

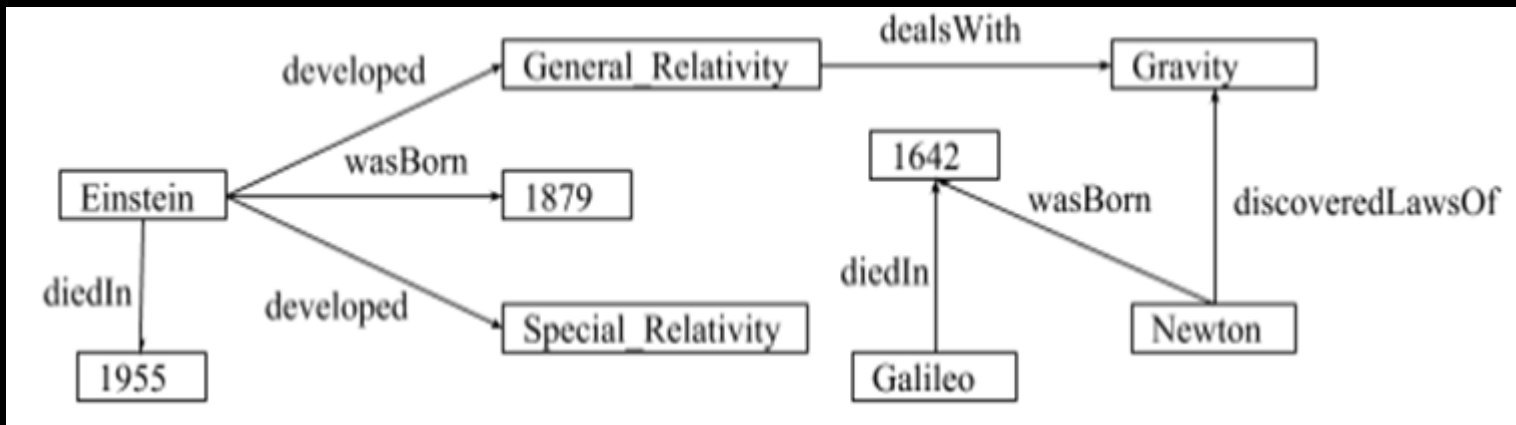
Safety Check: A Semantic Web Application for Emergency Management

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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

Problem Statement

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?

Problem Statement

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
 - Its 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?

Problem Statement

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

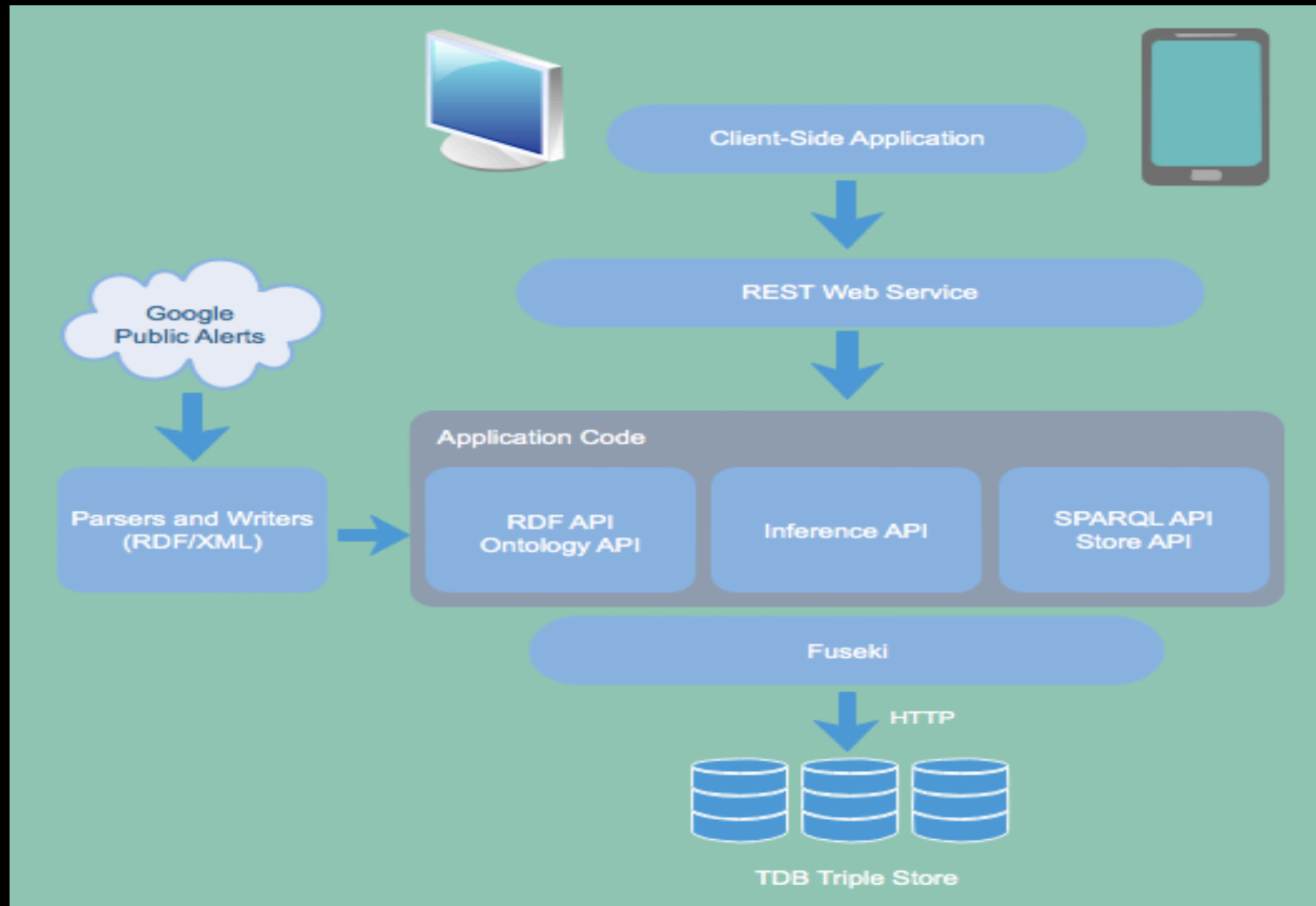
Methodology

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**



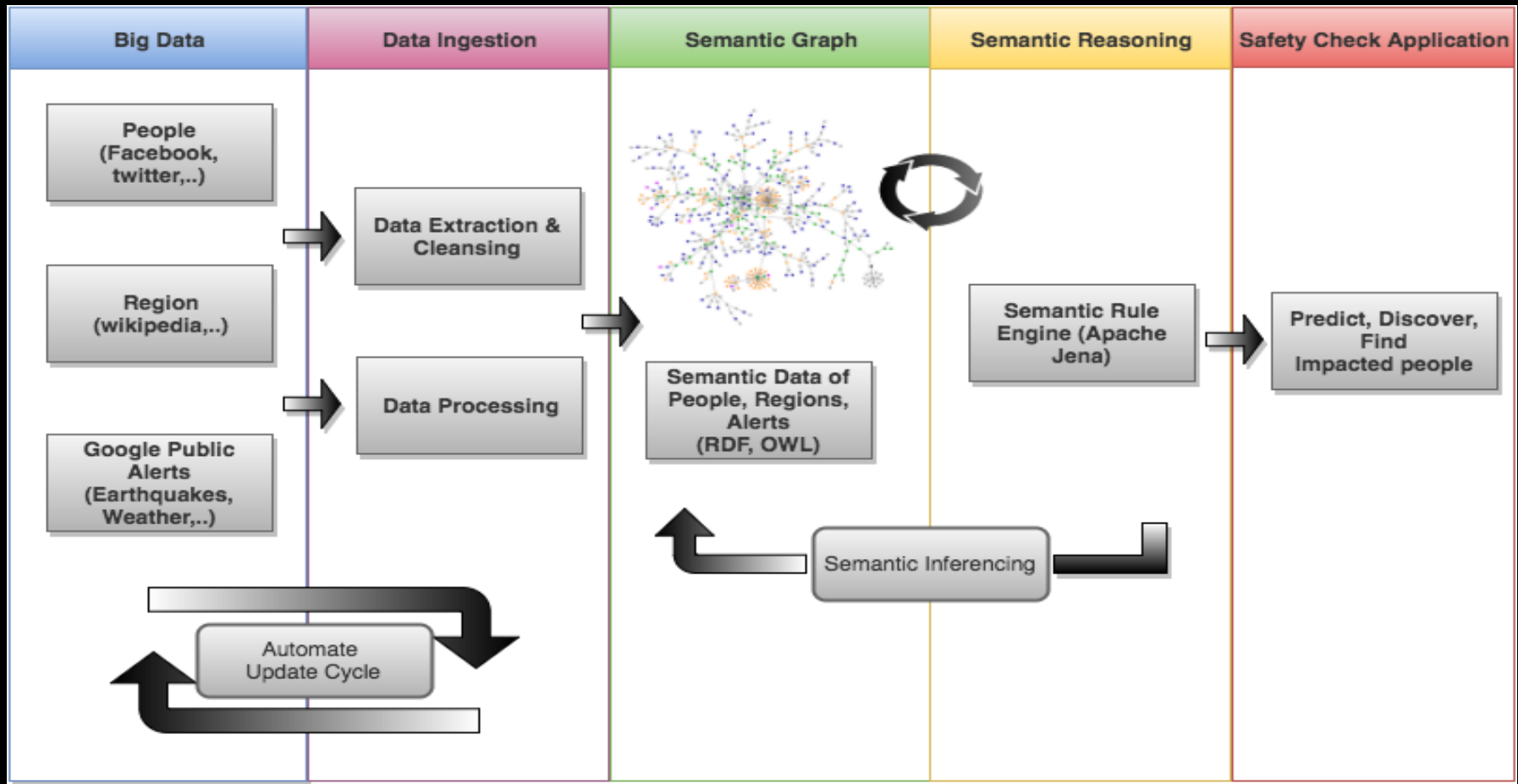
High-level System Architecture

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

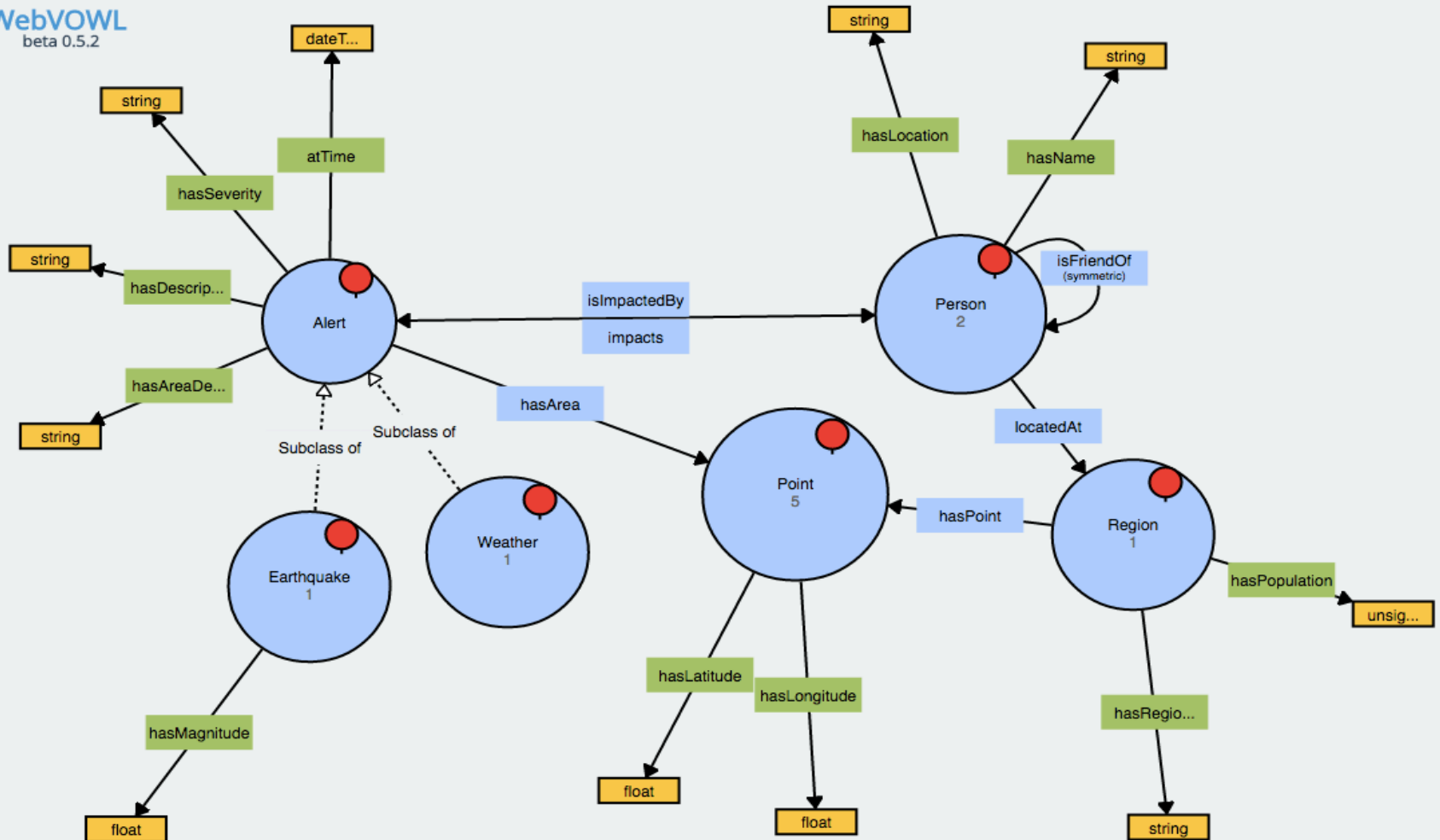
Solution



**Semantic Technology for Big Data analysis for
Emergency Management System**

Solution

WebVOWL
beta 0.5.2



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)
  eqlImpactMatch(?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.

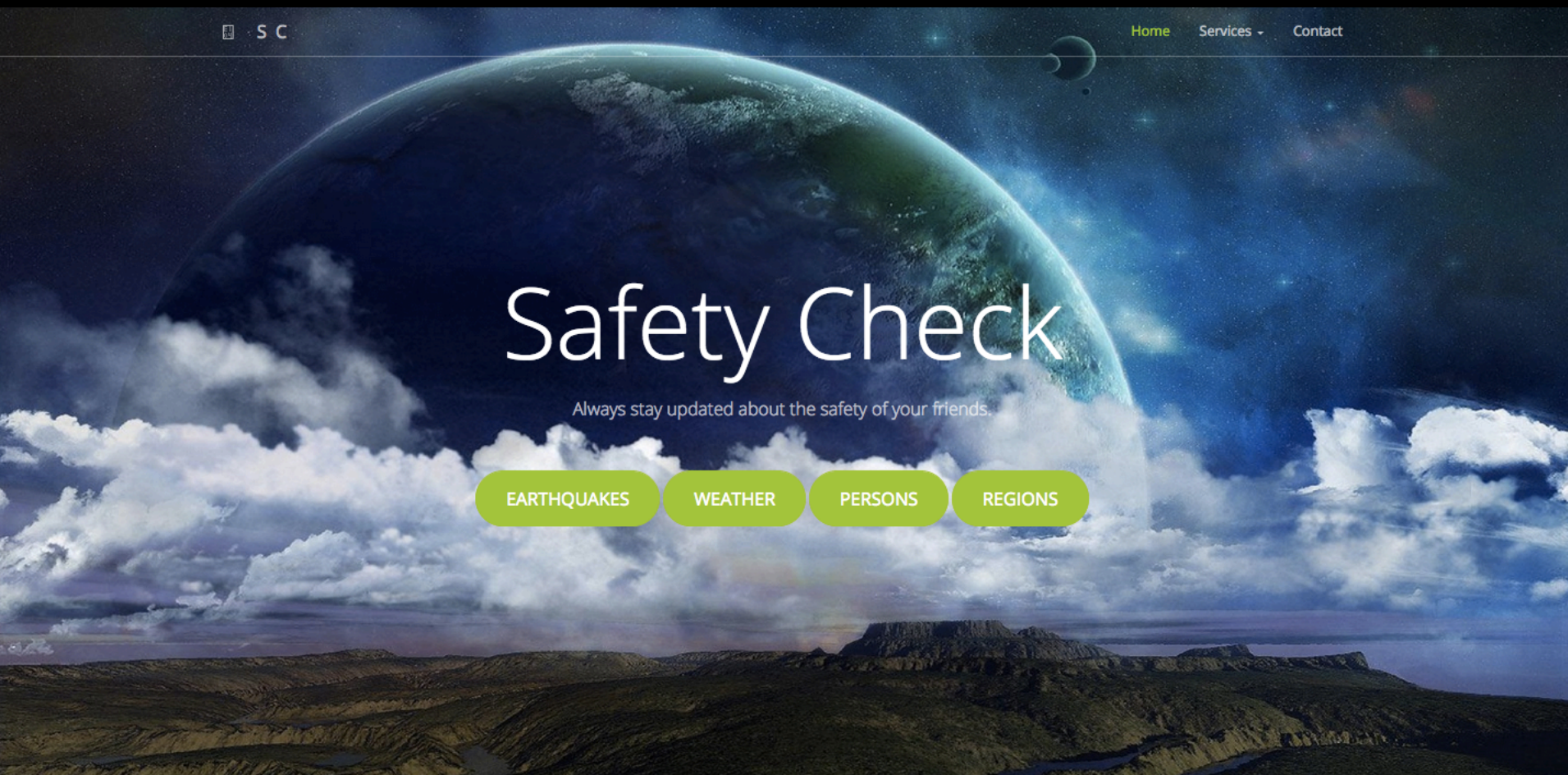
Semantic Reasoning

```
[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

Search

Clear Filters

Double click an earthquake to show impacted persons

#	Magnitude	Epicenter	Info	Time
1	5	-6.15 130.37	M 5.0 - 224km NNW of Saumlaki, Indonesia (This event has been reviewed by a seismologist.)	11:30 PM 01/20/2017 MST
2	5.7	2.8 128.18	M 5.7 - 120km N of Tobelo, Indonesia (This event has been reviewed by a seismologist.)	10:16 PM 01/20/2017 MST
3	5.2	-5.33 152.38	M 5.2 - 109km S of Kokopo, Papua New Guinea (This event has been reviewed by a seismologist.)	6:52 PM 01/20/2017 MST
7	4.5	29.68 51.48	M 4.5 - southern Iran (This event has been reviewed by a seismologist.)	3:58 PM 01/20/2017 MST
8	5	-17.24 -174.09	M 5.0 - 147km SSW of Hihifo, Tonga (This event has been reviewed by a seismologist.)	10:36 AM 01/20/2017 MST
9	4.5	-15.42 -178.74	M 4.5 - 138km SSW of Sigave, Wallis and Futuna (This event has been reviewed by a seismologist.)	7:06 AM 01/20/2017 MST
13	5.2	38.29 76.64	M 5.2 - southern Xinjiang, China (This event has been reviewed by a seismologist.)	2:54 AM 01/20/2017 MST
14	4.5	26.65 66.25	M 4.5 - 47km N of Bela, Pakistan (This event has been reviewed by a seismologist.)	8:47 PM 01/19/2017 MST
15	4.9	8.88 126.73	M 4.9 - 47km E of Aras-asan, Philippines (This event has been reviewed by a seismologist.)	8:43 PM 01/19/2017 MST
16	4.9	-36.42 -97.13	M 4.9 - West Chile Rise (This event has been reviewed by a seismologist.)	8:32 PM 01/19/2017 MST
17	4.7	-10.41 161.32	M 4.7 - 66km W of Kirakira, Solomon Islands (This event has been reviewed by a seismologist.)	7:20 PM 01/19/2017 MST
18	6.7	-10.66 161.44	M 6.7 - 56km WSW of Kirakira, Solomon Islands (This event has been reviewed by a seismologist.)	4:04 PM 01/19/2017 MST
19	6.7	-10.7 161.4	M 6.7 - 63km WSW of Kirakira, Solomon Islands (This event has been reviewed by a seismologist.)	4:04 PM 01/19/2017 MST
35	6.8	-10.39 161.31	M 6.8 - 71km W of Kirakira, Solomon Islands (This event has been reviewed by a seismologist.)	4:04 PM 01/19/2017 MST
36	4.8	-8.17 119.72	M 4.8 - 39km NNW of Cempa, Indonesia (This event has been reviewed by a seismologist.)	3:54 PM 01/19/2017 MST
52	4.8	19.96 121.24	M 4.8 - 79km SW of Sabtang, Philippines (This event has been reviewed by a seismologist.)	12:59 PM 01/19/2017 MST
53	5	-30.84 -71.55	M 5.0 - 42km SW of Ovalle, Chile (This event has been reviewed by a seismologist.)	5:01 AM 01/19/2017 MST
54	4.7	5.88 -76.13	M 4.7 - 11km WNW of Ciudad Bolivar, Colombia (This event has been reviewed by a seismologist.)	5:01 AM 01/19/2017 MST
55	5	-49.04 127.55	M 5.0 - Western Indian-Antarctic Ridge (This event has been reviewed by a seismologist.)	3:15 AM 01/19/2017 MST
56	4.6	21.63 120.09	M 4.6 - 79km WSW of Hengchun, Taiwan (This event has been reviewed by a seismologist.)	8:42 PM 01/18/2017 MST
57	4.6	4.25 126.92	M 4.6 - 205km SE of Sarangani, Philippines (This event has been reviewed by a seismologist.)	4:17 PM 01/18/2017 MST

Earthquake alerts web page

Solution - WebApp

□ S C

[Home](#)

[Services](#) ▾

[Contact](#)

+ Add

Search

Clear Filters

Double click an weather to show impacted persons

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 to recede, particularly from pinebluff and aberdeen west to near foxfire where an estimated 2 to 4 inches of rain fell between 10 pm and midnight. however, with no flooding reported thus far and no imminent threat of additional heavy rain, the flash flood warning will be allowed to expire 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 until 145 am edt at 109 am edt doppler radar was tracking a strong thunderstorm over antioch or near raeford moving east at 10 mph. pea size hail and winds in excess of 40 mph will be possible with this storm. locations impacted include red springs st. pauls rex shannon park on rennert and lumber bridge. this includes interstate 95 in north carolina between mile markers 31 and 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 affect southwestern caswell county at 1244 am edt a strong thunderstorm was located over lawsonville moving east at 15 mph. winds in excess of 30 mph and pea size hail are possible with this storm. locations impacted include yanceyville bethel and quick. torrential rainfall is also occurring with this storm and may cause localized flooding. do not drive your vehicle through flooded roadways.	9:44 PM 09/27/2016 MST

Weather alerts webpage

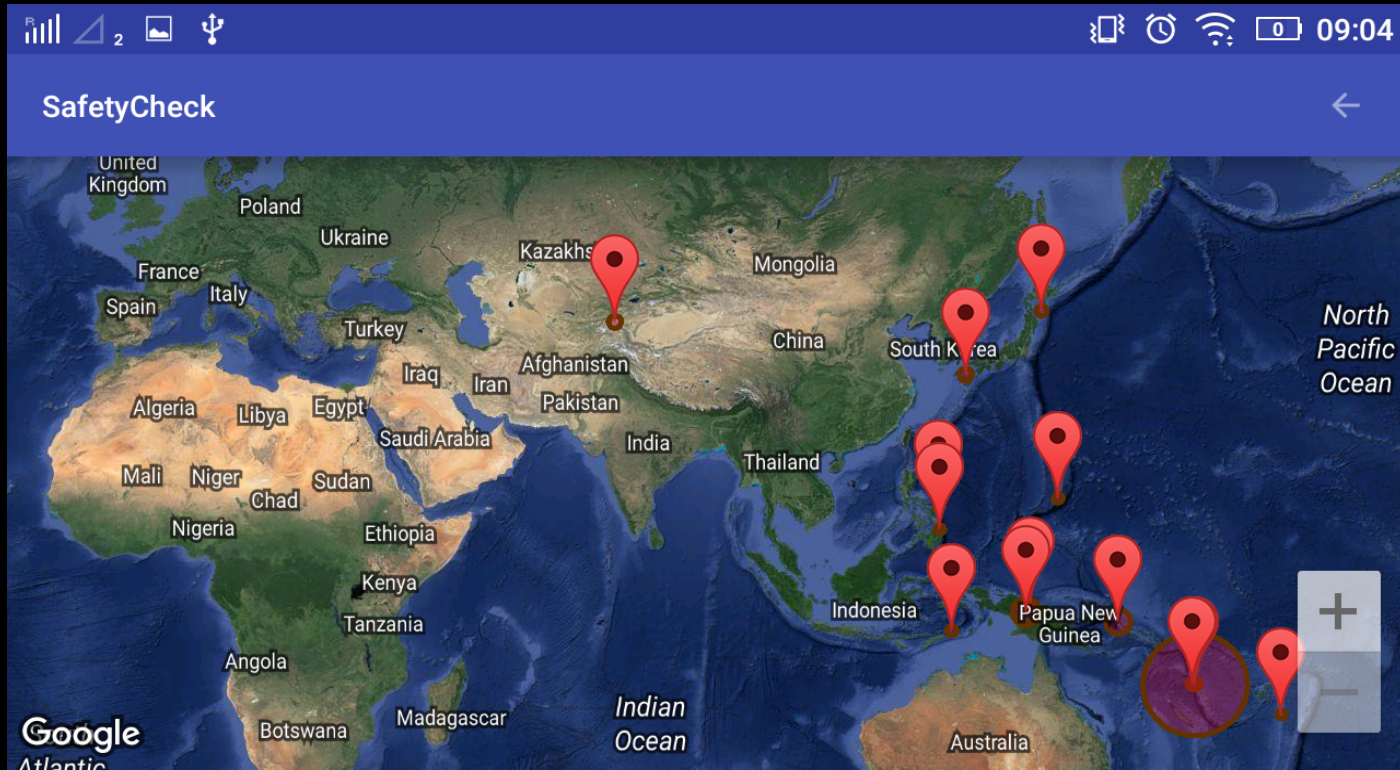
Solution - WebApp

[Search](#) [Clear Filters](#)

RegionId ↑	Name	Co-ordinates	Population
#region1	Fortin Falcon, Presidente Hayes, Paraguay	-23.05 -59.85	0
#region10	Elephant Island, South Shetland Islands, , Antarctica	-62 -58	3
#region100	Lake Minchumina, Alaska, United States of America	63.88 -152.31	32
#region1000	Kirundo, Kirundo, Burundi	-2.58 30.1	6083
#region1001	Narrabri, New South Wales, Australia	-30.33 149.79	6105
#region1002	Bathurst, New South Wales, Australia	-33.42 149.57	6111
#region1003	Iqaluit, Nunavut, Canada	63.75 -68.5	6124
#region1004	Umba, Murmansk, Russia	66.68 34.35	6128
#region1005	Atherton, Queensland, Australia	-17.27 145.47	6132
#region1006	Doctor Pedro P. Pena, Formosa, Argentina	-22.48 -62.3	6143
#region1007	Siteki, Lubombo, Swaziland	-26.45 31.95	6152
#region1008	Gizo, Choiseul, Solomon Islands	-8.1 156.84	6154
#region1009	Brokopondo, Brokopondo, Suriname	5.04 -55.02	6170
#region101	Maitri Station, , Antarctica	-70.78 11.73	33
#region1010	Brandfort, Orange Free State, South Africa	-28.7 26.47	6190
#region1011	Flin Flon, Manitoba, Canada	54.77 -101.88	6197
#region1012	Gunnedah, New South Wales, Australia	-30.99 150.26	6204
#region1013	Rinconada, Jujuy, Argentina	-22.43 -66.17	6209
#region1014	Goundam, Timbuktu, Mali	16.42 -3.67	6217
#region1015	Sidney, Nebraska, United States of America	41.14 -102.98	6221
#region1016	Diekirch, Diekirch, Luxembourg	49.88 6.17	6242
#region1017	Needles, California, United States of America	34.85 -114.61	6246

Regions web page

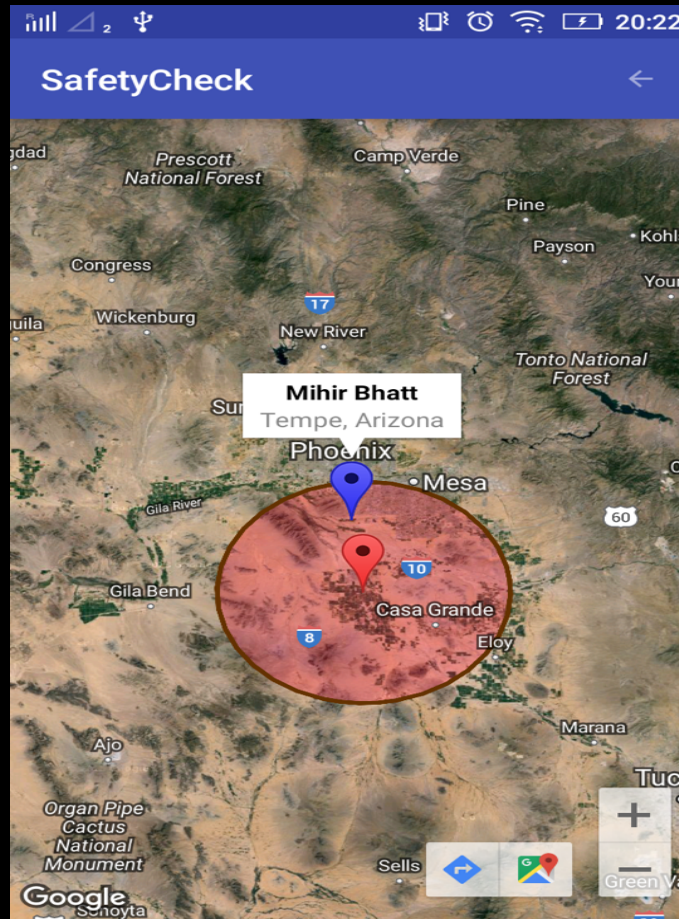
Solution – Mobile App



Map Earthquakes with impacted region

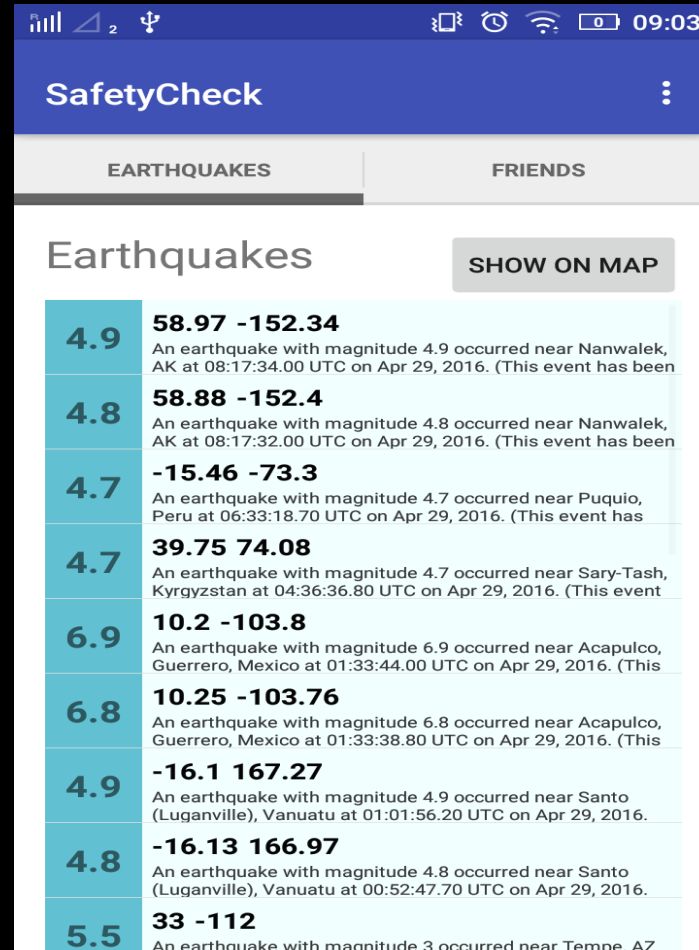
Android app: <https://github.com/yogeshpandey009/SafetyCheckAndroidApp>

Solution – Mobile App



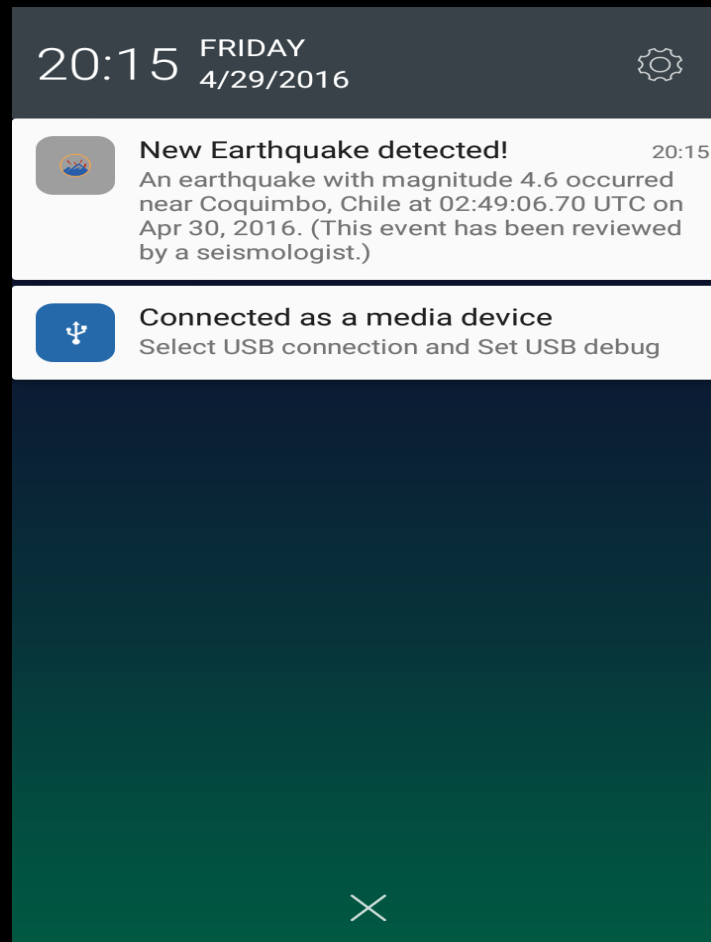
Map of impacted persons by an earthquake

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 possibly impacts them or their friends and family.
- ❖ Ability to contact affected person and provide appropriate actions or help.

Conclusions

Questions !!

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