IMPROVING THE PREDICTION OF OPINION DYNAMICS IN TEMPORAL SOCIAL NETWORKS: MATHEMATICAL MODELING AND SIMULATION FRAMEWORK

Goal of the project

Improving the prediction of opinion distribution in a target society by means of topological analysis, temporal and spatial distribution of opinion sources, and real-time simulation on empirically gathered data. As such, we define the following individual objectives:
1) Topological analysis of empirical social network data to understand how interconnection patterns of individuals and communities influence the spread of opinion.
2) Development of an innovative social interaction model, inspired by previous original work, considering the temporal aspect of opinion sources.
3) Definition of a strategy for real-time opinion seed selection by means of node and edge centrality distribution.
4) Synergy of results from objectives 1-3 with direct applicative socio-economic impact by developing a crowdsourcing web-platform for voting and gathering anonymized empirical data from citizens.

Short description of the project

In the wake of big data analytics, this project sets out to push the boundaries of scientific understanding of opinion dynamics in social networks by analyzing how the underlying network topology influences communication patterns and the polarization of opinion.

Project implemented by

Assist. Prof. Alexandru TOPÎRCEANU – responsible for outlining the research goals, modeling of experiments, simulation and data validation, writing scientific manuscripts, overall project management.
Prof. Radu-Emil PRECUP – mentor for the project director, research goals, experiment modeling, revising scientific manuscripts.
Denis Nuțiu (4th year student) – web platform implementation.

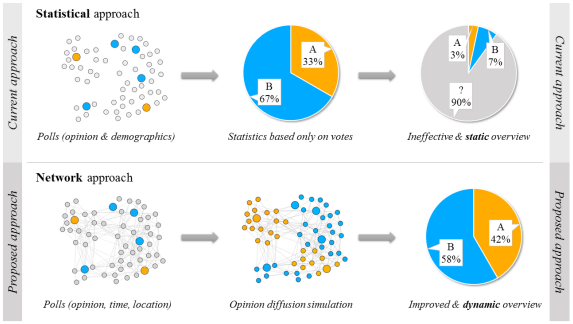
Implementation period

02.05.2018 – 30.11.2019 (19 months)

Main activities

This project comes to improve our understanding of opinion diffusion in emergent social networks. Consequently, to build models that are aware of these phenomena, we propose a topological analysis of empirical data using network motifs, community detection algorithms and statistics to understand the behavioral patterns and centralities which have an impact on the spatial and temporal distribution of opinion.

As opposed to most existing opinion interaction models, we propose a temporal opinion injection model which evolves over time according to basic human traits and underlying social topology.
Below is a schematic exemplifying the two different approaches considered.

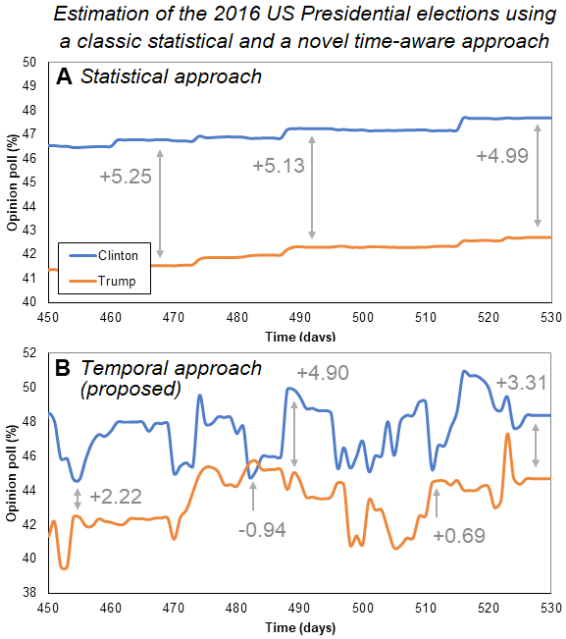


In the above figure we showcase the impact of the proposed project methodology in perspective to the current statistical approaches in opinion poll analysis and prediction. The statistical method relies solely on a small subset of individuals from which it tries to extrapolate overall opinion distribution; however, most of the opinion remains unknown (see gray pie chart in upper panel). Our proposed approach implies simulation of opinion propagation using more reliable scientific models and thus yields a more accurate perspective of opinion distribution (lower panel).

Results

We make use of temporal microscopic diffusion models to predict the macroscopic response of a target society being targeted by opinion injection. Our results pinpoint to the fact that time-awareness is more significant in poll prediction performance than previously considered.

Below, we exemplify a snapshot of the poll evolution calculated for the 2016 US presidential pre-election period. We provide snapshots of the final period before elections using cumulative counting (A), and our time-aware method (B) to estimate polls. Here, we exemplify the relative differences (Clinton--Trump) in polls at several time points.



For the 2012 US elections we can approximate the final poll results within a 2% margin, while current approaches produce much greater offsets of about 7%. Similarly, for the 2016 elections, our method (TA) manages to come within 1.5% of the real election results, while the current statistical approach (SA) remains outside the 4% margin. In terms of quantifying the overall performance boost of our method, compared to the benchmark methods, TA proves to be 75% more accurate for the 2012 elections, respectively 74% for estimating the 2016 elections.

As an explanation to why our TA method has a superior prediction capability is that, by taking into consideration the timing of pre-election opinion injection, TA captures the momentum of candidate popularity.

Applicability and transferability of the results

Current state of the art solutions for prediction, employed by respectable institutions in the US, like the *Huffington Post, Real Clear Politics, or Five Thirty Eight*, employ poll counting and combining polls with economic indices. Nevertheless, we have not seen any time-aware method that is similar to the one proposed by us in this project.

Consequently, we consider the framework developed in this project as very encouraging, and possibly opening a new line of research to further perfect our initial proposed method, which, to the best of our knowledge, is original and new. We hope to pave a new path of research targeting dynamic and temporal social network analysis, with immediate applicability in real-world systems where the needs for predictability and control are paramount.

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Research centre

- CCCTI: Research Centre for Computers and Information Technology (UPT)
- ACSA: Advanced computing systems and architectures research group

Research team

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