Big data application for Smart City

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Outline:

- Smart Cities
- Smart Cities and Big data
- Challenges
- Solution
- Smart Cities Example
- Recent Research
  - Scaling city attractiveness
- Summary

Smart Cities:

Why we need them :

- Rapidly Increasing population
- Limited Natural/Social resources
  - No room for wastage of these resources
- Need of hour : Sustainable development of every sector of society
  - Optimized and Orchestrated use of these resources

Smart Cities(contd.)

Some views:

“A smart city is “. . . a city which invests in ICT enhanced governance and participatory processes to define appropriate public service and transportation investments that can ensure sustainable socio-economic development, enhanced quality-of-life, and intelligent management of natural resources” - Khan Z, el at. 2013[1]

“Smart city is a very broad concept, which includes not only physical infrastructure but also human and social factors“ - Neirotti P, el at., 2014[2]

“Connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city” - Chourabi H, el at., 2012[3]

Smart Cities(contd.)

- No precise definition of smart city as it includes wide range of technologies and human involvement.
- But majority of them focus towards integrated solution for achieving
  - smart, efficient and sustainable utilization of resources
  - qualitative life to its citizens
  - better urban planning.

Smart Cities and Big data

Smartness of a city is digitally fueled by information extracted from data sources like transportation, healthcare, government, power grids, etc.

Information from these sources would eventually cascade into a massive information, which would be autonomous, heterogeneous and distributed, commonly know as big data.

This calls for prudent big data applications which can churn out useful information from this enormous data.

Smart cities and Big data(contd.)

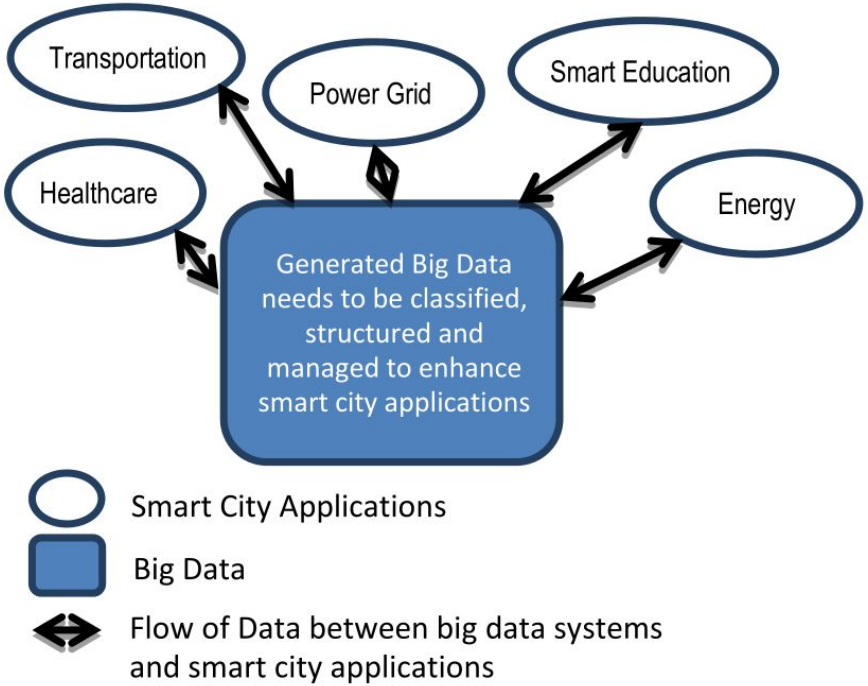

Figure. Smart city and big data relationship. [E. Al Nuaimi, el. at. 2015]

Big data application

Big data application driving smart cities:

- Smart Education
- Smart Traffic Management
- Smart Grid
- Smart Healthcare
- Smart irrigation system

Challenges

- Data source and types
  - sources ranging from power grids to traffic light
  - different sources generating different type of data
- Data and information sharing
  - raw data is huge to share
  - difficulty in knowing what to share
- Security and privacy
  - crucial information which need to be secured.
- Cost
  - expensive data handling
  - new technological requirements
- City Population
  - increase in big data volume.

Solution

Big data Processing Platform

- Open source platform like, HDFS, HPCC, Stratosphere, IBM Infosphere Streams
- Churn out useful information from big data.

Advanced Algorithm

- advance algorithm to handle high data volumes and types, time constraints and distributed component.

Smart Cities Examples

Barcelona

- Sensors deployed which alert farmers with real time data regarding water requirements
- Smart Bus network based upon real time data analysis of traffic patterns
- Smart Navigation of emergency vehicles with the help of traffic management software.

Amsterdam

- Smart parking using Mobypark application
- Smart energy meters providing incentives to one who save energy
- Smart traffic management using real time traffic data

Smart Cities Examples

Santa Cruz

- Local authorities feed historical crime data to application
- Application then predicts 10 probable places where crime may occur
- Helps in efficient deployment of human resources.

New Songdo City

- Smart sensors are deployed in entire city which monitor temperature, energy use and traffic flows and help authorities to respond to a problem.
- Smart sewage treatment which benefits from sensor data for processing.

Recent Research

Smartly quantification of city attractiveness

- Stanislav et. al. in their paper [5] discussed about quantification of city's attractiveness
- forecasting flows, tourism, economic and transportation requirements.
- helps local authorities to study effect of their measures on city attractiveness

Now what is City Attractiveness ?

- Includes not only touristic destination, but also includes the ability to attract the visitors for other reasons- business or any personal matter related ones.

Quantifying City attractiveness

- research based on Spanish cities
- Quantifying the city attractiveness and also detect the strong and robust pattern.
- four different city definition to validate the findings:

- Conurbations(CONs)	AUDES project	211 CONs
- Functional Urban Areas(FUAs)	ESPON	40 FUAs
- Large Urban Zones(LUZs)	EUAS	24 LUZs
- Provinces		52 provinces

- dataset involves the digital traces of foreign visitors on three different aspects:
  - Economical transactions
  - Taking photographs/videos
  - Tweeting during visit.
-

Quantifying City attractiveness (Contd.)

Dataset

- Flickr dataset
  - Merged two dataset of 100 million photographs/videos taken by more than one million users and generated dataset of 130 million after omitting duplicates
  - set 10 year of time window i.e from 2005 and until 2014
  - after applying *Filter(home country)*, the total of 3.5 million pictures taken in Spain, and 400 thousand pictures out of it are by over 16 thousand foreign visitor coming from 112 countries.
- Twitter dataset
  - Geotagged message posted during 2012 through Twitter.
  - collected with Twitter Streaming API
  - 35 million message sent by 641 thousand twitter users in Spain in 2012.
  - 2% of of total message sent by 80 thousand foreign visitors from 180 countries.

Quantifying City attractiveness (Contd.)

- Banco Bilbao Vizcaya Argentaria(BBVA) dataset
  - Bank card transaction registered by Spanish bank BBVA during 2011.
  - 17 million transaction made by 8.6 million foreign visitors from 175 different countries.
  - for privacy protection, card are identified by randomly generated IDs.

define filter(home country) by:

- a person is considered to be resident of certain country if this is country where he/she took the highest number of photographs/videos over the longest timespan.

Scaling of city attractiveness

A. Aggregated city attractiveness
- total number of activity not only user counts,
- also consider the length of stay and intensity of exploring the city over entire time frame.
- Result fits a power-law dependence $A \sim ap^b$ between observed pairs of attractiveness A and the population p.
    - Superlinear scaling trends for all three datasets.
    - Scaling exponent *b* remained approximately same for three datasets confirming robustness of pattern.
    - binning of data, considering average attractiveness of cities belonging to the five population ranges, also confirm the scaling pattern.

Aggregated city attractiveness

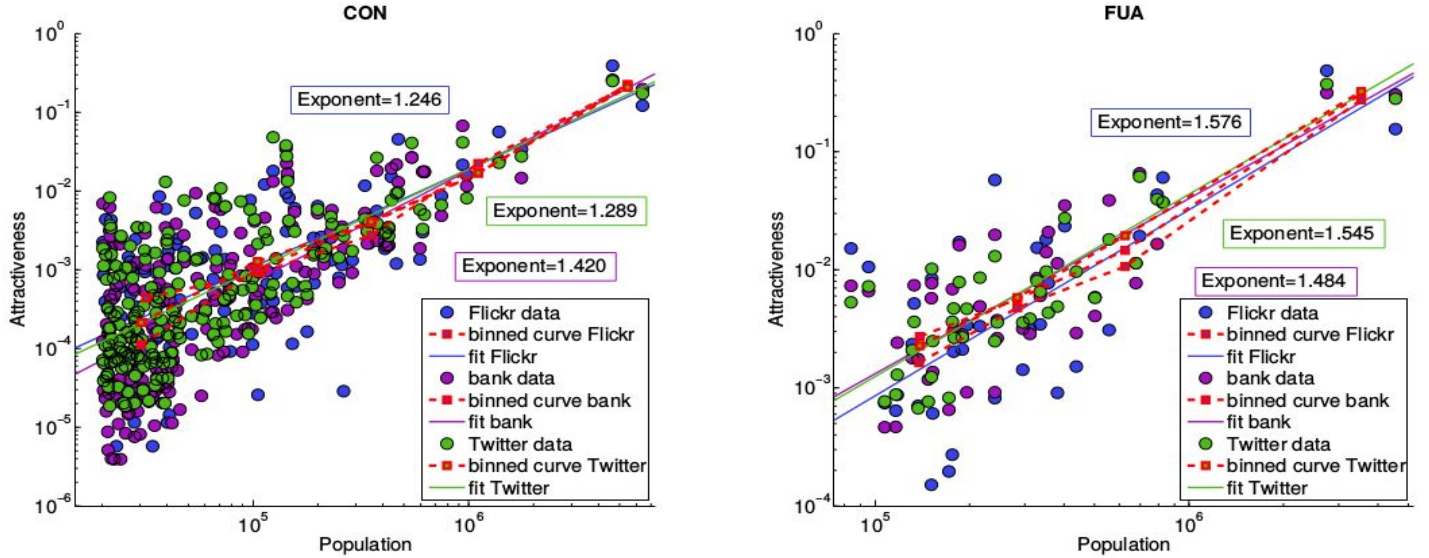

Fig. Scaling of city attractiveness with population size observed for Spanish city definition- CON and FUA. [Stanislav Sobolevsky, el. at. 2015]

Aggregated city attractiveness

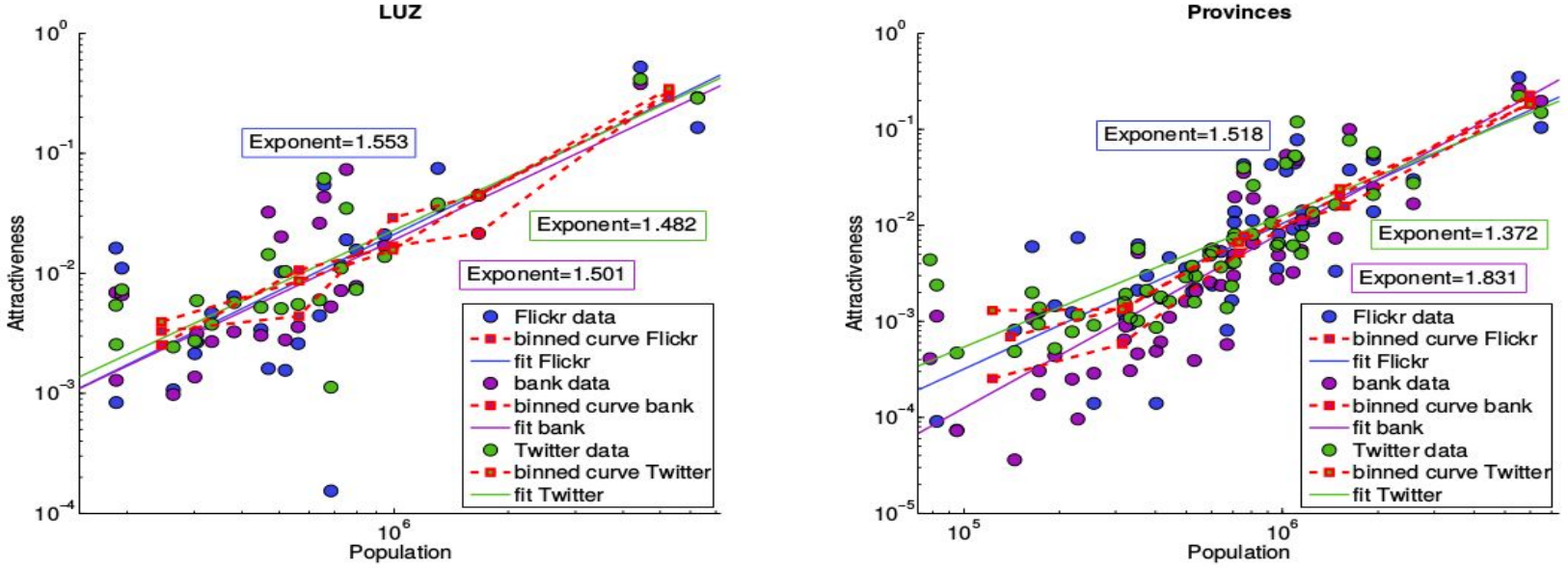

Fig. Scaling of city attractiveness with population size observed for Spanish city definition- lUZ and Provinces. [Stanislav Sobolevsky, el. at. 2015]

Scaling of city attractiveness(contd.)

B. Temporal aspects of city attractiveness

- to determine the seasonal visitor pattern affects the observed attractiveness scaling.
- window of three-month seasons, shifting monthly on entire year.
- Observed normalized exponential and the time of year exhibits:
  - Mostly consistent across different city definition
  - Slight variation across the dataset.
  - But pattern is always the same and confirmed by trends considered
    - drop over during summer(June,July,Aug,Sept)- touristic destination spread over the number of smaller destination, whereas on other month, primarily attached to major cities.

Scaling of city attractiveness(contd.)

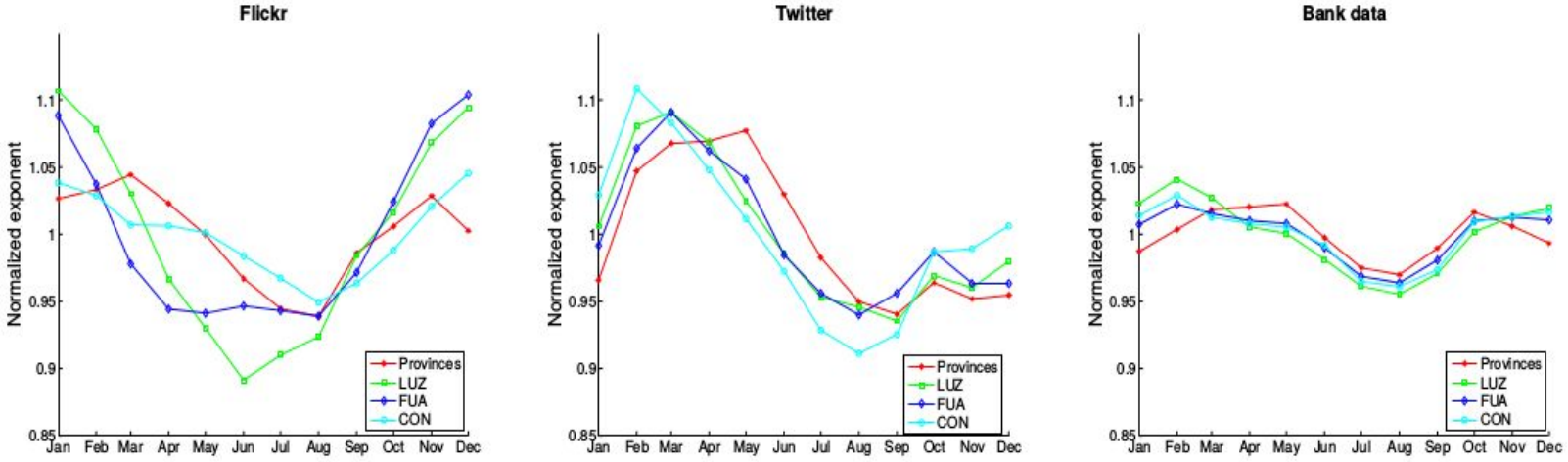

Figure. Dependency between the observed exponent and the time of year. [Stanislav Sobolevsky, el. at. 2015]

Scaling of city attractiveness(contd.)

C. Scale-free city attractiveness

- Scale-independent scoring of the city attractiveness :

  $$res = log(A) - b.log(p) - log(a)$$

  Log-scale residual of the actual attractiveness value vs the trend prediction.

- Positive residue means good performance.
- Negative residue value means the city is under-performing.

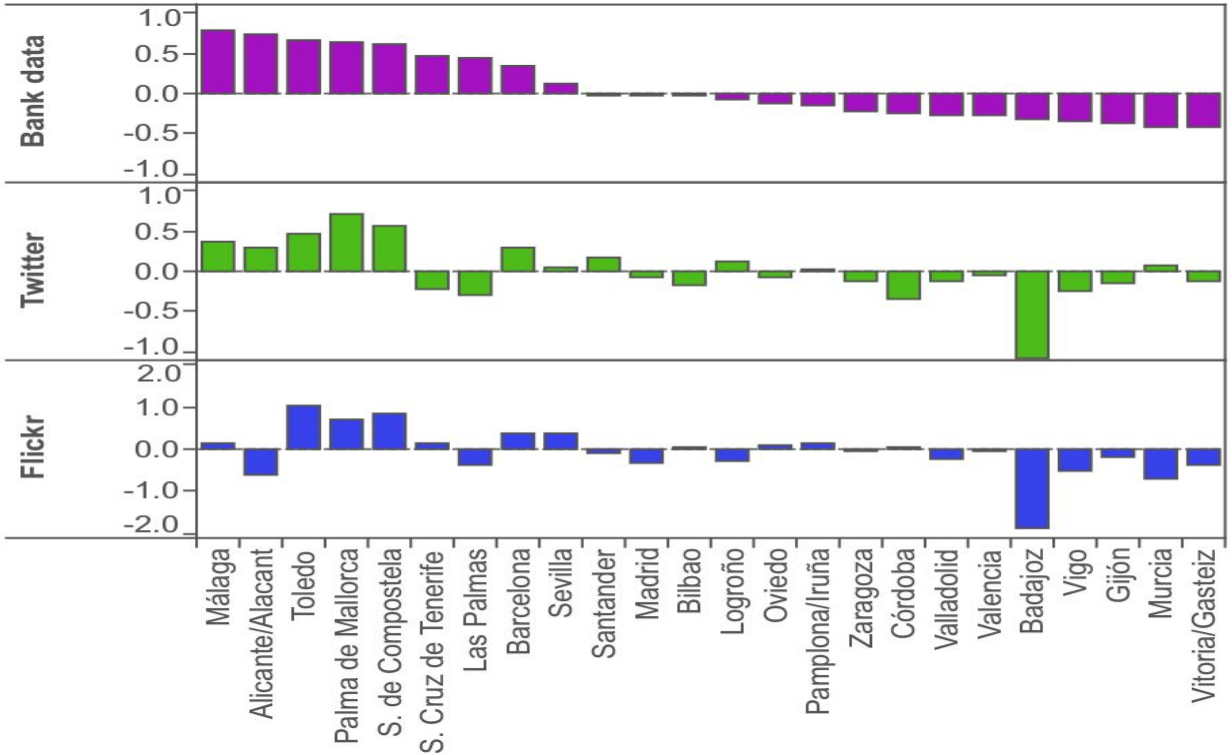

Figure.LUZ scale-independent attractiveness . [Stanislav Sobolevsky, el. at. 2015]

Summary

- Smart cities are need of present
- Judicious use of resources required
- Big data applications are digital drivers of smart cities
- These applications have special requirements
- Certain cities have successfully demonstrated potential of big data applications
- Many open issue still exists
- Prudent research approaches may help to overcome them.

QUESTIONS ?

References

1. E. Al Nuaimi, H. Al Neyadi, N. Mohamed, and J. Al-Jaroodi. *Applications of big data to smart cities*. Journal of Internet Services and Applications, 6(1):1–15, 2015.
2. S. Sobolevsky, I. Bojic, A. Belyi, I. Sitko, B. Hawelka, J. Murillo Arias, and C. Ratti. *Scaling of city attractiveness for foreign visitors through big data of human economical and social media activity*. In Big Data (BigData Congress), 2015 IEEE International Congress on, pages 600–607. IEEE, 2015.