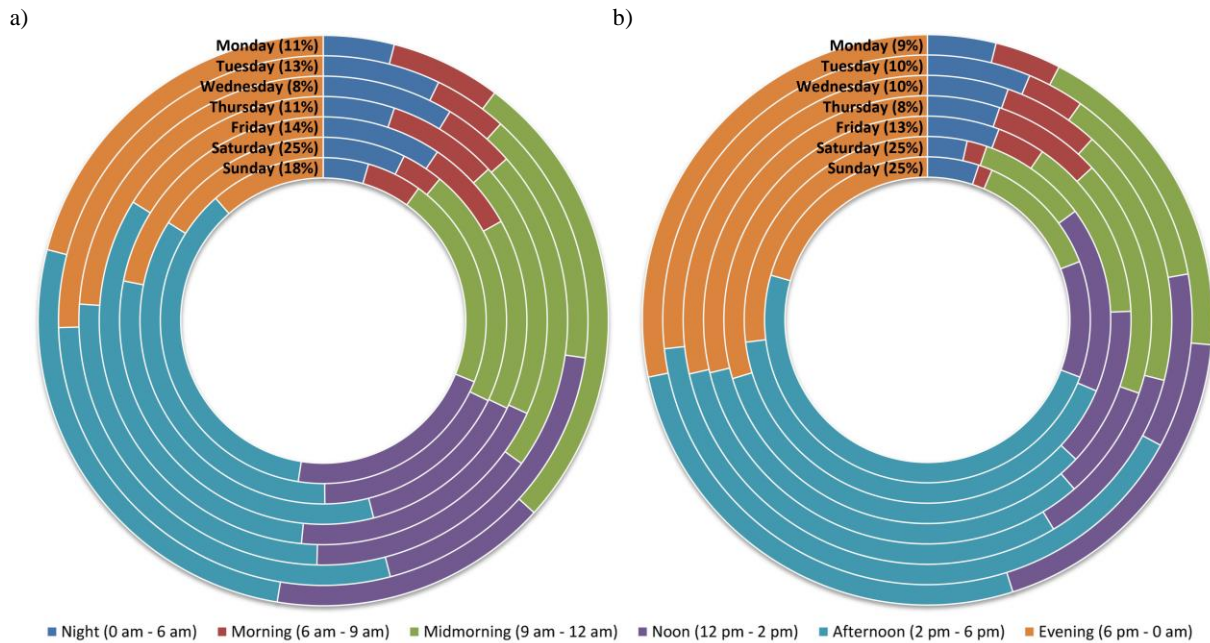
4.1 Quantitative differences

Regarding the amount of photos taken in Dresden compared with the total amount of photos that a user has uploaded, differences can be noted between tourists and locals. While

Table 1: Photo amounts for seasons and months

seasons					
	spring	*summer*	*autumn*	*winter*	σ
tourists	25%	33%	23%	19%	0,058
locals	24%	26%	30%	20%	0,031

months												
	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	σ
tourists	3%	7%	6%	7%	12%	13%	8%	11%	9%	10%	4%	9%	0,043
locals	5%	7%	6%	9%	9%	12%	7%	8%	11%	12%	7%	8%	0,022

Figure 2: Photo amounts per daytime on each weekday for (a) tourists and (b) locals

a)

b)

Monday (11%)
Tuesday (13%)
Wednesday (8%)
Thursday (11%)
Friday (14%)
Saturday (25%)
Sunday (18%)

Monday (9%)
Tuesday (10%)
Wednesday (10%)
Thursday (8%)
Friday (13%)
Saturday (25%)
Sunday (25%)

■ Night (0 am - 6 am) ■ Morning (6 am - 9 am) ■ Midmorning (9 am - 12 am) ■ Noon (12 pm - 2 pm) ■ Afternoon (2 pm - 6 pm) ■ Evening (6 pm - 0 am)

3.18% of all photos uploaded by tourists were taken in Dresden, the percentage for locals is 9.18%. Since users spend usually most of their time in their hometown, it makes sense that this amount is larger for locals.

A temporal analysis of the photo numbers reveals more differences. Regarding the seasons and months, fluctuations in tourism are identifiable whereas for locals the photo numbers are comparatively stable (see Table 1). In the warm months, i.e. from April to June, the number of tourists in Dresden is increasing but also again in December since in this month one of the oldest Christmas markets in Germany, the Striezelmarkt, takes place in Dresden. In the other winter months and in autumn, the number of tourists decreases, probably because of low temperatures. Local photo numbers vary less strongly but the data reflect that also locals prefer warm and dry weather for taking pictures outside as well and are also attracted by special events like the famous Christmas market Striezelmarkt. The lower seasonal variations for locals are reflected by the smaller standard deviation σ.

Regarding weekdays, it can be reported that locals take the majority of their photos at the weekend, the photo amounts of tourists are rather evenly spread over the weekdays but still with a minimum on Wednesday and a peak at the weekend too. The preferred daytime of locals for taking pictures is afternoon and evening, probably due to vocational obligations.

Tourists use the other daytimes stronger for picture taking than locals (see Figure 2).

The following amounts of emotions were detected for the previously described four quadrants of valence-arousal-space:

- positive valence & high arousal:
  25% (tourists) / 25% (locals)
- positive valence & low arousal:
  58% (tourists) / 59% (locals)
- negative valence & high arousal:
  6% (tourists) / 6% (locals)
- negative valence & low arousal:
  11% (tourists) / 10% (locals)

The detected amounts are nearly the same for tourists and locals. In general more than 80% of all detected emotions are positive ones and more than the half of those are of low arousal. So obviously users usually take pictures of positively appealing places. Emotions of negative valence are mainly of low arousal although it could be assumed that boring places are less often photographed than negatively arousing places but the latter ones might not exist quite as often. Another reason for the high amount of positive emotions with low arousal and for the same amounts for both user groups is the fact that also in ANEW and BAWL-R emotions of this quadrant are the prevailing ones.

Figure 3: Location of Flickr photos in Dresden. Blue: tourists, orange: locals, white: overlap.
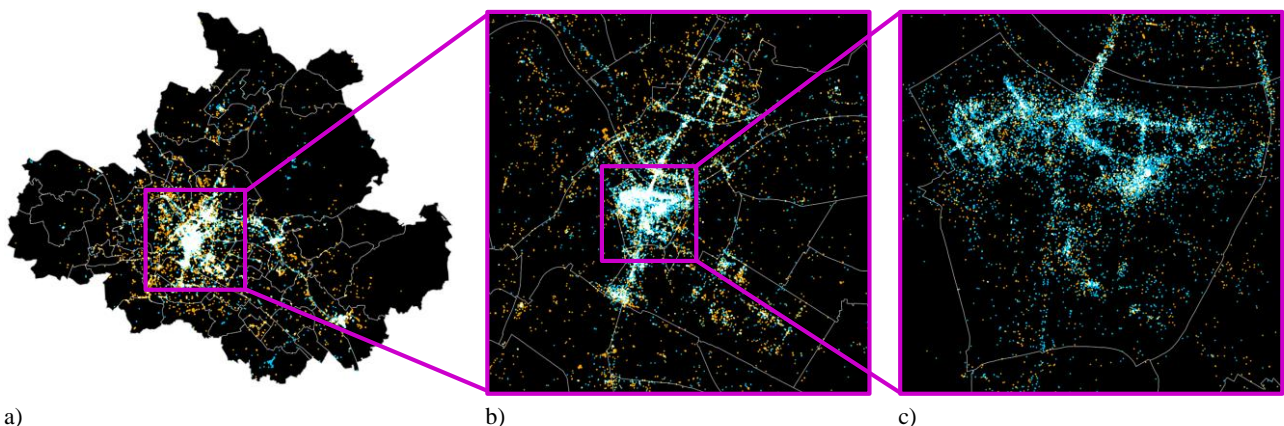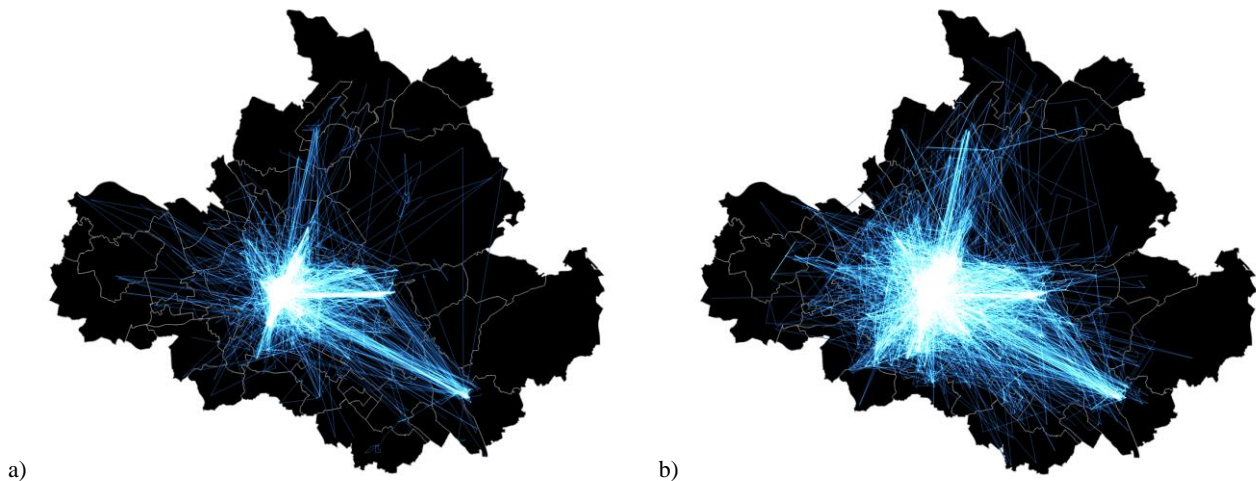a) township of Dresden, b) inner city, c) old town

a)

b)

c)

Figure 4: Polylines for each user connecting all photos in chronological order
for (a) tourists and (b) locals

a)

b)

4.2 Spatial differences

Visualizing the locations of tourists' and locals' photos reveals differences in the spatial distribution of photos within the city of Dresden (see Figure 3). Tourists' photos are concentrated at the main sightseeing spots whereas the photos taken by locals are spread over the entire city region. Zooming into the old town of Dresden, where most of the sights can be found, shows a vast majority of tourists' pictures. In Figure 3 each map scale reveals different patterns. This is achieved due to same signature sizes for every scale and thus aggregation by overlapping signatures.

Additionally a polyline was created for each user that connects all photos of this user in chronological order. The two resulting maps reflect again the different dispersion of pictures within town (see Figure 4).

Also for the detected emotions, distinct spatial distributions within the city of Dresden are appearing. Figure 5 and 6 illustrate that in the form of maps showing frequency-independently the location of emotions as well as density maps for highlighting emotional hotspots. In Figure 5 the quadrant colours from Figure 1 are applied. Overlaps are indicated in both figures. The kind of emotions sensed at certain places does not differ between tourists and locals although a larger number of emotional hotspots has been detected for locals indicating knowledge and activities that are typical for locals. The emotional places that seem to be

popular only amongst locals include certain museums, art galleries, parks or extraordinary graveyards and thus seem to be inside tips.

4.3 Lexical differences

Regarding the words that caused the extraction of emotions, differences can be noted for the two user groups tourists and locals. Figure 7 shows word clouds with the 20 most frequently used words for each user group. The most frequently used word of both groups is 'Kirche' (engl. church) since in Dresden several famous churches are forming the cityscape. In the tourists' word cloud some words hint at travel activities like 'trip' or 'travel'. In the locals' word cloud art-related words are appearing like 'art', 'Kunst' (engl. art) or 'film' indicating a participation in cultural life.

Word clouds for different time granularities contain miscellaneous words. For instance word clouds for winter contain the word 'Markt' (engl. market) in the case of tourists which points out the Christmas market Striezelmarkt in December. For locals the words 'Schnee' (engl. snow) and 'Winter' (engl. winter) show that locals take photos because of this certain season and not because of sightseeing. Observing merely negative words with high arousal used by locals reveals that photographing abandoned places seems to be quite popular since words like 'ruin', 'verlassen' (engl. abandoned) and 'Verfall' (engl. decay) are used. The most

Figure 5: Locations of emotions detected for a) tourists and b) locals.
Pink: negative valence & high arousal, orange: positive valence & high arousal,
blue: negative valence & low arousal, green: positive valence & low arousal, white: overlap
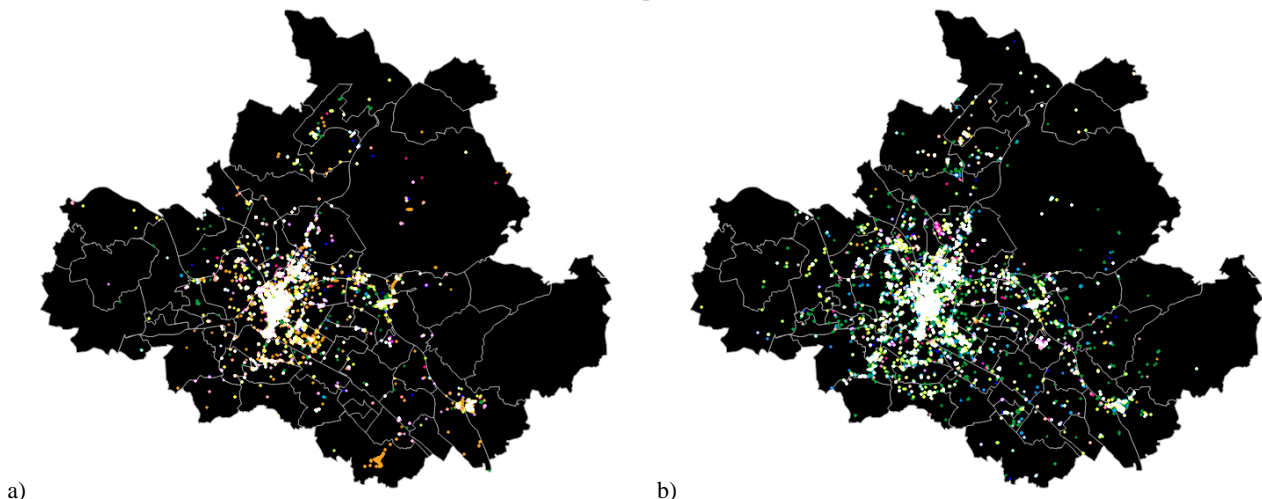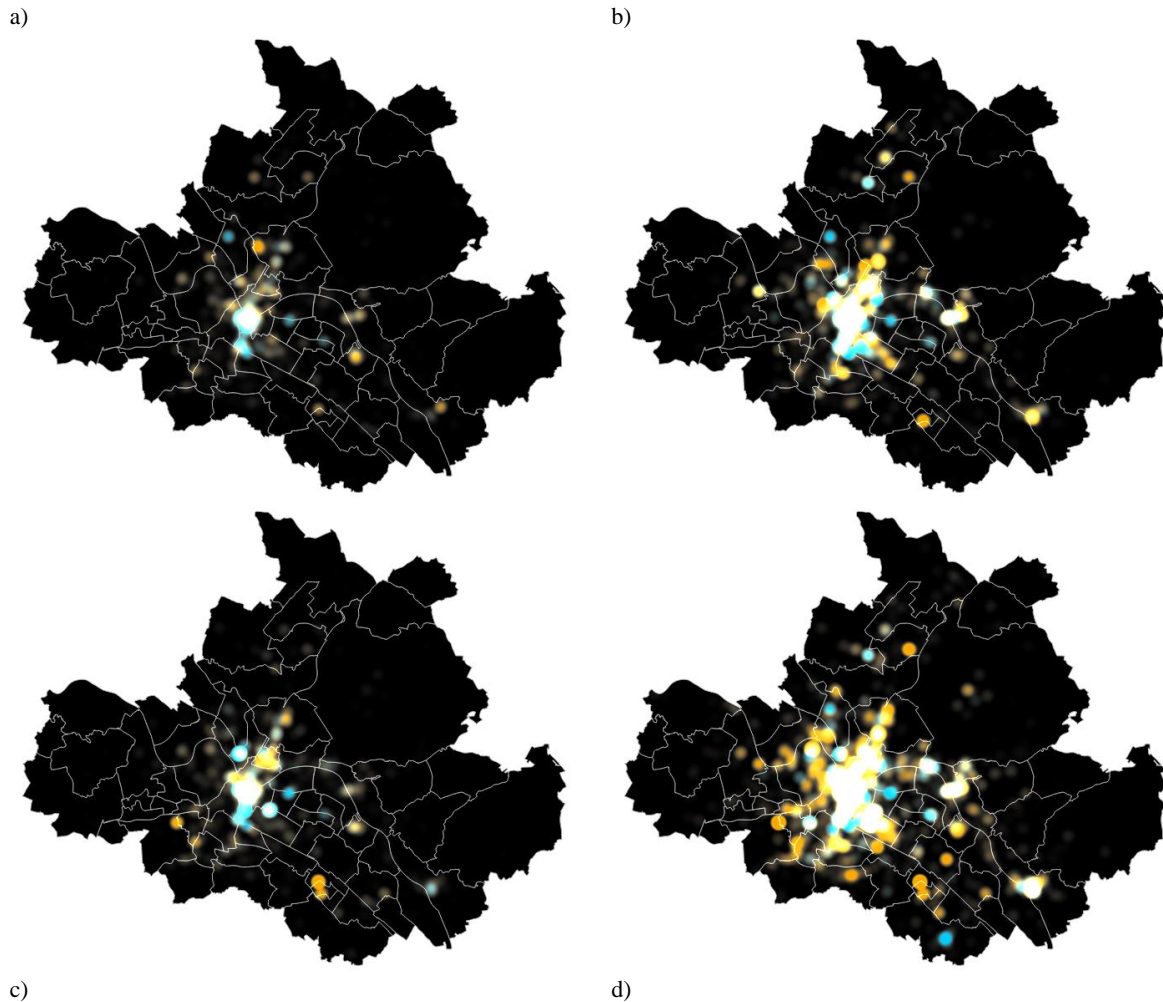

a)

b)

Figure 6: Density maps of detected emotions in Dresden for each quadrant.
Blue: tourists, orange: locals, white: overlap.
a) negative valence & high arousal, b) positive valence & high arousal,
c) negative valence & low arousal, d) positive valence & low arousal

a)

b)

c)

d)

frequently positive words with high arousal of the same user group include 'party', 'concert' and 'event' and indicate once again a participation in cultural life.

5 Summary

The presented study extends a research project about detection, modelling and visualisation of space-related emotions from VGI, i.e. from the metadata of georeferenced Flickr photos by applying a comprehensive linguistic analysis [7]. The extracted emotions are assigned to the location of the respective photo and are described by the two dimensions valence and arousal. For the city of Dresden (Germany) the detected emotions as well as the underlying photos are analysed regarding differences between tourists and locals. The division of users into these two groups is based on [6].

Major findings include that tourists take photos especially at the main sightseeing spots whereas the photos taken by locals are spread over the entire city region. The kind of emotions sensed at certain places does not differ between tourists and locals although a larger number of emotional places has been detected for locals indicating knowledge and activities that are typical for locals. Lexical differences between tourists and locals can be determined by considering the words that caused the detection of an emotion and thus were used by the user in the photo metadata. The words used by tourists refer to sightseeing activities whereas the words used by locals hint at leisure activities like participating in cultural events, visiting parties or photographing abandoned places. Further differences are revealed by temporal differentiation. For locals the photo number is rather equal over the seasons and the months of a year whereas variations are stronger for tourists.

Figure 7: Word clouds with the 20 most frequently used words by a) tourists and b) locals

a)

b)
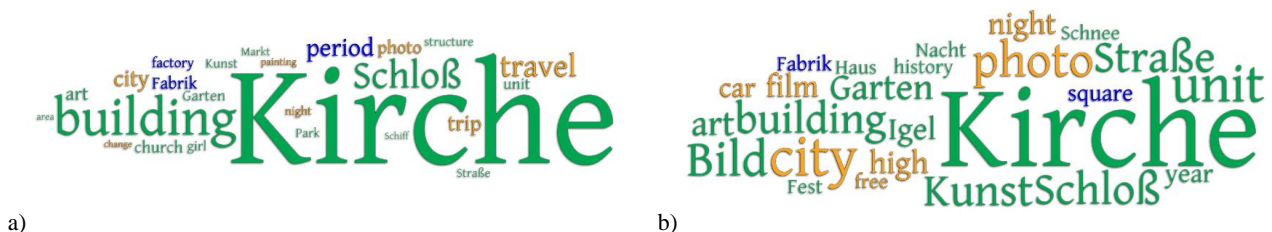
Locals take more than half of their photos at the weekend and in the afternoon and evening. In that regard the number of tourist photos is rather equally distributed due to missing vocational obligations during the visit.

References

[1] M.M. Bradley and P.J. Lang. Affective norms for English Words (ANEW): Stimuli, instruction manual and affective ratings. In *Technical Report C-2*, The Center for Research in Psychophysiology, University of Florida, Gainesville, 2010.

[2] G. Chareyron, J. Da-Rugna and B. Branchet. Mining tourist routes using flickr traces. In *Proceedings of the 2013 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining*, pages 1488 – 1489, IEEE, 2013.

[3] D. Crandall, L. Backstrom, D. Huttenlocher and J. Kleinberg. Mapping the World's Photos. In *Proceedings of the 18th international conference on World Wide Web*, pages 761-770, ACM, New York, 2009.

[4] E.A. Feisner and R. Reed. *Color studies*. A&C Black, London, 2013.

[5] J.C. García-Palomares, J. Gutiérrez and C. Mínguez. Identification of tourist hot spots based on social networks: A comparative analysis of European metropolises using photo-sharing services and GIS. In *Applied Geography*, 63: 408-417, 2015.

[6] F. Girardin, F.D. Fiore, J. Blat and C. Ratti. Understanding of tourist dynamics from explicitly disclosed location information. In *International Symposium on LBS & TeleCartography*, 2007.

[7] E. Hauthal and D. Burghardt. Mapping Space-Related Emotions out of User-Generated Photo Metadata Considering Grammatical Issues. In *Cartographic Journal*, 2016.

[8] E. Hauthal and D. Burghardt. Temporal occurrence and time-dependency of georeferenced emotions extracted from user-generated content. In *Proceedings of AGILE 2015: 18th AGILE International Conference on Geographic Information Science*, 2015.

[9] S. Hayakawa. *Language in Thought and Action*. George Allen & Unwin, London, 1952.

[10] B.J. Hecht and D. Gergle. On the "localness" of user-generated content. In *Proceedings of CSCW '10 Proceedings of the 2010 ACM conference on Computer supported cooperative work*, pages 229-232, ACM, New York, 2010.

[11] J. Itten. *Kunst der Farbe*. Otto Maier, Ravensburg, 1961.

[12] S. Kisilevich, M. Krstajic, D. Keim, N. Andrienko and G. Andrienko. Event-based analysis of people's activities and behavior using Flickr and Panoramio geotagged photo collections. In *Proceedings of the 14th International Conference Information Visualisation*, pages 289-296, IEEE, 2010.

[13] Y. Pang, Q. Hao, Y. Yuan, T. Hu, R. Cai and L. Zhang. Summarizing tourist destinations by mining user-generated travelogues and photos. In *Computer Vision and Image Understanding*, 3 (115): 352-363, 2011.

[14] A. Popescu, G. Grefenstette and P.-A. Moëllic. Mining tourist information from user-supplied collections. In *Proceedings of the 18th ACM conference on Information and knowledge management*, 2009.

[15] J.A. Russell. A circumflex model of affect. In *Journal of Personality and Social Psychology*, 39: 1161-1178, 1980.

[16] G. Sagl, B. Resch, B. Hawelka and E. Beinat. From Social Sensor Data to Collective Human Behaviour Patterns: Analysing and Visualising Spatio-Temporal Dynamics in Urban Environments. In T. Jekel, A. Car, J. Strobl, J. and G. Griesebner, editors, *GI-Forum 2012: Geovisualization, Society and Learning*, pages 54-63, Wichmann, Heidelberg: Salzburg, Austria, 2012.

[17] Y. Sun, H. Fan, M. Helbich and A. Zipf. Analyzing Human Activities Through Volunteered Geographic Information: Using Flickr to Analyze Spatial and Temporal Pattern of Tourist Accommodation. In J.M. Krisp, editor, *Progress in Location-Based Services, Lecture Notes in Geoinformation and Cartography*, pages 57-69 Springer, Heidelberg, 2013.

[18] M.L.-H. Võ, M. Conrad, L. Kuchinke, K. Hartfeld, M.F. Hofmann and A.M. Jacobs. The Berlin Affective Word List Reloaded (BAWL-R). In *Behavior Research Methods*, 41 (2): 534-538, 2009.

[19] H.Q. Vu, G. Li, R. Law and B.H. Ye. Exploring the travel behaviors of inbound tourists to Hong Kong using geotagged photos. In *Tourism Management*, 46: 222-232, 2015.

[20] J. Wolfrom. *The magical effects of color*. C & T Publishing, Lafayette, 2009.