



Computing for Ebola Challenge Hackathon

Network Dynamics and Simulation
Science Laboratory members

Presented by Caitlin Rivers
(cmrivers@vbi.vt.edu)



Background

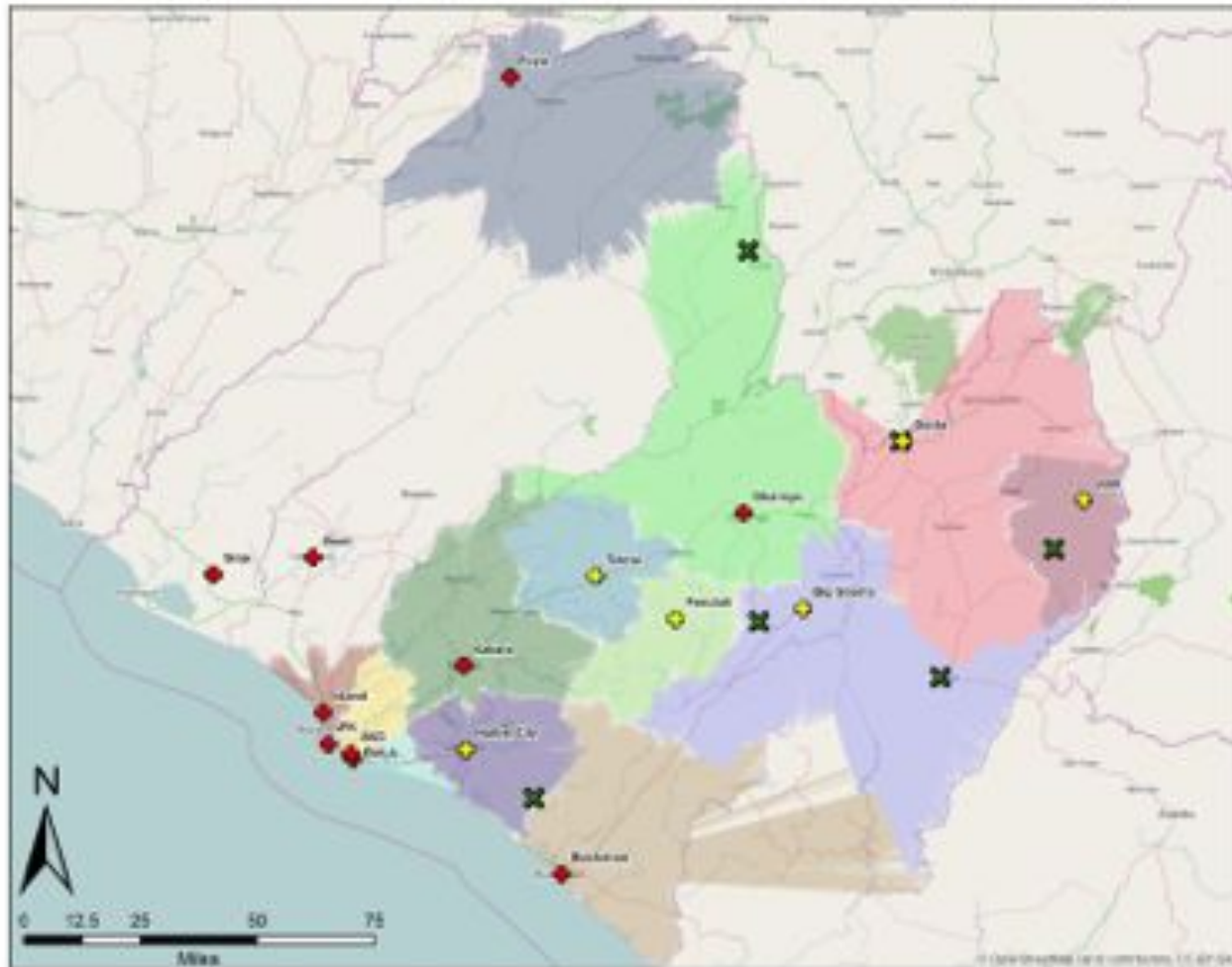
- Computer science and public health students collaborate to spend 1 week developing apps, analyses, etc. to fight Ebola
- Community members also joined
- 60-80 participants total





Optimal location of 6 new ETU's using two different optimization criteria (yellow and green crosses and using forecasted Incidence

MapOptimizer versus Location Allocation based on Ebola Burden (6 new ETUs)



ETUs	Cases	Long	Lat
All Monrovia	1,442	-10.7505	6.2411
Big Gbarra	296	-9.2951	6.7308
Bomi	1	-10.8207	6.8663
Bushanan	287	-10.0442	5.8834
Ferutofo	205	-9.6912	6.6790
Foya	287	-10.2130	8.3632
Ganta	237	-8.9851	7.2322
Gbarnga	598	-9.4812	7.0084
Harbel City	368	-10.3430	6.2709
Jekla	66	-8.4210	7.0482
Kakata	707	-10.3518	6.5313
Sinje	0	-11.1905	6.8129
Totota	290	-9.9418	6.8206

Legend

- ◆ Facility Already Built
- ◆ Location Allocation
- ✕ MapOptimizer

Coordinate System: WGS 1984 UTM Zone 29N
 Projection: Transverse Mercator
 Datum: GRS 1984
 False easting: 500 000 000
 False northing: 0 0000
 Central meridian: 0 0000
 Scale factor: 0.9996
 Latitude of origin: 0 0000
 Units: Meter

Work done at NDSSL - Virginia Tech

Notes:

- ◆ Based on County Level ODE Model
- ◆ No demand on Sinje
- ◆ Minimal Demand on Bomi

Sources:
 Pop: LandScan 2013
 Roads: LISGIS (Eherton)
 Rivers: DIVA-GIS



EBOLA DATA ACCESS API

Ebola Link Data Publishing

OPEN LINK SOFTWARE

About: http://ndssl.vbi.vt.edu/ebola/EBOLA_COUNTRY_TIMESERIES/9/10/14 Sponge PermLink
 An Entity of Type : http://ndssl.vbi.vt.edu/ebola/vocab/COUNTRY_TIMESERIES, within Data Space : <http://ndssl.vbi.vt.edu/8892> associated with source [dataset\(s\)](#)
 Type: http://ndssl.vbi.vt.edu/ebola/vocab/COUNTRY_TIMESERIES • Command: Start New Facet •

Attributes	Values
rdf:type	http://ndssl.vbi.vt.edu/ebola/vocab/COUNTRY_TIMESERIES
rdf:label	COUNTRY_TIMESERIES #9/10/14
http://ndssl.vbi.vt.edu/ebola/vocab/RIES_CASES_GUINEA	899
http://ndssl.vbi.vt.edu/ebola/vocab/RIES_CASES_NIGERIA	21
http://ndssl.vbi.vt.edu/ebola/vocab/CASES_SIERRALEONE	1478
http://ndssl.vbi.vt.edu/ebola/vocab/RIES_CASE_SENEGAL	1
http://ndssl.vbi.vt.edu/ebola/vocab/RY_TIMESERIES_DAY	172
http://ndssl.vbi.vt.edu/ebola/vocab/RIES_DEATHS_GUINEA	568
http://ndssl.vbi.vt.edu/ebola/vocab/RIES_DEATHS_NIGERIA	8
http://ndssl.vbi.vt.edu/ebola/vocab/RIES_DEATHS_SIERRALEONE	536
http://ndssl.vbi.vt.edu/ebola/vocab/RIES_INCIDENT_DATE	9/10/14
http://ndssl.vbi.vt.edu/ebola/vocab/RIES_INCIDENT_DATE of http://ndssl.vbi.vt.edu/ebola/EBOLA_LIBERIA_SEP_10/Case Fatality Rate (CFR) Confirmed & Probable Cases	http://ndssl.vbi.vt.edu/ebola/EBOLA_LIBERIA_SEP_10/Contacts lost to follow-up http://ndssl.vbi.vt.edu/ebola/EBOLA_LIBERIA_SEP_10/Contacts seen http://ndssl.vbi.vt.edu/ebola/EBOLA_LIBERIA_SEP_10/Contacts who completed 21 day follow-up http://ndssl.vbi.vt.edu/ebola/EBOLA_LIBERIA_SEP_10/Cumulative admission/isolation more
http://ndssl.vbi.vt.edu/ebola/vocab/RIES_INCIDENT_DATE of http://ndssl.vbi.vt.edu/ebola/EBOLA_SL_SEP_10/cum_noncase	http://ndssl.vbi.vt.edu/ebola/EBOLA_SL_SEP_10/cf http://ndssl.vbi.vt.edu/ebola/EBOLA_SL_SEP_10/contacts_followed http://ndssl.vbi.vt.edu/ebola/EBOLA_SL_SEP_10/contacts_healthy http://ndssl.vbi.vt.edu/ebola/EBOLA_SL_SEP_10/contacts_ill more

SPARQL Endpoint to Access Data

Virtuoso SPARQL Query Editor

Default Data Set Name (Graph IRI)

Query Text

```
select ?Location ?Contact_III from <http://ndssl.vbi.vt.edu/ebola>
where
{
  ?s ?p "contacts_ill".
  ?s ?Location ?Contact_III.BIND (xsd:decimal(?Contact_III) as ?a).FILTER (?a >10)
}
```

(Security restrictions of this server do not allow you to retrieve remote RDF data, see [details](#).)

Results Format: HTML

Execution timeout: 0 milliseconds (values less than 1000 are ignored)

Options: Strict checking of void variables

(The result can only be sent back to browser, not saved on the server, see [details](#).)

Example Query: Days and locations where the number of contacts found ill is greater than 10

Query Result

Location	Contact_III
http://ndssl.vbi.vt.edu/ebola/vocab/SL_SEP_10_NATIONAL	"37"
http://ndssl.vbi.vt.edu/ebola/vocab/SL_SEP_10_PORT_LOKO	"13"
http://ndssl.vbi.vt.edu/ebola/vocab/SL_SEP_13_NATIONAL	"21"
http://ndssl.vbi.vt.edu/ebola/vocab/SL_SEP_14_NATIONAL	"14"



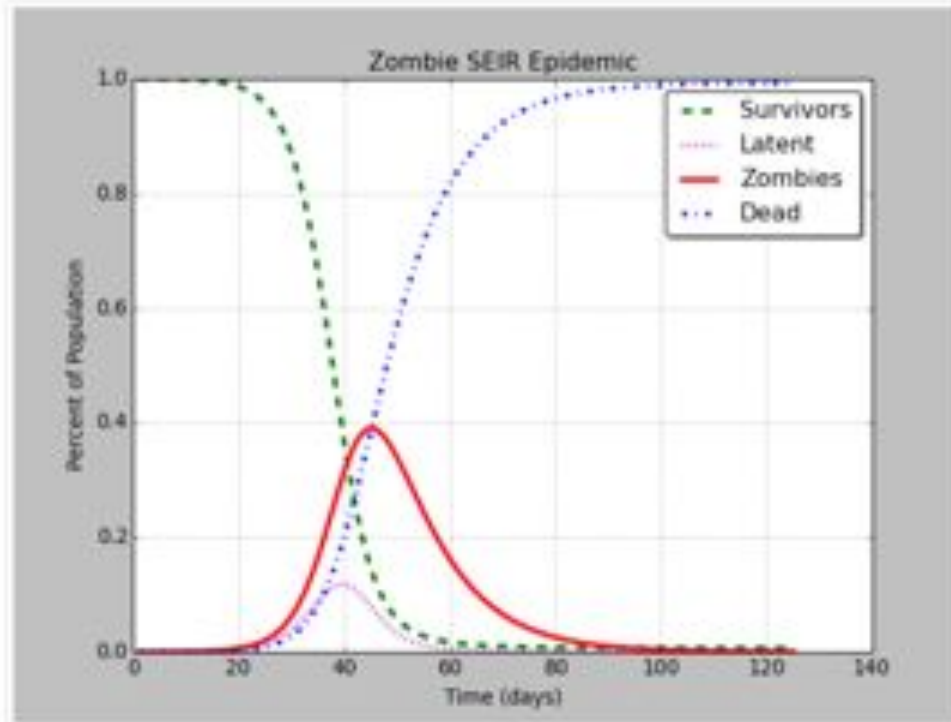
Zeke Example

Zeke About Contact

Sign in

Select a model

SEIR



Controls

Zombie epidemic model with latent infection period. Takes three arguments:

- Beta: Contact rate
- Gamma: Infection duration in days
- Alpha: A latent (non-zombie infected) period in days

Beta
Gamma
Alpha

Set values

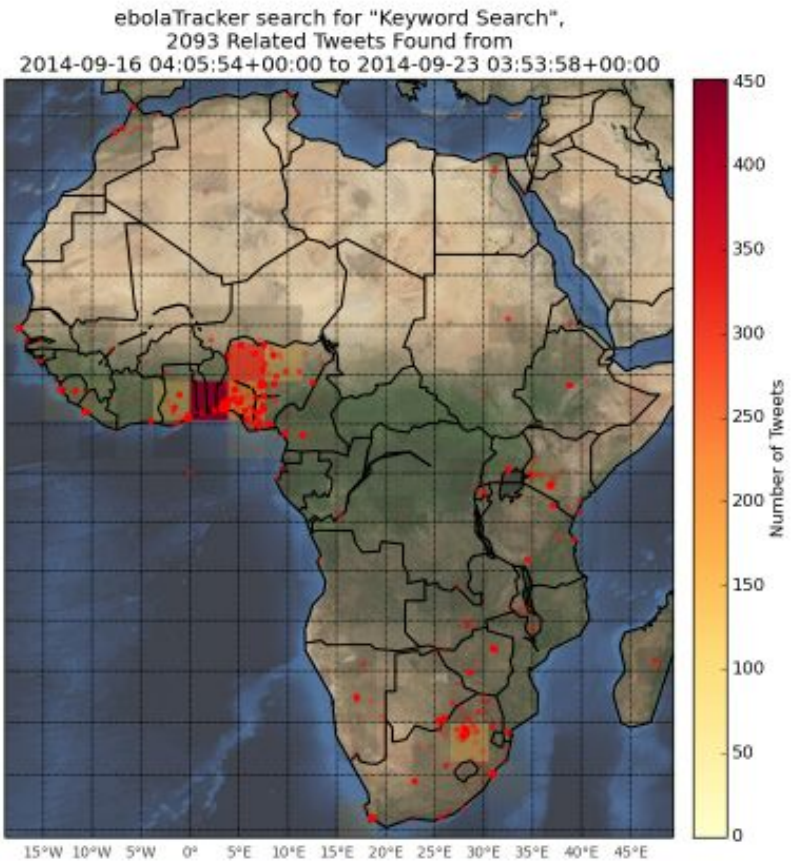
Reset

Screen shot represents what results will look like but with NDSSL's Ebola models in the place of the models used for instructional purposes in Zeke

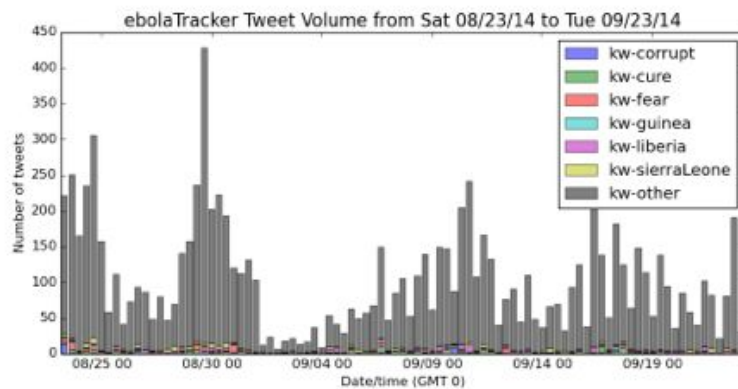


Twitter Tracking

Most common images:



Solidarity with Ebola affected countries, Jokes about bushmeat, Ebola risk, and names, Positive health message



James Schlitt



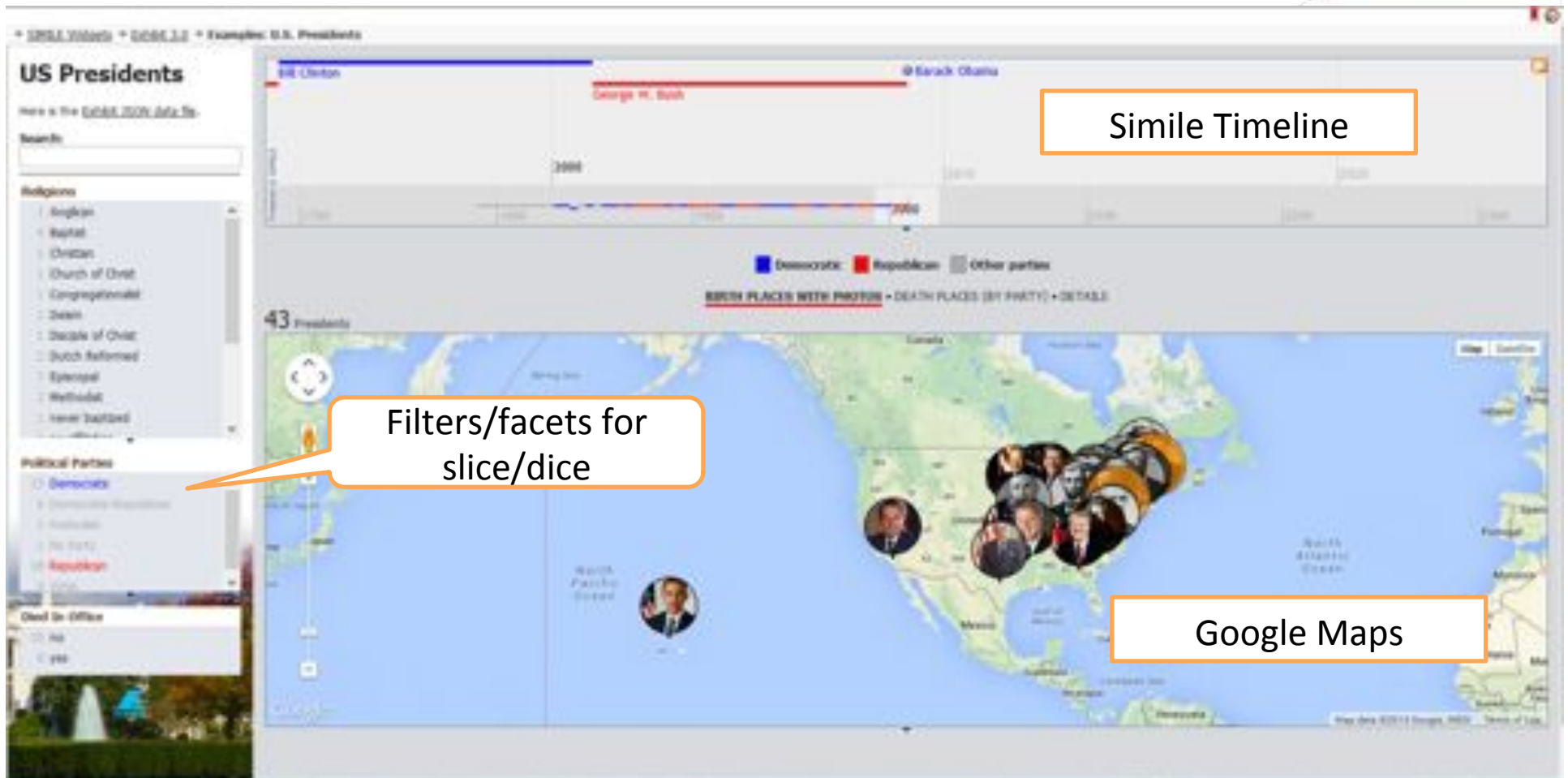
Epidemiological analyses

- Analyzed subnational data from Sierra Leone and Guinea for epidemiological insights
- Caitlin Rivers & Jessie Gunter
- Published at caitlinrivers.com/blog





MIT SIMILE Exhibit



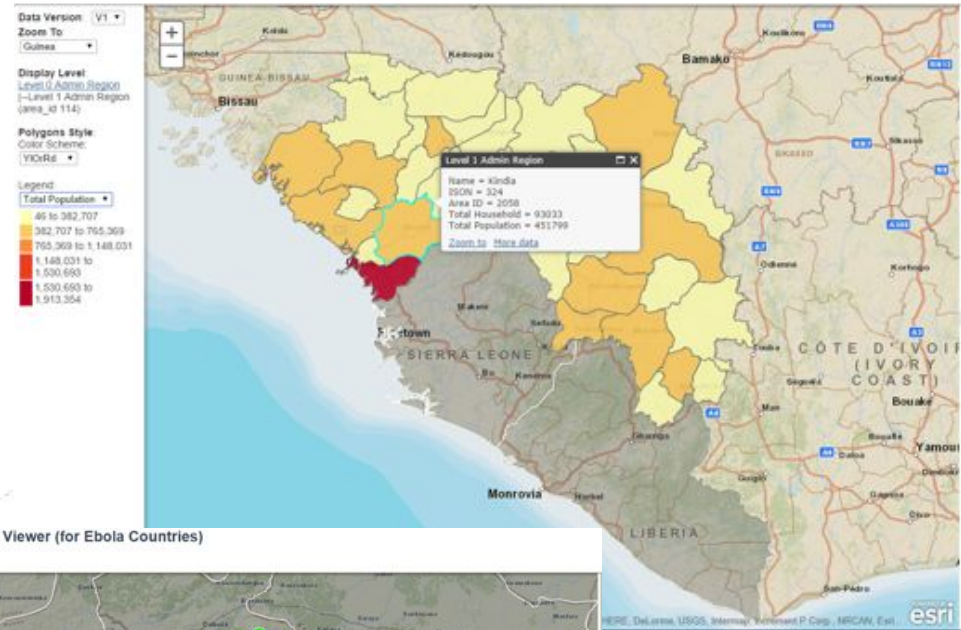
<http://simile-widgets.org/exhibit3>



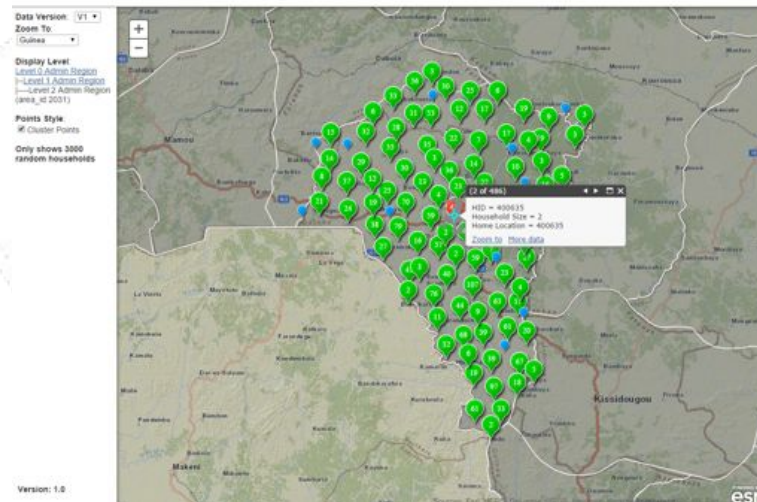
Visualizations

- Visualize epidemiological data and data from our agent based models

Synthetic Information Viewer (for Ebola Countries)



Synthetic Information Viewer (for Ebola Countries)



(External) Outbreak Investigator

Contact: Neil Abernethy, neila@uw.edu

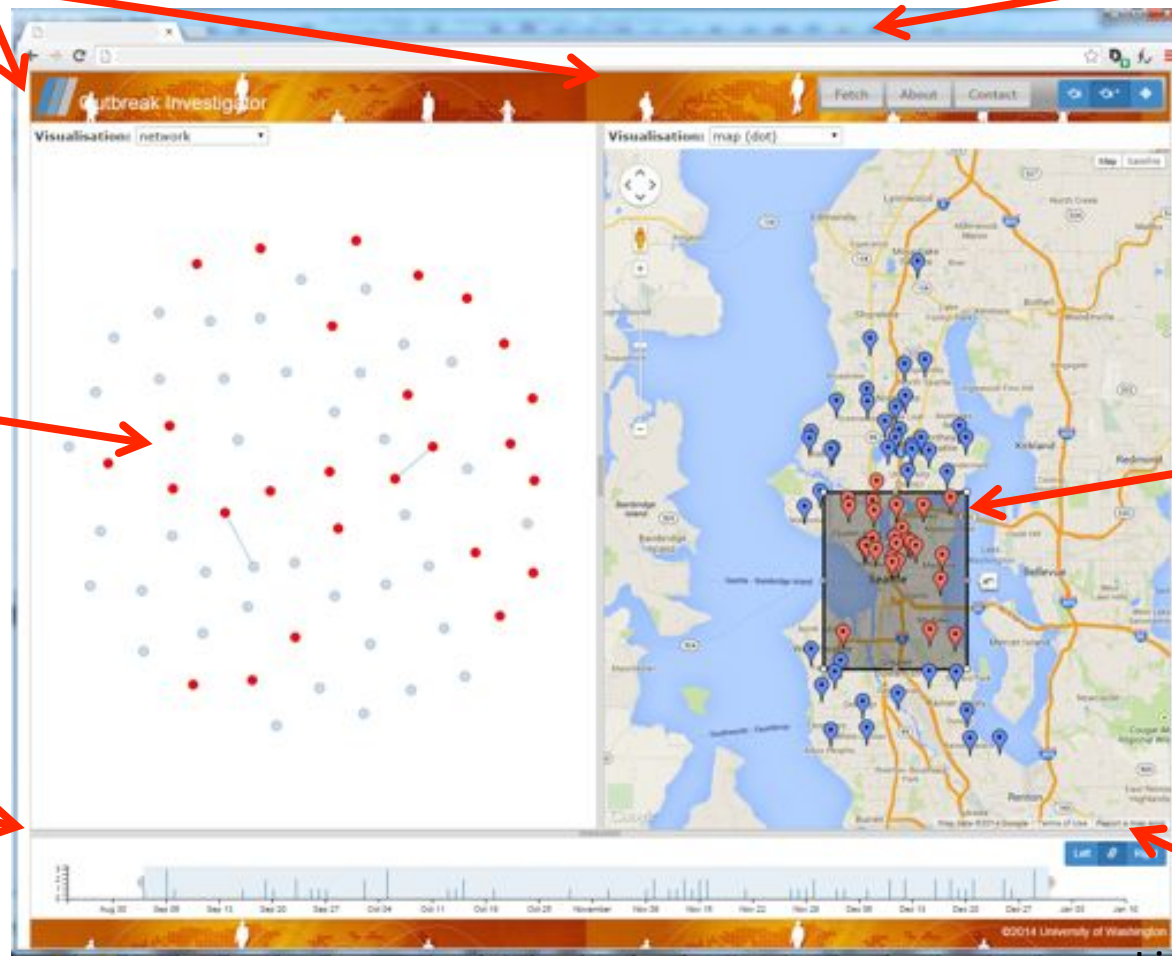
Selectable
Visualizations

Flexible
Queries

Multi-selected
nodes in social
network display
in map

Multi-selected
cases in region
display in
network

Selectable
Time window
slider – filters
results



Link displays
or show before-after
with time slider

Other visualization options:

Case roster, choropleth map, temporal network



APPENDIX



Optimal Ebola Treatment Unit Placement in Liberia

Oct 14th Update

Bryan Lewis PhD, MPH (blewis@vbi.vt.edu)

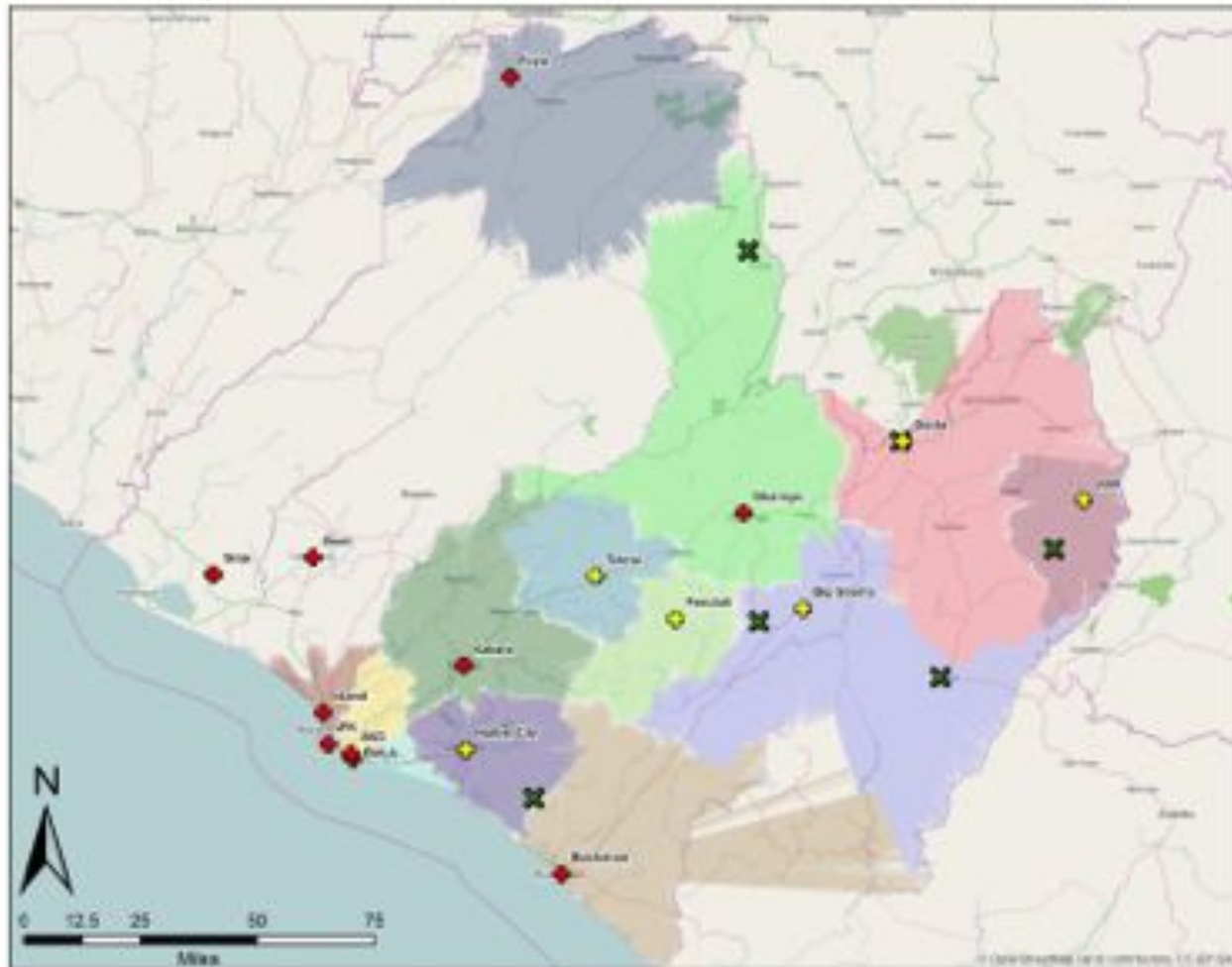
Caitlin Rivers MPH, Eric Lofgren PhD, **James Schlitt**, **Alex Telionis MPH**,
Henning Mortveit PhD, Dawen Xie MS, Samarth Swarup PhD, Hannah Chungbaek,
Keith Bisset PhD, Maleq Khan PhD, Chris Kuhlman PhD, Farzaneh Tabataba, Anil Vullikanti, Dana Kuan
(DTRA)

Stephen Eubank PhD, Madhav Marathe PhD,
and Chris Barrett PhD



Optimal location of 6 new ETU's using two different optimization criteria (yellow and green crosses and using forecasted Incidence

MapOptimizer versus Location Allocation based on Ebola Burden (6 new ETUs)



ETUs	Cases	Long	Lat
All Monrovia	1,442	-10.7505	6.2411
Big Gbarra	296	-9.2951	6.7308
Bomi	1	-10.8207	6.8663
Buchanan	287	-10.0442	5.8834
Ferutofi	205	-9.6912	6.6790
Foya	287	-10.2130	8.3632
Ganta	237	-8.9851	7.2322
Gbarnga	598	-9.4812	7.0084
Harbel City	368	-10.3430	6.2709
Jehi	66	-8.4210	7.0482
Kakata	707	-10.3518	6.5313
Sinje	0	-11.1305	6.8129
Totota	290	-9.9418	6.8206

Legend

- Facility Already Built
- Location Allocation
- MapOptimizer

Coordinate System: WGS 1984 UTM Zone 29N
 Projection: Transverse Mercator
 Datum: GRS 1984
 False easting: 500 000 000
 False northing: 0 0000
 Central meridian: 0 0000
 Scale factor: 0.9996
 Latitude of origin: 0 0000
 Units: Meter

Work done at NDSSL - Virginia Tech

Notes:

- Based on County Level ODE Model
- No demand on Sinje
- Minimal Demand on Bomi

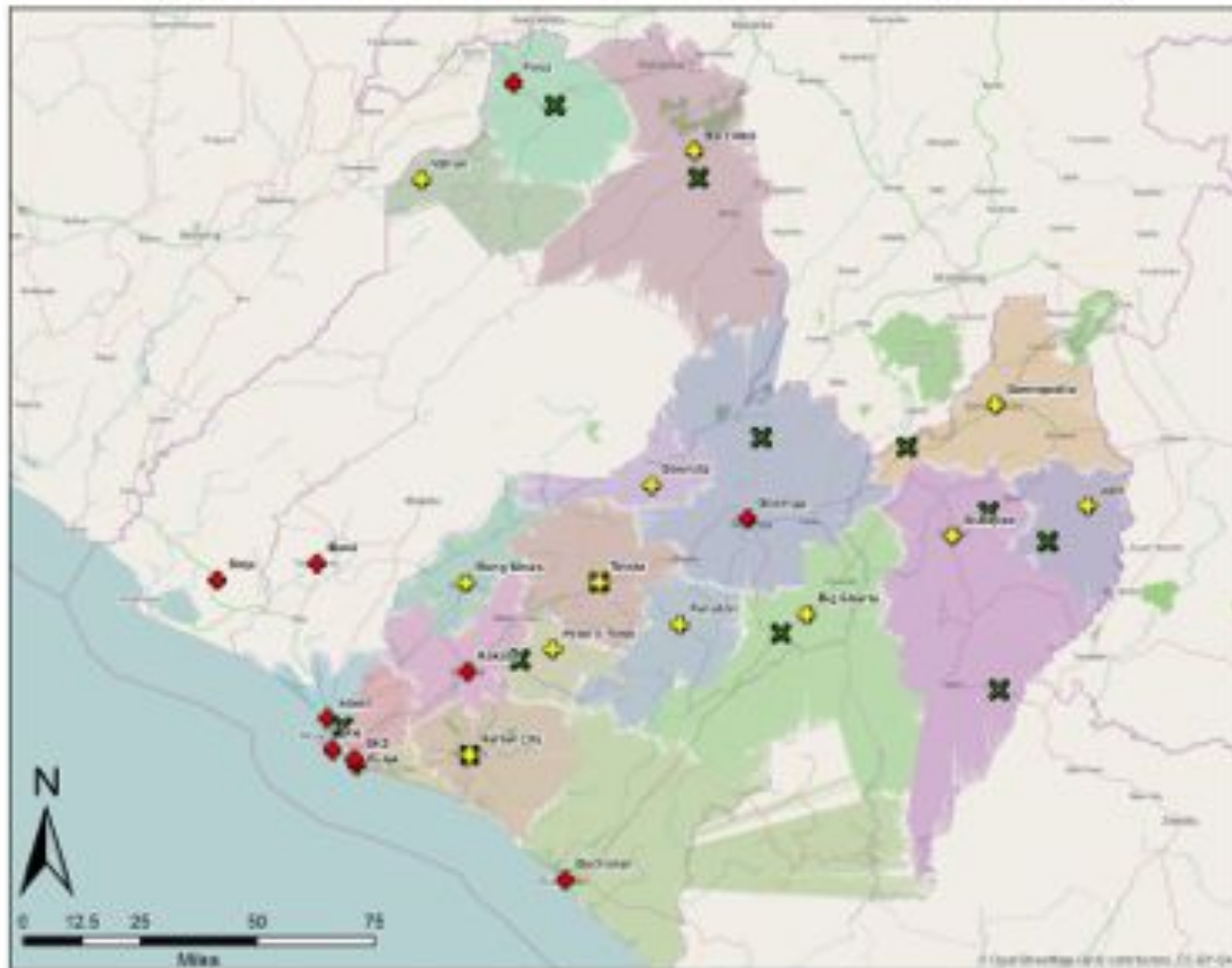
Sources:

- Pop: LandScan 2013
- Roads: LISGIS (Etherton)
- Rivers: DIVA-GIS



Optimal location of 12 new ETU's using two different optimization criteria (yellow vs green) using forecasted Incidence

MapOptimizer versus Location Allocation based on Ebola Burden (12 new ETUs)



ETUs	Cases	Long	Lat
All Monrovia	1,442	-10.7698	6.2867
Barzuew	79	-9.6478	8.1533
Big Gbarba	218	-9.2951	6.7108
Boni	1	-10.8207	6.8663
Bong Mines	152	-10.3568	6.8073
Buchanan	187	-10.0442	5.8834
Ferutshi	103	-9.6912	6.6790
Foya	108	-10.2130	8.3632
Gbarnga	533	-9.4812	7.0084
Gbonota	70	-9.7798	7.1134
Harbel City	368	-10.3430	6.2709
Jehli	54	-8.4210	7.0482
Kakata	440	-10.3518	6.5313
Peter's Town	125	-10.0865	6.6011
Saclepesa	128	-8.8418	6.9562
Sanniquellie	117	-8.7069	7.3634
Sinje	0	-11.1305	6.8129
Totota	283	-9.9418	6.8106
Vehun	30	-10.0997	8.0624

Legend

- Facility Already Built
- Location Allocation
- ✕ MapOptimizer

Work done at NDSSL - Virginia Tech

Notes:

- Based on County Level ODE Model
- No demand on Sinje
- Minimal Demand on Boni

Sources:

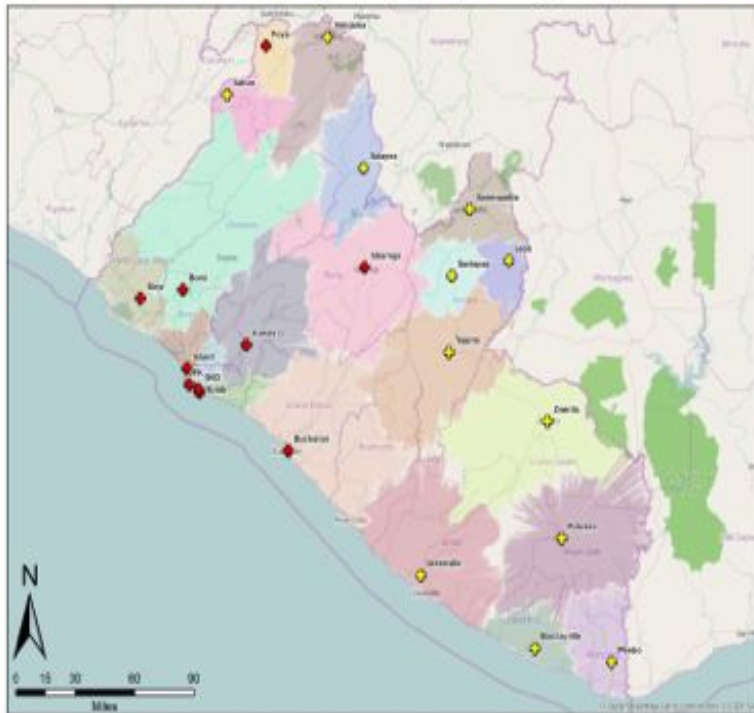
- Pop: LandScan 2013
- Roads: LISGIS (Eherton)
- Rivers: DIVA-GIS



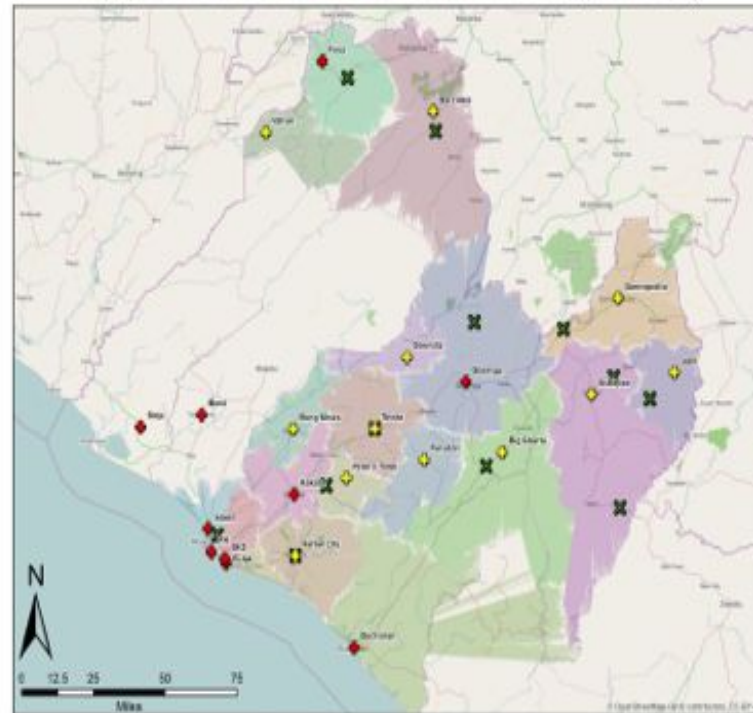
Comparison of the location with (right) and without (left) using ODE based forecasted values

Note that forecast show no demand in Sinje and minimal demand in Bomi

K-median Allocation by Total Population (10 existing, 12 new)



MapOptimizer versus Location Allocation based on Ebola Burden (12 new ETUs)



ETUs	Cases	Long	Lat
All Marvros	1,442	-10.7908	6.2867
Barrowen	79	-9.6478	8.1533
Big Gbarla	218	-9.2951	6.7108
Bomi	1	-10.8207	6.8663
Bong Mines	152	-10.3568	6.8073
Bushman	187	-10.0442	5.8834
Ferutasi	103	-9.8912	6.6790
Foya	108	-10.2130	8.3632
Gbarnga	533	-9.4812	7.0584
Gbonza	70	-9.7798	7.1134
Harbel City	368	-10.3430	6.2709
Jehi	54	-8.4210	7.0482
Kakata	440	-10.3518	6.5313
Pete's Town	125	-10.0865	6.0511
Sacleapra	128	-8.8418	6.9562
Serriquilla	117	-8.7669	7.3634
Sinje	0	-11.1305	6.8129
Totote	283	-9.9418	6.8106
Vahun	30	-10.4997	8.0624

Legend

- Facility Already Built
- Location Allocation
- ✕ MapOptimizer

Work done at NDSSL - Virginia Tech

- Notes:
- Based on County Level ODE Model
 - No demand on Sinje
 - Minimal Demand on Bomi

Sources:
 Pop: LandScan 2013
 Roads: LISGIS (Esri/Esri)
 Rivers: DIVA-GIS



EbolaZeke:

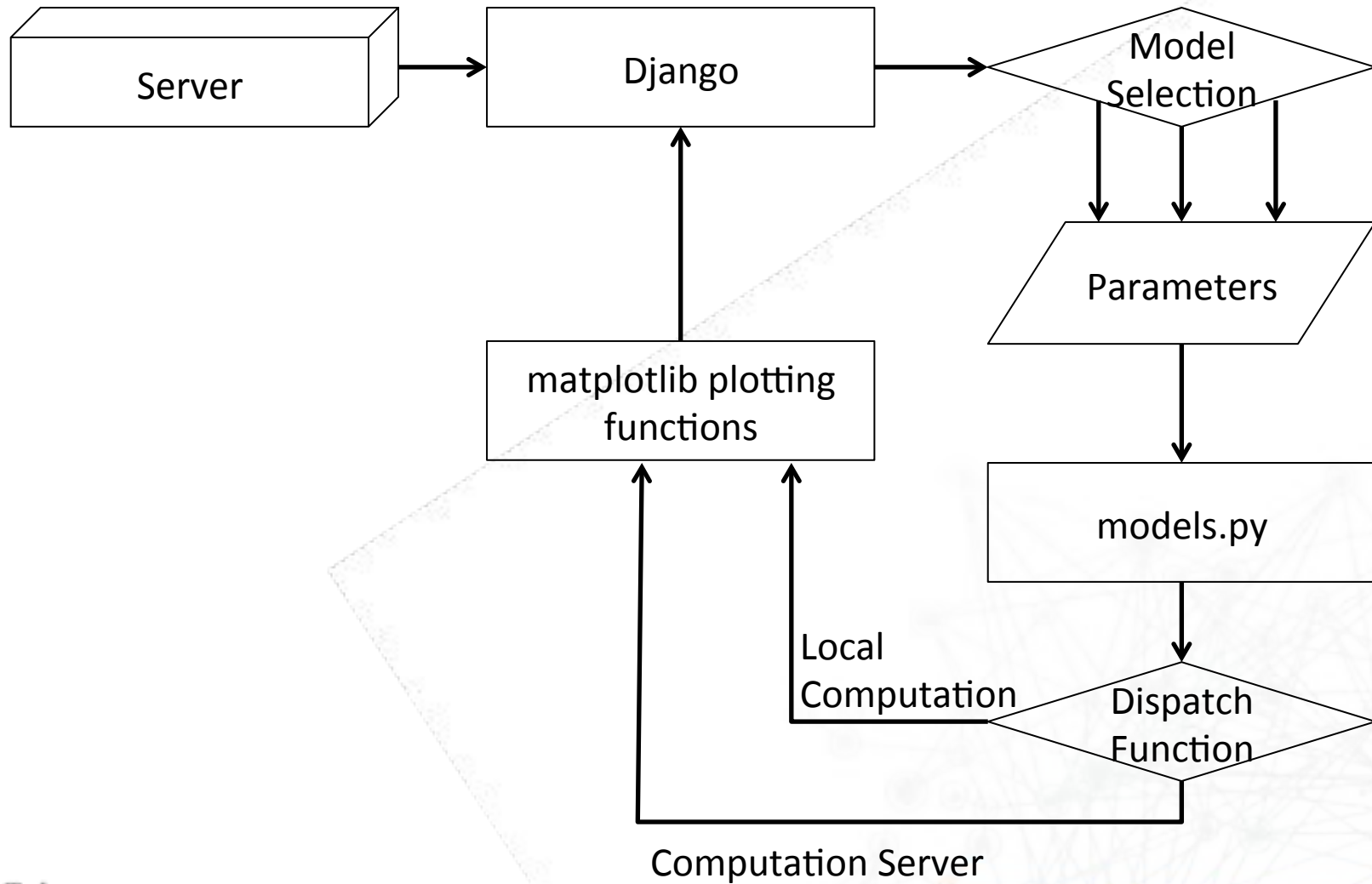
Python Platform for Ebola Modeling
and Visualization

Eric Lofgren, Ph.D.



Ebola Modeling

- Demand for the ability to see NDSSL modeling results as they are updated
- Desire to allow interested parties to ask their own “what if” questions without requiring bespoke analysis
- Web-based epidemic modeling interface
 - Hides code unless code is of interest
 - Grew out the the *Zeke* modeling platform developed for teaching mathematical modeling
- Allows interaction with modeling results without coding expertise





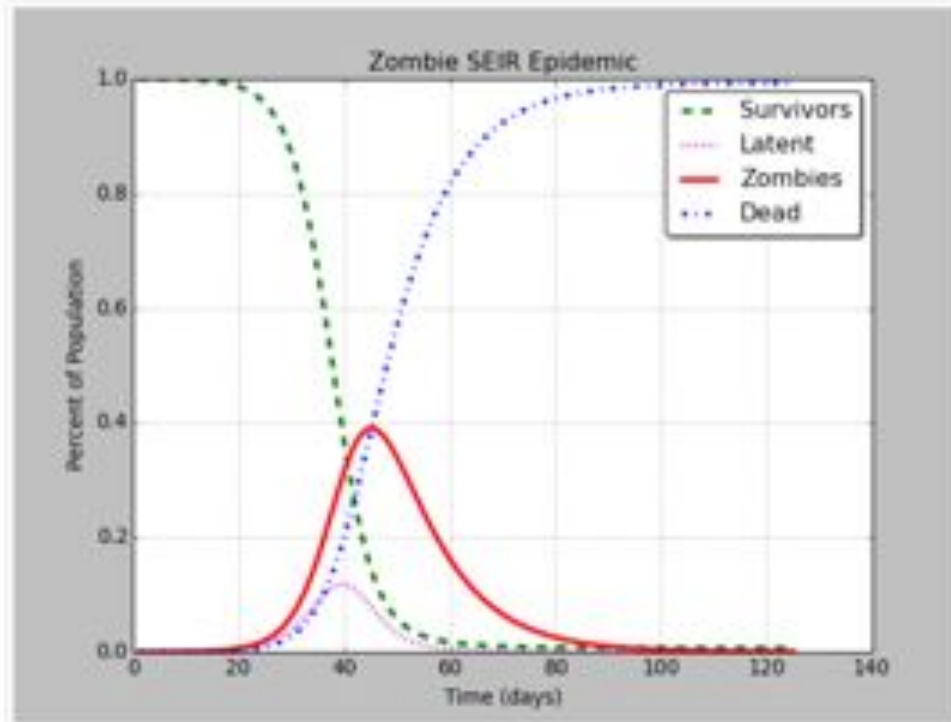
Zeke Example

Zeke About Contact

Sign in

Select a model

SEIR



Controls

Zombie epidemic model with latent infection period. Takes three arguments:

- Beta: Contact rate
- Gamma: Infection duration in days
- Alpha: A latent (non-zombie infected) period in days

Beta
Gamma
Alpha

Set values

Reset

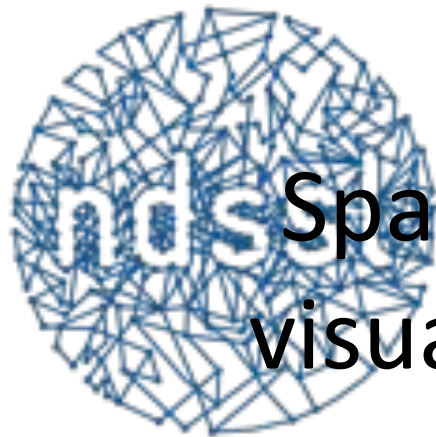
Screen shot represents what results will look like but with NDSSL's Ebola models in the place of the models used for instructional purposes in Zeke



Epidemiological analyses

- Analyzed subnational data from Sierra Leone and Guinea for epidemiological insights
- Caitlin Rivers & Jessie Gunter
- Published at caitlinrivers.com/blog





Spatio-temporal coordinated visualization of Ebola data and analysis

Proof of concept using WHO data

By

Harshal Ganpatrao Hayatnagarkar, PhD Candidate, Dept of Comp Sci, Virginia Tech

Acknowledgement: Dr. Madhav Marathe, Dr. Bryan Lewis, Dr. Keith Bisset, Caitlin Rivers, Vivek Akupatni



Ebola data and analyses

- Ebola epidemics is spread across boundaries
 - Spatial: Countries and regions.
 - Temporal: Weeks and months.
- Spatial and temporal hierarchical dimensions
 - Villages → Counties → Countries → Continents
 - Hours → Days → Months → Years
- Analysis to make sense of data
 - Statistical: Mean, median, distributions, etc
 - Visual: Charts, graphs, etc.



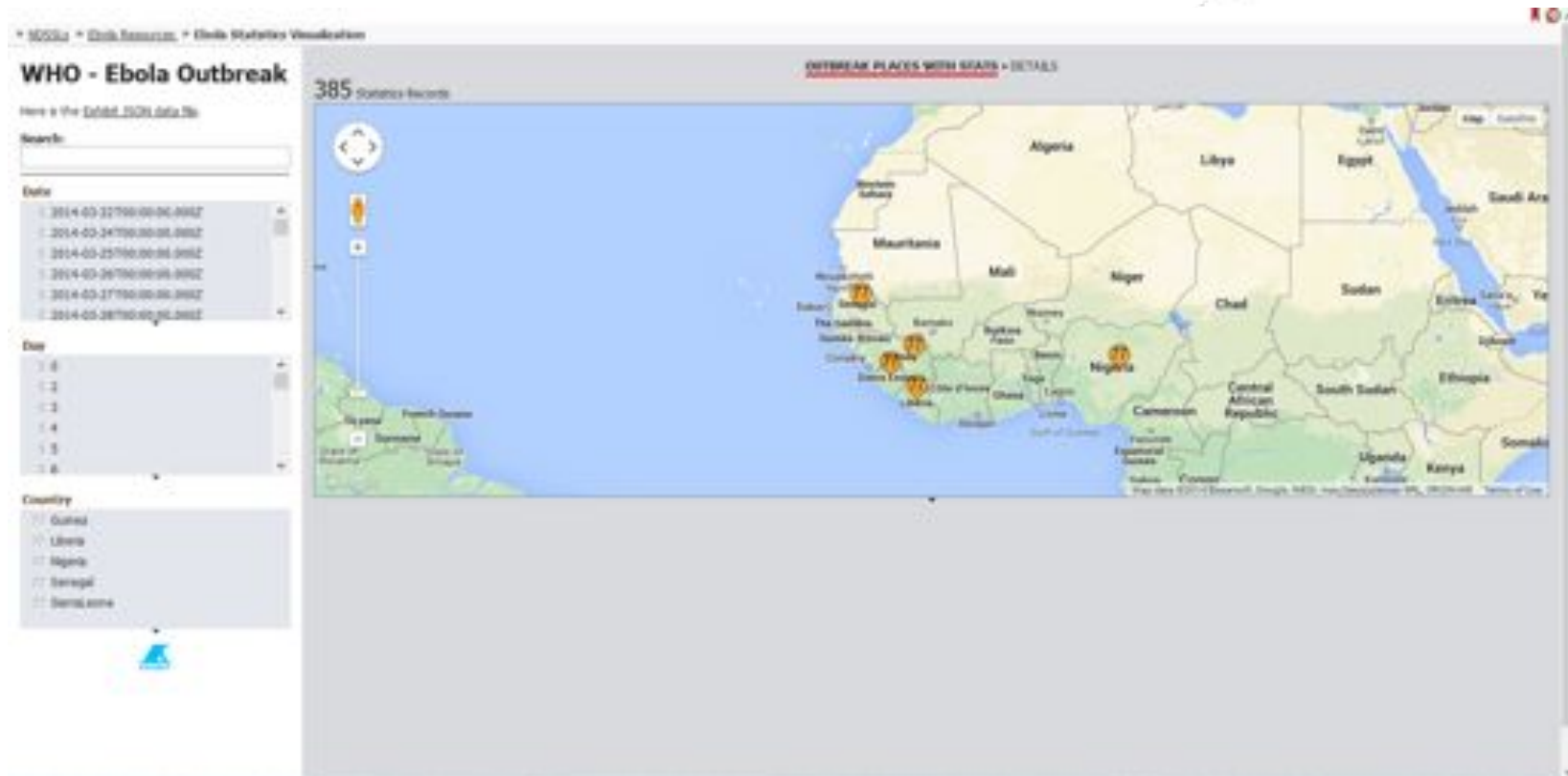
Challenge

- Is it possible to visualize spatial and temporal details –
 - With aggregations, such as total cases, minimum, maximum and so on.
 - With slicing and dicing along dimensions such as a village in a country or on a day in month.
 - With coordinate visualization across dimensions
 - For example, if a date is selected then data related to that date across countries should be filtered and visualized.



Concept proposal

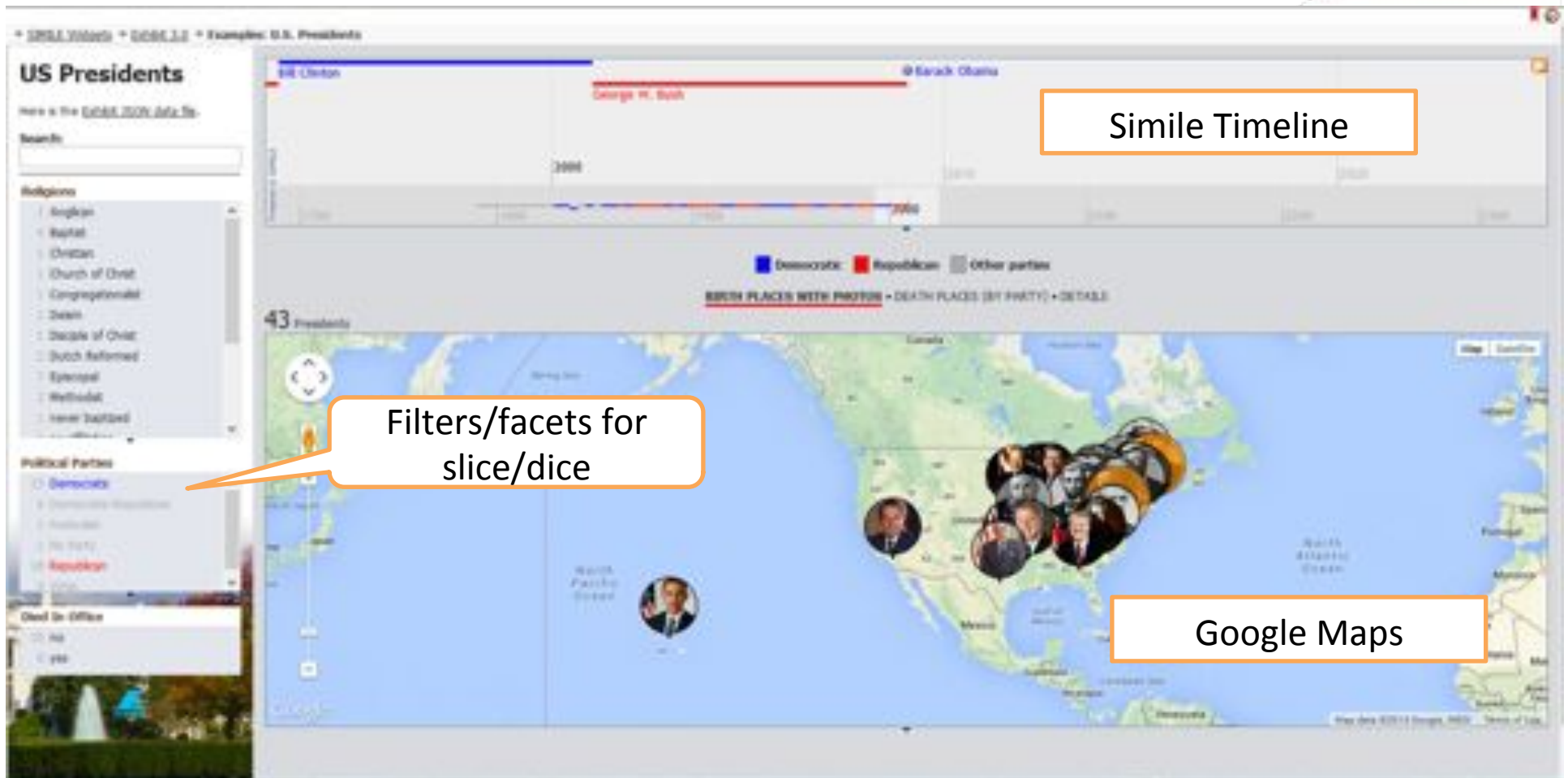
- Using MIT SIMILE Exhibit backed by web-services to visualize WHO data.



<http://simile-widgets.org/exhibit3>



MIT SIMILE Exhibit



<http://simile-widgets.org/exhibit3>



Synthetic Information Viewer for Ebola Affected Countries

Aditya Agashe

Dawen Xie



Introduction

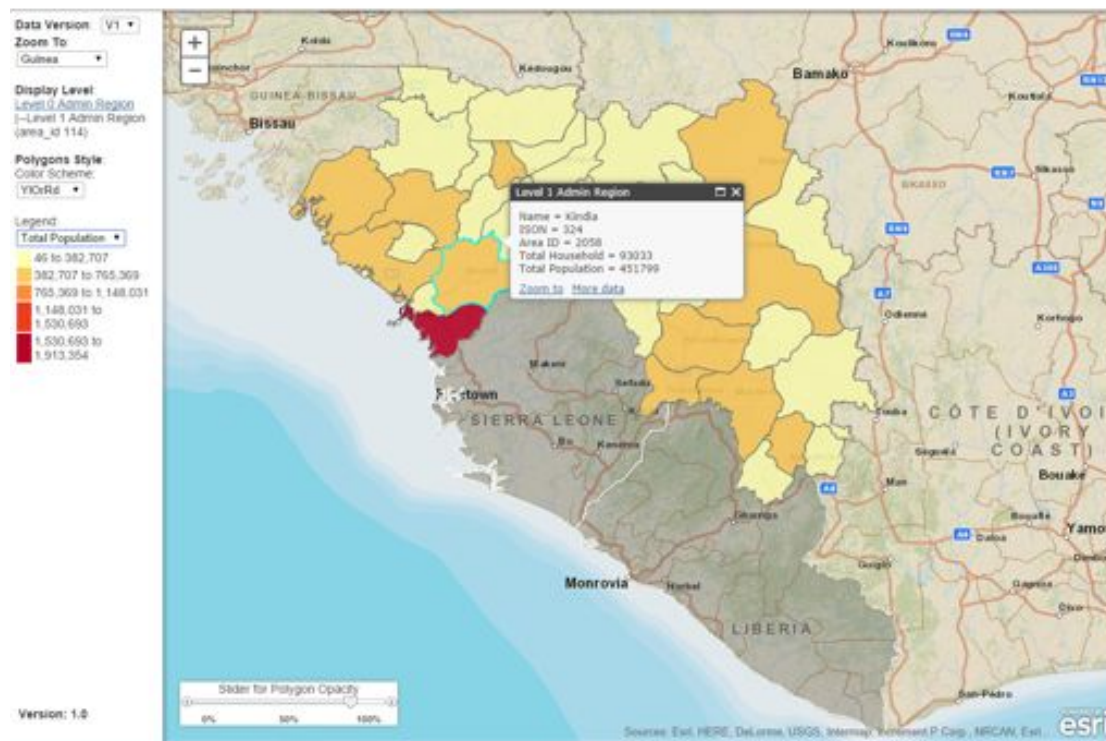
- Synthetic Information Viewer (SIV) is a web-based tool to visualize a synthetic information at desired level of aggregation or disaggregation on map.
- There are 3 types of visualization available
 - Aggregation Data on different levels of admin region.
 - Point data for a selected admin region
 - Activities data for selected version.
- We've developed custom version of SIV-Intl for Ebola affected countries featuring Guinea, Liberia and Sierra Leone.
- More information on SIV can be found on
 - <http://ndssl.vbi.vt.edu/gis/>



Visualizations

- Aggregation Data on different levels of admin region

Synthetic Information Viewer (for Ebola Countries)

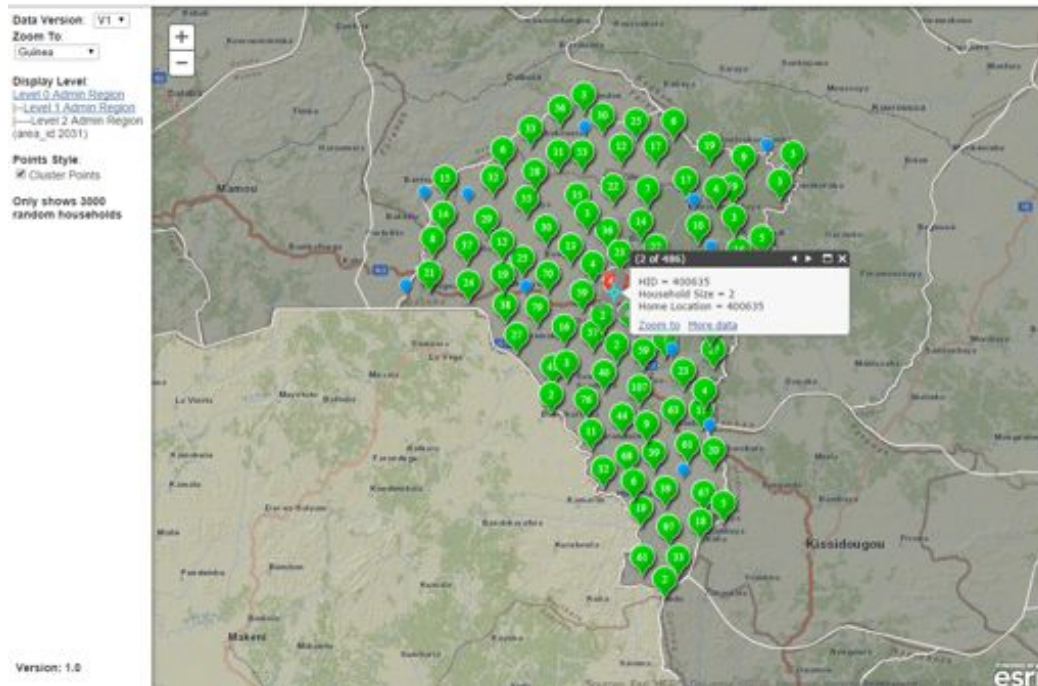




Visualizations (Cont.)

- A point can be a household or a person. Since there could be many points in the same location, we use a technique called point clustering to group nearby points.

Synthetic Information Viewer (for Ebola Countries)



Outbreak Investigator

- Research sponsored by National Library of Medicine
- Developing and assessing visualization tools for disease investigators
 - Social networks, GIS, molecular epidemiology
- Qualitative research on their work practices and interactive design sessions
- Link to case/contact databases
- Web-based tools enable use in the field
- Queries enable focus on specific strains, conditions, risk groups
- Investigators and epidemiologists working on different parts of an outbreak see a synthesis of all collected data on a given outbreak
- **PI: Neil F. Abernethy, Associate Professor, Biomedical Informatics, University of Washington; neila@uw.edu**

(External) Outbreak Investigator

Selectable
Visualizations

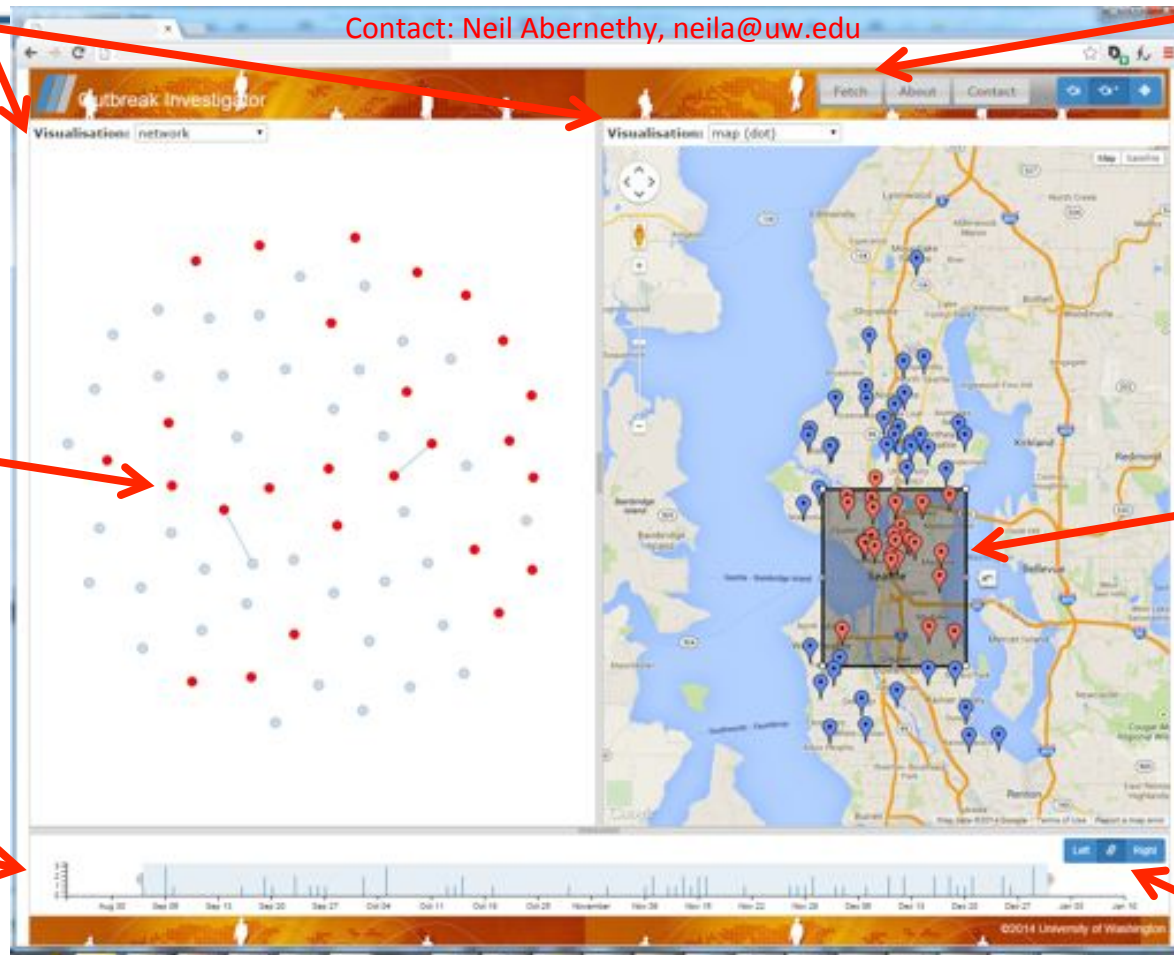
Contact: Neil Abernethy, neila@uw.edu

Flexible
Queries

Multi-selected
nodes in social
network display
in map

Multi-selected
cases in region
display in
network

Selectable
Time window
slider – filters
results



Link displays
or show before-after
with time slider

Other visualization options:

Case roster, choropleth map, temporal network



RDF BASED API FOR EBOLA DATA ACCESS AND QUERIES

S.M.Shamimul Hasan

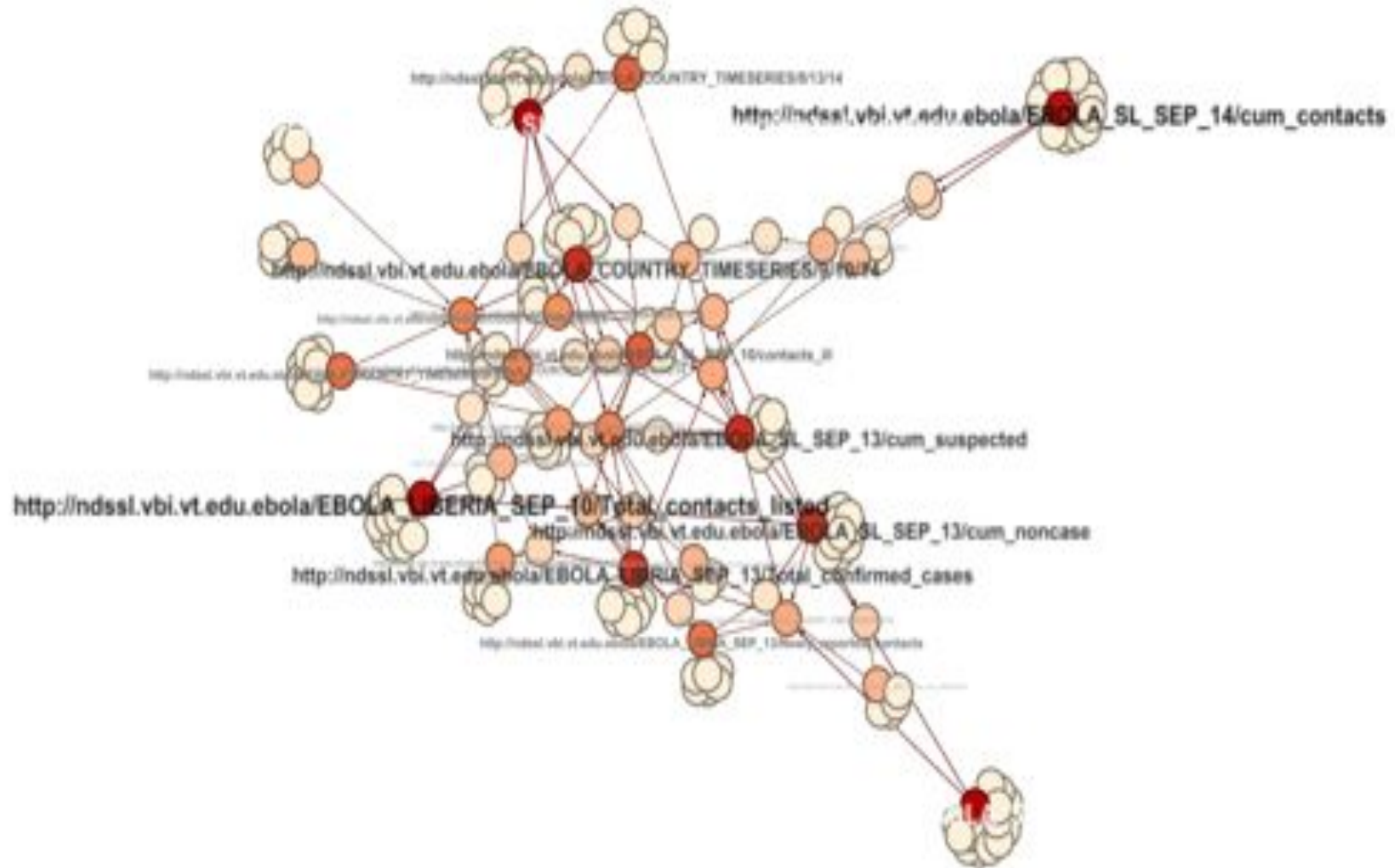


PROJECT CONTRIBUTIONS

- Currently Ebola Data are stored in CSV files
- We converted Ebola data as linked open data (LOD) and publish it in the web
- Linked data structure allows us to quickly disseminate information
- We used Resource Description Framework to store data in Graph format
- Graph structure allows us to visualize data
- Our web-based link data publishing interface provides browsing entities, their properties, and explore content interlink information
- We also provide SPARQL endpoint that acts as an API for computer programs to access Ebola data and execute complex queries over it



VISUALIZATION OF EBOLA RDF GRAPH





EBOLA DATA ACCESS API

Ebola Link Data Publishing

OPEN LINK SOFTWARE

About: http://ndssl.vbi.vt.edu/ebola/EBOLA_COUNTRY_TIMESERIES/9/10/14 Sponge Permalink
 An Entity of Type : http://ndssl.vbi.vt.edu/ebola/vocab/COUNTRY_TIMESERIES, within Data Space : <http://ndssl.vbi.vt.edu/ebola/9/10/14> associated with source [dataset\(s\)](#)
 Type: http://ndssl.vbi.vt.edu/ebola/vocab/COUNTRY_TIMESERIES Command: Start New Facet

Attributes	Values
rdf:type	http://ndssl.vbi.vt.edu/ebola/vocab/COUNTRY_TIMESERIES
rdf:label	COUNTRY_TIMESERIES #9/10/14
http://ndssl.vbi.vt.edu/ebola/vocab/RIES_CASES_GUINEA	899
http://ndssl.vbi.vt.edu/ebola/vocab/RIES_CASES_NIGERIA	21
http://ndssl.vbi.vt.edu/ebola/vocab/CASES_SIERRALEONE	1478
http://ndssl.vbi.vt.edu/ebola/vocab/RIES_CASE_SENEGAL	1
http://ndssl.vbi.vt.edu/ebola/vocab/RY_TIMESERIES_DAY	172
http://ndssl.vbi.vt.edu/ebola/vocab/RIES_DEATHS_GUINEA	568
http://ndssl.vbi.vt.edu/ebola/vocab/RIES_DEATHS_NIGERIA	8
http://ndssl.vbi.vt.edu/ebola/vocab/RIES_DEATHS_SIERRALEONE	536
http://ndssl.vbi.vt.edu/ebola/vocab/RIES_INCIDENT_DATE	9/10/14
http://ndssl.vbi.vt.edu/ebola/vocab/RIES_INCIDENT_DATE of http://ndssl.vbi.vt.edu/ebola/EBOLA_LIBERIA_SEP_10/Case Fatality Rate (CFR) Confirmed & Probable Cases	http://ndssl.vbi.vt.edu/ebola/EBOLA_LIBERIA_SEP_10/Contacts lost to follow-up http://ndssl.vbi.vt.edu/ebola/EBOLA_LIBERIA_SEP_10/Contacts seen http://ndssl.vbi.vt.edu/ebola/EBOLA_LIBERIA_SEP_10/Contacts who completed 21 day follow-up http://ndssl.vbi.vt.edu/ebola/EBOLA_LIBERIA_SEP_10/Cumulative admission/isolation more
http://ndssl.vbi.vt.edu/ebola/vocab/RIES_INCIDENT_DATE of http://ndssl.vbi.vt.edu/ebola/SL_SEP_10/cum_noncase	http://ndssl.vbi.vt.edu/ebola/EBOLA_SL_SEP_10/cf http://ndssl.vbi.vt.edu/ebola/EBOLA_SL_SEP_10/contacts_followed http://ndssl.vbi.vt.edu/ebola/EBOLA_SL_SEP_10/contacts_healthy http://ndssl.vbi.vt.edu/ebola/EBOLA_SL_SEP_10/contacts_ill more

SPARQL Endpoint to Access Data

Virtuoso SPARQL Query Editor

Default Data Set Name (Graph IRI)

Query Text

```
select ?Location ?Contact_ill from <http://ndssl.vbi.vt.edu/ebola>
where
{
  ?s ?p "contacts_ill".
  ?s ?Location ?Contact_ill.BIND (xsd:decimal(?Contact_ill) as ?a).FILTER (?a >10)
}
```

(Security restrictions of this server do not allow you to retrieve remote RDF data, see [details](#))

Results Format: HTML

Execution timeout: 0 milliseconds (values less than 1000 are ignored)

Options: Strict checking of void variables

(The result can only be sent back to browser, not saved on the server, see [details](#))

Example Query: Days and locations where the number of contacts found ill is greater than 10

Query Result

Location	Contact_ill
http://ndssl.vbi.vt.edu/ebola/vocab/SL_SEP_10_NATIONAL	"37"
http://ndssl.vbi.vt.edu/ebola/vocab/SL_SEP_10_PORT_LOKO	"13"
http://ndssl.vbi.vt.edu/ebola/vocab/SL_SEP_13_NATIONAL	"21"
http://ndssl.vbi.vt.edu/ebola/vocab/SL_SEP_14_NATIONAL	"14"