# Early Model-Based Event Recognition using Surrogates

# *EMBERS*

### About

EMBERS is a fully automated 24x7 forecasting system for significant societal events using open source data including tweets, Facebook pages, news articles, blog posts, Google search volume, Wikipedia, meteorological data, economic and financial indicators, coded event data, online restaurant reservations (OpenTable), and satellite imagery. EMBERS is sponsored by a contract for over $15M from the Intelligence Advanced Research Projects Activity (IARPA) Open Source Indicators (OSI) Program. Unlike retrospective studies of forecasting, EMBERS processes massive data streams into alerts of significant events which are emailed in real-time as they are generated. EMBERS has been making forecasts into the future since 2012 which have been evaluated by an independent party. Key event classes studied in EMBERS include influenza-like illness (ILI) case counts, rare disease outbreaks, civil unrest, domestic political crises, and elections. For more information about EMBERS, see http://dac.cs.vt.edu/projects/embers.
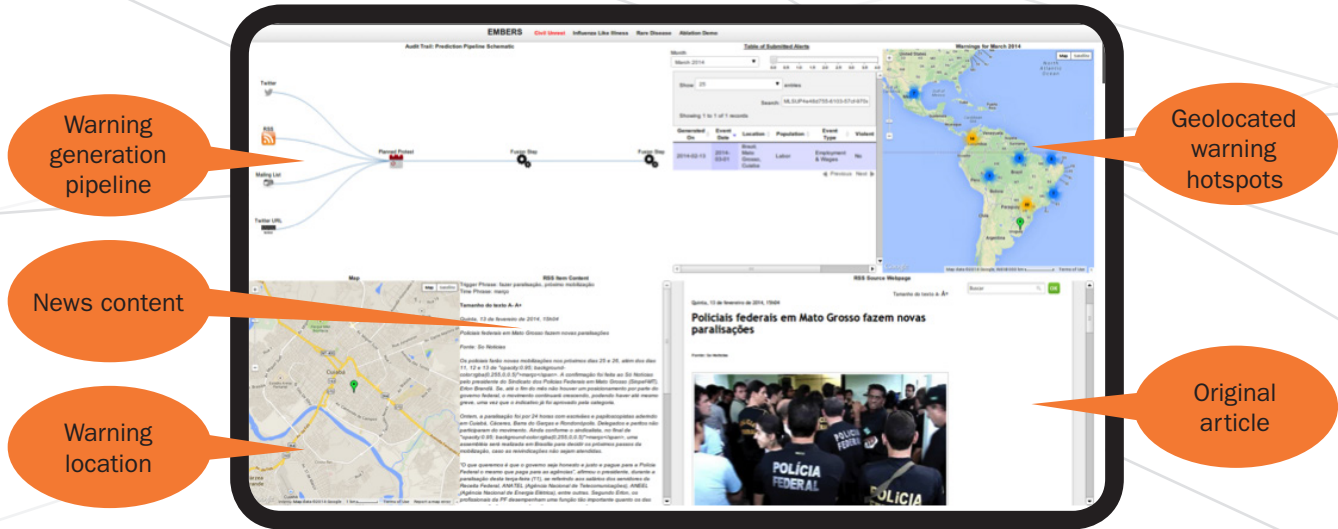
### Highlights

EMBERS generates 45-50 alerts per day across multiple countries of Latin America. In March 2014, EMBERS was named as the winner of the OSI forecasting tournament. Key events forecast by EMBERS since project inception include protests after the impeachment of Paraguay's president (May 2012), the "Brazilian Spring" (June 2013), Hantavirus outbreaks in Argentina and Chile (2013), violent protests led by Venezuelan students (Feb 2014), and presidential elections in Panama and Colombia (2014).

### Who

The Virginia Tech Discovery Analytics Center (http://dac.cs.vt.edu) leads the EMBERS effort. The team comprises the departments of Computer Science, Statistics, and Mechanical Engineering, Virginia Bioinformatics Institute, Institute for Critical Technology and Applied Science at Virginia Tech, and partners from University of Maryland, College Park, Cornell University, University of California San Diego, Children's Hospital Boston, San Diego State University and the companies CACI Inc. and Basis Technology.

http://dac.cs.vt.edu

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# EMBERS Warning Visualization for Civil Unrest Event

Warning generation pipeline

Geolocated warning hotspots

News content

Original article

Warning location

EMBERS dashboard interface on a multi-touch visualization wall where users can inspect audit trails, conduct ablation tests, and explore alerting scenarios.

EMBERS is "a tunable system– it provides an opportunity for analysts...to cut across all the chatter."

**Metrics:**
- Forecasts evaluated against actual events in Latin America
  - Quality/Accuracy (How good is the warning as graded on a 0-4 scale?)
  - Lead Time/Timeliness (How far in advance of a news report?)
  - Recall, i.e., Completeness (How many events were there warnings for?)
  - Precision (How many warnings matched an event?)
  - Probability, i.e., Reliability (How confident were the predictions?)

## PROGRAM METRICS

| Metric | Month 24 | | Month 36 |
|---|---|---|---|
| | Targets | Actual Results | |
| Mean Lead Time | 3 days | 7.54 days | 7 days |
| Mean Probability Score | 0.70 | 0.89 | 0.85 |
| Mean Quality Score | 3.25 | 3.10 | 3.5 |
| Recall | 0.65 | 0.65 | 0.80 |
| Precision | 0.65 | 0.94 | 0.80 |

**Discovery Analytics Center**
Naren Ramakrishnan, *Principal Investigator*  |  naren@cs.vt.edu
Chris Walker, *Project Manager*  |  cwalk89@vt.edu

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