AI and Computational Politics

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VML

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Computational Politics

- **Definitions**
- Citizens and Political Data
- Computational Politics Methods
- Computational Politics Topics
- Political Analysis Tools
- Future Research

Political Science

Political science is a field of social and liberal studies which:
- studies the systems of governance and the power/authority relations of authority within a community and
- analyses the political activities, political thought, political behavior, and associated constitutions and laws [WIKP].

- This analysis considers the legislations, the institutions and the reasons behind certain political actions.

- Political science tries to pinpoint the ways that the government can be influenced, through political actions, such as elections, activism, or strikes.

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Political Science

Political actors (in Democracy)

- Political institutions
  - Parliament, Government.

- Political parties
  - Party organs, party members.
  - Deputies

- Citizens
  - Social strata
  - Citizen communities
  - Political supporters
  - Voters.

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Computer Science

Computer Science (CS) employs algorithms, computational methods and machines for the data analysis towards deriving information and knowledge to understand and interact with our environment.

- Its fields of study range from entirely theoretical topics to the implementation of computational methods and computing systems in hardware and software.

- CS has various subfields:
    - Theoretical Computer Science,
    - Data structures and data bases
    - Data communications
    - Artificial Intelligence and data analysis
    - Computer systems.

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Computational Methods

- ***Computation*** is a calculation which possibly combines arithmetic and non-arithmetic data and follows a structured calculation model (***algorithm***).

- Computational methods are mathematical models utilized to research the behavior of complex natural or man-made systems.

- They are used to:
  - understand complex system behavior
  - meaningfully interact with a system
  - control a system.

Computational Politics

Computational politics is derived from the combination of Computer Science and Political Science.

- It focuses on using computational methods to:
  - analyze political data and citizen behavior
  - influence the political behavior of individuals or groups.

- More narrow definition of computational politics: "application of computational methods to large datasets derived from online and offline data sources for conducting outreach, persuasion and mobilization in the service of electing, furthering or opposing a candidate, policy or legislation" [TUF2014].

Computational Politics

- Computational politics are utilized to bring political persuasion and marketing in the focal point.

- Mass media is essential in shaping **public opinion**.

- The computational methods for **political data analysis** include probabilistic models, statistical analysis and data representations.

- They can aid the discovery of citizens' social/political beliefs and behaviors.

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Computational Politics

Political data analysis can be fed by:
- Opinion mining polls,
- Social media data
- Mass media entries.

- It enables the analysis of ***information spread*** in the real world and its effects on people.

- The analysis results can be utilized for numerous political purposes, e.g.,:
  - Design of political strategies
  - Design of political campaigns
  - Political marketing
  - New legislation.

Computational Politics
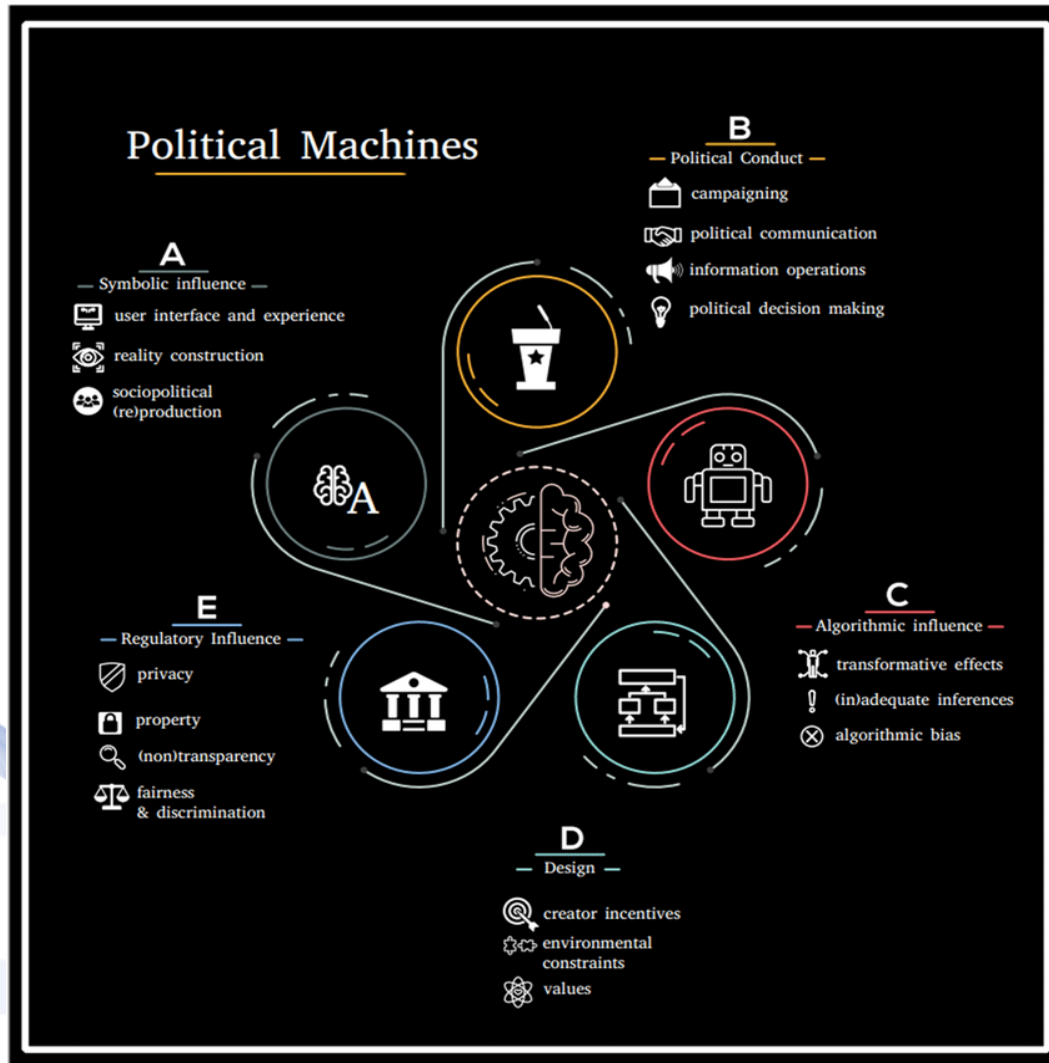
Main categories of political machines [PAP2022].

Computational Politics

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Citizens and Political Data

Computational politics utilizes data from numerous sources:

- Social media
- Mass media covering political debates.

- Data can be considered from two perspectives:

- Data Perspective.

- Citizen Perspective.

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Data Perspective

Political data: measured quantities related to citizens and their activities.

- ***They are primarily numbers*** representing human characteristics (features):
  - Income, age.
- Semantic (alphanumeric data):
  - Political affiliation, province.
- Data sampling.
- ***Measured in bits.***

Data Perspective

Data can have **spatiotemporal structure**:

- 1D temporal **signals**, e.g., currency exchange rate
- 2D spatial signals (**images**), e.g., banners, news images.
- Signals and object features can be represented by **vectors**:

$$\mathbf{x}^T = [x_1, x_2, \ldots, x_n].$$
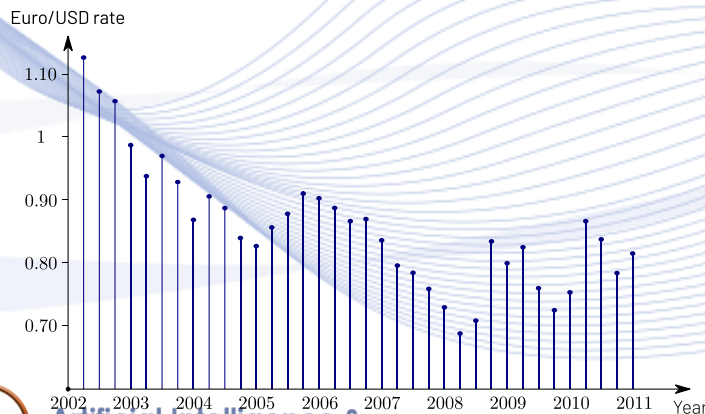
Data Perspective

- Most computational politics studies use data collected from social media platforms, such as Facebook or Twitter.
  - Easy and cheap to collect.
  - Twitter API.
- Research focuses on the content of messages people share on their social media accounts.

- Important data attributes:
  - the written message,
  - multimedia content (images, videos),
  - metadata,
  - thread features, showcasing the information flow of the information,
  - topic features (e.g., in the form of **hashtags**) describing the message concept.

Data Perspective
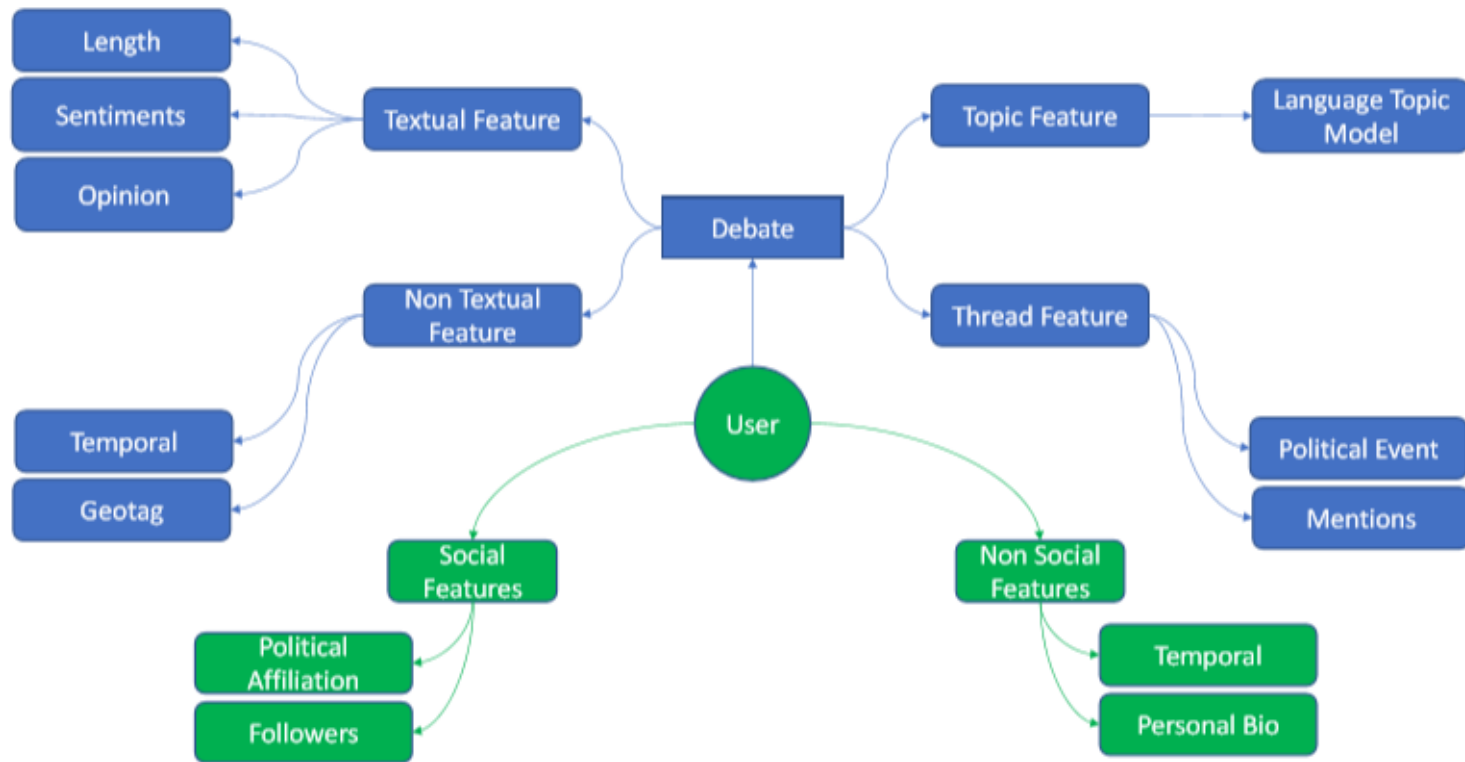
Data model of a political debate [HAQ2021].

Citizen Perspective

Irrespective of their communication and organization form, **citizens** are the most significant political entities that provide the vast majority of data.

- A citizen may explicitly share their political affiliation or not.

- **Citizen profiling** (modeling) can reveal hidden political attributes about a citizen.
- Citizens are political data sources and sinks:
    - **Tweets** or **retweets** on Twitter.
- Information flow reveals political citizens links.

- Modeling can be also done at a **citizen community** level.
- Citizen profiles can be used for citizen **clustering** or **classification** into communities.

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Citizen Perspective

Citizen communities (graphs)

- Citizens are graph nodes connected by relations (graph edges):
  - friendship, political affiliation, etc.
- Node centrality.
- Power law of node centrality.
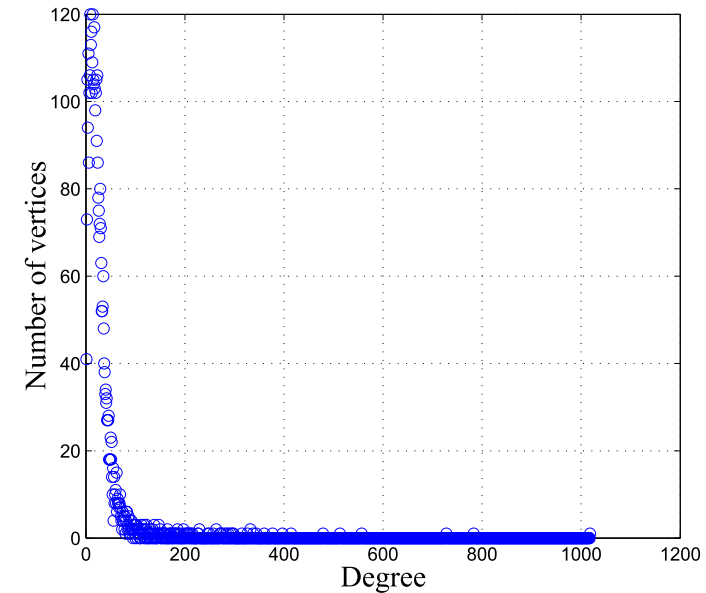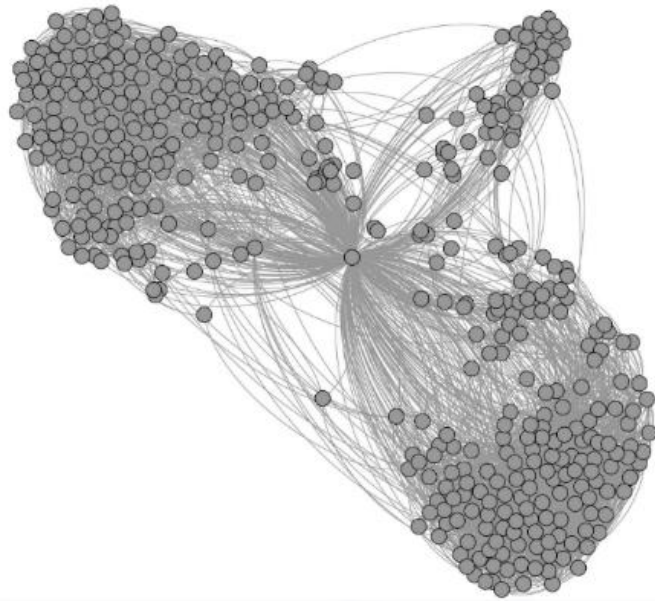
Computational Politics

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- Future Research

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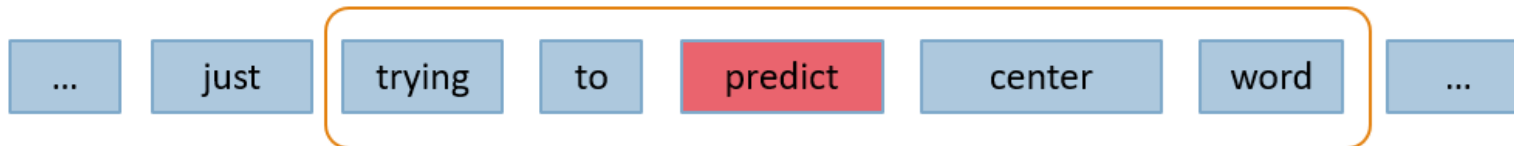
Computational Politics Methods

Computational politics methods depend on the data used and the research target.

- Typically, they are Machine Learning methods.
    - **Data clustering** groups data (or citizens) into homogeneous clusters that differ from each other:
        - Citizen communities.
    - **Data classification** characterizes data or citizens:
        - **Text sentiment analysis**: offensive, biased, positive/negative.
        - Video footage classification according to event/location.
        - **Citizen classification** according to political party affiliation.

    - Most current Machine Learning methods employ **Deep Neural Networks**.

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Computational Politics Methods

Natural Language Processing

- Text data (words) can be transformed into vectors (numbers) through ***word embedding***.

| ... | just | trying | to | predict | center | word | ... |

Word 'predict' is mapped to vector $\mathbf{x}^T = [x_1, x_2, ..., x_n]$.

- Political texts (e.g., tweets) can be transformed into a series of word vectors.

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Computational Politics Methods VML

Natural Language Processing

- Political texts (e.g., tweets) can be transformed into a series of vectors that are amenable to data analysis through Machine Learning:
  - Text sentiment analysis
  - Text topic analysis
  - Argumentation analysis
  - Text replication (re-tweet) analysis.

  - Multilingual text analysis.

- Example: Linguistic features from Facebook were utilized to categorize citizen's posts according to their political beliefs [CHI2018].

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Computational Politics Methods

Public opinion monitoring mechanism utilizing a semantic descriptor that relies on Natural Language Processing (NLP) [KAR2021].
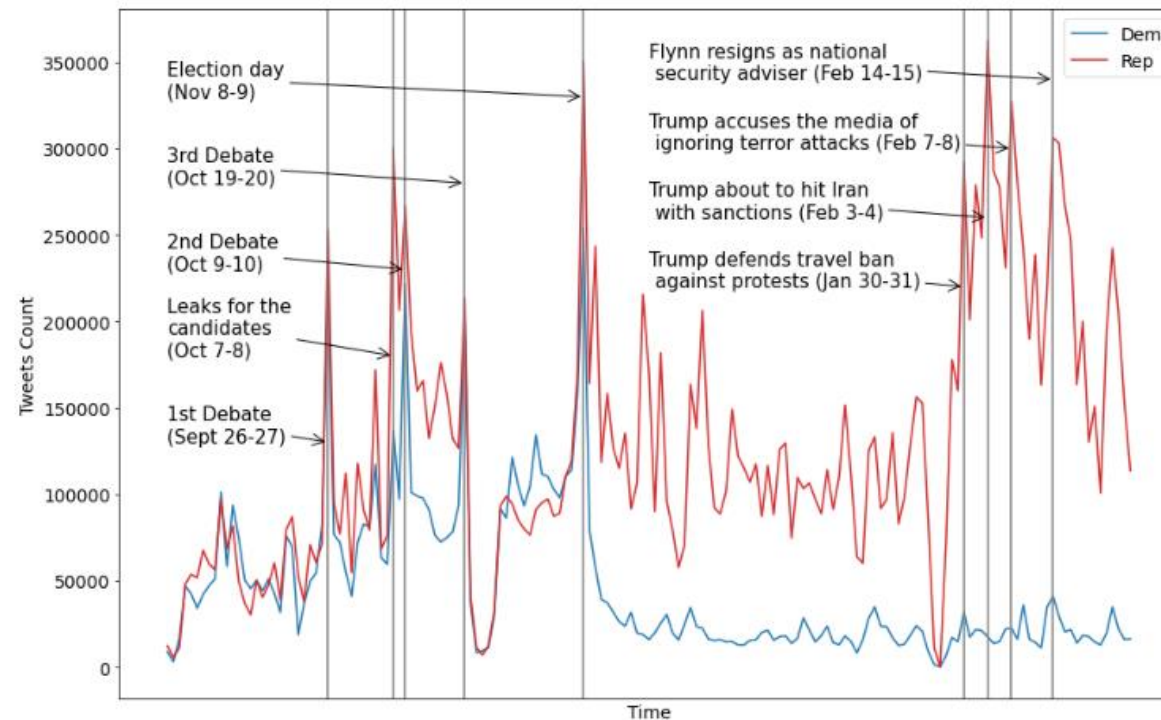
- A four-dimensional descriptor is produced for each of the tweets, indicating the following aspects of each tweet:

  - political polarity,

  - offensiveness,

  - bias and

  - figurativeness.

Computational Politics Methods

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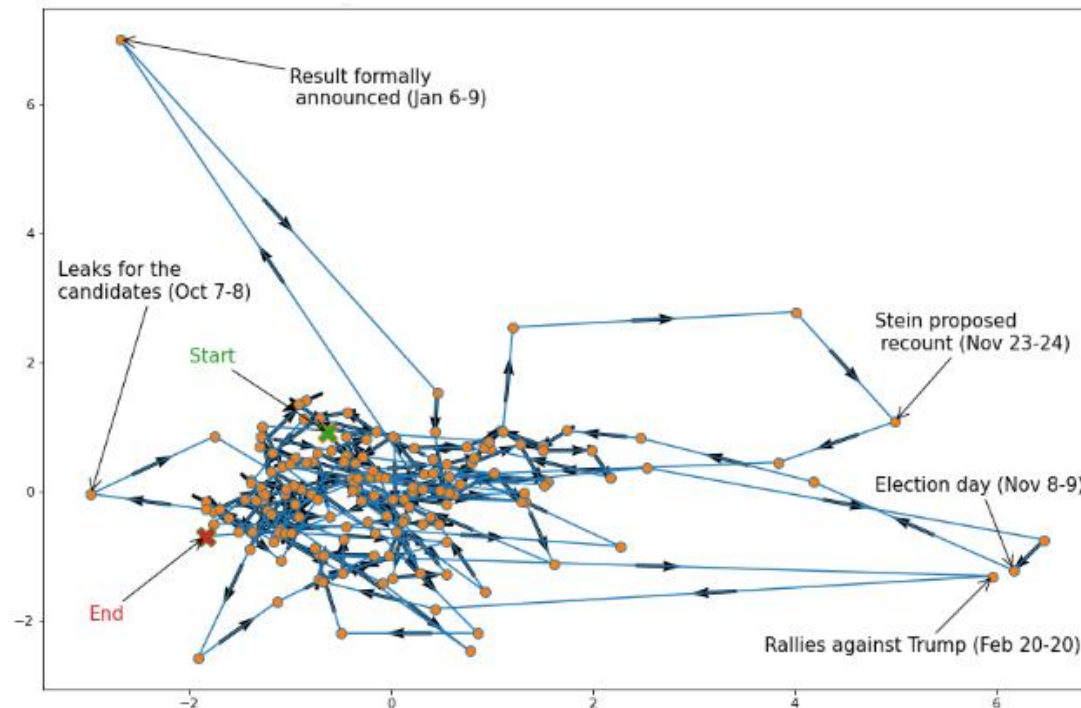## *Time series analysis and prediction*

- Public opinion monitoring.

Daily number of tweets for Democrats and Republicans for the 2016 presidential election in USA [KAR2021].

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Computational Politics Methods

VML

Time series analysis and prediction

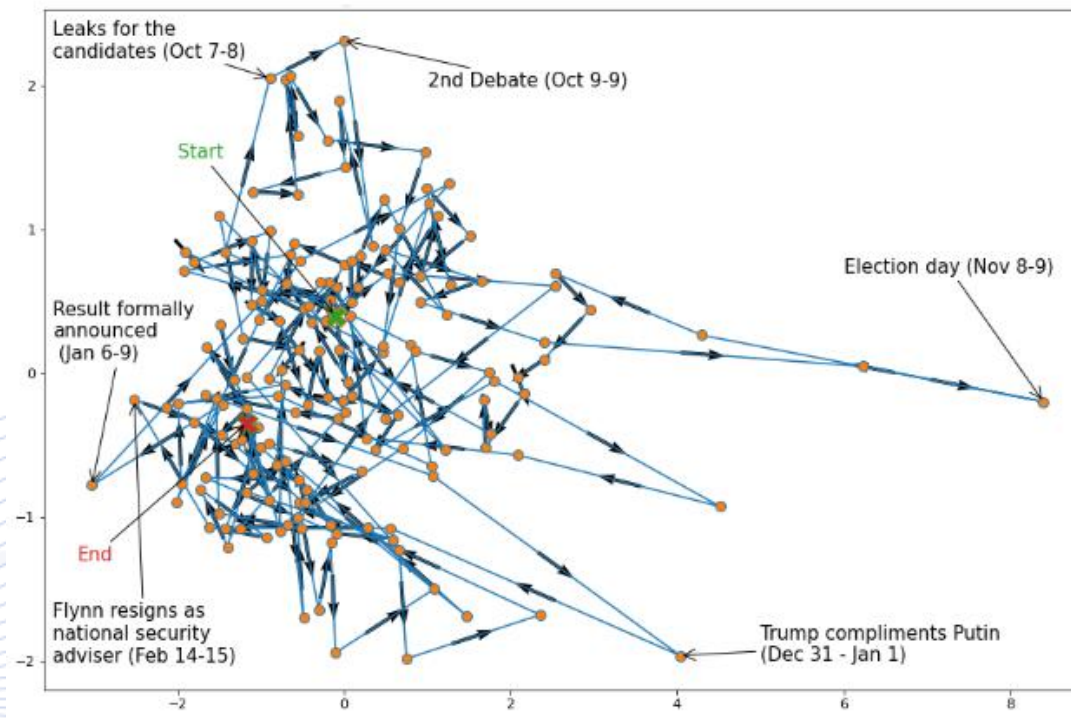- Political event detection through tweet sentiment analysis.

PCA based 2D visualization of the 4D tweet sentiment timeseries for the Democrats over 163 days [KAR2021].

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Computational Politics Methods

Time series analysis and prediction

- Political event detection through tweet sentiment analysis.

PCA based 2D visualization of the 4D tweet sentiment timeseries for the Republicans over 163 days [KAR2021].
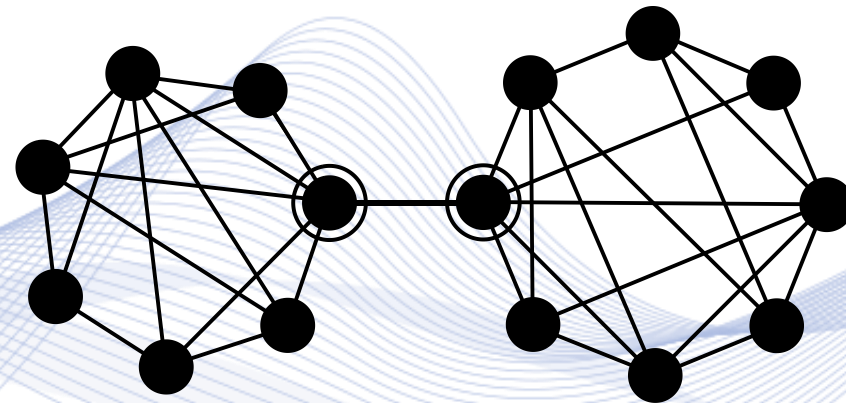
Computational Politics Methods

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Citizen communities (graph) analysis

- Graph clustering to communities.

- Information flow in graphs.

- ***Information cascades***.

- Example: Citizen's Twitter profile and network features were used to cluster them according to their political beliefs [FRI2001].
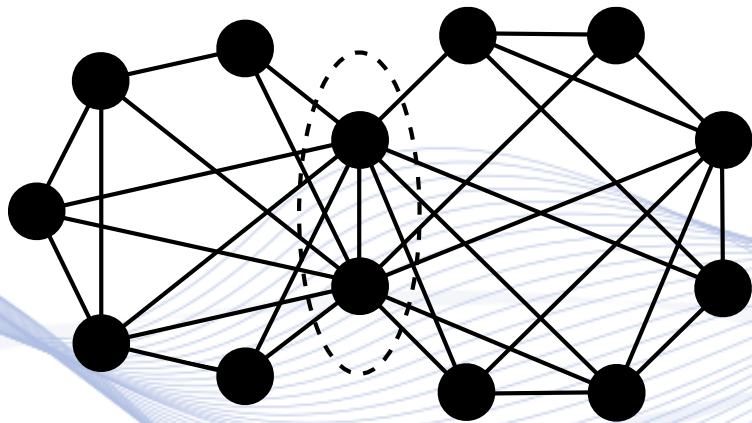
Two overlapping citizen communities.   Network bridge between two citizen communities.

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Computational Politics

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Computational Politics Topics

Topics covered by Computational Politics [HAQ2020]:

- Political system modeling and design.
- Community and citizen modeling
- Information flow
- Political discourse analysis
- Election campaigns
- Political history
- Politics and Economics

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Computational Politics Topics
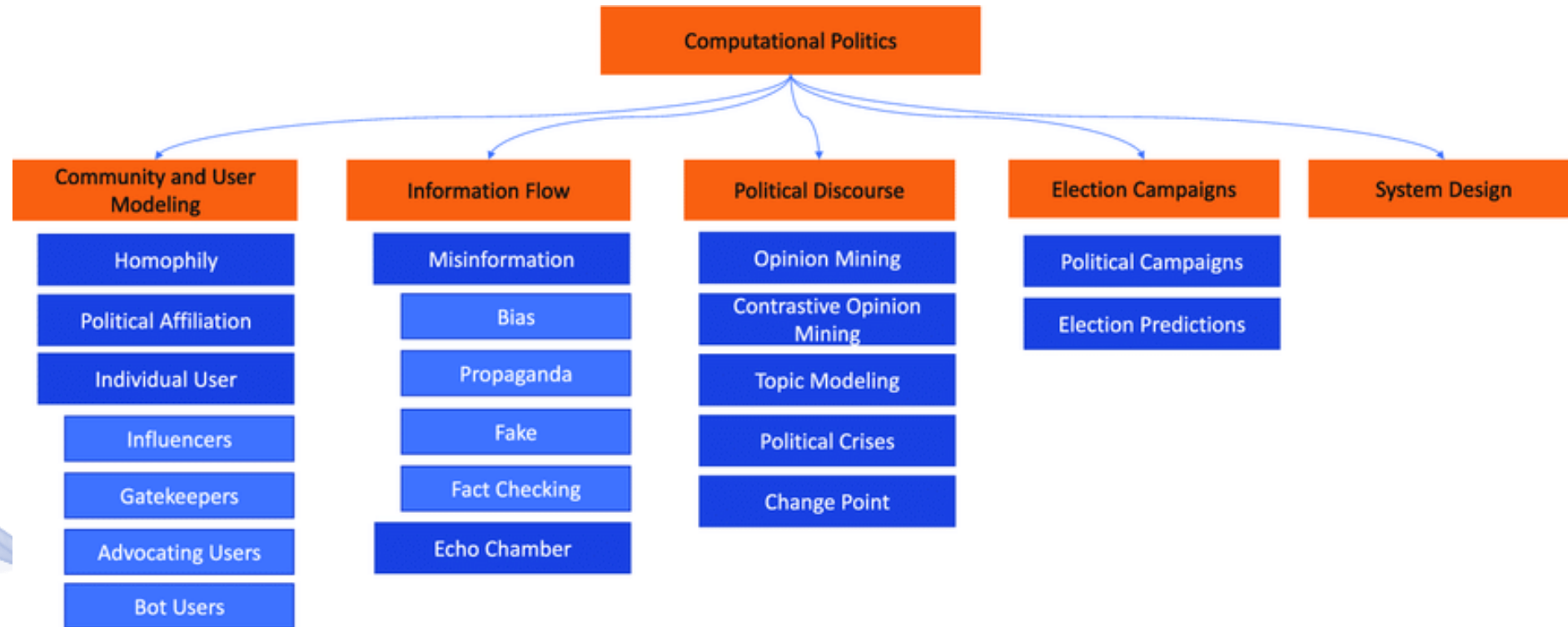
[HAQ2021]

Political System Modeling

Political System Modeling accurately represents the entities of a political system and their relationships.

Political system modeling and design:
- **Cybernetics**: (political) system management.
- Computational modeling of political systems.
- Political decision-making structures:
  - Single-layer, multi-layer systems
- Political system stability.

Political System Modeling

AI and Politics: parallelism between Neural Network and political structures.
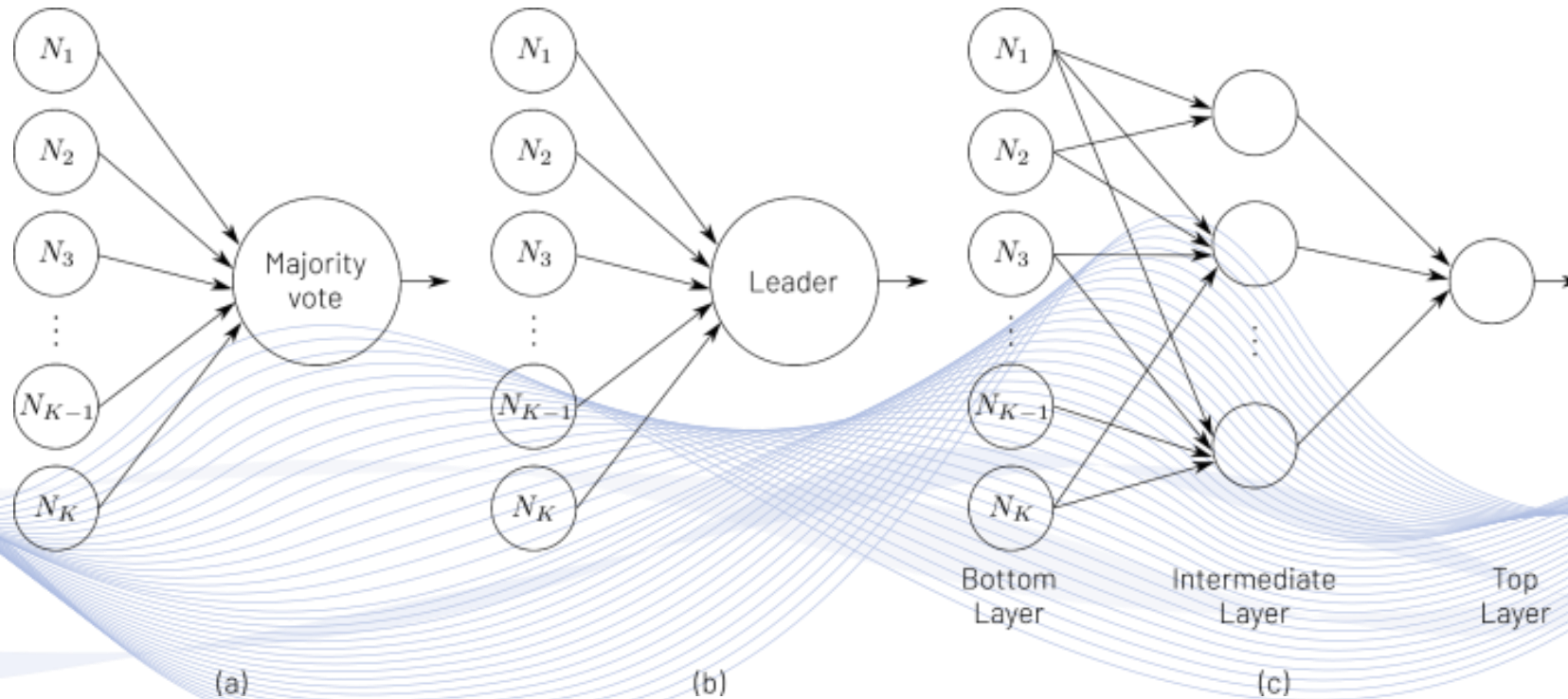
Single layer and multilayer structures.

Political System Modeling

Single layer and multilayer political structures.

- **Direct democracy** is a single-layer structure.

- **Dictatorship** is a two-layer structure.

- Parliamentary democracy is a multilayer structure.

- Multilayer structure have bigger capacity in knowledge storage.

- Single-layer structures are faster, have less capacity and maybe prone to instability.

- Political and **social complexity** studies [CIO2014].
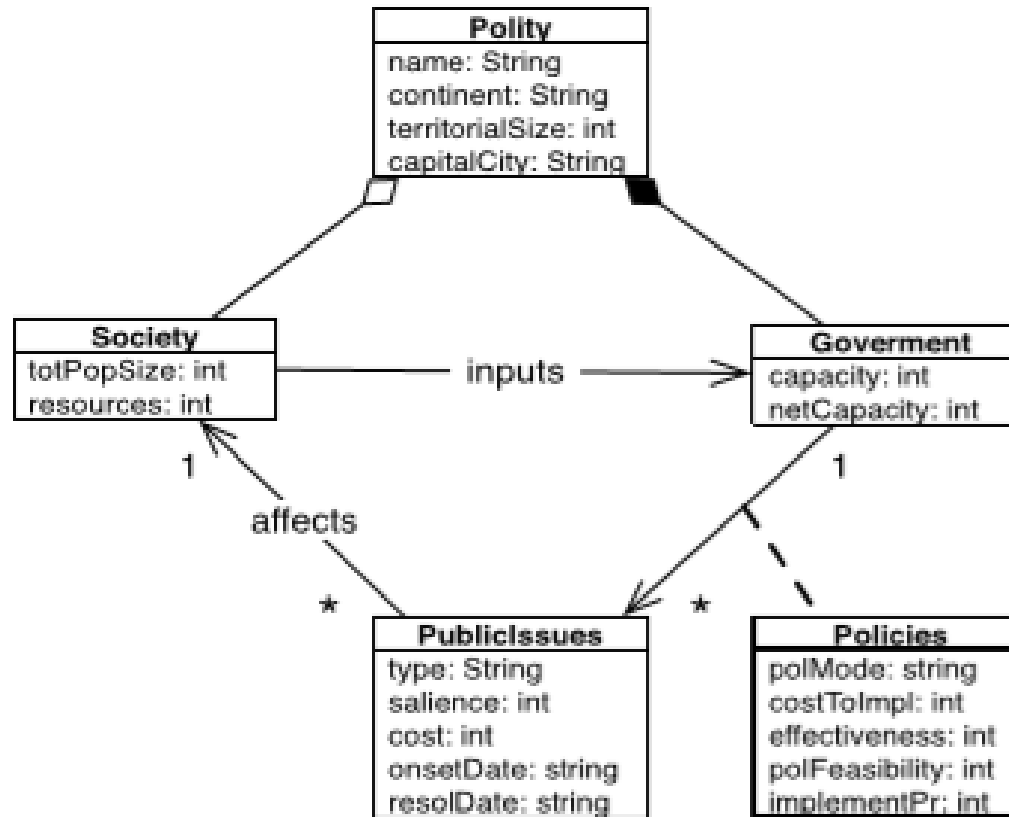
Political System Modeling

Political systems are complex and hence difficult to model.

- The SimPol model employs 3 different depths of complexity [CIO2009].
- Both Object-oriented Modeling (OOM) and Unified Modeling Language (UML) are employed.
- A sequence diagram dynamically represents the relationships between the political system entities and the different conditions that occur because of the interactions.
- The sequence diagram models governmental decision making when an issue arises.

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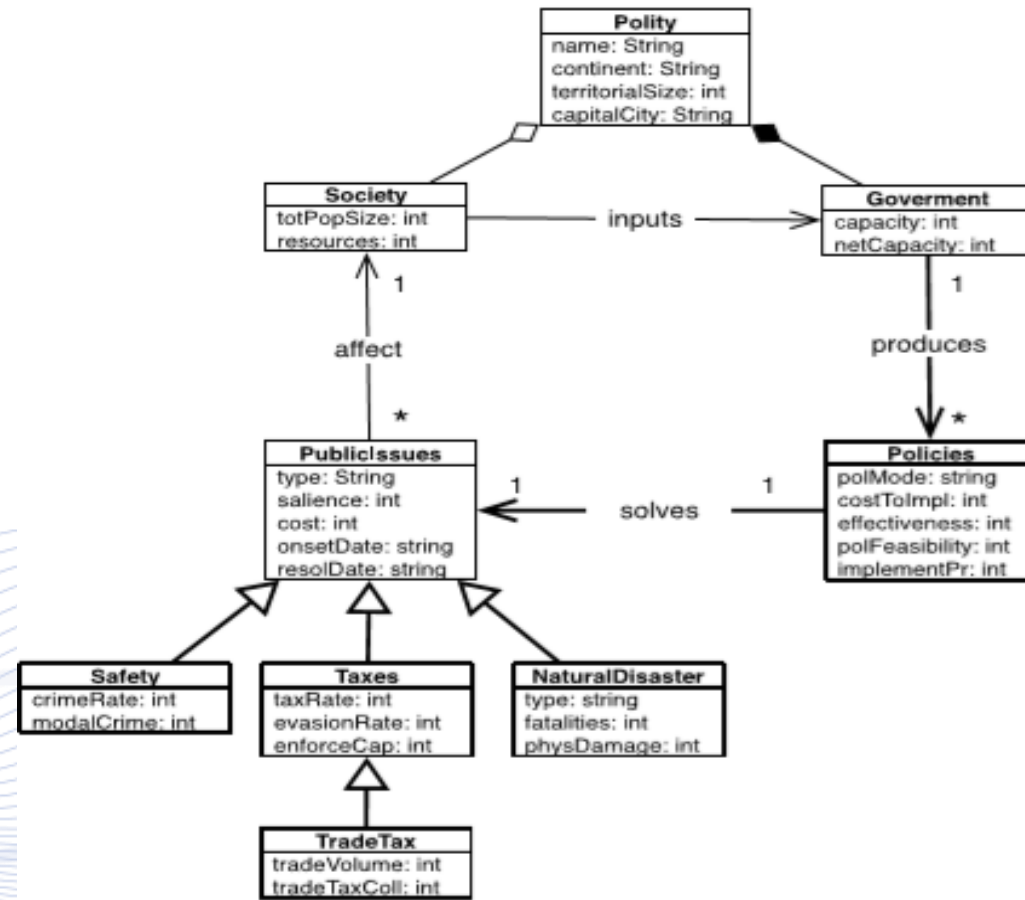
Political System Modeling

- A sequence diagram dynamically represents the relationships between the entities and the different conditions that occur because of the interactions.

- This type of diagram contains the social entities, their conditions and the interactions between them.

- Through a sequence diagram, the way governments make decisions when an issue arises can be tackled in the model of the political system.

Political System Modeling

The SimPol low-resolution model containing the society, the government, the public issues, and policies [CIO2009].
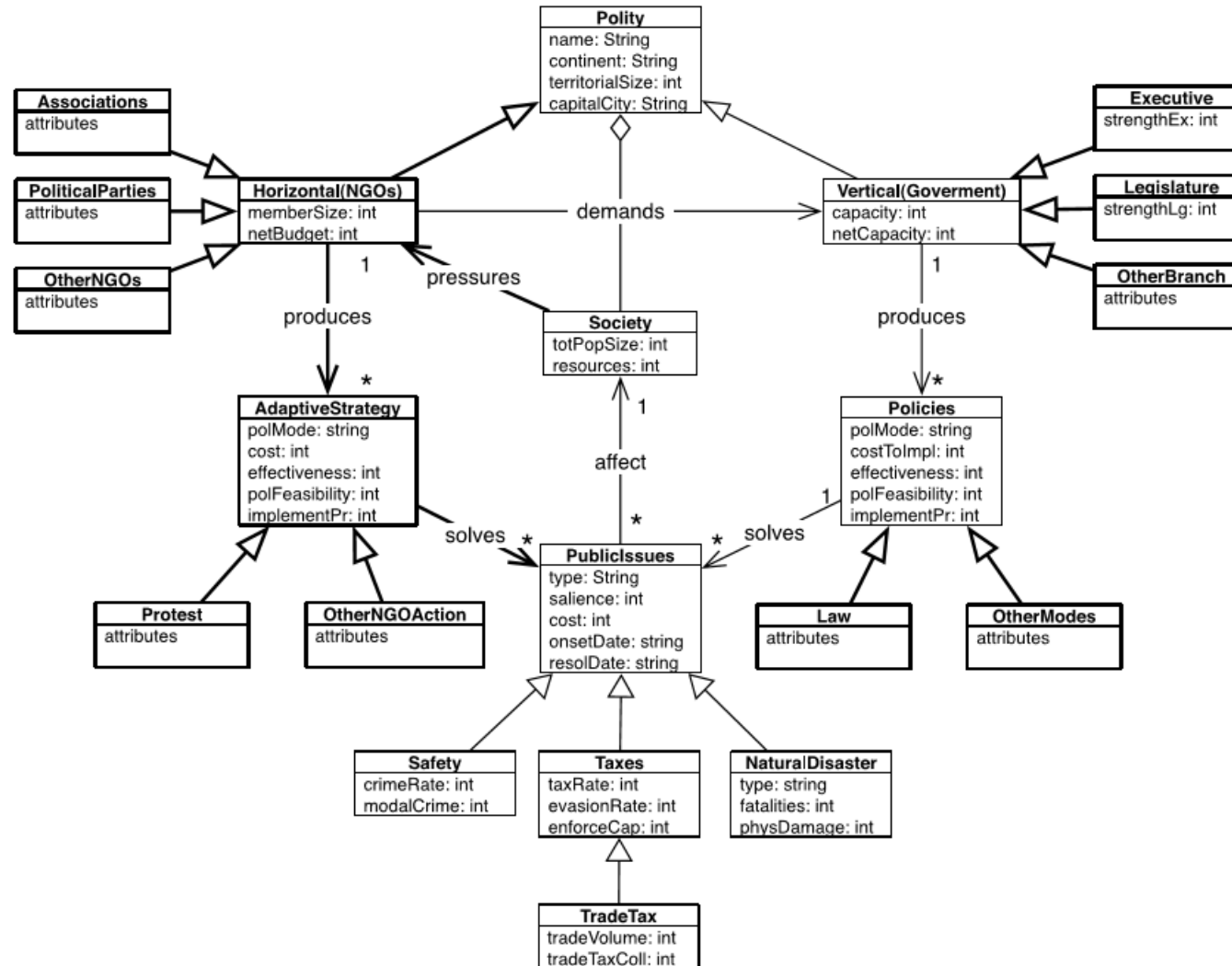
Political System Modeling

The SimPol medium-resolution model [CIO2009].

Political System Modeling

- These model can be used to express any political system, as they are abstract enough to contain main concepts that exist in every system.

- Both diagrams fail to express the concurrent existence of more than one governance mechanisms.

- The final diagram tackles this weakness and represents a more realistic model of a political system.

Political System Modeling

The SimPol high-resolution model [CIO2009].

Political System Modeling

- Effect of Information and Communication Technologies on political system structure.
  - E-voting.
  - Referenda and direct democracy.
  - E-participatory tools.

Community and Citizen Modeling VML

- Individual citizen as well as citizen group/community modeling.

- Formation of citizen communities
  - Virtual online communities.

- Significant aspects concerning citizens' online behavior:

  - **Homophily**: tendency to form connections with people who are politically similarly minded [GER2013].

- Virtual communities facilitate **information spread** by citizens to citizens:
  - Electronic **word of mouth**.

Community and Citizen Modeling

VML

Virtual Communities

Virtual community structure fuels their further strengthening:

- social media **rich-get-richer mechanisms**.

- Small world diameter (5-6 hops) allows deep penetration in far-away audience.

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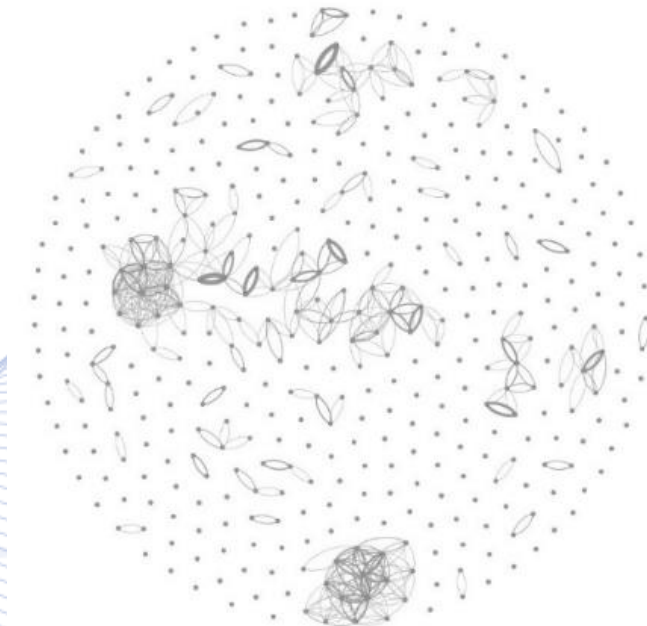
Community and Citizen Modeling **VML**

Small world di
Special online virtual community entities:

- **Influencers**: citizens that have the power to shape audience attitudes through social media [FRE2011] and

- **Gatekeepers**: citizens who despite being informed about diverse leaning content, produce partisan content to their followers [GAR2018].

Information Flow

Information flows along communication links.

- Spread of Christianity along Roman empire highways and sea routes.

- **Internet and Social Media:**
  - Worldwide connectivity.
  - *Huge information diffusion.*
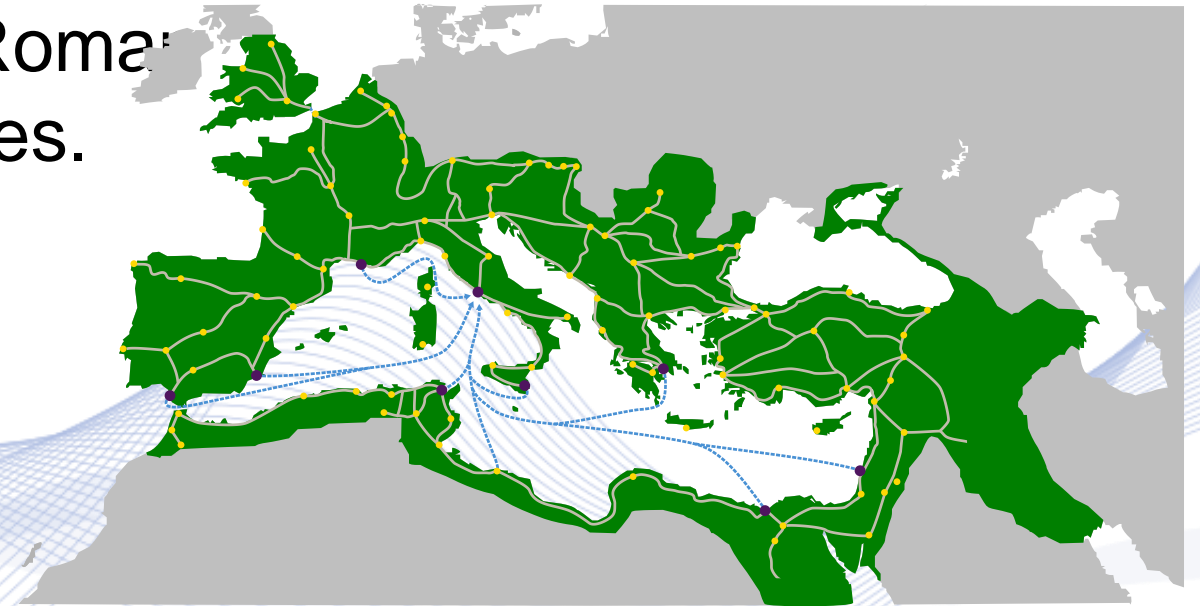
Computational Propaganda

Computational propaganda is the use of social media platforms, autonomous agents, and big data to manipulate the public opinion [WOO2016].

- It utilizes social media and mobile technologies to intentionally spread misinformation and propaganda to influence social media users [MEK2020].

- Computational propaganda is one of the most recent strategies used worldwide for *social control* and manipulation.

- The use of such tools on Twitter data concerning the 2016 US Presidential election is explored in [BES2016].

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Echo Chambers

Echo chambers are the result of selective algorithmic grouping of people, who share similar beliefs and are like-minded [CIN2021].
- They exist primarily in social media.
- People taking part in the such groups strengthen their shared ideas and are not exposed to any opposing views.

- This can result in opinion bias and polarization.

- A well-functioning democracy need more ***shared virtual spaces***, where people of all political beliefs can express their opinions and take part in a universal conversation.

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Social Bots and Politics

Social bots are social media accounts controlled by algorithms that imitate the human activity online, but at a much higher speed.

- They hide their personal id, so their identity remains unknown.
- They can be used to produce numerous political tweets in favor or against certain people, e.g., a political leader .
- They can also point to fake news web sites.
- The use of bots is progressively becoming less complicated and more accessible even to small political entities.

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Social Bots and Politics

Investigation on the use of social bots in the election campaigns of the 2016 US Presidential election:

- A list of hashtags and keywords was created.
- A large dataset of 20.7 million tweets having these hashtages was collected.

- The BotOrNot detector was created to detect if an account is a bot or not.

- It utilizes Machine Learning algorithms to analyze over 1000 tweet features:
  - content, network structure, temporal activity, profile data and sentiment analysis.

- 400,000 bots are estimated to have been used in the 2016 US Presidential election.
- They are responsible for 3.8 million tweets analyzed (one-fifth of the total tweets).
- It is not possible to easily discover the culprits.

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# Social Bots and Politics
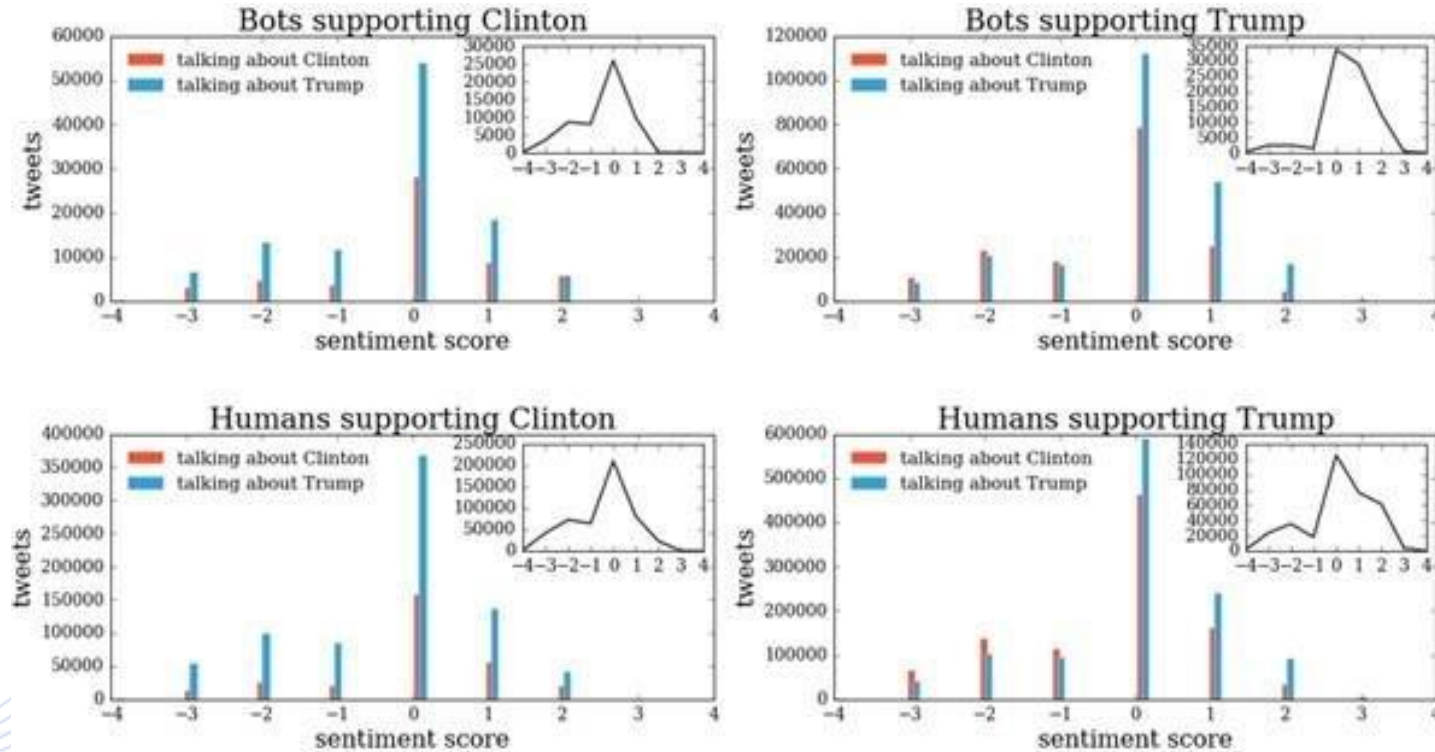
[BES2016]

Political Recommendations

- Social media platforms gather data on user preferences, beliefs and behavior.
- Citizens can be affected through personal data surveillance, massive data analysis and targeted **political recommendations**.
- They can be used in politic campaigns to manipulate voter behavior.
- Disinformation propagates easier through personalized recommendations.
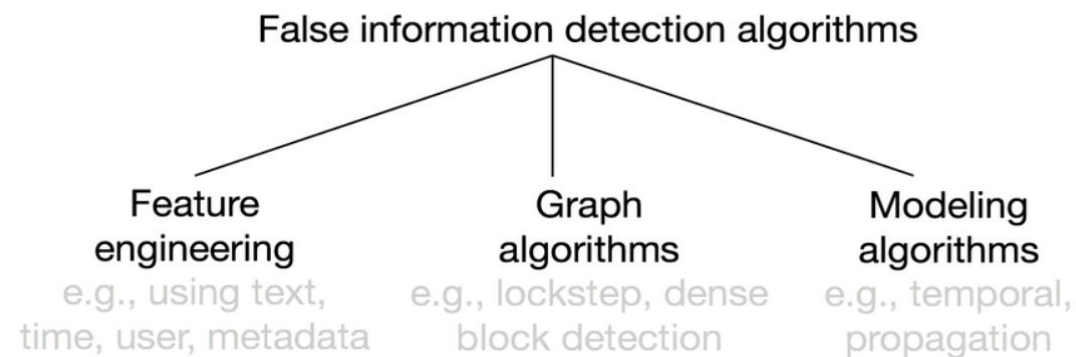
Disinformation detection algorithms [SRI2018].

Political Recommendations

VML

Data activism is a response to the unfair data usage and distribution, [LEH2019].

- *Citizen-centric data economy* should enable citizens to control their personal data and disable companies and campaigns to profit of them.

- Data activism is a novel decentralized and data-based form of citizen media, that can redefine the relationship of data and people [MIL2015].

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Political Discourse Analysis

Political Discourse (or debate, dialog) is the oral or written form of political dialog by professional politicians, political institutions or citizens.
- ***Political discourse analysis*** is the study of political texts and speeches.
- They can be delivered by one or multiple individuals, typically on a single event or topic.
- Its aim is to better understand political thought.

Research in ***political discourse*** includes an extensive range of topics:
- Political language analysis
- Political topics, concepts, ideas, actions, decisions identification

Political Discourse Analysis

- Study tools include:

  - Natural Language Processing
  - Audiovisual content analysis
  - Opinion mining
  - Discourse topic modeling
  - Argumentation analysis
    - scrutinizing the logic and structure for presenting argument

- Results:
  - Improvement of political speech
  - Better political (collective) decision making and actions
  - constructive engagement of citizens.
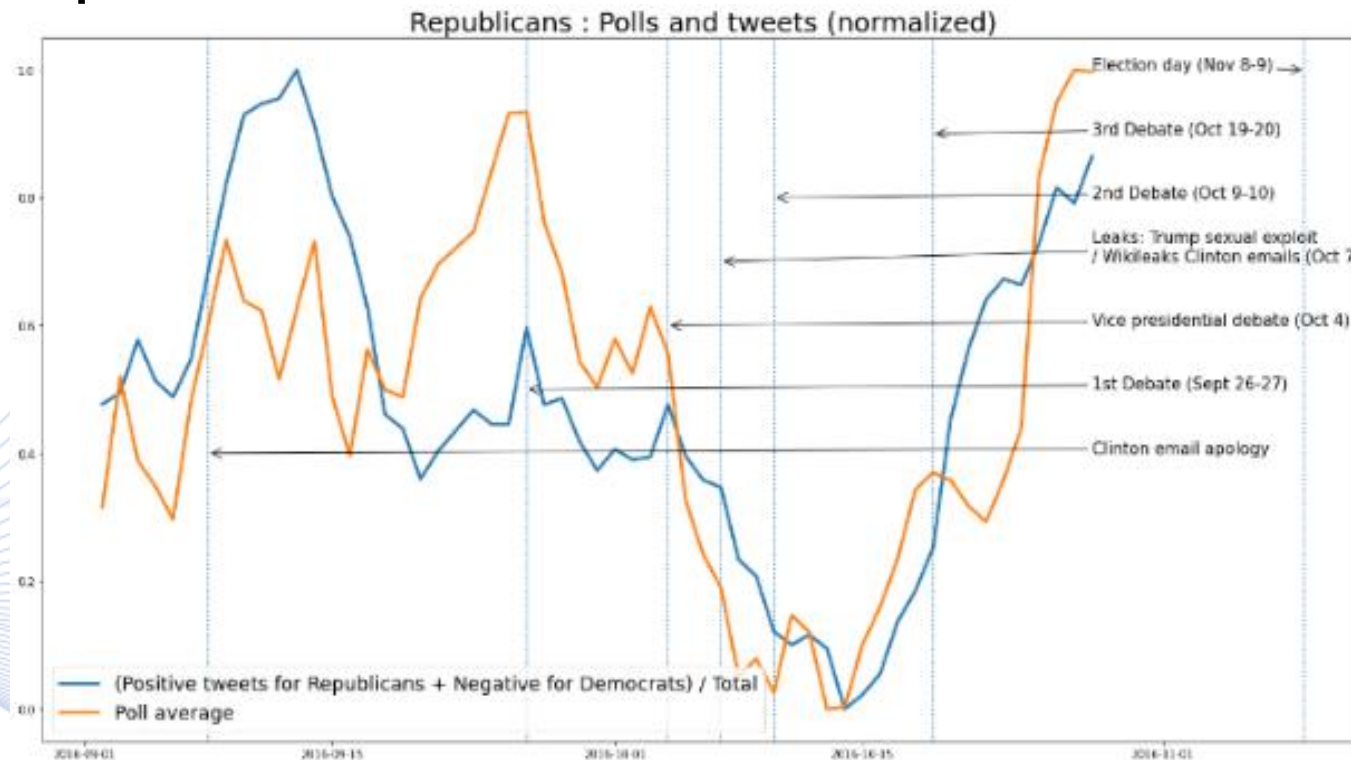
Election Campaigns

Election campaign research deals with the constructive engagement of online users utilizing:

- opinion polls
- political campaign design and execution
- political campaign analysis.

- This field can be categorized further into:

  - political campaigns execution through social media,

  - *election result prediction* through a combination of traditional surveys and opinions of users online.

Election Campaigns

AI and Politics: observing the society.
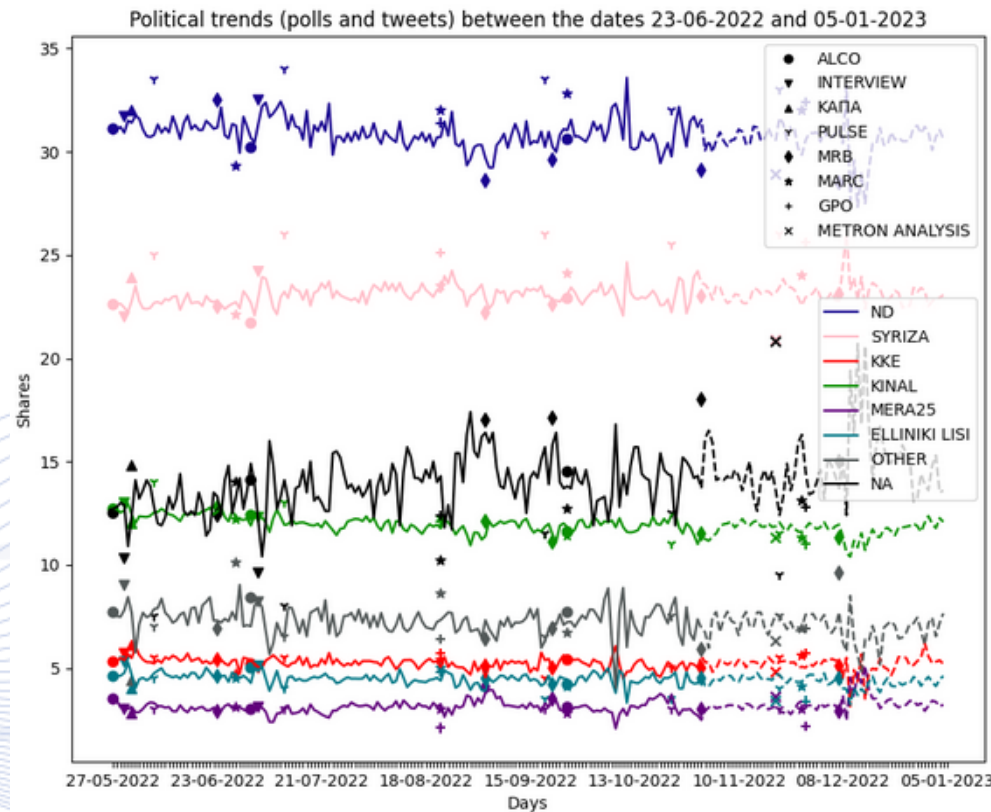
- Are political polls redundant?

Poll and tweet sentiment trends for Republicans in the 2016 presidential election in USA.

Election Campaigns

Time series analysis and prediction

- Forecasting election results through tweet sentiment analysis.

Forecasting 2023 Greek election results (6/1/2023).

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Political History

Data analysis can provide quantitative tools for ***political history*** analysis:

- Identification of major political periods and their major characteristics.
- Identification of major political players in each period.
- Quantitative analysis of political alliances and competition.

- Cross-analysis of economic, social and political factors.

Greek Political History

Visualization of the recent Greek political history.

- There were elections in Greece in the period 1974-2019.
- 31 Greek parties that participated even once in these elections.
- **Principal Component Analysis** of election results.
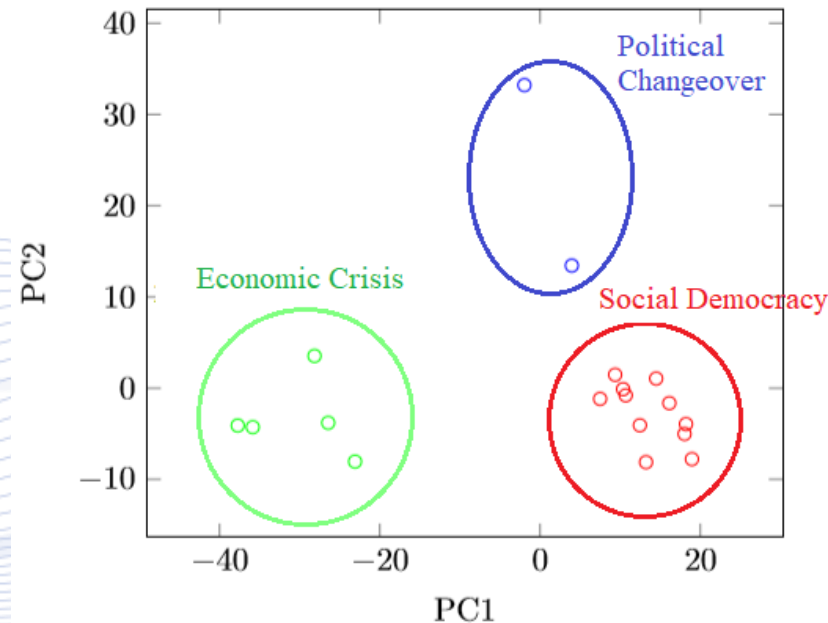
Greek election result clusters revealing the 3 political history periods 1974-2019.

Greek Political History

VML

Principal components of the Greek political scene.
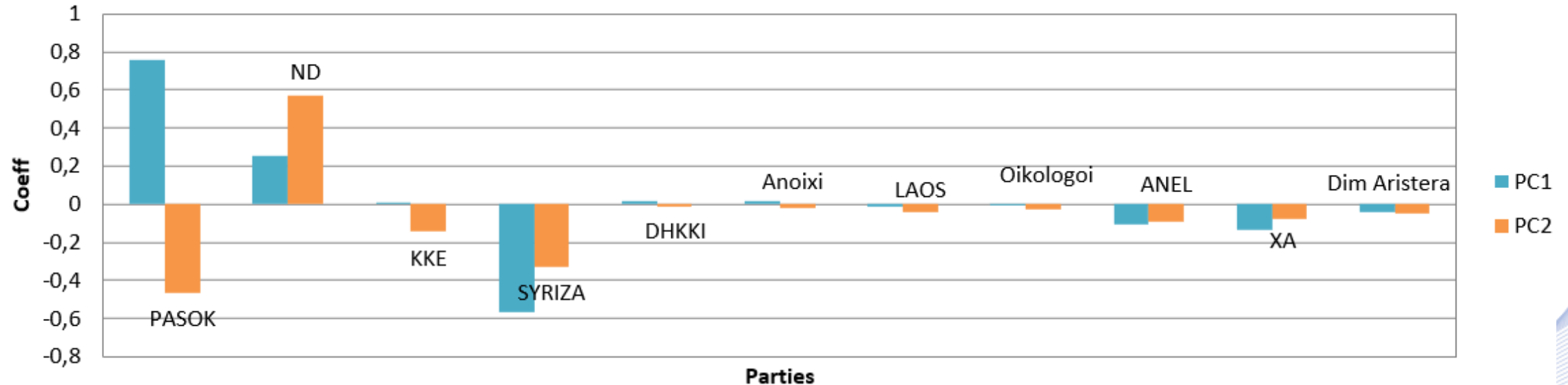
- The first dimension (PC1) shows a negative relationship between a) New Democracy (ND), PASOK and b) SYRIZA parties.
- The second dimension (PC2) shows a negative relationship between a) New Democracy (ND) and b) PASOK, KKE and SYRIZA parties.

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Greek Political History

PCA on national election results
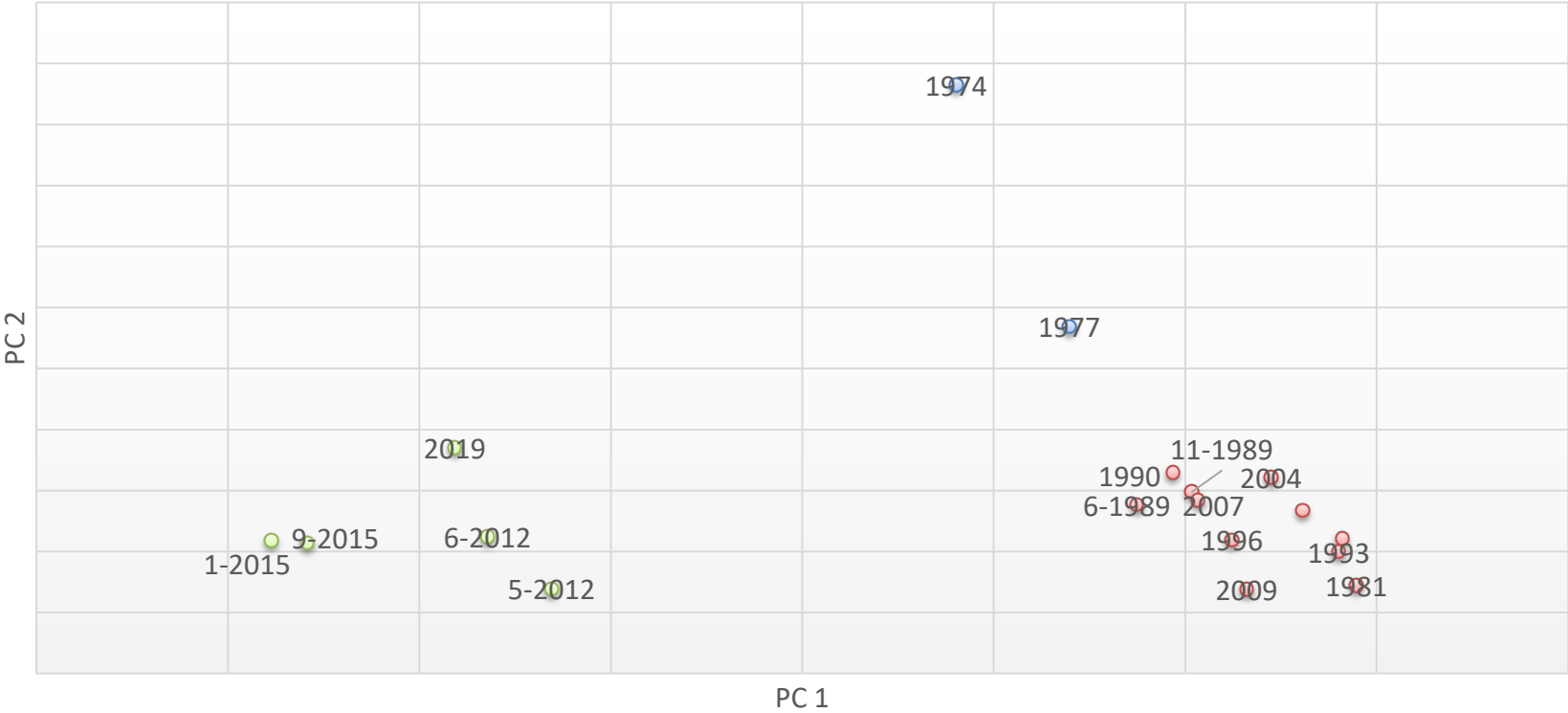
Greek Political History

- Furthermore, each of the elections was then studied separately.

- Through this analysis, visual representations for each election are created.

- This representations provide insight on the vote distribution of each district with regards to the overall national election results.

- Each representation, serves as a "compass" of the vote distribution within the districts.

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Greek Political History

Vote distribution in 2019 (electoral districts with labels outliers).

PC 2

PC 1

RODOPIS

LASITHIOU

ILEIAS

ARGOLIDOS

CHIOU

THESPROTIAS

IRAKLEIOU

LAKONIAS

ACHAIAS

NATIONAL

SERRON

B PIREOS

KASTORIAS

A PIREOS   ZAKYNTHOU

○ 2019   ○ NATIONAL

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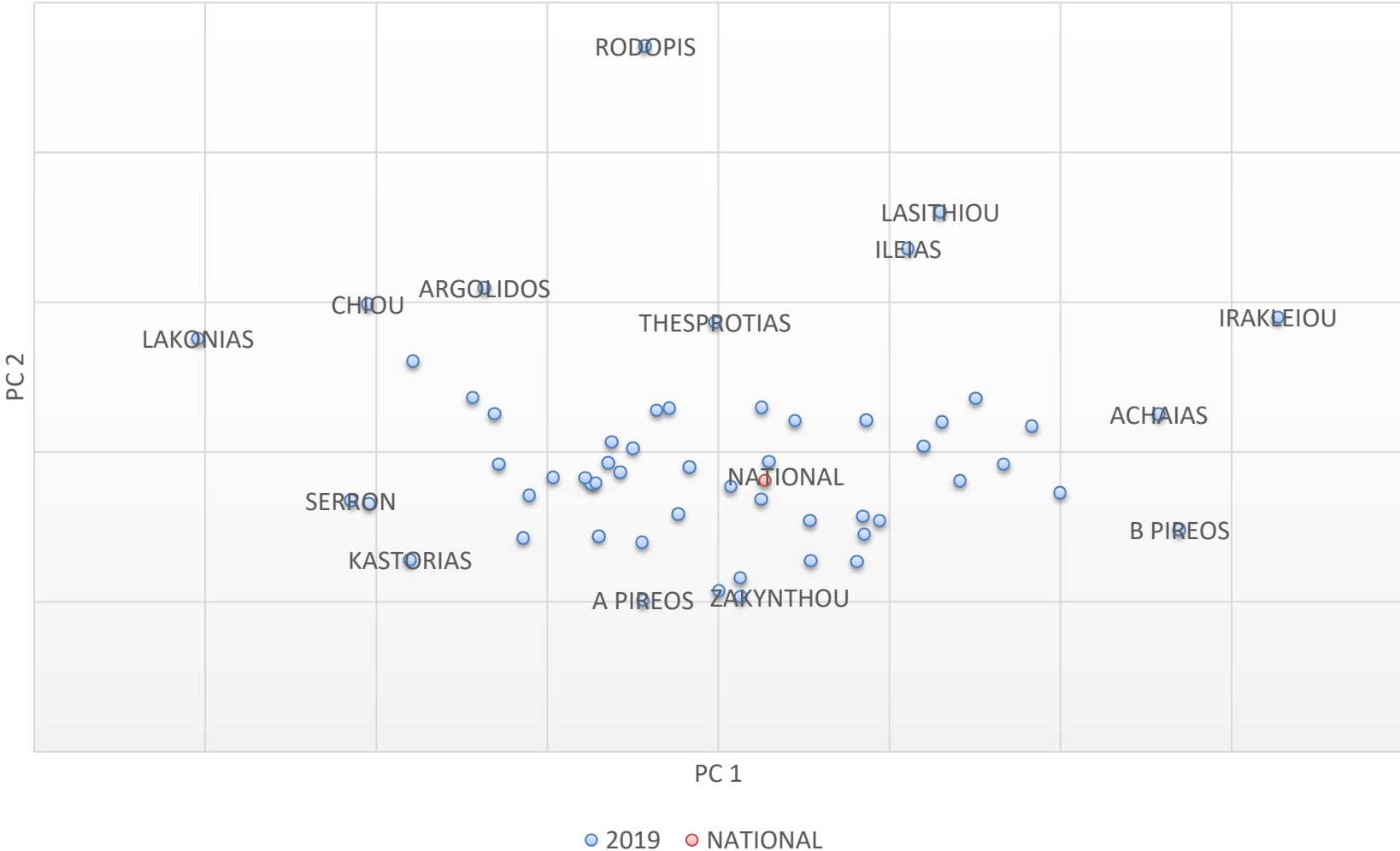
Computational History

- Graphs can represent relations of political actors.
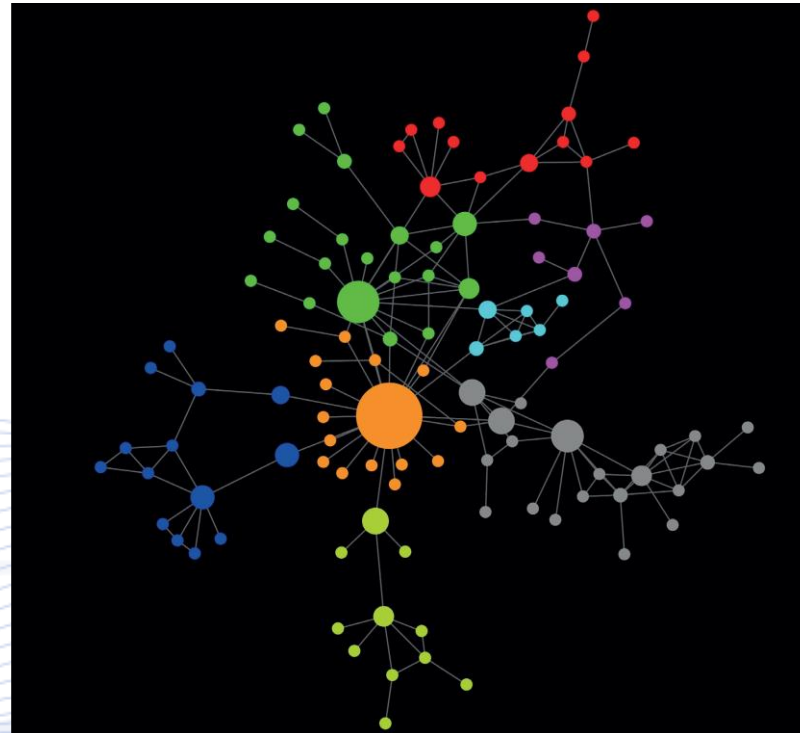
Clusters of the Byzantine nobility in the civil war period 1321-1328 AD.

Economics and Politics

The election results can be analyzed in combination with the economic performance of the country [AKA2006].
- Different regressions are considered, to find the combination that can most fittingly express the original election data.

- To express the economic performance of the country, some variables are introduced, e.g.:
  - the growth rate of the per capita real GDP.
  - the inflation rate in GDP implicit price deflator.
  - the "cost of ruling", i.e., vote loss due to ruling defficiencies.
  - dummy variables expressing important events.

Economics and Politics

- The Greek National Elections were studied and associated with the economic performance of Greece during 1974-2019.

- It provides insight on whether economic matters guide the way Greek citizens vote.

- The relationship between the political parties and the economy is considered.

Economics and Politics

- To retrieve the relationships between the vote percentages and the economic performance, different regressions are calculated.

- The regressions share a dependent variable, the vote share of the party in question, and then take different independent variables into consideration.

- Metrics, such as $R^2, adj. R$, $F - statistic$ and $Durbin - h$ are considered when choosing the best fitting model.

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Economics and Politics

VML

Best fitting model of the incumbent (winning) party votes:

$$V_t = 21.37 + 0.419V_{t-1} - 5.56D89_t - 3.263D02_t -$$
$$12.5D10_t - 0.29r_tV_{t-1} + 1.498g_t + 0.266p_t.$$

- V_t: number of winning party votes (t: voting year counter).
- $D89_t, D02_t, D10_t$: dummy variables for the years 1989 (political turmoil over corruption), 2002 (introduction of the euro) and 2010 (debt crisis).
- r_t: number of years in power (input to the "cost of ruling") [PAL1995].
- g_t: per capita GDP growth rate.
- p_t: inflation rate.

Modeling error: $\qquad e(t) = (V_{ot} - V_t)/V_t,$

- V_{ot}: true number of votes.

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Economics and Politics
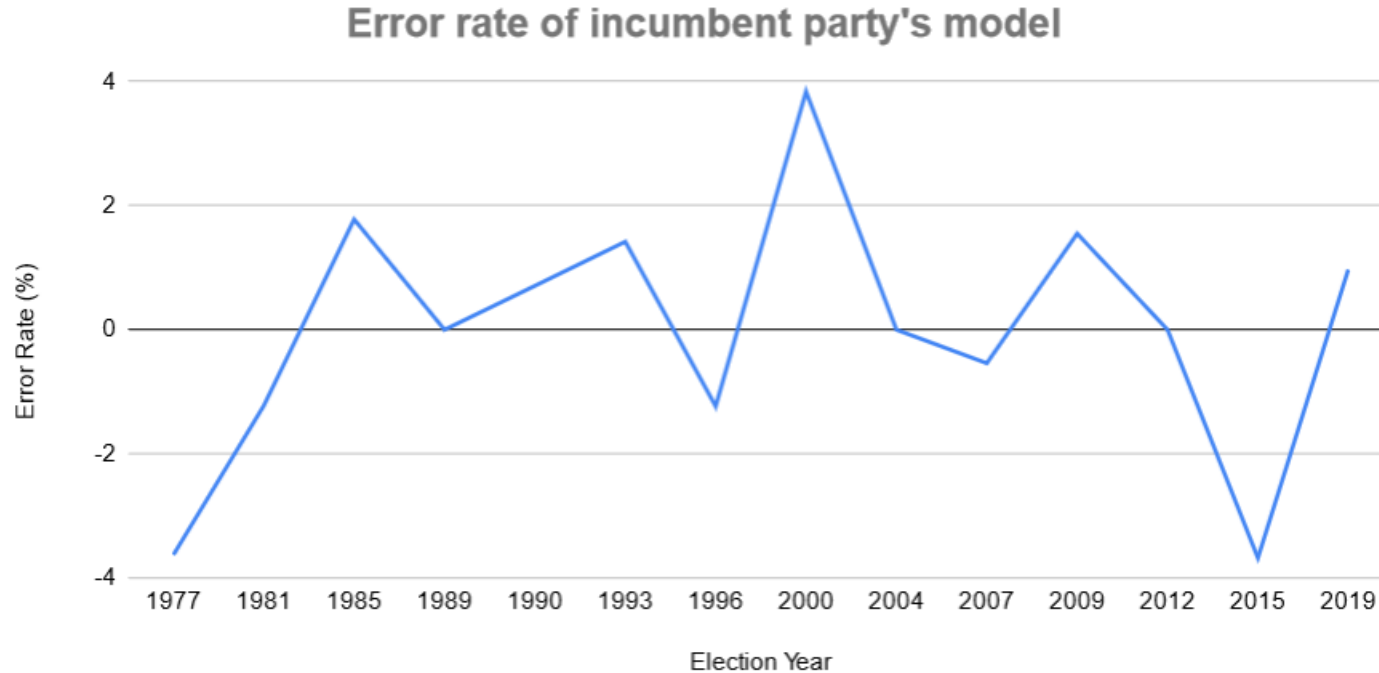
Incumbent (winning) party vote modeling error $e(t)$ (%).

Economics and Politics

Best fitting model for the New Democracy (ND) party votes:

$$V_t = 29.667 + 0.212V_{t-1} + 1.38D89_t + 2.456D10_t + 1.688g_t.$$

- V_t: number of ND party votes.
- $D89_t, D10_t$: dummy variables for the years 1989 (political turmoil over corruption) and 2010 (debt crisis).

- g_t: per capita GDP growth rate.

Modeling error: $\qquad e(t) = (V_{ot} - V_t)/V_t,$
- V_{ot}: true number of votes.

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Economics and Politics
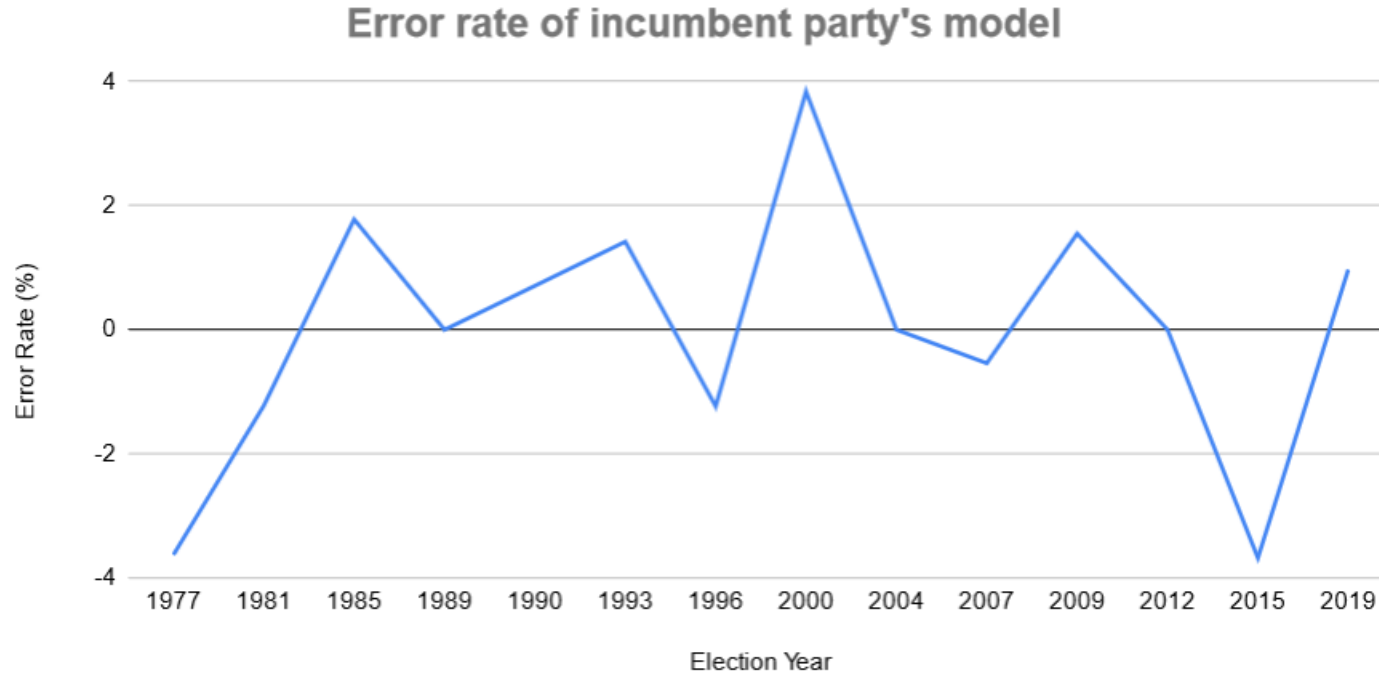
Incumbent New Democracy party vote modeling error $e(t)$ (%).

Computational Politics

- Definitions
- Citizens and Political Data
- Computational Politics Methods
- Computational Politics Topics
- **Political Analysis Tools**
- Future Research

Political Analysis Tools

Software tools for:

- ***Political data analysis***
  - Statistical analysis, Machine Learning tools.

- ***Political campaign design and execution***
  - communication with supporters, fundraising campaigns.
  - Analysis of voters' behavior.

Political Analysis Tools

QGIS3:

- Open-source tool allowing users to visualize, manage and analyze political data, and create maps.

- Data mapping is commonly used in political campaign design and ganalysis.

- Politicians can visualize their supporters and their vote distribution.

Political Analysis Tools

Stata for Political Science:

- Stata is a statistics software for data manipulation, visualization, statistics, and automated reporting.

- Statistical tools for computational politics, all the needed to pursue numerous political science questions are provided, some of which include:
  - Structural equation modeling, estimating mediation effects and analyzing relationships between concepts.
  - Regressions finding relationships between parameters.
  - Forecasting through multi-equation models.
  - Meta-analysis, combining multiple studies to estimate an overall result.
  - Survival analysis, analyzing complications that may occur.

Political Analysis Tools

PolicyMaker Software:

- It helps a political team to analyze, understand and create effective strategies.

- Political features:
  - coalition diagrams,
  - quantitative modeling of position and power,
  - graphs summarizing political feasibility and
  - the creation of strategies.

Political Analysis Tools

CallHub:

- It facilitates the engagement of voters in a political campaign.

- CallHub offers calling and texting tools.
  - Pre-recorded messages or SMS can be sent to a voters list.

- Supporting campaign volunteers to contact voters, conduct surveys and collect political campaign data.

Political Analysis Tools

Nation Builder:

- It is used extensively in political campaigns.

- Dynamic voter database to retrieve voter information and supporter interaction.

- Political message (email and text) customization to supporters to maximize fundraising.

- Campaign webpage design to advertise events, volunteer hubs and fundraising efforts.

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Computational Politics

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Future Research

- The majority of the limitations in the field of computational politics is caused by the lack of data.

- The limited number of annotated datasets and election results available can compromise the reliability of results and their generalizations.

- Data privacy also causes more difficulties, as research in the field can be utilized as an unfair advantage in elections [CONF2018].

Future Research

- The creation and sharing of annotated datasets by researchers would greatly help overcome the most significant limitation, the lack of data.

- Simultaneously, attempts to create new computational methods that automatically annotate data would also benefit this cause.

- Knowledge graphs utilizing both textual and contextual information, could help identify fake news.

- Data from more countries, who's systems are not strongly democratic should also be explored.

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Q & A

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More material in
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