SIGGIS PRIMER: GIS & SOCIAL MEDIA

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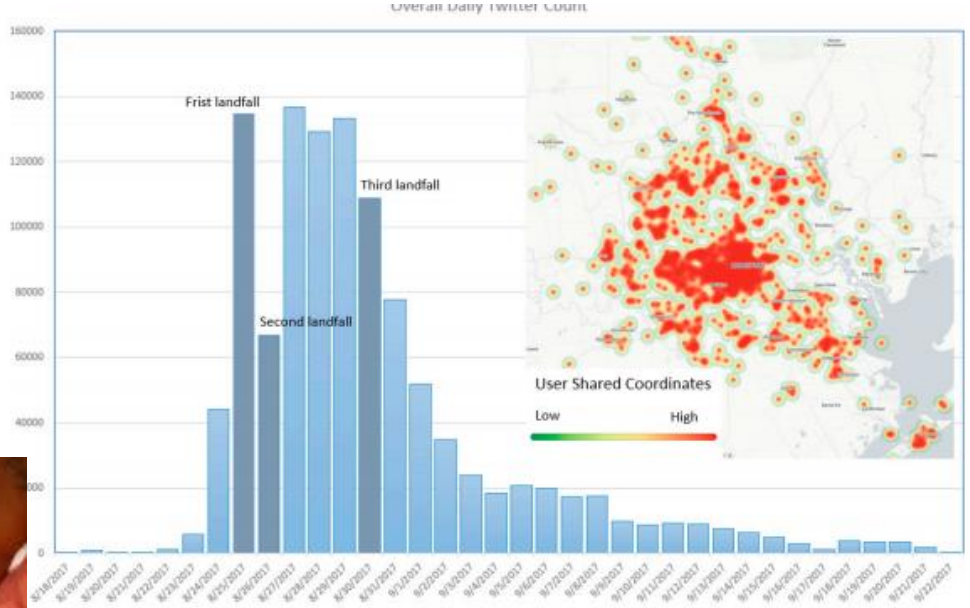

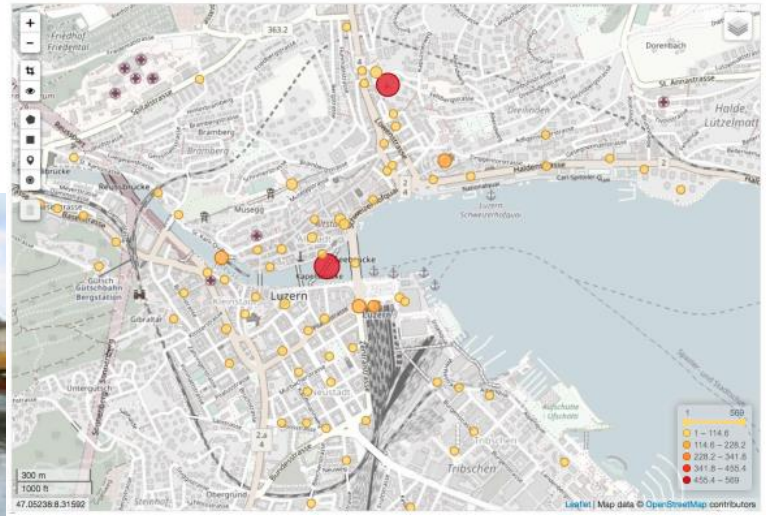

(Sources. Texastribune. Org, Alami.com, 2019, Kauffman et al., 2019; Yang et al. 2019)

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SIGGIS PRIMER ON GIS AND SOCIAL MEDIA- PURPOSE

- **Purpose**
- **Special Issue on Convergence of GIS & social media**
- **Convergence illustrated with three cases**
- **Convergence briefly mentioned for four additional cases**
- **Typology of convergence of GIS & social media**
  - **Social media information as focus of the convergence**
  - **Algorithms: a key to how convergence is determined**
  - **Theory as focus**
  - **Types of social media involved**
  - **Analytics perspective: description, prediction, prescription**
- **Conclusion**

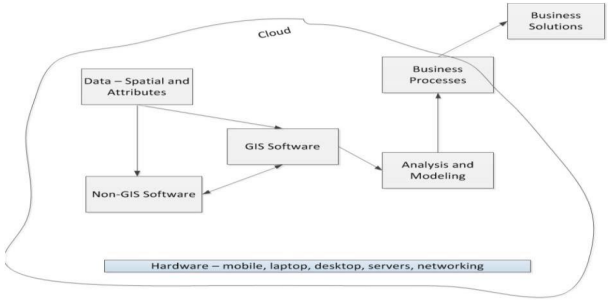
This talk is mostly based on published papers in the special issue of *International Journal of Geo-Information,* which contains seven articles published in winter of 2020. The presenter co-authored one of the papers with Dr. Avijit Sarkar and Jessica Rosales. https://www.mdpi.com/journal/ijgi/special_issues/media

Acknowledgments: to Special issue authors and Esade Business School for sponsoring a seminar in 2019.

SOCIAL MEDIA AND GIS DEFINED

- Social Media "Forms of electronic communication (such as websites for social networking and microblogging) through which users create online communities to share information, ideas, personal messages, and other content" (Webster's, 2019).

- GIS (Geographic Information System) is "GIS is a computer system capable of capturing, storing, analyzing, and displaying geographically referenced information; that is, data identified according to location" (USGS, 2020) (See *CAIS*, Pick, 2006; Farkas et al., 2016)



PURPOSE TO STUDY CONVERGENCE OF GIS AND SOCIAL MEDIA

- The goal of the talk is to provide novel research insights on how GIS and social media converge, based on the findings of a special issue edited by the presenter and published by *Int'l J. of Geo-Information* in winter, 2020.
- Social media platforms are able to trace the proximity of persons with each other and with organizational assets for the purposes of meeting, socializing, collaborating, locating, and making decisions.
- One convergence perspective involves GIS as a way to communicate social media knowledge. Study is brought forward on analytic tools to handle social-media locational big data that have multimedia attributes and rich location-based content for harvesting.
- Another view is how GIS can be utilized as a tool to map and understand the prevalence and content of social media in varied geographies.
- Additionally, the convergence studies can inform management of organizations about location-based social media for decision-making.
- On the other side, convergence can raise issues in data quality, preserving personal privacy of locational social media information, and managerial ethics.

ARTICLES APPEARING IN THE SPECIAL ISSUE OF INT'L JOURNAL OF GEO-INFORMATION, WINTER 2020

- A Twitter Data Credibility Framework – Hurricane Harvey as a Use Case
  J. Yang, M. Yu, H. Qin, M. Lu, and C. Yang
- Analysis of Tourism Hotspot Behaviour based on Geolocated Travel Blog Data: The Case Study of Qyer
  M. Kaufmann, P. Siegfried, L. Huck,and J. Stetler
- Social Media Use in American Counties: Geography and Determinants
  J. Pick, A. Sarkar, and Jessica Rosales
- Context-Aware Group-Oriented Location Recommendation in Location-based Social Networks (briefly)
  E. Khazaei and A. Alimohammadi
- Solving Competitive Location Problems with Social Media based on Customers' Local Sensitivities (briefly)
  W. Jiang, Y. Wang, M. Dou, S. Liu, S. Shao, and H. Liu
- Retrieving Landmark Salience Based on Wikipedia: An Integrated Ranking Model (briefly)
  N. Binski, A. Natapov, and S. Dalyot
- A New Approach to Refining Land Use Types: Predicting Point-of-interest Categories using Weibo Check-in Data
  X. Zhang, Y. Sun, A. Zheng, and Y. Wang (briefly)

Note: there are other articles on the convergence of GIS and social media in IJGI and elsewhere going back nearly a decade, beginning with studies such as Sui and Goodhild (2011).

A TWITTER DATA CREDIBILITY FRAMEWORK – HURRICANE HARVEY AS A USE CASE

- Situation awareness in emergencies has been enhanced by social media data over the past 15 years.
  - Before social media was utilized, emergency data were mostly from governmental sources – meteorological, public safety, emergency management, as well as from media reporting from the field.
  - Social media added information immediacy from persons experiencing the emergency, combined with sentiment.
- A problem with emergency data is credibility, i.e. accuracy, which has special importance, since lives, property, infrastructure may be at risk.

- Emergency social media data may be viewed somewhat as crowdsourced data although the contributors are often less focused than in crowdsourcing.
  - A lesson from crowdsourcing is that "errors propagated in volunteered information decrease as the number of contributors increase."

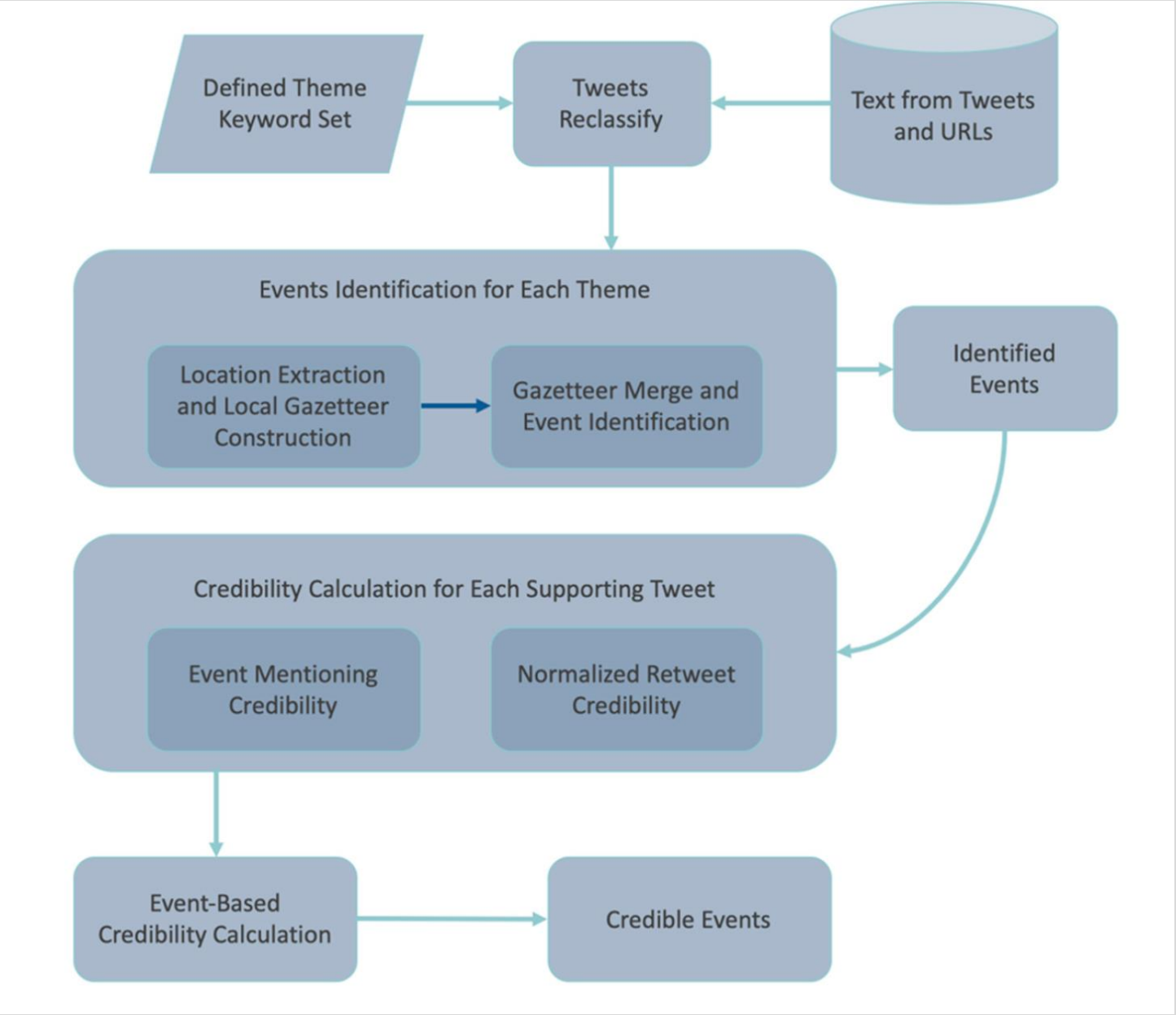
Source: Live Science

Source: The Atlantic

A FRAMEWORK FOR DETERMINING CREDIBILITY OF TWEETS (YANG ET AL.)

- Hurricane Harvey, a Category 4 hurricane, hit the Texas and Louisiana coasts over a 4-day period in August of 2017, leading to deaths, flooding, and damages estimated at $125 billion. Damages were huge from flooding in Houston.
- This article's study framework is built from Twitter data over the study period. Tweets related to the Hurricane were extracted and enhanced with a two-tier approach.
  - Tier 1. Disaster-related tweets were identified by a group of keywords that included "power, shelter, damage, casualty, flood."
  - Tier 2. For an extracted tweet the tweet message information was enhanced by adding associated text messages and websites (URLs).
- An event was identified by aggregating a set of enhanced tweets having similar topics, location, and time.
- Event credibility was estimated through use of scales, yielding insight on the events that were more or less "trustworthy."

Tweet Credibility Famework (Yang et al.)



Note: a "gazetteer" is a geographical dictionary

Event is a group of Tweets identified by common theme

Credibility is measured by answering, Was there consistency across the enhanced tweet information, plus was there a high proportion of retweets?

CALCULATING EVENT-BASED CREDIBILITY & CRITIQUE

$$\mathrm{EBC}_{\mathrm{NORM}} = 0.5 \times \mathrm{text} + 0.5 \times \mathrm{URL}$$

$$\mathrm{Retweet}_{\mathrm{NORM}} = \frac{\mathrm{Retweet}_{\mathrm{tweet}}}{\mathrm{Retweet}_{\mathrm{max}}}$$

$$\mathrm{EBC}_{\mathrm{tweet}} = \mathrm{EBC}_{\mathrm{NORM}} + \mathrm{Retweet}_{\mathrm{NORM}}$$

$$\mathrm{EBC}_{\mathrm{total}} = \sum_{i=1}^{i=n} \mathrm{EBC}_{\mathrm{tweet}}{}^{i}$$

Where n is the total no. of tweets associated with the event

$\mathrm{Retweet}_{\mathrm{tweet}}$ is the no. of retweets for a given tweet

$\mathrm{Retweet}_{\mathrm{max}}$ is the maximum no. of retweets among all supporting tweets for the event

"text" refers to mentioning the event in the tweet text

"URL" refers to mentioning the event in the URL

- Critique.

There are possible errors (intentional or unintentional) in the tweet message's reference to an event or a URL's mention of the event.

What if more than one URL is referenced in a tweet?

Does a larger proportion of retweets actually reflect credibility?

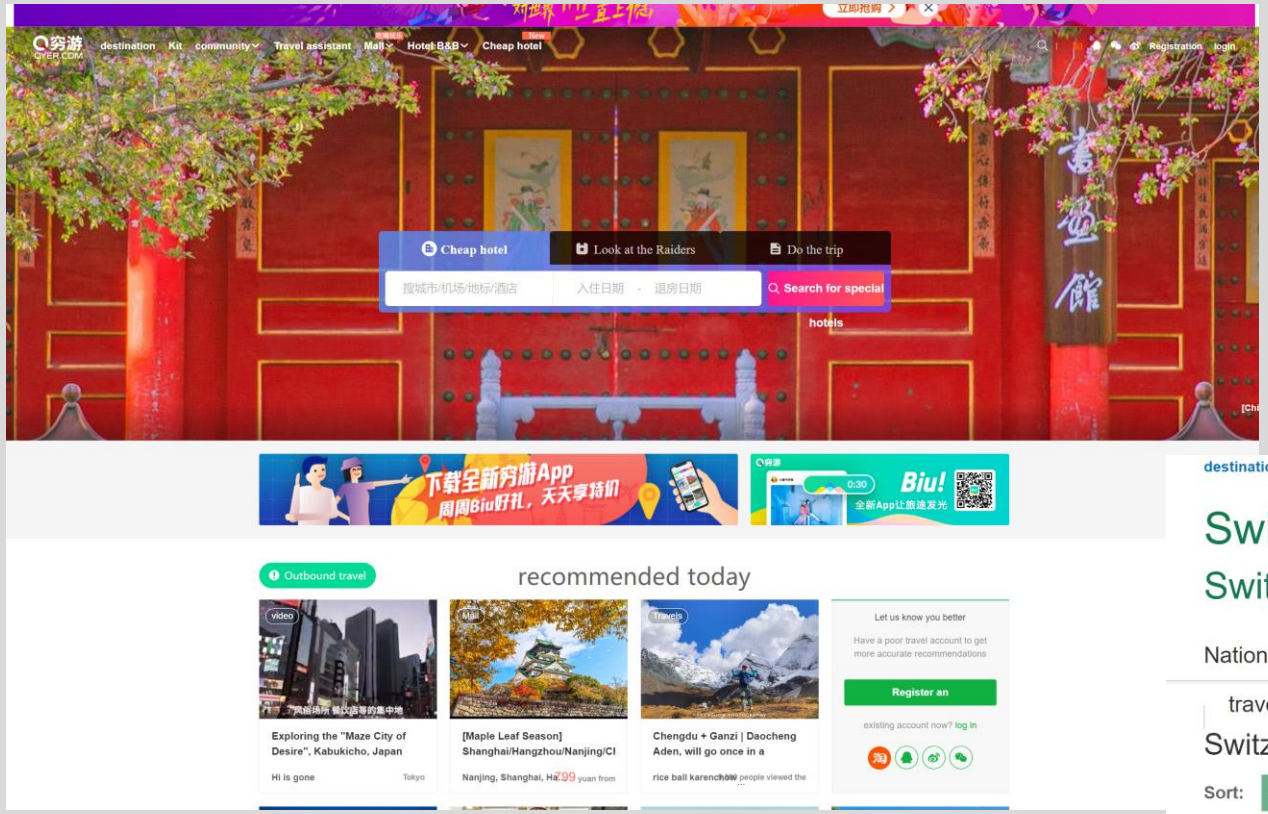
ANALYSIS OF TOURISM HOTSPOT BEHAVIOR BASED ON GEOLOCATED TRAVEL BLOG DATA AS A USE CASE (M. KAUFFMAN ET AL.)

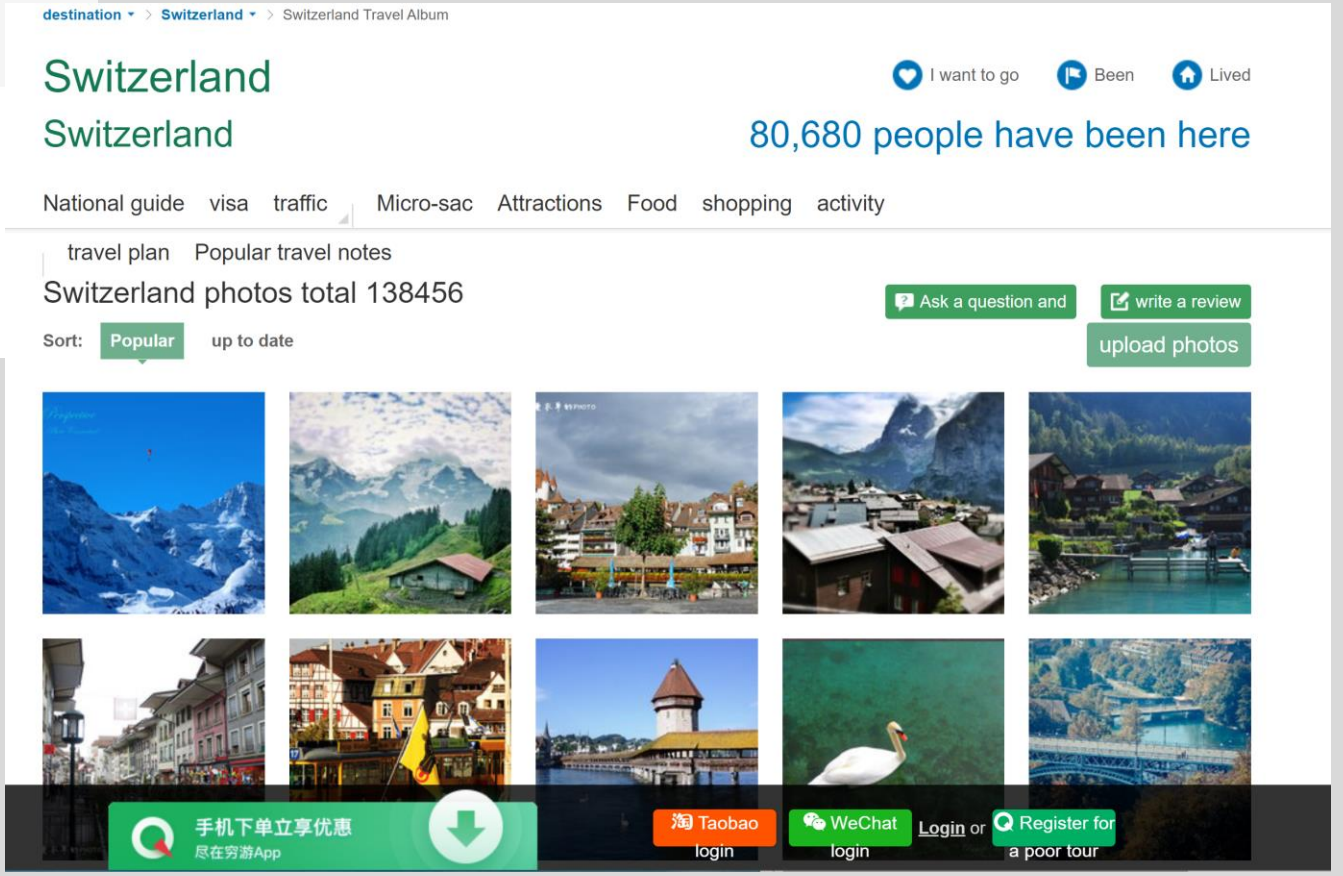
- Chinese tourists to Switzerland blog about their travel experiences and frequently do so on the Qyer website.
- Chinese tourists were selected to study because they are the tourist group that has grown tremendously in Switzerland – over 500 percent in past 10 years.
- By designing a web crawler to locate the blogs and extract their ratings of tourist locations in Switzerland, and then geo-locating the points of interest (POIs), a broad map of tourist hotspots can be produced for Switzerland.
- Users can be segmented based on their blogging profiles into several groups that indicate differences in "hot spots" based on their web-behavior.
- Since the blogging site Qyer was predominantly for individual travelers, not groups, a practical objective is to identify *individual tourist interests*, as differentiated from *interests of group travelers*, who are managed or influenced strongly by tour operators and other enterprises.

GOAL OF QYER STUDY, DATA SOURCE, METHOD

- The goal of the study is "to segment tourists based on their content-generating behavior on geolocated travel blogs and identify those who are more interested in places other than tourist hotspots."
- The study reveals the features of independent travelers whose blog content indicate they are not interested in conventional Swiss hotspots.
  - The practical implication is that tourist locations other than the hotspots can be encouraged to undertake development.
- The travel blog Qyer.com is selected as the use case, and a system is developed to identify tourist destination preferences.
  - Qyer.com is one of the two most popular Chinese blog sites for independent travelers
  - Qyer provides consumer-driven, interactive content, somewhat like TripAdvisor but for the Chinese market.
- As part of the methodology, the Qyer.com site was "reverse-engineered"

Qyer.com (translated with Google Translate)





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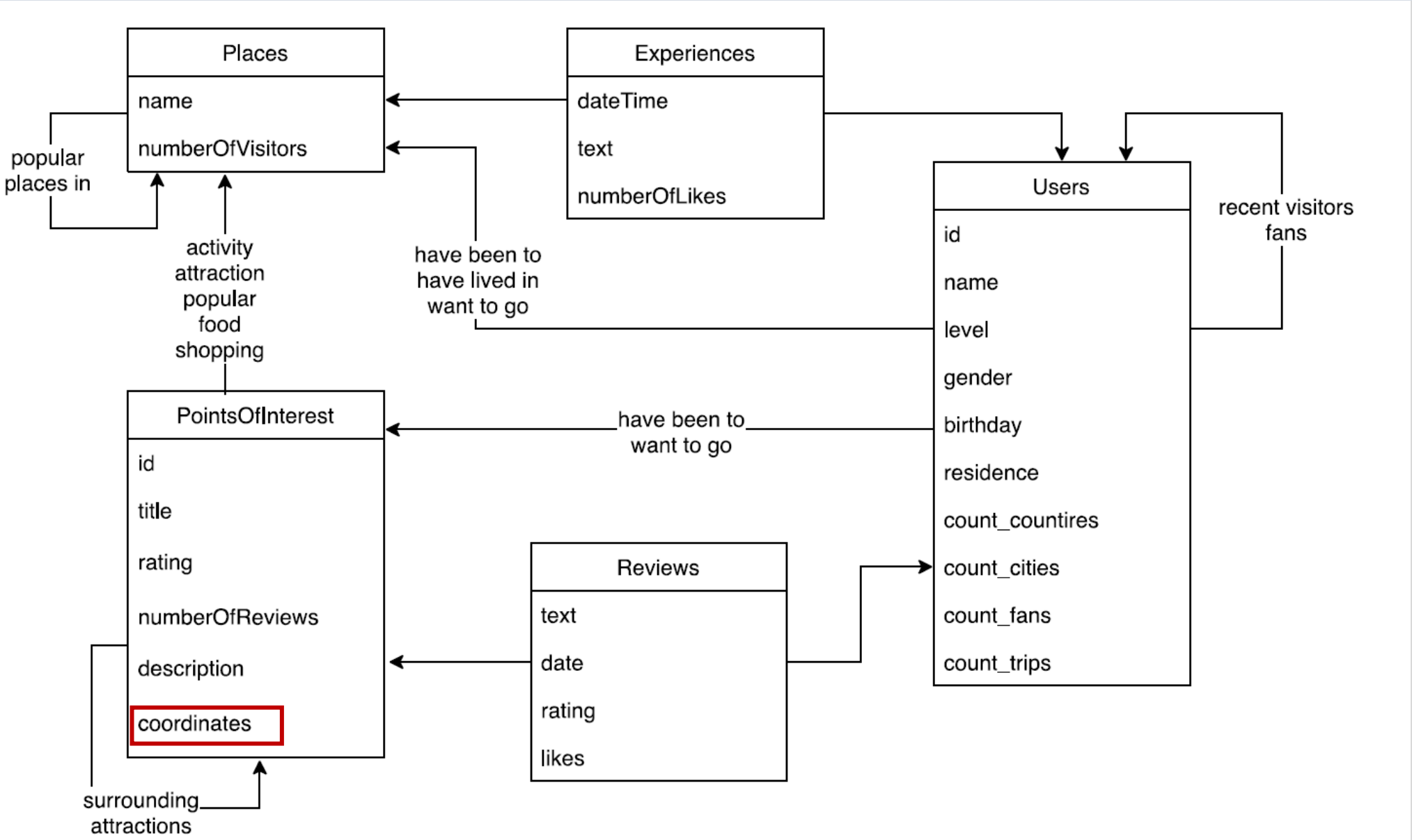
Reverse Engineering of Qyer.com. For each major place, the web was scraped by a Python web-crawler to provide all of the information given in the model below. Geographical location is represented by "coordinates" – marked in red in lower left.



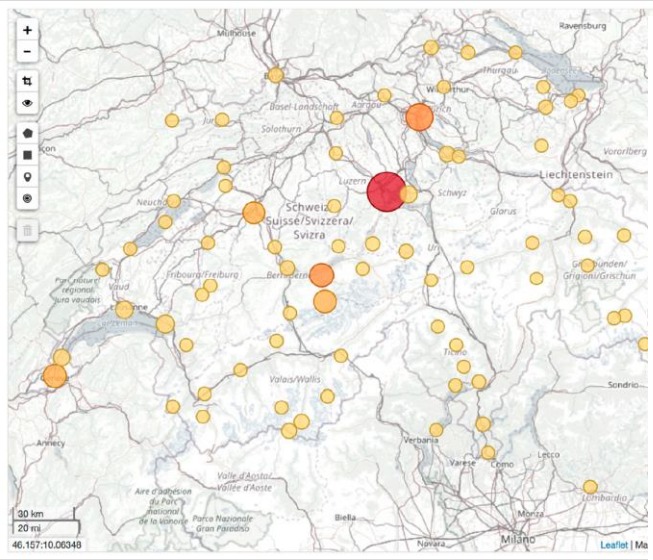
QYER USE CASE - MULTI-STEP EXTRACTION INTO EXCEL AND CLUSTERING THROUGH MACHINE LEARNING KIT (WEKA)

The web-scraped information was further processed in 8 steps that include

- Converting text to JSON (to transfer data objects)
- Querying and manipulation with the Kibana GUI
- Interactive map visualization of user comment based on Point-of-Interest locations.
- Data aggregation and export
- Use of Excel spreadsheet for analytics
- Clustering with Weka Machine learning kit

QYER AND CHINESE TOURISM - PRACTICAL FINDINGS

- Data were collected on the visit volume and travel preferences of Chinese tourists based on the comments regarding an individual, geo-referenced point of interest.
- Users can be segmented into those with interest in conventional hot spots, especially Lucerne, Zurich, Interlaken, and Geneva, while also revealing the "long tail" of places with current small blog-expressed interest.
  - The visitation of these independent travelers to the less-known hot spots can guide future planning of tourist development, geographically spreading the rising tide of Chinese travelers to Switzerland.
- The study uses novel methods that were able to uncover alternative destinations through re-engineering, geo-locating, and extraction methods for social media.



Heat maps, which are produced in this Qyer study by a complex clustering algorithm, reveal the frequency of blogger comments, shown for the nation (top) and for the city of Lucerne (bottom).

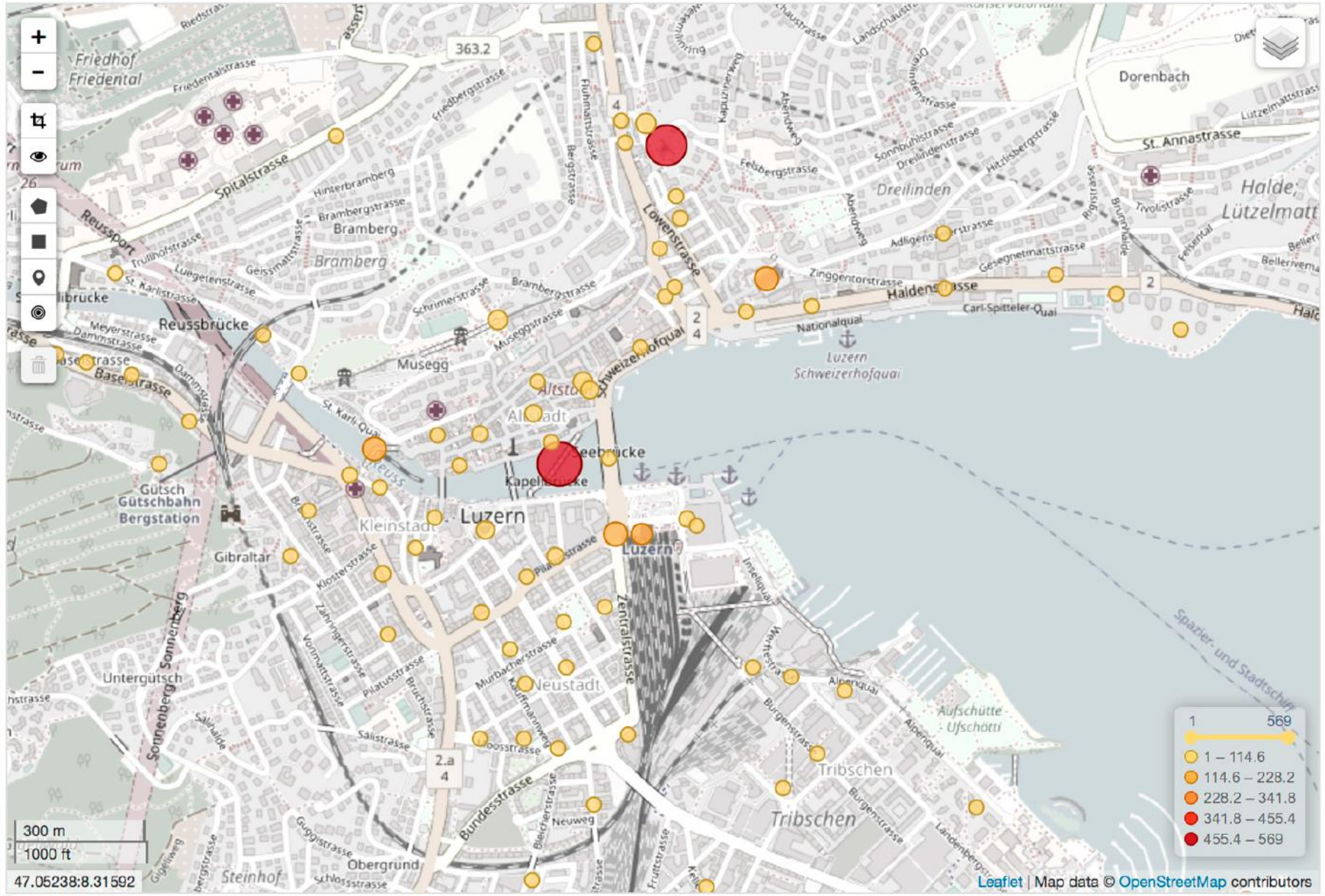


Figure 5. Screenshot: Frequency of comments by users in an interactive heatmap zoomed to the area of Lucerne.

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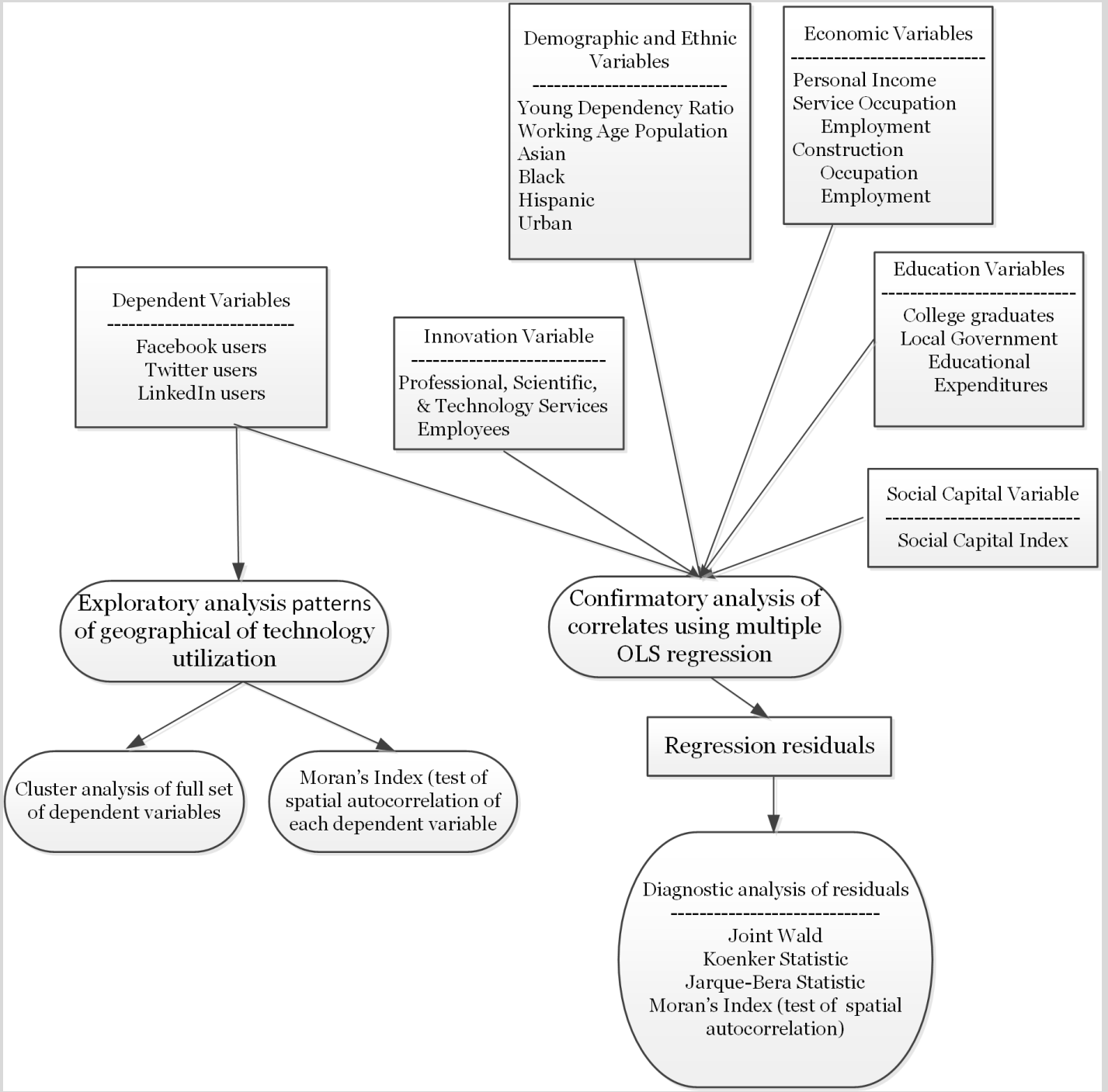
USE CASE ON SOCIAL MEDIA USE IN AMERICAN COUNTIES: GEOGRAPHY AND DETERMINANTS (J. PICK, A. SARKAR, J. ROSALES)

- Spatial analysis is conducted to show Twitter, Facebook, and Linked-in distribution of users in the 3,109 counties in the lower 48 states of the US.
- Social media use is growing in the US. Among persons aged 15 years or older, 74.4% of Americans (153.7 million) used the Internet for online social networking in November 2017.
- The spatially-aware technology utilization model (SATUM) is applied to conduct the spatial analysis and identify the determinants of levels of social media.
- Methods employed are geographic mapping, k-means cluster analysis, OLS stepwise regression, and spatial autocorrelation.
- The socio-economic determinants considered are demographic indicators, service occupations, ethnicities, and urban location.
- The analysis was done for samples of all US counties, metropolitan counties, micropolitan counties, and rural counties.

SATUM model for the study of social media in US Counties



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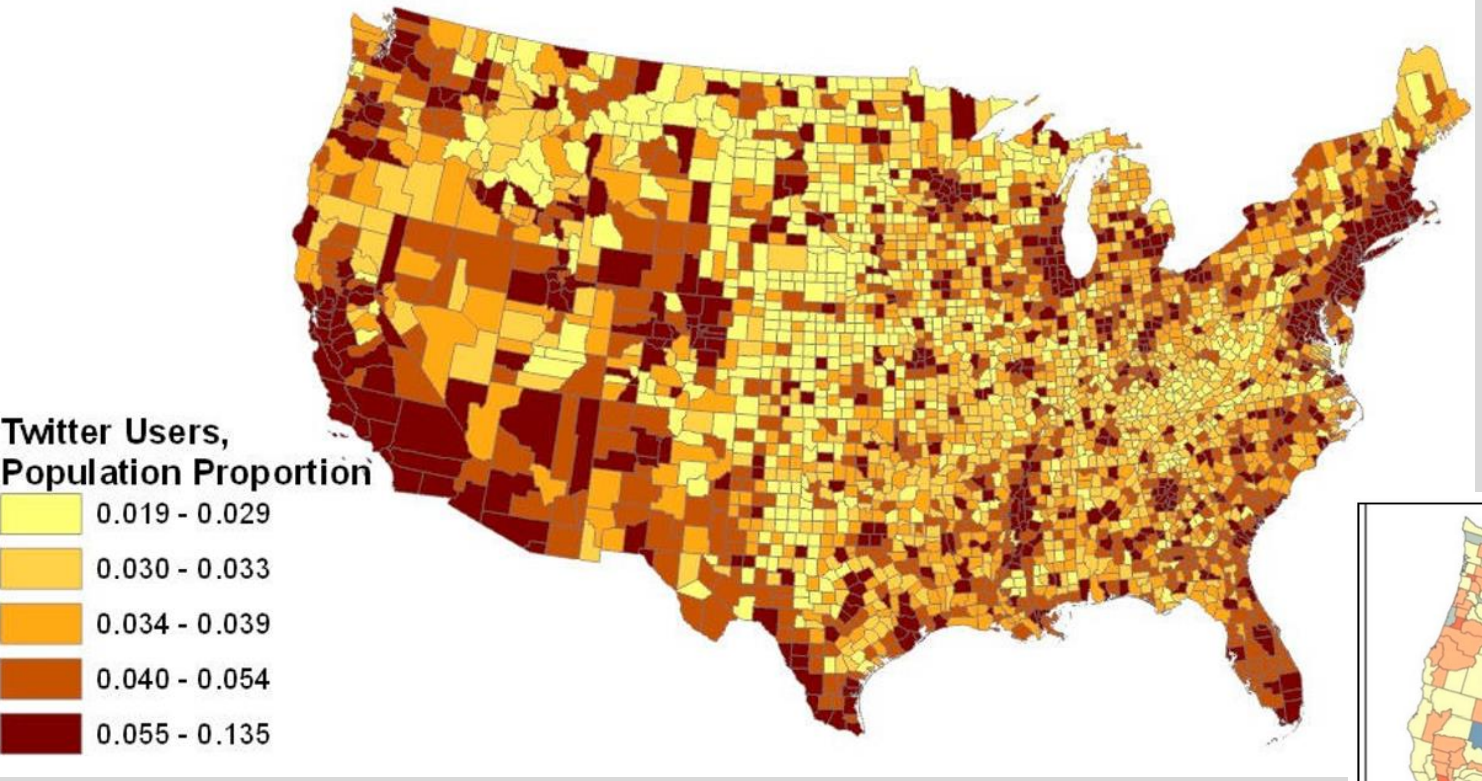
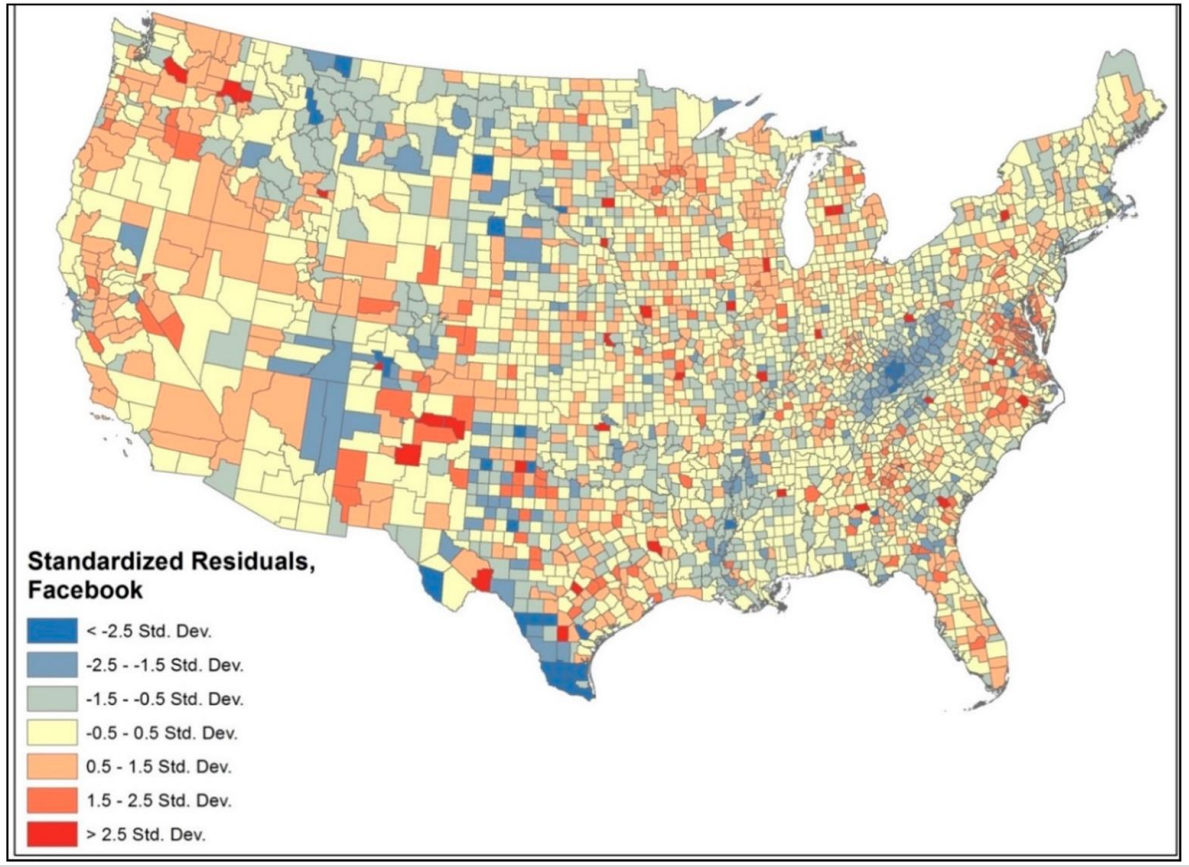
FINDINGS ON THE GEOGRAPHIC PATTERNS OF SOCIAL MEDIA USE IN THE US

- Twitter users were more heavily concentrated in southern California and had a strong presence in the Mississippi region, while Facebook users were highly concentrated in Colorado, Utah, and adjacent Rocky Mountain States.
- Social media usage was lowest in the Great Plains, lower Midwest, and South with the exceptions of Florida and major southern cities such as Atlanta. The spatial distribution of Twitter users (Figure 3) generally corresponded to the Facebook pattern Facebook, but with the following differences: (1) the levels of Twitter use on the southwest border of Texas were very reduced when compared to Facebook use; (2) usage in Southern California was
- Overall extent of spatial agglomeration were very high.





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FINDINGS OF STUDY ON DETERMINANTS OF SOCIAL MEDIA IN US

- Major determinants of social media use are demographic factors of urban location and ethnicities; and the economic factor of service occupation.
- These determinants correspond to other studies for social media and ICT levels for US counties, US states, and Eurostat regionas across Europe.
- The spatially aware technology utilization model (SATUM) is applicable to this investigation. Almost all the independent variables had at least some empirical association with social media. The only exception was personal income, which was eliminated due to multi-collinearity. The present SATUM model has the potential to be applied to small geographic samples of counties, with sample sizes as small as 50.
- Micropolitan and rural samples showed strong associations with service occupations, as well inverse association with social capital for LinkedIn and Twitter use

POLICY IMPLICATIONS FOR U.S. COUNTY GOVERNMENTS

Based on the study, county governments can

- ✓Foster or support college education for citizenry;
- ✓Attract service sector employees for businesses and government and encourage existing service-oriented organizations;
- ✓Encourage jobs for a younger population and families and stemming the outflow of the young population from impacted counties;
- ✓Encourage attracting more professional, scientific, and technical workers, which is a challenging task given paucity of enterprises that would attract such workers; and

USE CASE: CONTEXT-AWARE GROUP-ORIENTED LOCATION RECOMMENDATIONS FROM SOCIAL MEDIA (E.KHAZAEI ET AL.)

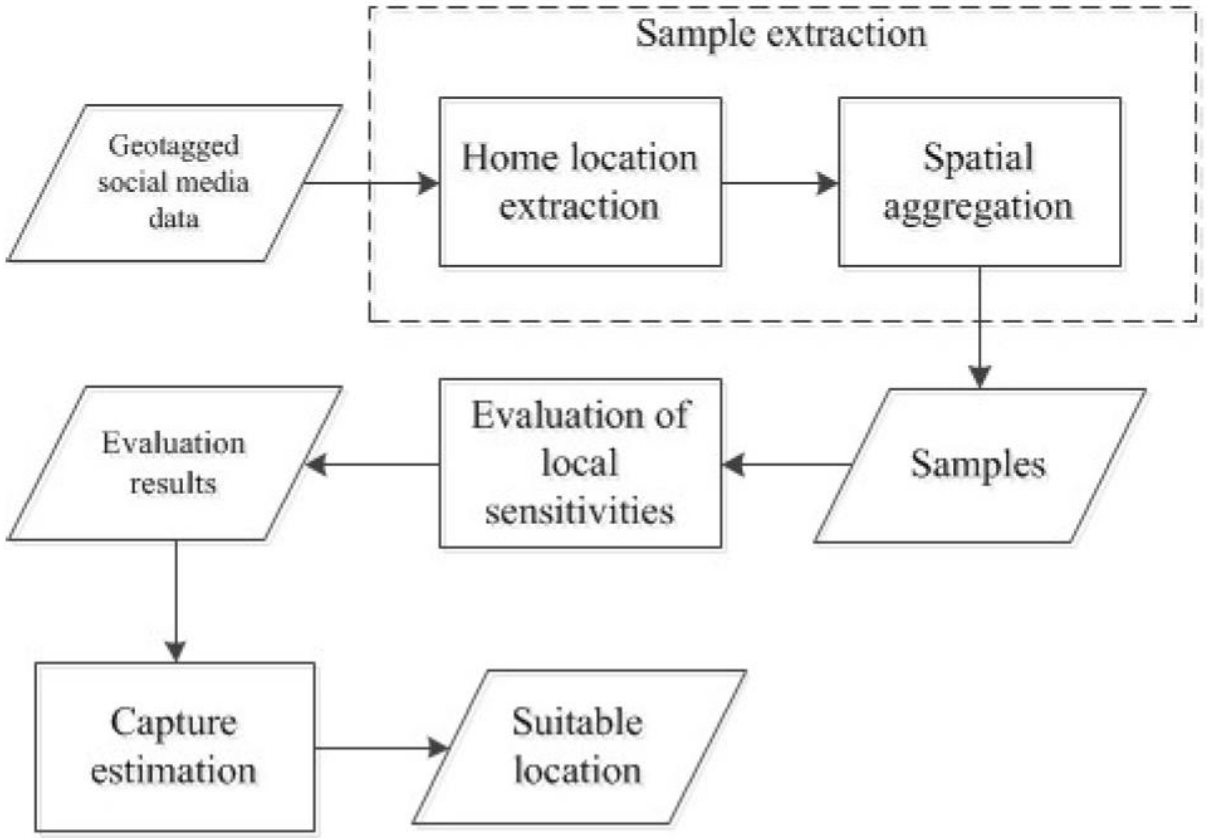
- A system is built that seeks to identify locations that are ideal for the *group* of individuals, as much as possible.
- In optimizing the location, a multi-step algorithm takes into account user context (social relationships, personal preferences), location context (category of location, popularity, capacity, spatial proximities) and environmental context (weather, day of week).
- The system was tested with the Gowalla locational data-set in the city of London from 2009-2011. The system for group location preferences is successful compared to standard methods in matching locations with individual user desires, and has higher precision of relevant recommendations.

SOLVING COMPETITIVE LOCATION PROBLEMS WITH SOCIAL MEDIA DATA-CUSTOMERS' LOCAL SENSITIVITIES

W. JIANG, Y, WANG, M. DOU, S. LIU, S. SHAO, H.LIU

- Customers' sensitivities to facility attractions, such as sensitivity to distance or business area, can influence competitive locational choice.
  - Many studies of locational siting assume customer sensitivities do not vary over time or space.
- Using social media sentiments, variation in customer sensitivities to location can be tracked and used for competitive siting. This was done for 5 retail areas in Beijing.
- The process has three steps.
  1. Use social media data to identify areas of common social media sentiment.
  2. Apply Huff Model of market attractions and geographically-weighted regression to extract the extent of local sensitivities.
  3. Test the sensitivity findings against possible locations for a new retail facility to determine the competitively best one.

MODEL APPROACH AND RESULTS FOR FIVE RETAIL AREAS IN BEIJING



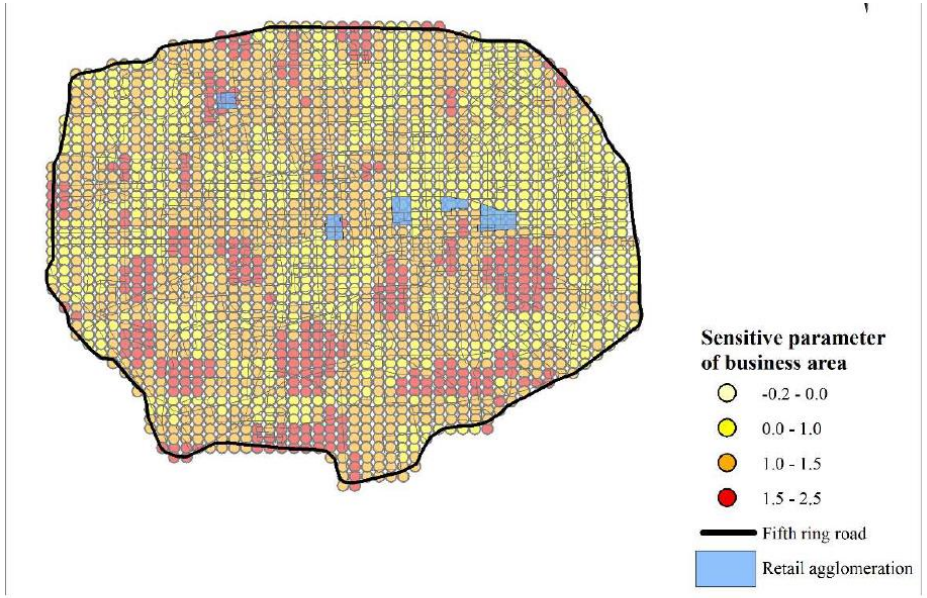


Figure 4. Spatial distribution of local sensitive parameters of business area.

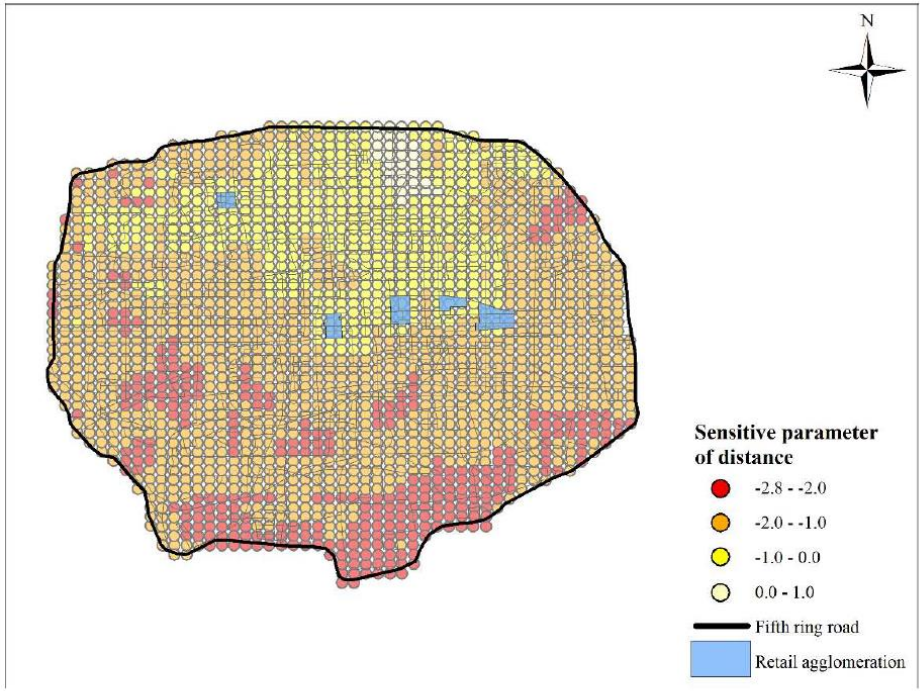


Figure 5. Spatial distribution of local sensitive parameters of distance.

RETRIEVNG LANDMARK SALIENCE BASED ON WIKIPEDIA: AN INTEGRATED RANKING MODEL

N.BINSKI, A.NATAPOV,S. DALYOT

- Landmarks in Wikipedia are evaluated for how valuable and instructive they are, i.e. salience.
  - Prominence of landmarks is based on permanence, visibility, and uniqueness, based on a survey
- The ranking of landmarks uses mixed methods.
  - Numerical ratings from Wikipedia landmark category types are ranked, yielding the category rankings for common types of landmarks, i.e. an airport has a high category rank while a coffee shop has a low category rank.
  - Wikipedia metrics are additionally input into the ranking algorithm based on page attribute and traffic statistics and the site's own landmark popularity statistics
- The combined approach results in an integrated rank order for landmarks
- The model is tested for landmarks in London and Tel Aviv. The findings can be applied to optimize routing to visit landmarks for tourism and other purposes.

A NEW APPROACH TO REFINING LAND USE TYPES: PREDICTING POINT-OF-INTEREST CATEGORIES USING WEIBO CHECK-IN DATA

X.ZHANG, Y.SUN, A.ZHENG, Y.WANG

- Weibo social network check-in data is input into a system that identifies four types of points-of-interest (POIs), namely residential, entertainment, hotel, and food.
- In this process, Weibo check-in data area converted to Baidu check-in data, since Baidu has better mapping properties.
- The sequence of check-ins provides a human mobility pattern that is included with other socioeconomic variables in predicting POI types.
- The random forest decision tree approach yields more accurate results than Naïve Bayes or Support Vector Machines methods.
  - RF decision results can predict POI categories at accuracies that approach 75%.
- The method allows much faster and more efficient classification that gives accuracies of land use that go beyond parcels.
  - The method can be applied by city planners who seek fine-grained POI classifications for planning and operational purposes.

RUDIMENTS OF TYPOLOGY OF SOCIAL MEDIA FOR THE SEVEN CASES

Social media information: locations, numbers of users or messages, characteristics, behavior, geographies

- Actual location, Numbers of social media users. (study of geography in lower 48 states of United States)
- Locations referred to in blogs. Characteristics of user. Kaufmann et al. (Switzerland)
- Actual location to compute distances and gravity estimates for chosen retail locations. Jiang et al. (Beijing)
- Actual location, message information. Yang.et al. (Hurricane Harvey)
- User location-based behavior and user environment. Khazaei & Alimohammadi (London)
- Wikipedia landmarks (Binsky et al.) (tested in London and Tel Aviv)
- Weibo social media reveals visitors to point-of-interest locations over time & provides their social media attributes (Guangzhou, China, metro area)

Algorithms

- Spatial autocorrelation, cluster analysis, OLS stepwise regression. (Pick, Sarkar, Rosales)
- Extraction of Tweets, events identification, credibility classification. (Yang et al.)
- Reverse engineering of data model from Qyer, visualization, clustering with machine learning. (Kauffman et al.)
- Social media extraction, similarity computing, building of graph structure, recommending algorithm for groups. (Khazaei & Alimohammadi)
- Extraction of micro-blog data (Gowilla), evaluation of local sensitivities from sampled social media data, estimation of optimal location. (Jiang et al.)
- A mixed method ranking algorithm can rate Landmarks on their salience (Binsky, Natapov, and Dalyot)
- Social network data that combine conventional variables with temporal human mobility variables can be input to random forest algorithm to estimate the category of points-of-interest (POIs) accurately (Zhang et al.)

TYPOLOGY OF SOCIAL MEDIA IN THE SEVEN CASES

Tweet

x,y of sender,

Type of social media

Tweet

x,y of sender,

Message info

Micro blog

x,y of sender,

Used to compute distance and gravity measures

Location-based social networking website

Check-in to x,y location of user.

Characteristics of user,

Space-time features of check-in point

Wiki

x,y of landmarks, Characteristics of landmarks

Blog

Estimated x,y of a past user locations,

User characteristics

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Note: x,y refers to the latitude, longitude location on the earth

ANALYTICS TYPOLOGY

- **Descriptive**

Map and perform multivariate analysis of Facebook, Twitter, LinkedIn in US counties

Describe the credibility of tweets in areas affected by Hurricane Harvey.

- **Predictive**

Predict new tourist destinations for Chinese tourists in Switzerland

- **Prescriptive**

Evaluate local social media sentiments to determine a location that is the most promising among five retail locations in Beijing

Identify locations in London that are optimized as ideal for a group of people, based on individual sentiments

Societal, Ethical, Sustainable Aspects of Location Analytics

Evaluate the credibility of social media sentiments that are outpouring in an emergency situation (Hurricane Harvey).

LIMITED THEORY SO FAR FOR THE RELATIONSHIP AND CONVERGENCE OF GIS AND SOCIAL MEDIA

Research study

- A Twitter Data Credibility Framework – Hurricane Harvey as a Use Case
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  W. Jiang, Y. Wang, M. Dou, S. Liu, S. Shao, and H. Liu

Note: the 2 other *IJGI* studies were empirical only

Theoretical model

- ***Credibility Framework*** (induced by authors)
- ***Mathematical model for hotspot detection*** and tourist segmentation from georeferenced social media data, drawing on data engineering (induced by authors)
- ***SATUM*** *(Spatially Aware Technology Utilization Model), HICSS, 2017*
- ***Context-aware recommender system*** *(CAR),* modified to recommend locations for groups, taking into account user contextual information (Majid et al., 2013, *Intl. J. Geographical Inf. Science*; Xu et al, 2015, *Neurocomputing)*
- Modified ***Huff model*** for competitive location studies. Gravity model with multiple points of attraction (Huff, 1963, *Land Economics*)

Theoretical Research Opportunities

CONCLUSION

- GIS and Social Media can converge in a growing variety of ways.
- The convergence is based on often massive social media data that are geo-referenced.
- A wide variety of analytical methods and algorithms can be utilized to exploit the convergence and yield analytic results and discoveries.
- This convergence can be applied to benefit businesses and inform citizens.
- A Typology seeks to understand the multiple dimensions of this convergence.
  - A weakness presently is a deficit in theory to account for GIS and social media
- The data quality, ethical, and legal aspects are only beginning to be studied much less sorted out ethically or litigated through the courts.
- The Convergence offers novel territory and opportunities for research in MIS, Analytics, and Management.

(Source: Shell, 2019)

(Source: Pinterest, 2020)

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Discussion and questions

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(to request powerpoint, send e-mail)

Will also be posted on SIGGIS page at aisnet.org

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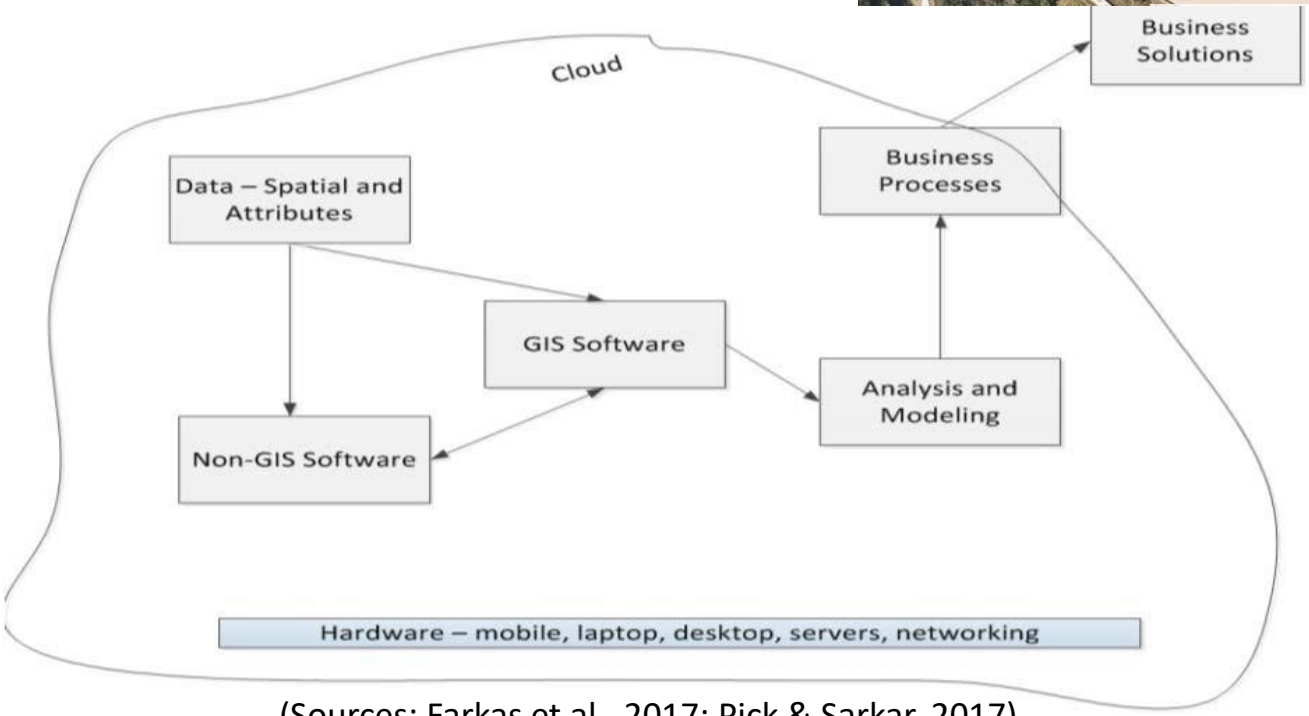
APPENDIX: WHAT ARE GIS AND LOCATION ANALYTICS?

GIS (Geographic Information System)



(Sources: Farkas et al., 2017; Pick & Sarkar, 2017)

Location Analytics (LA)
using specialized spatial analysis techniques to understand spatial arrangements, patterns, groupings and relationships in geographically referenced phenomena. Methods include overlays, buffers, hot spot analysis, spatial cluster analysis, spatial autocorrelation, proximity polygons, spatial econometrics and other techniques.

APPENDIX - SPATIAL AUTOCORRELATION

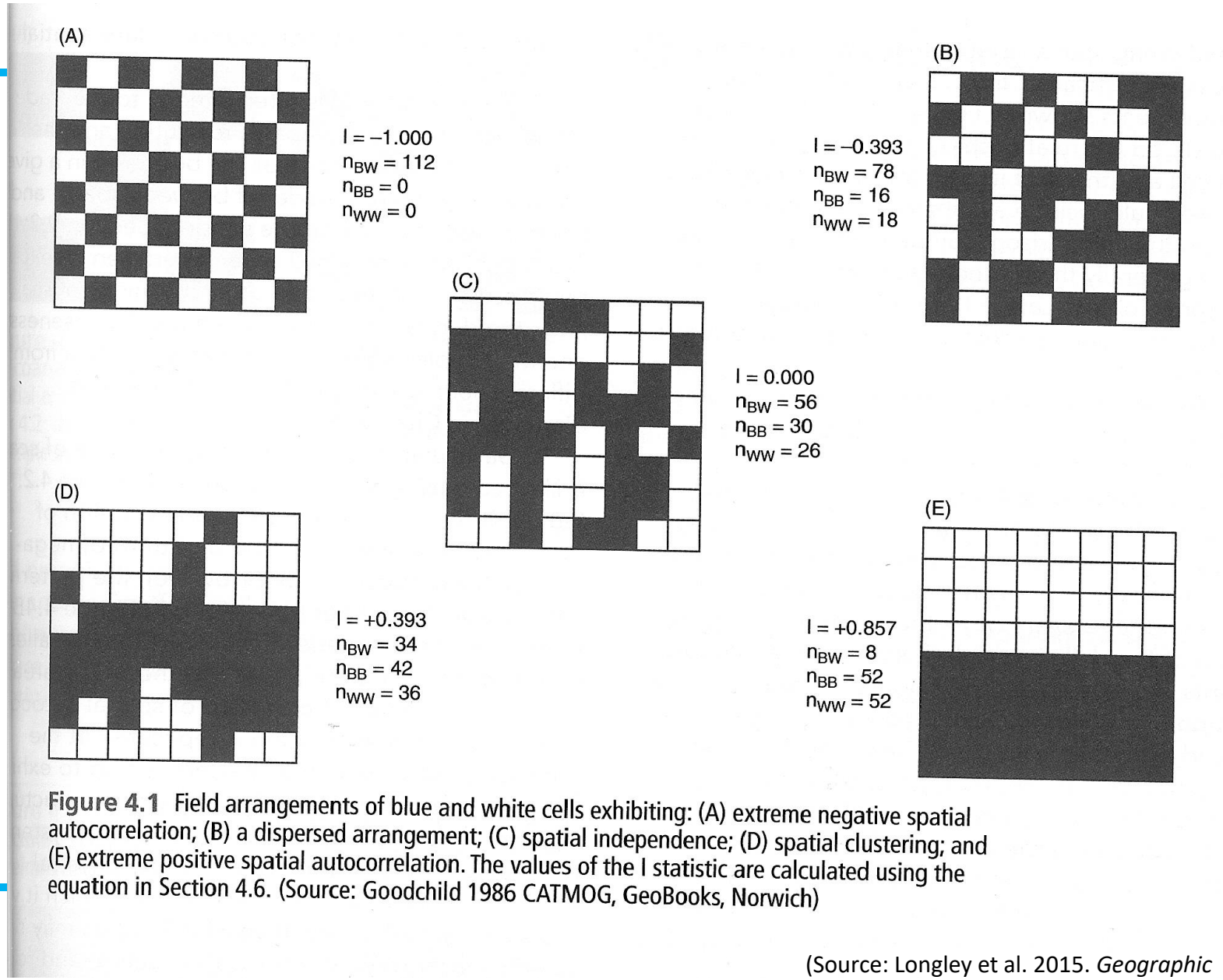


Figure 4.1 Field arrangements of blue and white cells exhibiting: (A) extreme negative spatial autocorrelation; (B) a dispersed arrangement; (C) spatial independence; (D) spatial clustering; and (E) extreme positive spatial autocorrelation. The values of the I statistic are calculated using the equation in Section 4.6. (Source: Goodchild 1986 CATMOG, GeoBooks, Norwich)

(Source: Longley et al. 2015. *Geographic Information Science and Systems*, Wiley.)