Real-time Geosocial Media Event Detection and Prediction

Assignment for Research Methods in Computer Science course at Ryerson University

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Contents

1 Introduction

The wide availability of mobile devices have enabled millions of people to share online content, such as text, images, sound, and videos, from any location with wireless Internet connection. Social media platforms, such as Facebook (Facebook, 2017) and Twitter (Twitter Inc, 2017), are commonly used to share large amounts of online content in near real-time. This online content produces valuable sources of real-time locational data, known as geosocial media data, that may provide information on current real-world events such as traffic jams, natural disasters, disease spread, and terrorist attacks. Geosocial media data can be used to detect and predict real-world events given particular locations and times. However, human errors, inconsistencies, noise, high volumes, and constant changes make it difficult to extract useful information from geosocial media data. These issues cause a divide in the methods and approaches for geosocial media event detection and prediction, where standards, comparisons, and integration between different data sources and use cases are rare. This proposal documents a plan to develop a generalized framework and open source software for detecting and predicting real-world events using geosocial media data.

The objective of this proposal is to develop a framework and accompanying software to detect and predict real-world events in real-time with geosocial media data. A literature review was done to provide background knowledge on current research on event detection and prediction methods and applications. An approach, built on the knowledge from the literature review, was developed to satisfy the objectives. Recent progress was detailed to provide preliminary results and relevant past work related to the objectives. A discussion of the impacts was provided to address the importance and effect of the proposed research work.

The remaining sections are organized as follows:

- **Section 2** details the objectives of the proposed research
- **Section 3** provides a literature review of current research
- **Section 4** details the proposed approach to satisfy the objectives
- **Section 5** details the recent progress based on the approaches and objectives
- **Section 6** discusses the impact of the proposed research
- **Section 7** provides concluding summaries and remarks

2 Objectives

This section provides details objectives of this proposal. The main objective is to develop the following for detecting and predicting real-world events using geosocial media data:

1. Framework that can be applied to a wide variety of applications and data
2. Open Source Software based on (1)

2.1 Framework

The framework objective requires that the following components be identified and developed:

- **Data Sources**: Popular geosocial media platforms and data sources
- **Data Structures**: Geosocial media data structures
- **Event Detection Methods**: Common event detection methods and patterns
- **Event Prediction Methods**: Common event prediction methods and patterns
- **Output**: Resulting human-readable output information
- **Use Cases**: Common applications of geosocial media event detection and prediction

2.2 Software

The software objective requires that the following open source components be identified and developed:

- **Databases**: Popular databases used for geosocial media data
- **Event Detection and Prediction Software**: Libraries or packages for event detection and prediction algorithms and models
- **Information Software**: Libraries or packages for displaying and extracting information from model outputs
- **Online Platform**: Online websites to host and distribute software
- **Testing Software**: Libraries or packages to conduct standard unit tests
- **Documentation Software**: Libraries or packages to document software for a wide audience

3 Literature Review

This section provides a literature review to provide background knowledge on current research related to the topic of *"real-time geosocial media event detection and prediction"*. The paper selection process involved identifying reputable digital libraries using the Journal Impact Factor (JIF) measure (Garfield, 2006b), followed by using automatic search queries to produce an initial list of potential papers. The potential papers were then further filtered by manual selection criteria to produce a list of selected papers for reviewing. Appendix A provides details of the literature methods seen in Figure 1.

3.1 Event Detection

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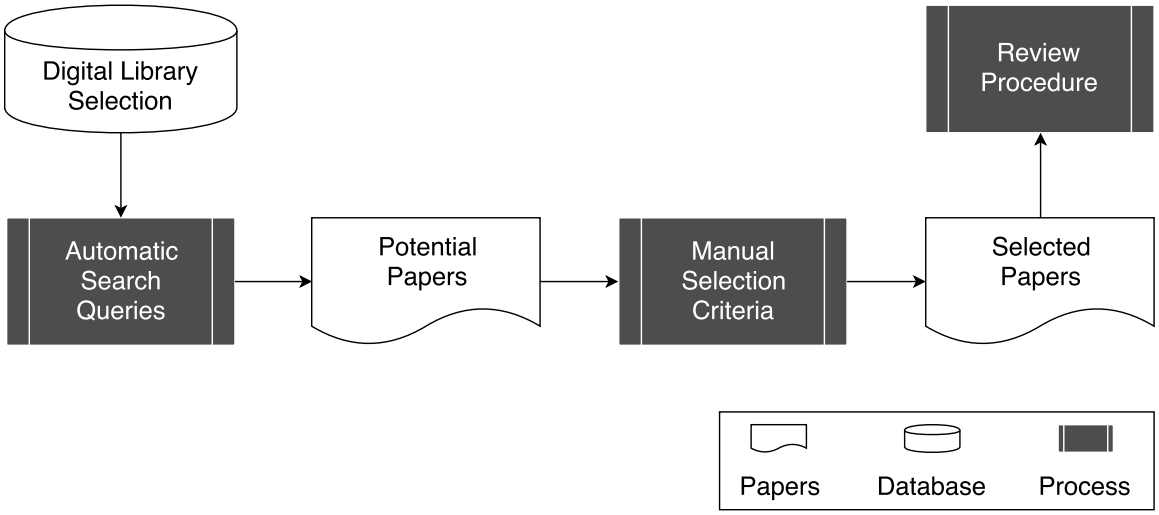

Figure 1: **Literature Review Methods.**

3.2 Event Prediction

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3.3 Visualization

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3.4 Applications

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4 Approach

The

5 Recent Progress

Recent progress involved the partial identification of several framework components and development of a small software package. The identified framework and software components are provided in Table 1 and 2 respectively. A small software package was developed for Node.js (Node.js Foundation, 2017) named *"twitter2pg"* (Wen, 2017) to conveniently extract real-time Twitter data into a relational PostgreSQL database (The PostgreSQL Global Development Group , 2017). The package has been downloaded 259 times as of December 2, 2017 after approximately a month of release, and consists of documentation, unit tests, and automatic Linux builds for continuous tests every month.

Table 1: **Identified Framework Objective Components.**

Component	**Identified**
Data Sources	Twitter Streaming API, Programmable Web
Data Structures	Unstructured (JSON), Location Points, Time Stamps
Event Detection Methods	Frequency, Sliding Window, Normalization, Clustering, Sampling, Graphs, Machine Learning
Output	Textual Summary, Webmap, Wordcloud
Use Cases	Influenza, Earthquake, Psychosocial, Energy, Traffic, Air Quality

Table 2: **Identified Software Objective Components.**

Component	**Identified**
Databases	PostgreSQL, MongoDB, MySQL, Hbase, Cassandra, Accumulo, GeoMesa
Event Detection and Prediction Software	Massive Online Analysis (MOA), scikit-learn, Apache Spark/Kafka
Information Software	Leaflet, Carto, D3.js
Online Platform	Github, PyPi, npm
Testing Software	travis Continuous Integration (CI), Docker
Documentation Software	HTML, Markdown

6 Impact

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7 Conclusion

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Appendices

Appendix A Literature Review Methods

A.1 Digital Library Selection

The papers for the literature review were found with the search engines available in the Association for Computing Machinery (ACM) (Association for Computing Machinery, 2017) and Institute of Electrical and Electronics Engineers (IEEE) Xplore digital libraries (Institute of Electrical and Electronics Engineers, 2017). A search for the top journals in computer science by journal impact factor (Garfield, 2006b) was done using the InCites journal citation reports web tool (Clarivate Analytics, 2017a). A majority of ACM and IEEE journals were found to be in the first quartile of journal impact factor values for the computer science category. A visualization of the top 25 journals in computer science by journal impact factor in 2016 is shown in Figure 2.

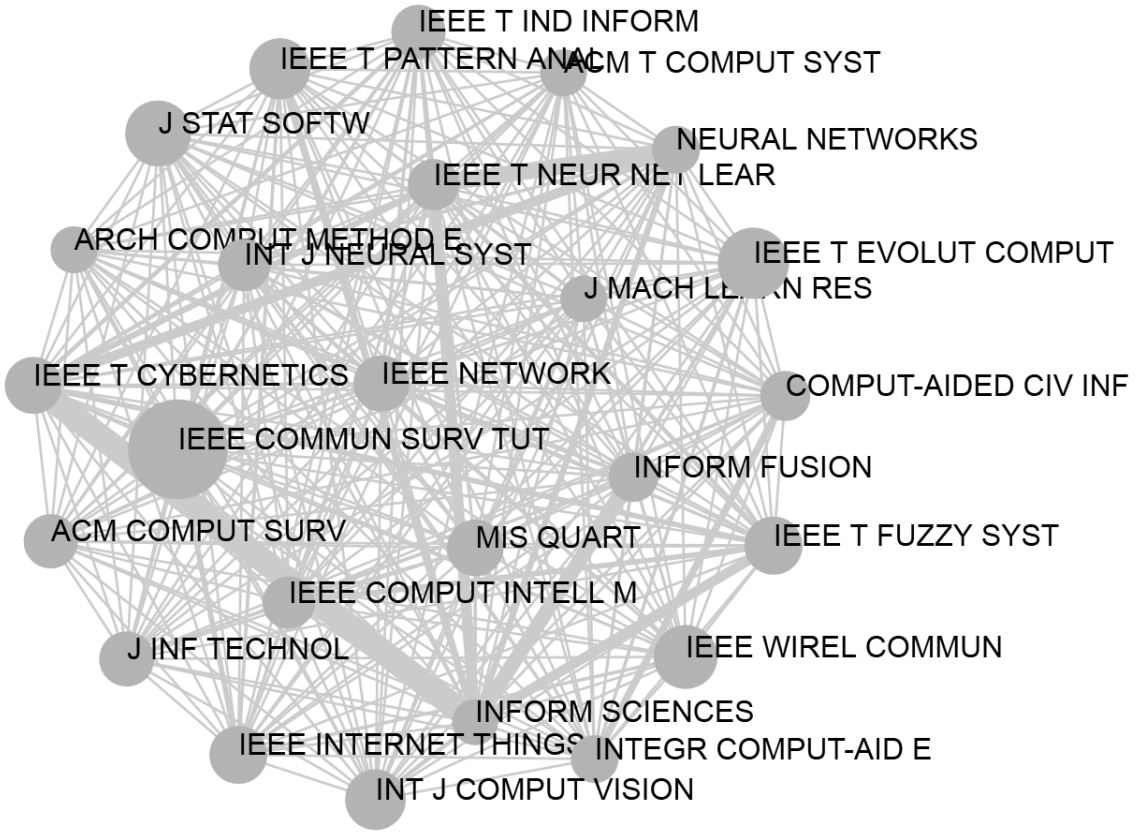

Figure 2: **Top 25 Computer Science Journals by Journal Impact Factor from InCites Journal Citation Report in 2016.** Gray circles represent the Journal Impact Factor, where higher Journal Impact Factor values are represented by larger sizes. Connected lines represent the citation relationships between each journal, where thicker lines mean stronger relationships.

The search for the top 25 computer science journals was based on the Journal Impact Factor (JIF) (Garfield, 2006b) measure, and was done using the InCites Journal Citation Reports (JCR)

web tool (Clarivate Analytics, 2017a). The search used the following options available on InCites:

- **Categories**:
  - COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE
  - COMPUTER SCIENCE, CYBERNETICS
  - COMPUTER SCIENCE, HARDWARE & ARCHITECTURE
  - COMPUTER SCIENCE, INFORMATION SYSTEMS
  - COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS
  - COMPUTER SCIENCE, SOFTWARE ENGINEERING
  - COMPUTER SCIENCE, THEORY & METHODS
- **JCR Year**: 2016
- **Edition**: Science Citation Index Expanded (SCIE) (Garfield, 2006a) and Social Sciences Citation Index (SSCI) (Klein et al., 2004)
- **Category Schema**: Web of Science (Clarivate Analytics, 2017b)
- **JIF Quartile**: Quarter 1 (Q1)

A.2 Automatic Search Queries

Potential papers were found using search engine queries in the ACM (Association for Computing Machinery, 2017) and IEEE Xplore (Institute of Electrical and Electronics Engineers, 2017) digital libraries identified in Appendix A.1. Search queries were modified from the defaults and sorted by relevance. Each search query was defined to filter for potential papers with the following requirements:

(a) **Publication**: Published in ACM or IEEE

(b) **Year**: Published from 2012 to December 2, 2017

(c) **Keywords**: Contains the keywords *"real time"* and *"social media"* in the paper title, and *"prediction"*, *"predict"*, *"detection"*, or *"detect"* anywhere in the text

The query syntax in the ACM digital library was accessed through the advanced search page by clicking *"show query syntax"*. The *"+"* symbol includes each keyword in the title. *"gte"* and *"lte"* represent *"greater than or equal to"* and *"less than or equal to"* respectively. The publication date query syntax must be manually generated using the web interface. The full advanced query syntax used for the ACM digital library to return potential papers is shown below:

```
"query": { acmdlTitle:(+real +time +social +media) AND (prediction predict detection detect) }

"filter": {"publicationYear":{ "gte":2012, "lte":2017 }},
{owners.owner=HOSTED}
```

The command search in the IEEE Xplore digital library was accessed through the advanced search page by clicking *"command search"*. Refinements were manually applied using the web interface to filter command search results for the years 2012 to 2017 and to search in *"Full Text & Metadata"*. The command search used for the IEEE Xplore digital library to return potential papers is shown below:

> "Document Title":"real time" AND "Document Title":"social media" AND ("prediction" OR "predict" OR "detection" OR "detect")

A.3 Manual Selection Criteria

The potential papers from Appendix A.2 were further filtered with the abstracts and paper length. The abstracts were inspected for relevancy to the topic: *"real-time geosocial media event detection and prediction"*. This included mentions of methods that deal with detecting or predicting real-world events in real-time using geosocial media data. After inspections of the abstract, each paper was further evaluated for practicality by searching for mentions of event prediction or detection applications, benchmarks, and experiments in the results sections. The manual selection criteria sought to find papers with the following characteristics:

(a) **Detailed**: Paper contained sufficient details and explanations to obtain a general understanding of the methods and results

(b) **Relevant**: Paper had mentions of real-time geosocial media event detection or prediction

(c) **Practical**: Paper had conducted experiments, benchmarks, or applications using described event detection or prediction methods

A.4 Review Procedure

A literature review of the papers selected using the methods in Appendix A.3 was done with the following procedure:

1. **Identify** methods used for real-time geosocial media event detection or prediction
2. **Summarize** methods in (1)
3. **Summarize** applications and results for the methods in (1)
4. **Discuss** limitations, possible improvements, and future directions relative to the summaries from (2) and (3)

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