Semantic Big Data @ SIGMOD 2017

Safety Check: A Semantic Web Application for Emergency Management

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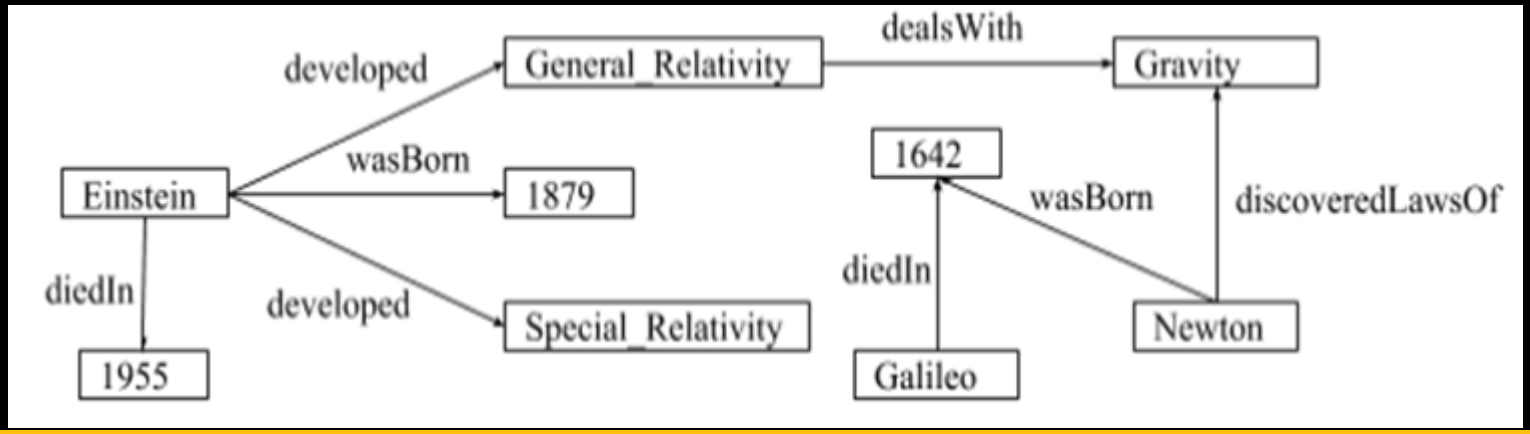
Introduction

- The essential element of the Semantic Web data model is a *resource*
  - ✓ A *resource* is a specific entity or thing that can be identified
  - ✓ A statement, *triple*, is description about a resource (represented using RDF)
  - ✓ Data is represented as a *set* of linked statements
  - ✓ *SPARQL* is query language for RDF data



Semantic Web, Triples

Motivation

- Large amount of data is currently available on the web
- Important information about natural disasters like earthquakes, floods, droughts, storms, etc. is available
- Google Crisis Response Public Alerts service is an online notification service
- Information about people, their friends and families, and their location is available through various social media sites

Emergency or Disaster Management

With the availability of a variety of data on the web, can we provide better emergency management in case of natural disasters and humanitarian crises as needed?

Related Work

- Facebook Safety Check feature allows people to share with their friends and family that they are safe
  - Uses people data graph from within their application
  - Does not use Linked Data or web of data for contacts information
  - Feature is activated only for major disasters
  - Facebook works with local authorities to determine what constitutes a major disaster
  - It main feature is that it allows Emergency Checkin for the affected person indicating that they are safe

Facebook – Safety Check

Problem Statement - revisited

Can we provide better emergency management in case of natural disasters and humanitarian crises, i.e., lookout for who may be impacted and provide appropriate assistance?

Solution

Build a knowledge intensive application that identifies those people that may have been affected due to natural disasters or man-made disasters at any geographical location and notify them with safety instructions.

Proposed Solution

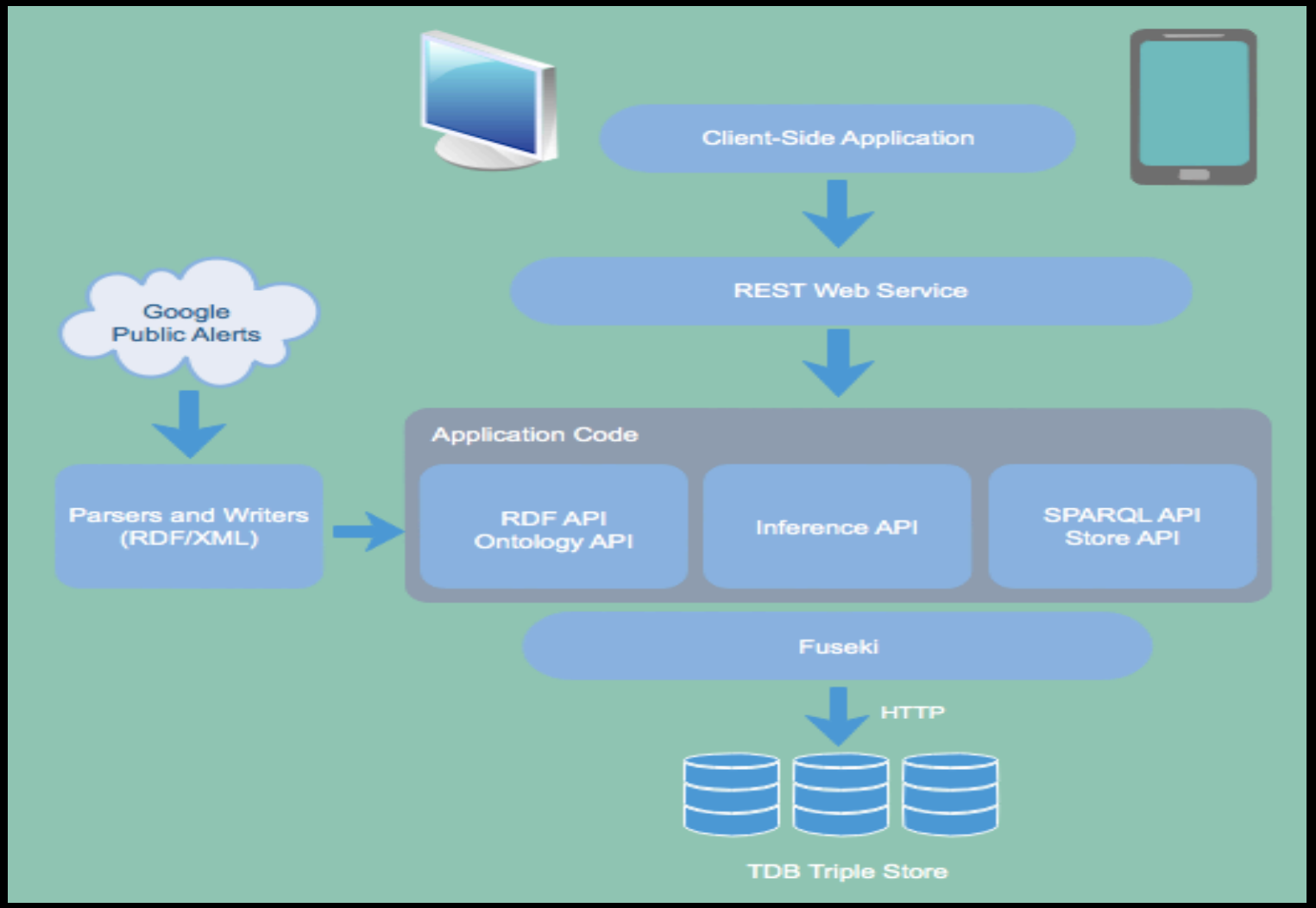
Methodology

Creation of semantic data model via ontologies

Creation of integrated semantic data using RDF as graph data model

Extraction of useful knowledge and information from combined data

Use of semantic technologies to connect, link, and load integrated data into a database



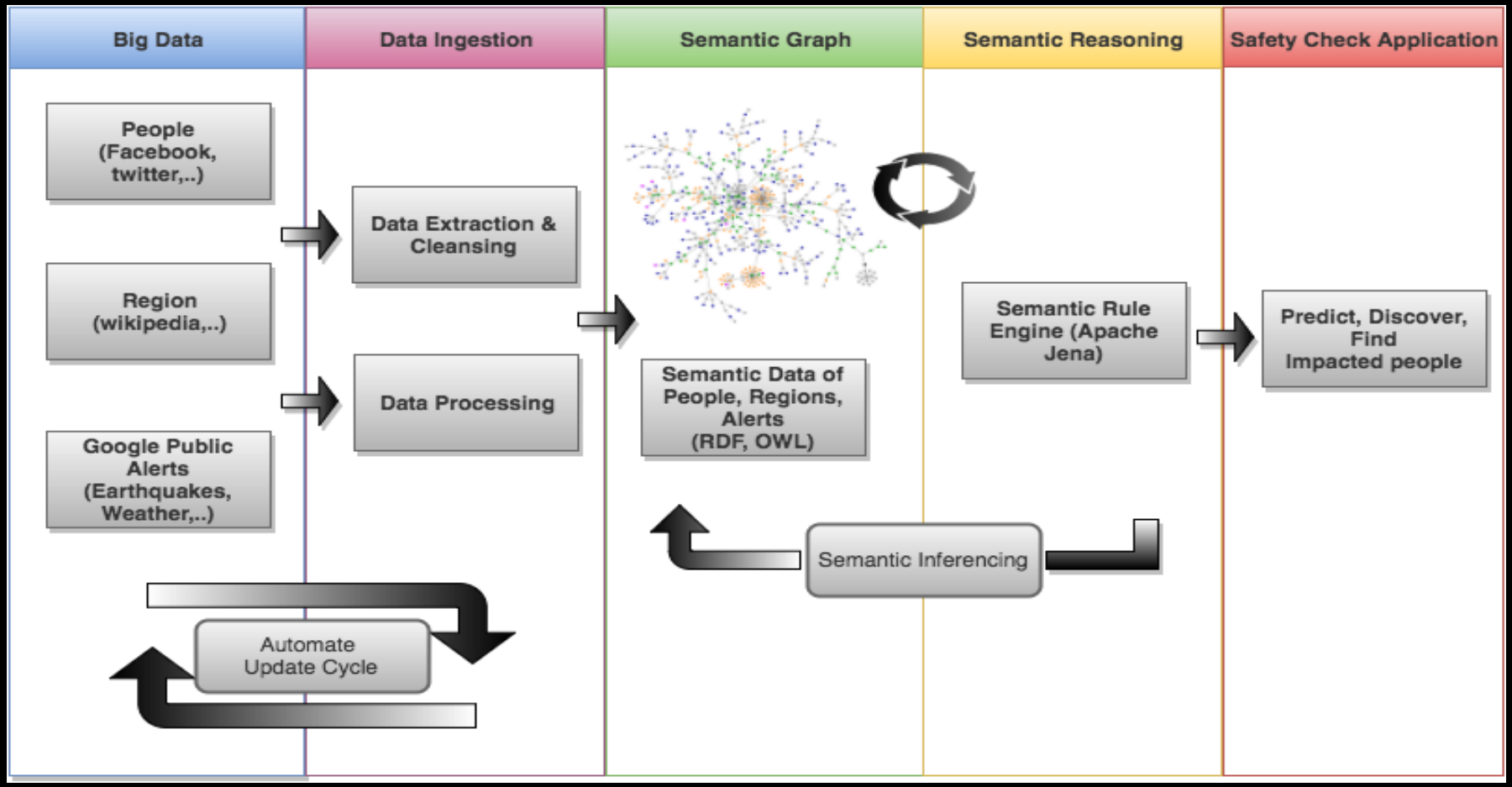
High-level System Architecture

Data Extraction

- People data: from Facebook's Graph API. Developed a client that uses our access tokens, to get information on our friends and family members.
- City/Regions data: information like latitude , longitude, area, population, etc. We used APIs and wrote web crawlers (where needed) to gather data in csv format.
- Earthquakes and Weather data: subscribed to Google Public Alerts. Google's Alert Hub implements PubSubHubbub, a simple, open, server-to-server publisher and subscriber protocol. Publishers send their alert feeds to Alert Hub, which pushes those updates to our server.

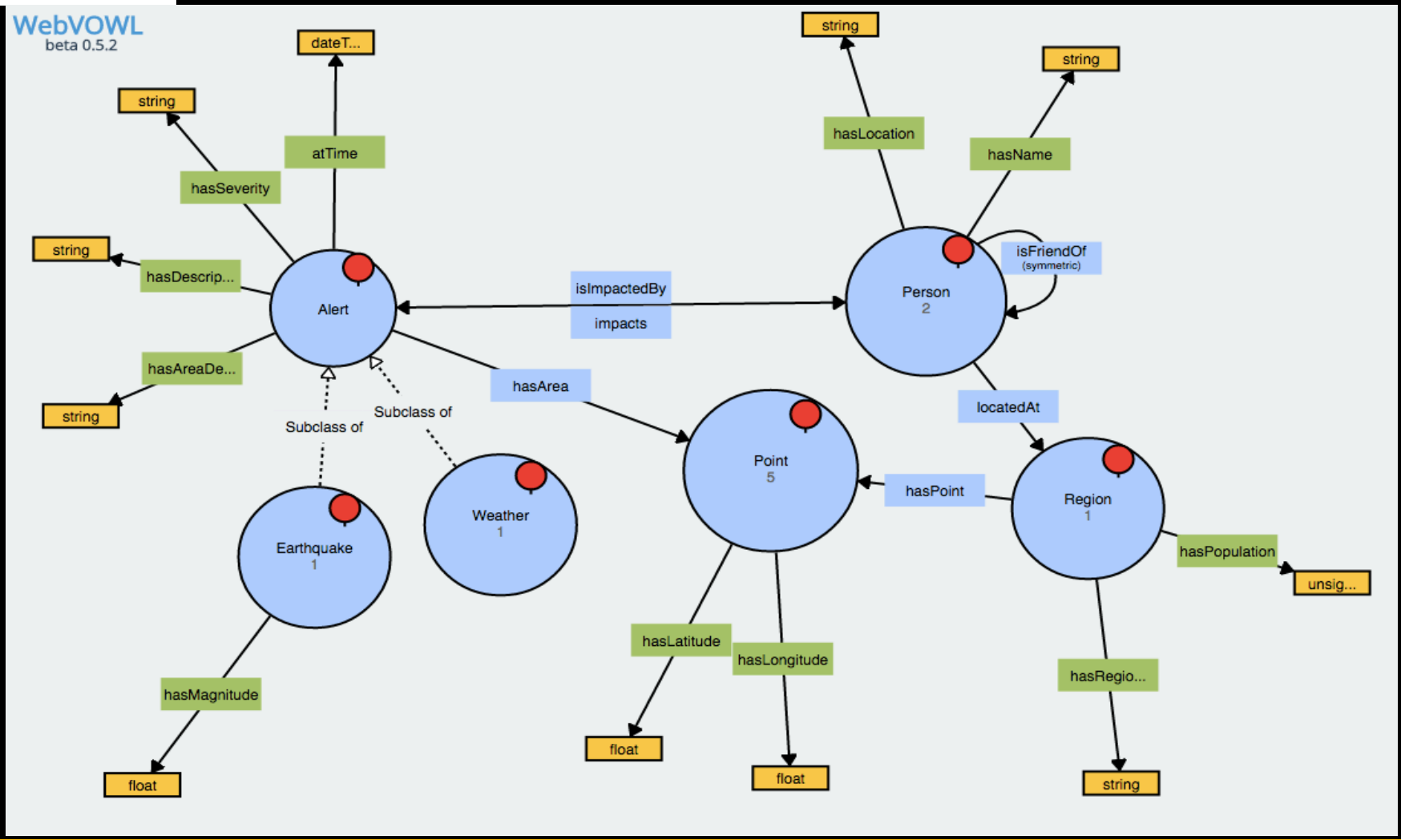
Proposed Solution

Solution



Semantic Technology for Big Data analysis for Emergency Management System

Solution



Semantic Data Model

Semantic Reasoning

```
[rule1: (?person rdf:type sc:Person)
        (?region rdf:type sc:Region)
        (?person sc:hasLocation ?ploc)
        (?region sc:hasRegionName ?rloc)
        regionMatch(?ploc, ?rloc) -> (?person sc:locatedAt ?region)]
```

Rule 1: Link persons with their regions based on “locationName” attribute; Inferred knowledge (models) provides the coordinate location of a person

Semantic Reasoning

```
[rule2: (?earthquake rdf:type sc:Earthquake)
        (?person sc:locatedAt ?region)
        (?earthquake sc:hasMagnitude ?mag)
        (?earthquake sc:hasArea ?epoint)
        (?epoint sc:hasLatitude ?elat)
        (?epoint sc:hasLongitude ?elong)
        (?region sc:hasPoint ?rpoint)
        (?rpoint sc:hasLatitude ?rlat)
        (?rpoint sc:hasLongitude ?rlong)
        eqImpactMatch(?elat, ?elong, ?rlat, ?rlong, ?mag) ->
        (?person sc:isImpactedBy ?earthquake)]
```

Radial distance over which the effects of an earthquake should be felt has been estimated using McCue Radius of Perception Calculator.

Rule 2: Identify all persons who may have been impacted due to an earthquake.

Semantic Reasoning

```
[rule3: (?weather rdf:type sc:Weather)
        (?weather sc:hasPolygon ?wpoly)
        (?person sc:locatedAt ?region)
        (?region sc:hasPoint ?rpoint)
        (?rpoint sc:hasLatitude ?rlat)
        (?rpoint sc:hasLongitude ?rlong)
        weatherImpactMatch (?wpoly, ?rlat, ?rlong) -> (?person
sc:isImpactedBy ?weather)]
```

Checks if person's location (or coordinates) lies inside polygon region of the weather alert and if it does, it adds an inferred model that the person is impacted by the weather alert

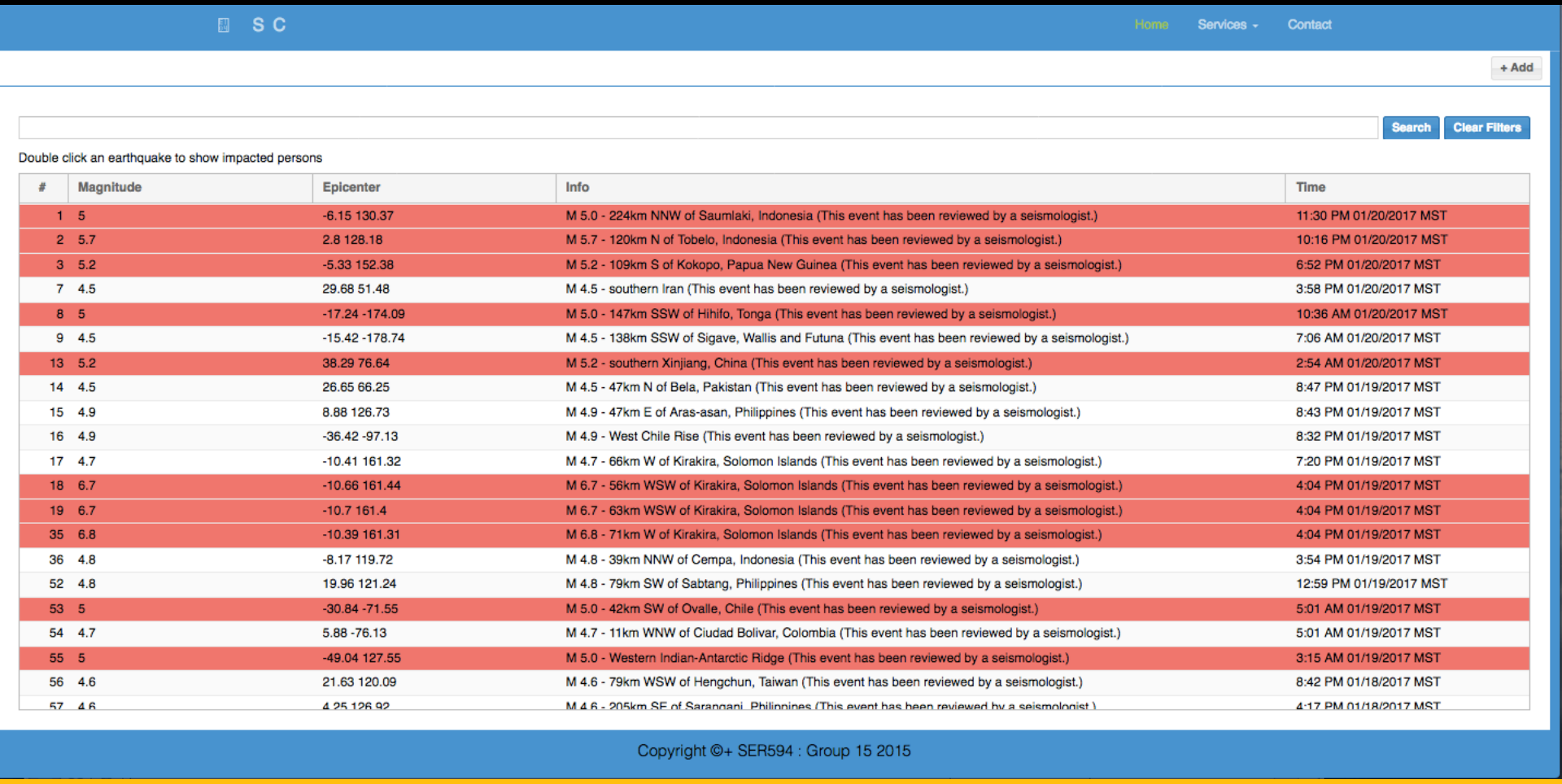
Rule 3: Identify all persons who may have been impacted by a weather alert

Solution - WebApp

Safety Check – Web Application

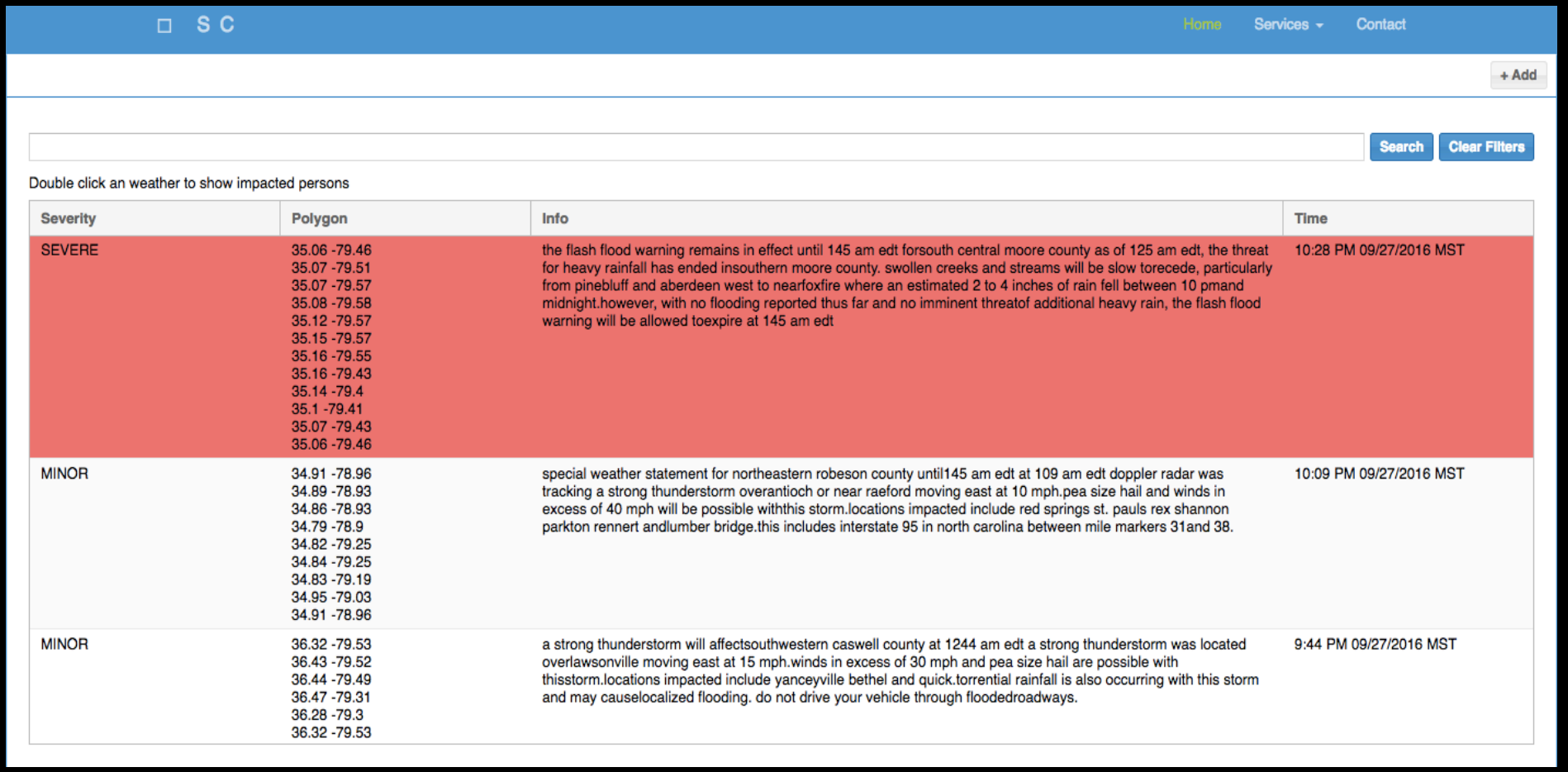
(http://imod.poly.asu.edu:8080/SafetyCheckWeb)

Solution - WebApp



Earthquake alerts web page

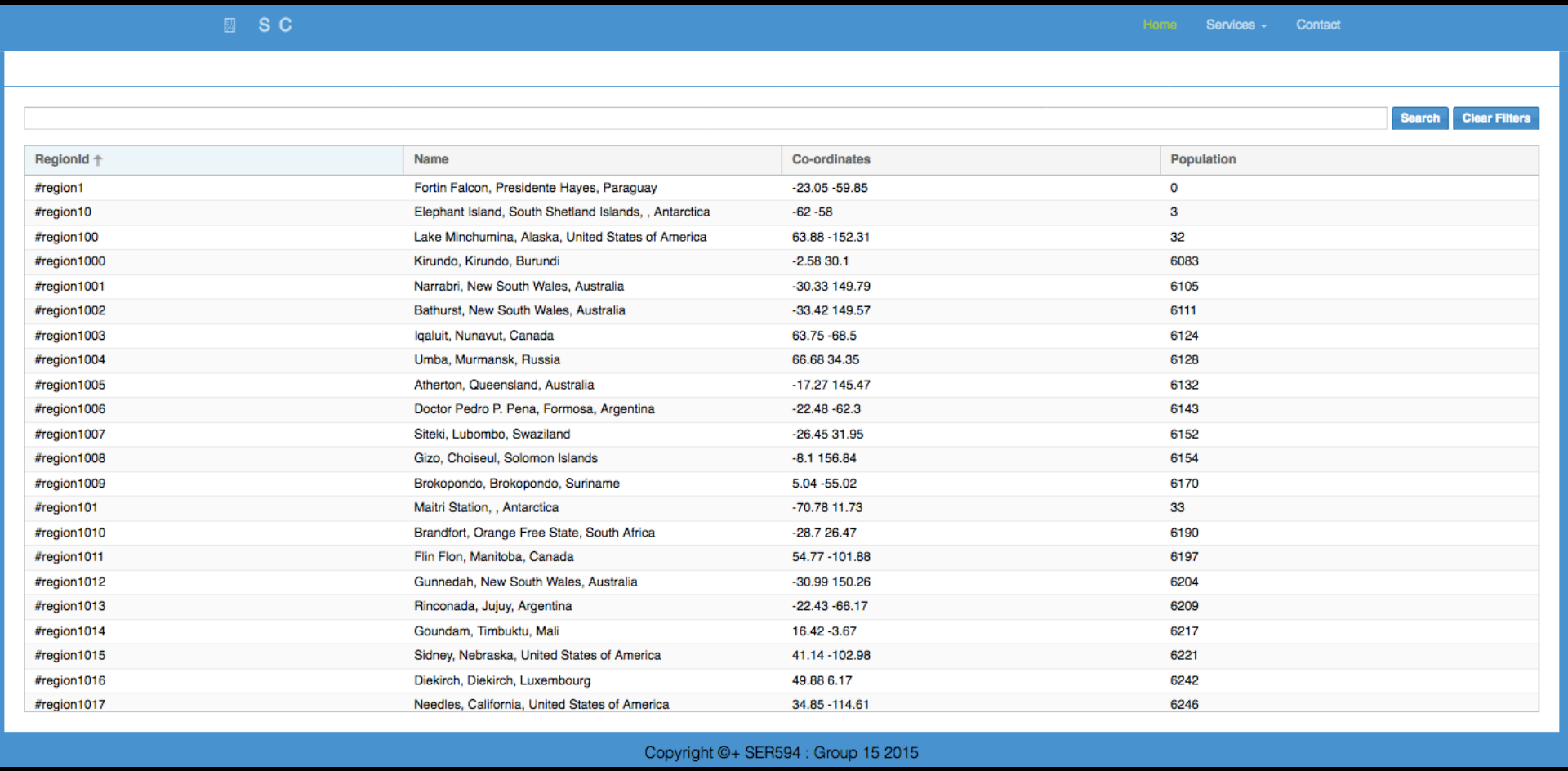
Solution - WebApp



Severity	Polygon	Info	Time
SEVERE	35.06 -79.46 35.07 -79.51 35.07 -79.57 35.08 -79.58 35.12 -79.57 35.15 -79.57 35.16 -79.55 35.16 -79.43 35.14 -79.4 35.1 -79.41 35.07 -79.43 35.06 -79.46	the flash flood warning remains in effect until 145 am edt forsouth central moore county as of 125 am edt, the threat for heavy rainfall has ended insouthern moore county. swollen creeks and streams will be slow torecede, particularly from pinebluff and aberdeen west to nearfoxfire where an estimated 2 to 4 inches of rain fell between 10 pmand midnight.however, with no flooding reported thus far and no imminent threatof additional heavy rain, the flash flood warning will be allowed toexpire at 145 am edt	10:28 PM 09/27/2016 MST
MINOR	34.91 -78.96 34.89 -78.93 34.86 -78.93 34.79 -78.9 34.82 -79.25 34.84 -79.25 34.83 -79.19 34.95 -79.03 34.91 -78.96	special weather statement for northeastern robeson county until145 am edt at 109 am edt doppler radar was tracking a strong thunderstorm overantioch or near raeford moving east at 10 mph.pea size hail and winds in excess of 40 mph will be possible withthis storm.locations impacted include red springs st. pauls rex shannon parkton rennert andlumber bridge.this includes interstate 95 in north carolina between mile markers 31and 38.	10:09 PM 09/27/2016 MST
MINOR	36.32 -79.53 36.43 -79.52 36.44 -79.49 36.47 -79.31 36.28 -79.3 36.32 -79.53	a strong thunderstorm will affectsouthwestern caswell county at 1244 am edt a strong thunderstorm was located overlawsonville moving east at 15 mph.winds in excess of 30 mph and pea size hail are possible with thisstorm.locations impacted include yanceyville bethel and quick.torrential rainfall is also occurring with this storm and may causelocalized flooding. do not drive your vehicle through floodedroadways.	9:44 PM 09/27/2016 MST

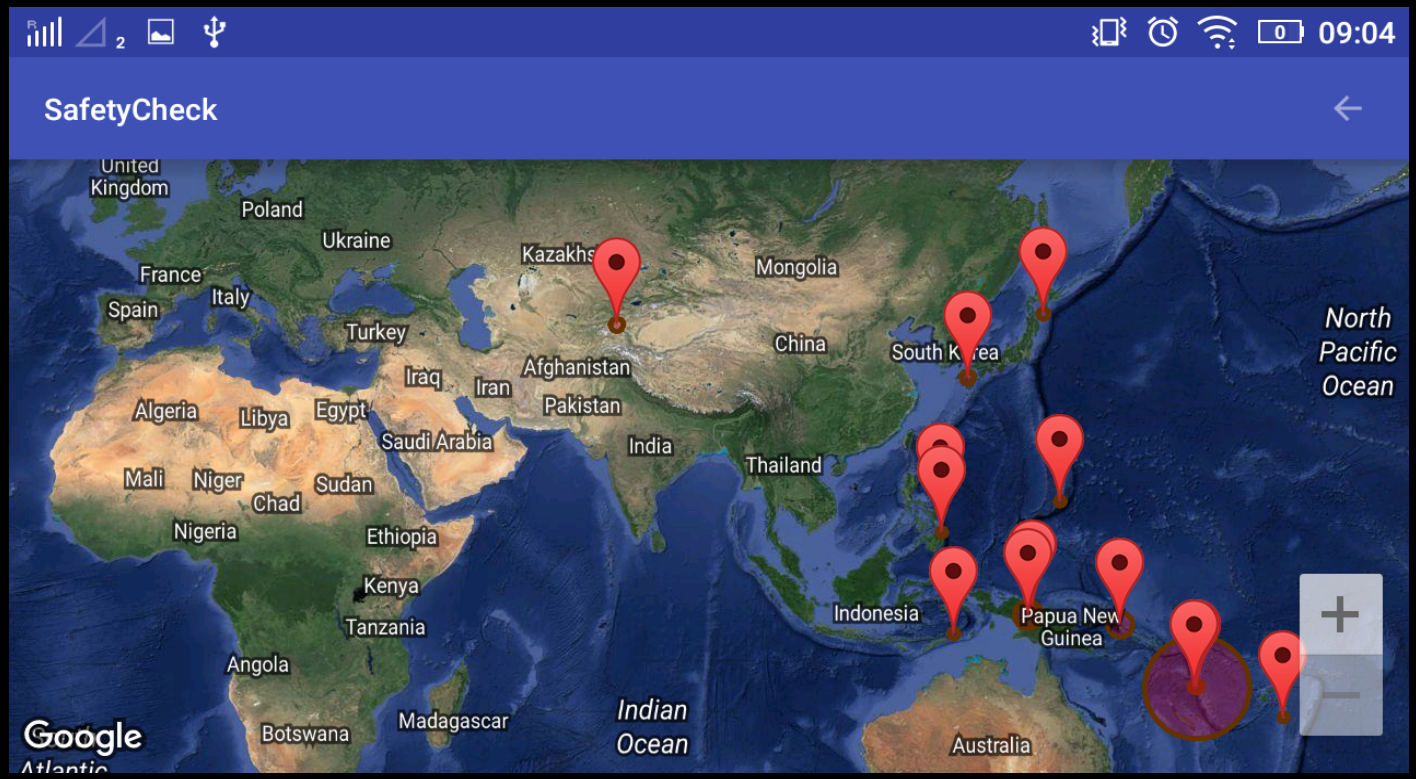
Weather alerts webpage

Solution - WebApp



Regions web page

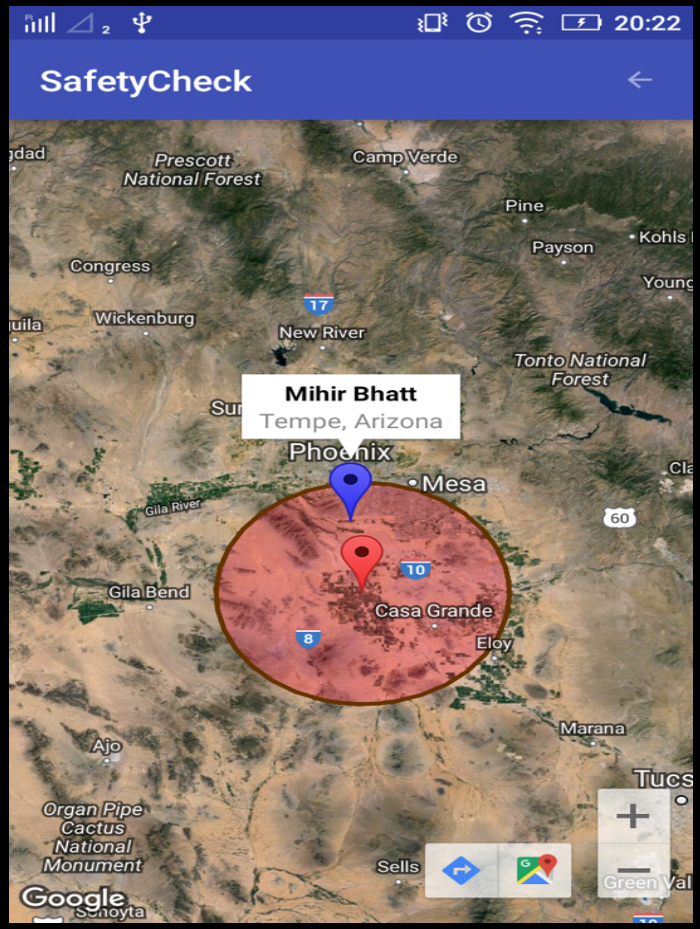
Solution – Mobile App



Map Earthquakes with impacted region

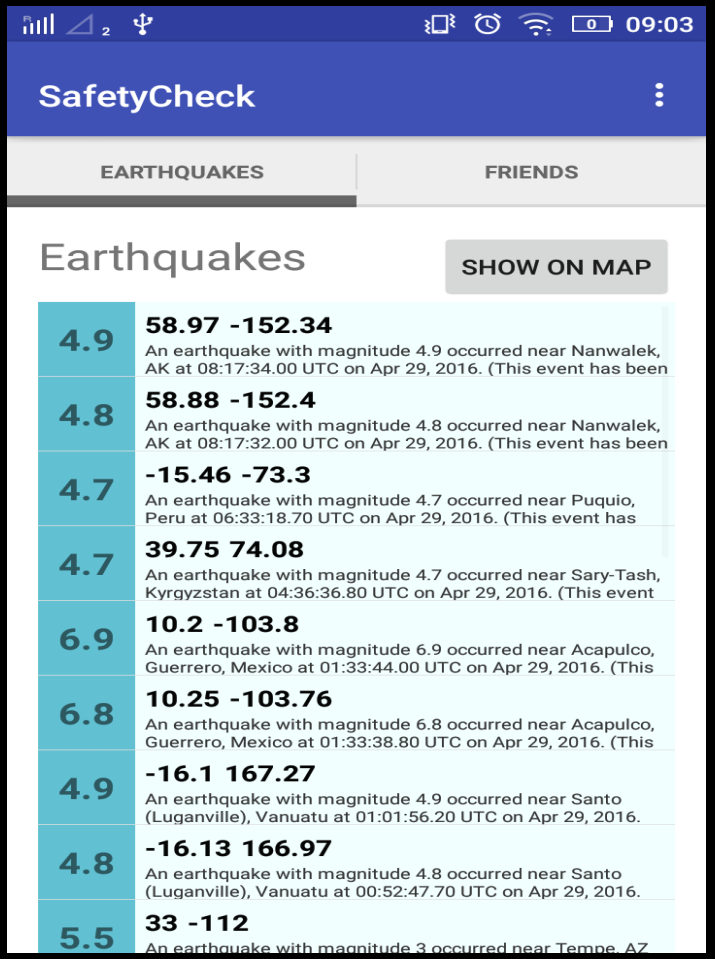
Android app: https://github.com/yogeshpandey009/SafetyCheckAndroidApp

Solution – Mobile App



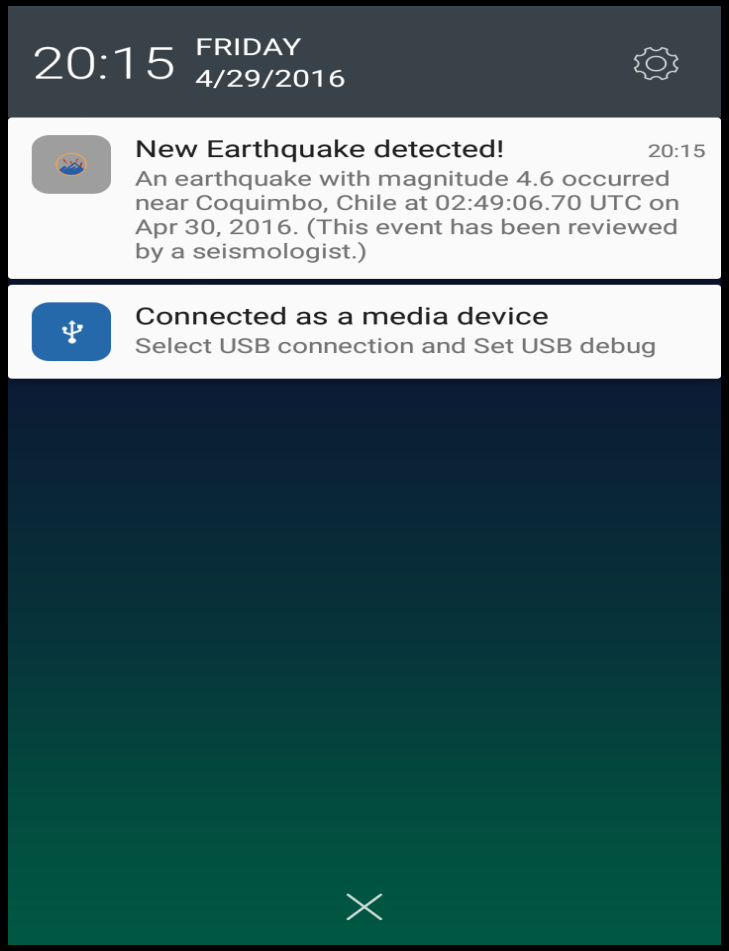
Map of impacted persons by an earthquake

Solution – Mobile App



List of all earthquake alerts

Solution – Mobile App



New earthquake alert notification

Semantic Querying

```
select ?earthquake ?point ?lat ?lon ?mag ?time ?desc ?areaDesc
where {
    ?earthquake rdf:type sc:Earthquake.
    ?earthquake sc:hasMagnitude ?mag.
    ?earthquake sc:hasAreaDescription ?areaDesc.
    ?earthquake sc:hasArea ?point.
    ?point      sc:hasLongitude ?lon.
    ?point      sc:hasLatitude ?lat.
    ?earthquake sc:atTime ?time.
    ?earthquake sc:hasDescription ?desc. }
```

Query 1: Get all earthquake instances

Semantic Querying

```
select ?weather ?areaDesc ?sev ?time ?desc (GROUP_CONCAT(?lat)
AS ?lats) (GROUP_CONCAT(?lon) AS ?lons)
where {
?weather rdf:type sc:Weather.
?weather sc:hasSeverity ?sev.
?weather sc:hasAreaDescription ?areaDesc.
?weather sc:hasArea ?area.
?area rdfs:member ?point.
?point sc:hasLongitude ?lon.
?point sc:hasLatitude ?lat.
?weather sc:atTime ?time.
?weather sc:hasDescription ?desc. }
GROUP BY ?weather ?areaDesc ?sev ?time ?desc
```

Query 2: Get all weather alerts

Semantic Querying

```
select ?person ?name ?location ?region ?point ?lat ?lon
where {
?person sc:isImpactedBy <http://www.semanticweb.org/ontologies/
2015/10/SafetyCheck#20005hxx>.
?person sc:hasName ?name.
?person sc:hasLocation ?location.
?person sc:locatedAt ?region.
?region sc:hasPoint ?point.
?point sc:hasLatitude ?lat.
?point sc:hasLongitude ?lon.
}
```

Query 3: Get all persons impacted by an alert

Challenges

- Data from different sources and domains have different formats
  - structured, semi-structured, unstructured
  - require different approaches to extraction
- City and Region data obtained from multiple sources
  - Some records had missing information
  - Require data cleansing and processing after extraction
- Integrating datasets from different sources
  - Requires good understanding of each domain and source in order to design an integrated semantic data model

Conclusions

Summary

- Safety Check – being a semantic web app allows extensibility and interoperability
- Currently monitors earthquakes and weather alerts
- People data is obtained from facebook
- Available at http://imod.poly.asu.edu:8080/SafetyCheckWeb

Conclusions

Future Work

- Application can be extended to alerts about other disasters and humanitarian crises such as riots, terrorist attacks, epidemics, etc.
- People data can be obtained from additional social media sites such as Twitter, LinkedIn, etc.
- Personalization can be added based on user profile and instantly notify (over email or SMS) in case of emergencies that possibily impacts them or their friends and family.
- Ability to contact affected person and provide appropriate actions or help.

Conclusions

Questions !!

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