What is in a Rumour: Combined Visual Analysis of Rumour Flow and User Activity

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Problems

- A rumour is defined as a truth-unverifiable statement that is spread in uncertain situations and arose when:
  - themes are significant to a large number of individuals.
  - truths are not straightforward to verify.

- Experts' observation of rumour spread:
  - Topics about a rumour evolve over time. Some new topics may appear, and others may fade.
  - Most rumours are spread by comparatively few active users.

- How to detect, analyze, and limit the spread of rumours effectively?

Related Work

- Wu et al.[1] utilized information diffusion theories to visualize how opinions are disseminated by Twitter users through the adoption of Sankey diagram and a tailored density map.

- Zhao et al.[2] presented FluxFlow, an interactive visualization system to analyze and discover anomalous information.

- RumourFlow differs from previous approaches both in focusing on rumour lifecycle as well as in integrating information diffusion, social science theories and user activity to provide a complete view of rumour spread.

1. Y. Wu, S. Liu, K. Yan, M. Liu, and F. Wu. OpinionFlow: Visual analysis of opinion diffusion on social media. TVCG, 20(12):1763{1772, 2014.
2. J. Zhao, N. Cao, Z. Wen, Y. Song, Y.-R. Lin, and C. Collins. #Fluxflow: Visual analysis of anomalous information spreading on social media. TVCG, 20(12):1773{1782, 2014.

Our contributions

- Design and implement an end-to-end visualization framework that coordinates multiple representations of rumour spread.

- Integrate text mining and information diffusion models to facilitate data exploration and analysis for online rumour spread.

- Adapt and visualize rumours based on social science theories, for example, DiFonzo's rumour spread psychology[1] and Daley and Kendall's rumour spread theory[2], with preliminary results supporting its confirmation.

1. N. DiFonzo and P. Bordia. Rumor psychology: Social and organizational approaches. American Psychological Association, 2007.
2. D. J. Daley and D. G. Kendall. Stochastic Rumours. Journal of Applied Mathematics, 1:42{55, 1965.

RumourFlow Framework

The RumourFlow visualization framework is to:
- collect and analyze data in Reddit automatically.
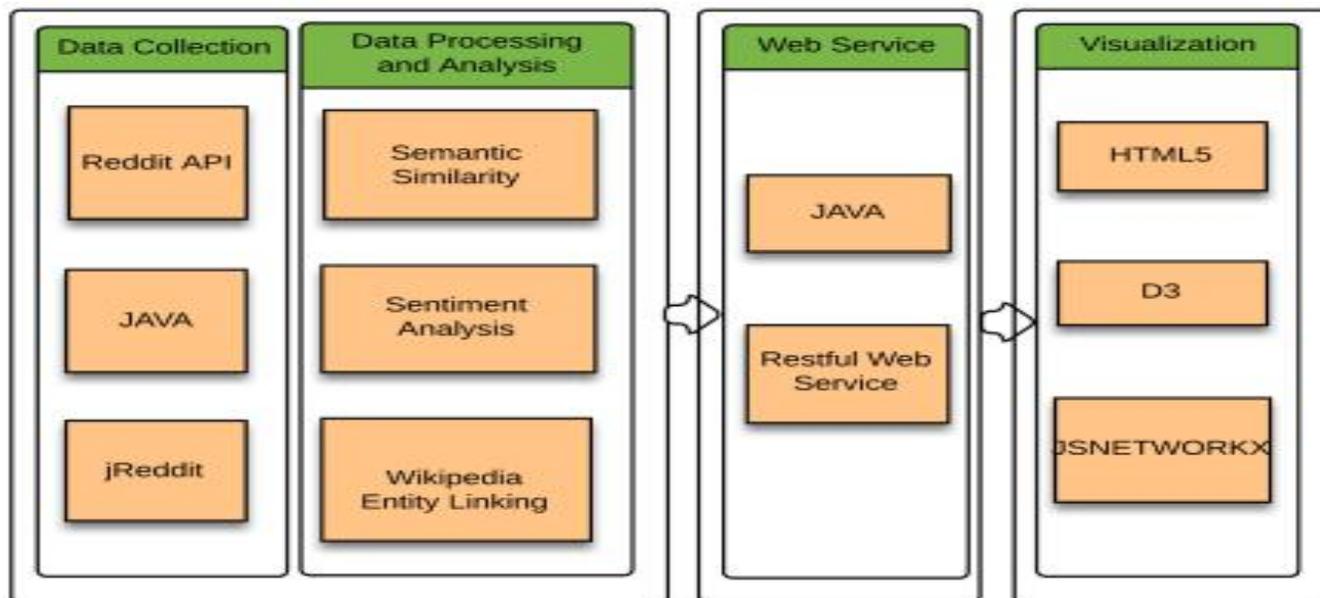- analyze and visualize rumour spread derived from social science theories.

Fig. 1: RumourFlow proposed visualization framework.

RumourFlow - Main Layout

Figure 2. RumourFlow visualization interface for 8 rumours and $k = 20$. The top part is the current overall view, including evolution of 8 rumours and concept wordcloud. The bottom part details some aspect of the data, in this case the topics extracted for one particular rumour, as well as rumour wordcloud.

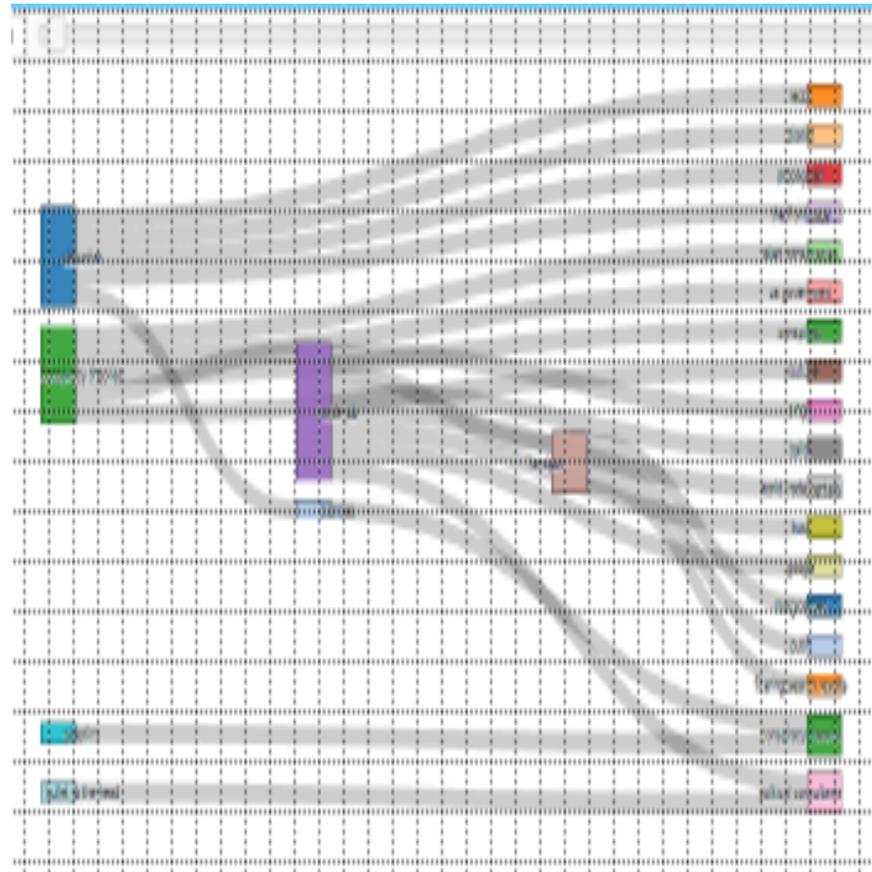# RumourFlow - Rumour Spread Models

- DiFonzo rumour spread theory:
  - the significance of rumour spread is represented by the high-level formula:
  - Rumour = Importance + Ambiguity

- Our formula:
  - Rumour(t) = Topics(St) + Users(St) + Sentiment(St)
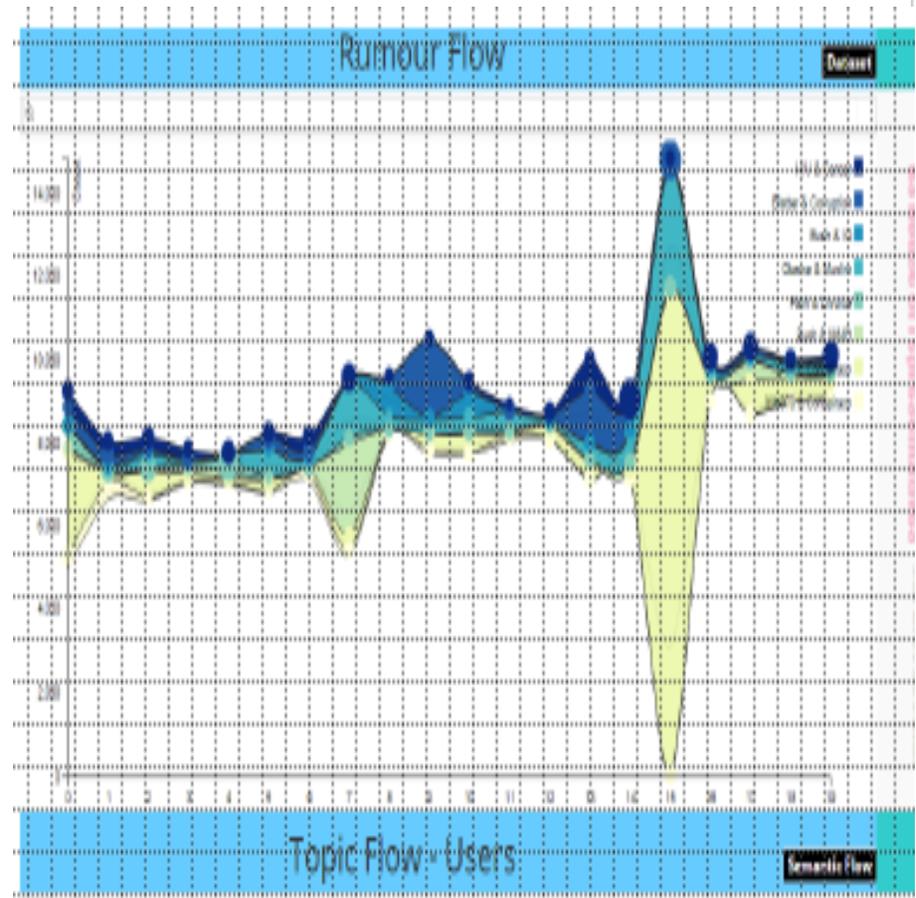
Rumour Flow – Main Visualization

RumourFlow – Topic Models

- The Topic Flow view visualizes the evolution of topics for a given rumour.
  - employs a Sankey graph to represent how topics flow inside a rumour.

- Two modes:
  - Semantic Flow.
  - User Flow.

An example of Semantic Topic Flow

RumourFlow - User Models

- Daley and Kendall's rumour spread theory:
  - N is the number of users that interact with this rumour.
  - One user learns about this rumour from another source and tries to spread it.
  - At each stage, each user will be categorized into one of the three categories:
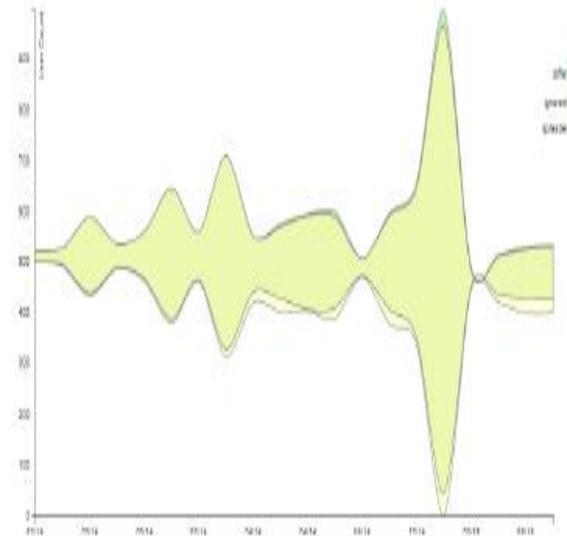   - Spreader.
    - Ignorant
    - Stifler.

Figure 3. User Flows in OSNs for three types of users of "Obama is a Muslim"

Conclusions

- RumourFlow presents a number of important insights into rumour evolution, topic ramification and user activity.

- The approach bridges a gap currently existing in the analysis of micro-blog data related to rumour dynamics.

- Two particular important extensions are planned.
    - involves using the system to inspire and extract features for categorization of user behaviors towards rumours,
    - adds the possibility for user to remove and add information, influencing the layouts.

- Questions