# AI and Computational Politics

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Version 5.3

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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.

# 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.

# 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.

# 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.

# Computational Politics

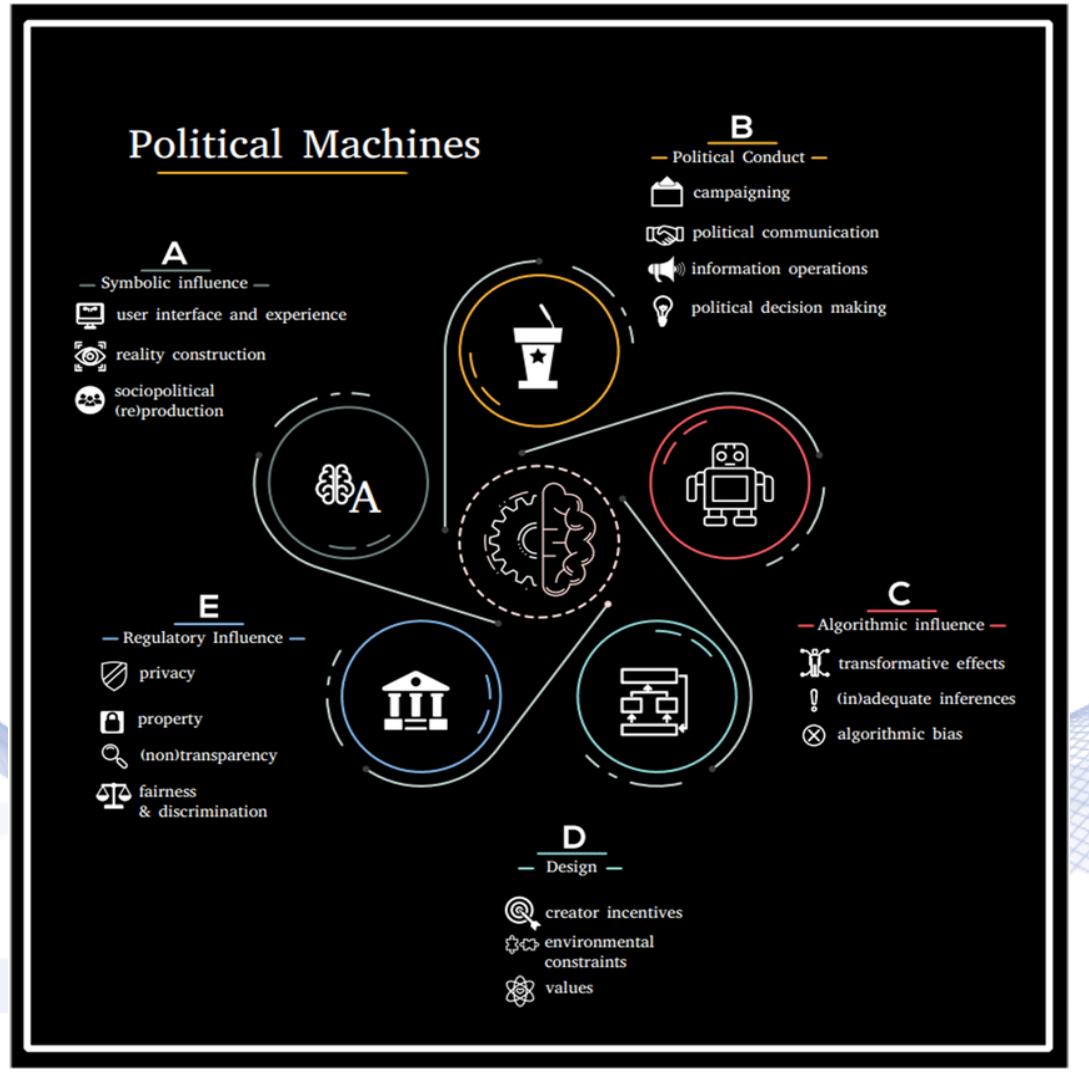
Political data analysis can be fed by:

- 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.

# 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.***

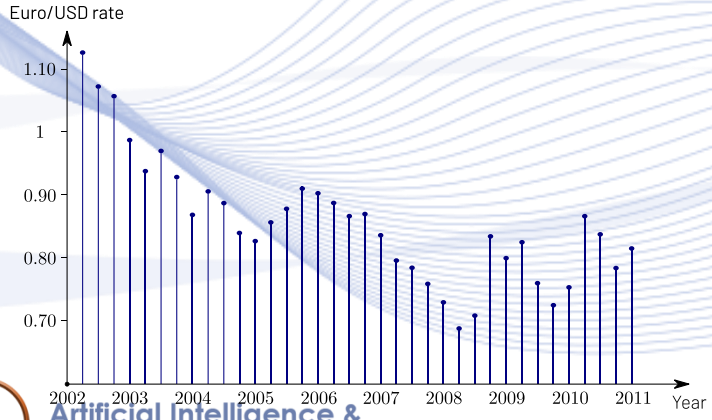
# Data Perspective

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***:

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

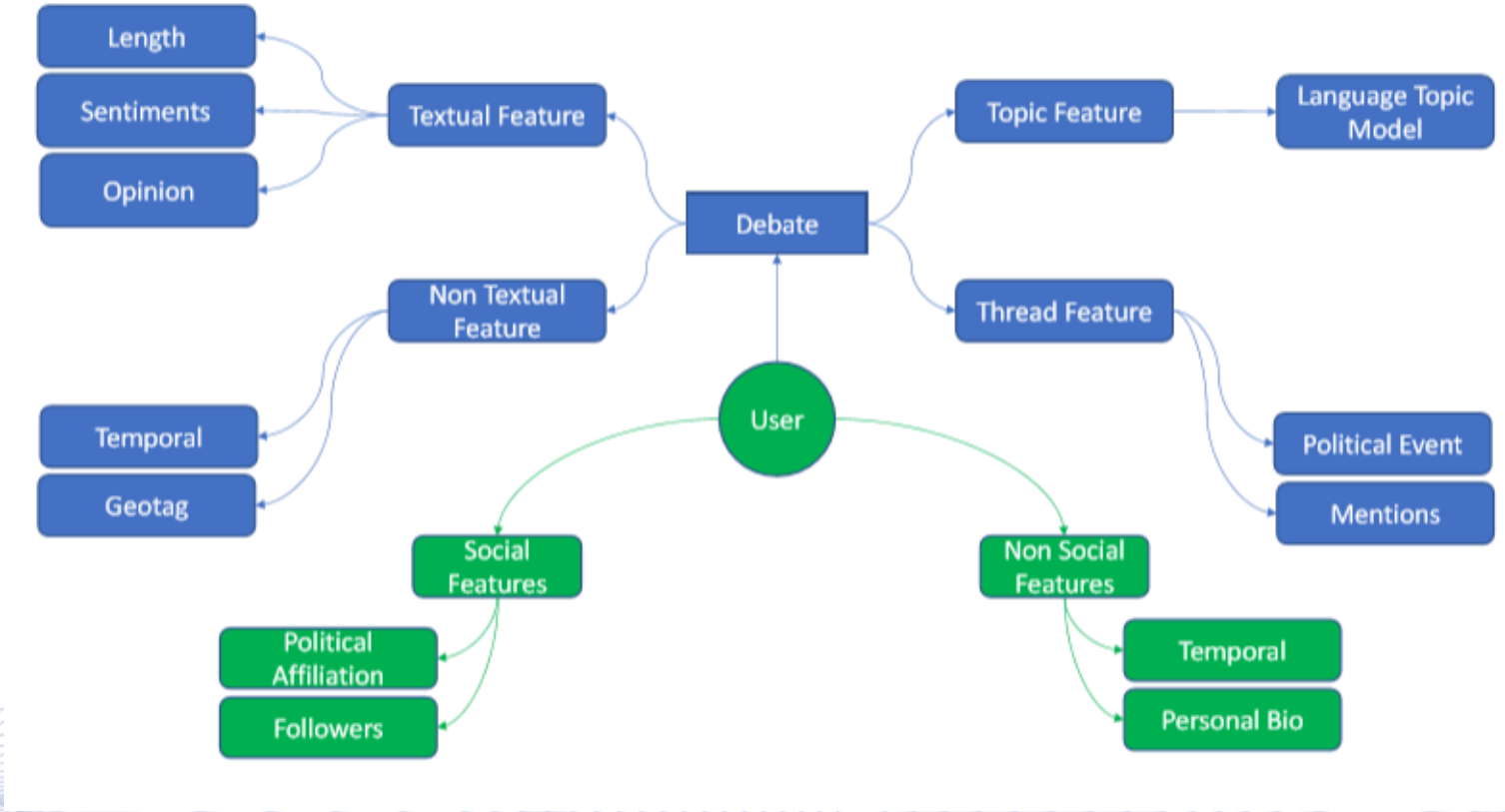



# Data Perspective

- 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.

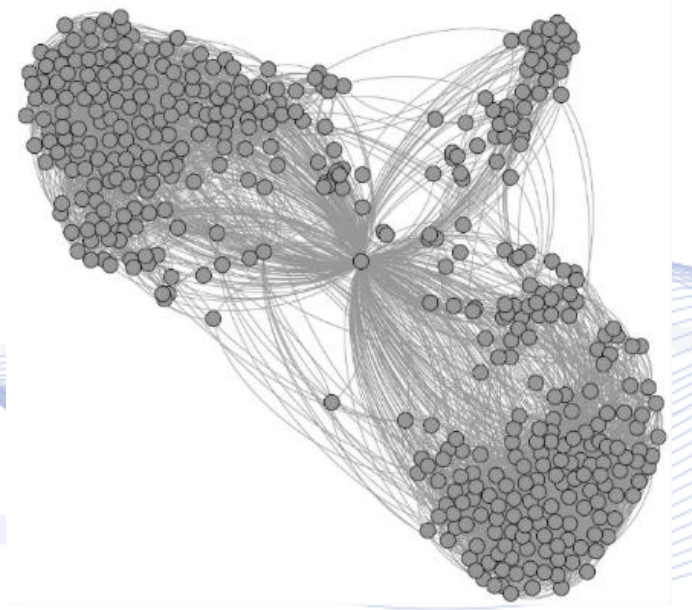
- ***Citizen profiling*** (modeling) can reveal hidden political attributes about a citizen.
- Citizens are political data sources and sinks:
  - ***Tweets*** or ***retweets*** on Twitter.
- Information flow reveals political citizens links.

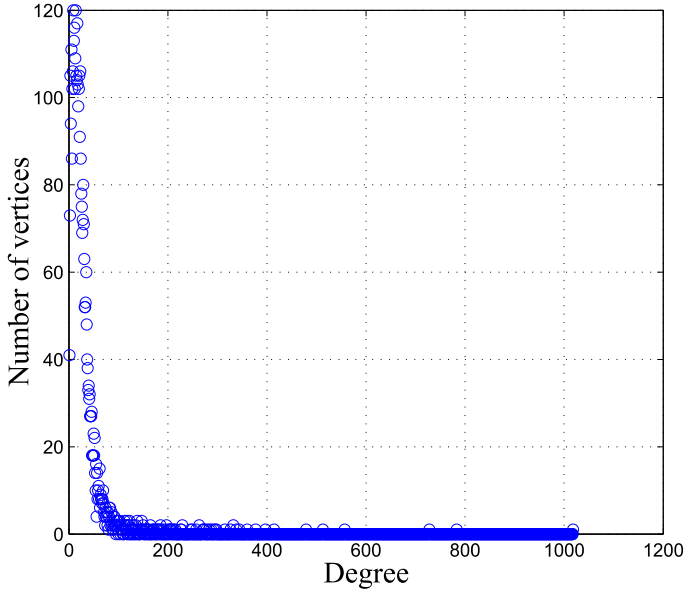
- Modeling can be also done at a ***citizen community*** level.
- Citizen profiles can be used for citizen ***clustering*** or ***classification*** into communities.

# 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.





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# Computational Politics Methods

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

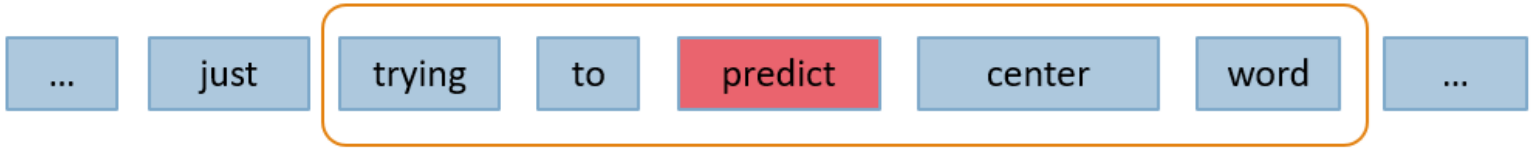
- Typically, they are Machine Learning methods.
  - ***Data clustering*** groups data (or citizens) into homogeneous clusters that differ from each other:
    - Citizen communities.
  - ***Data classification*** characterizes data or citizens:
    - ***Text sentiment analysis***: offensive, biased, positive/negative.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

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

# Computational Politics Methods

***Natural Language Processing***

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




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

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

# Computational Politics Methods

***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].

# Computational Politics Methods

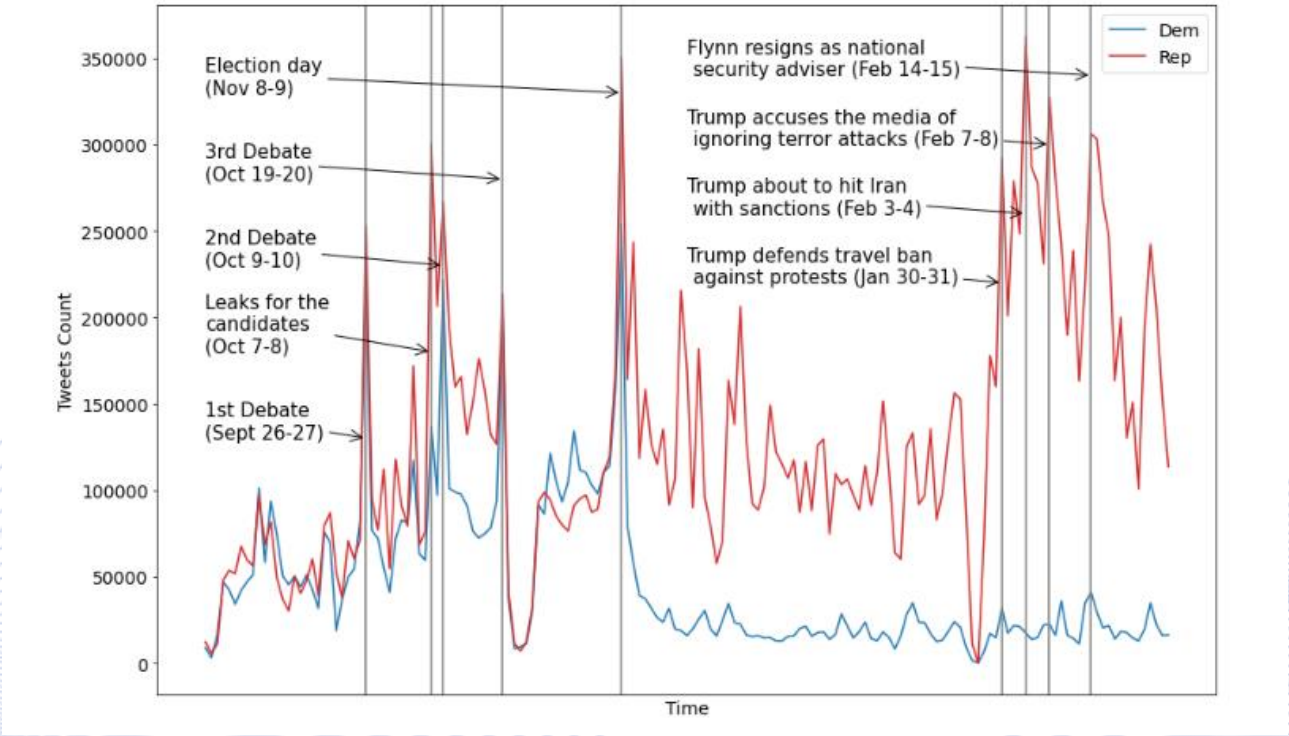
Public opinion monitoring mechanism utilizing a semantic descriptor that relies on Natural Language Processing (NLP) [KAR2021].

- 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

***Time series analysis and prediction***

- Public opinion monitoring.

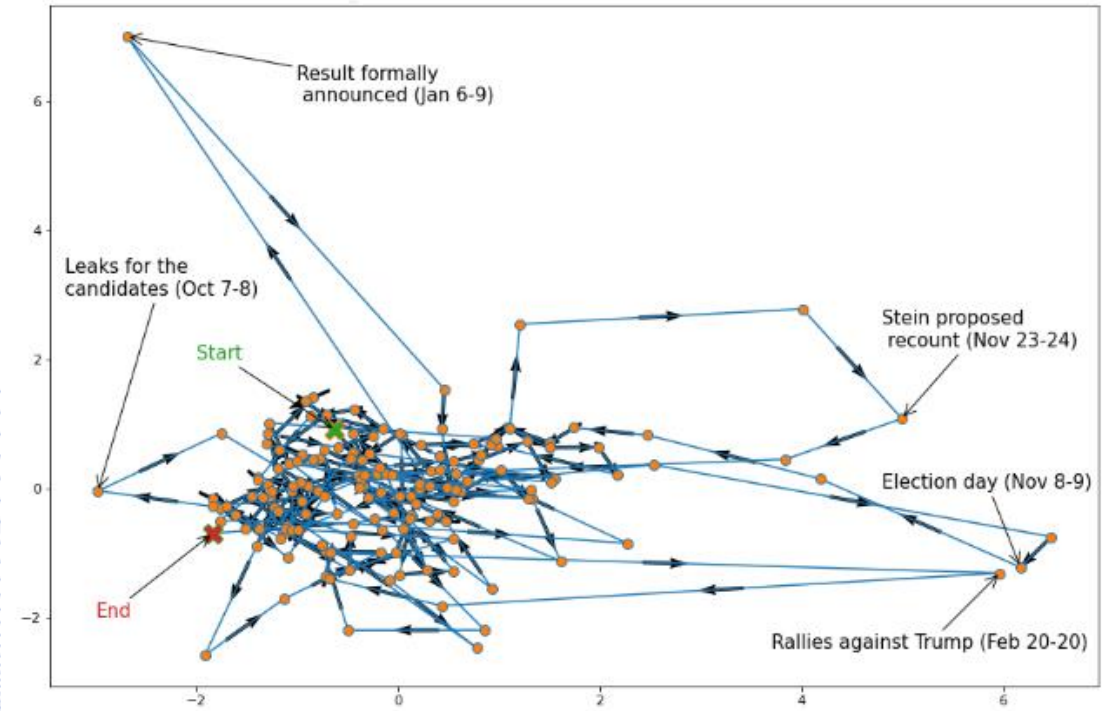



Daily number of tweets for Democrats and Republicans for the 2016 presidential election in USA [KAR2021].

# 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 Democrats over 163 days [KAR2021].

# Computational Politics Methods

***Time series analysis and prediction***

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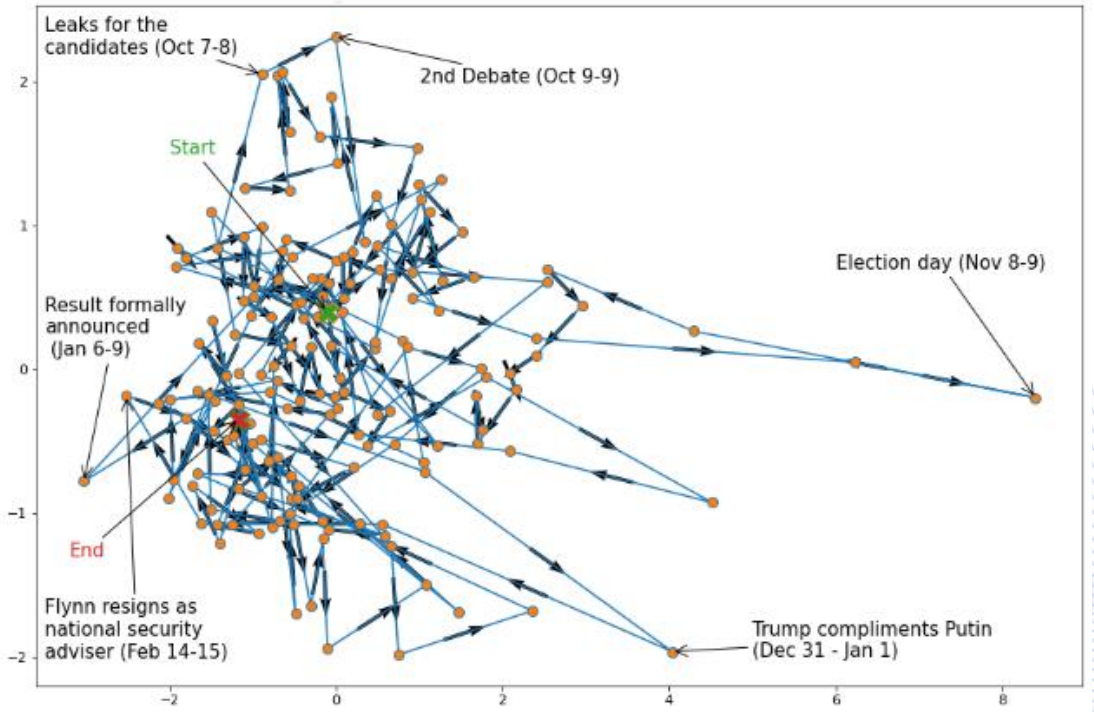
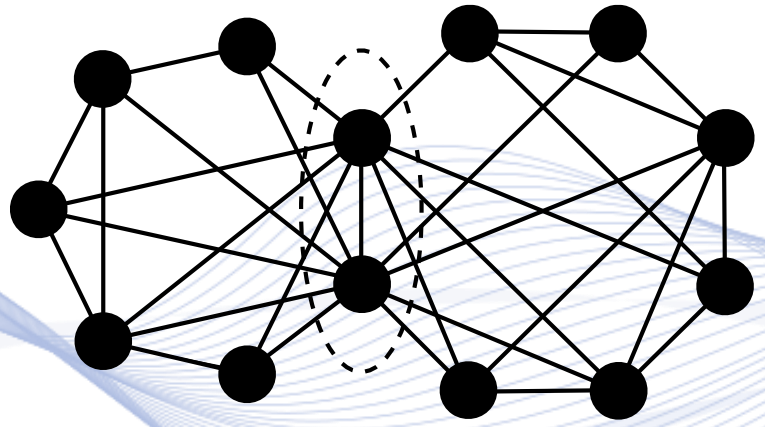



PCA based 2D visualization of the 4D tweet sentiment timeseries for the Republicans over 163 days [KAR2021].

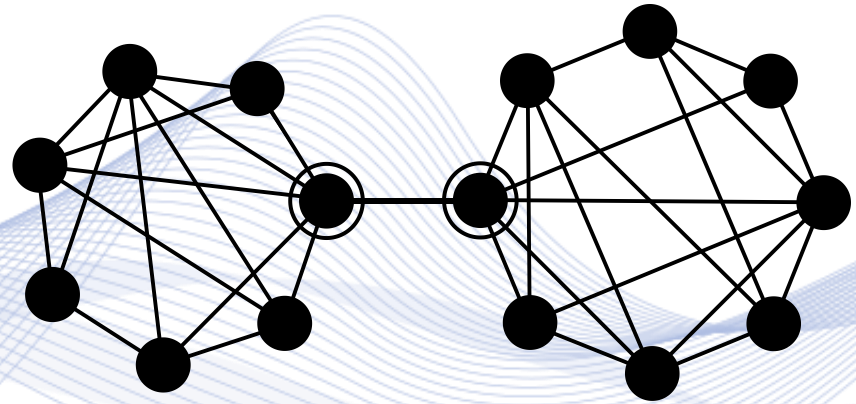
# Computational Politics Methods

***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.

# Computational Politics

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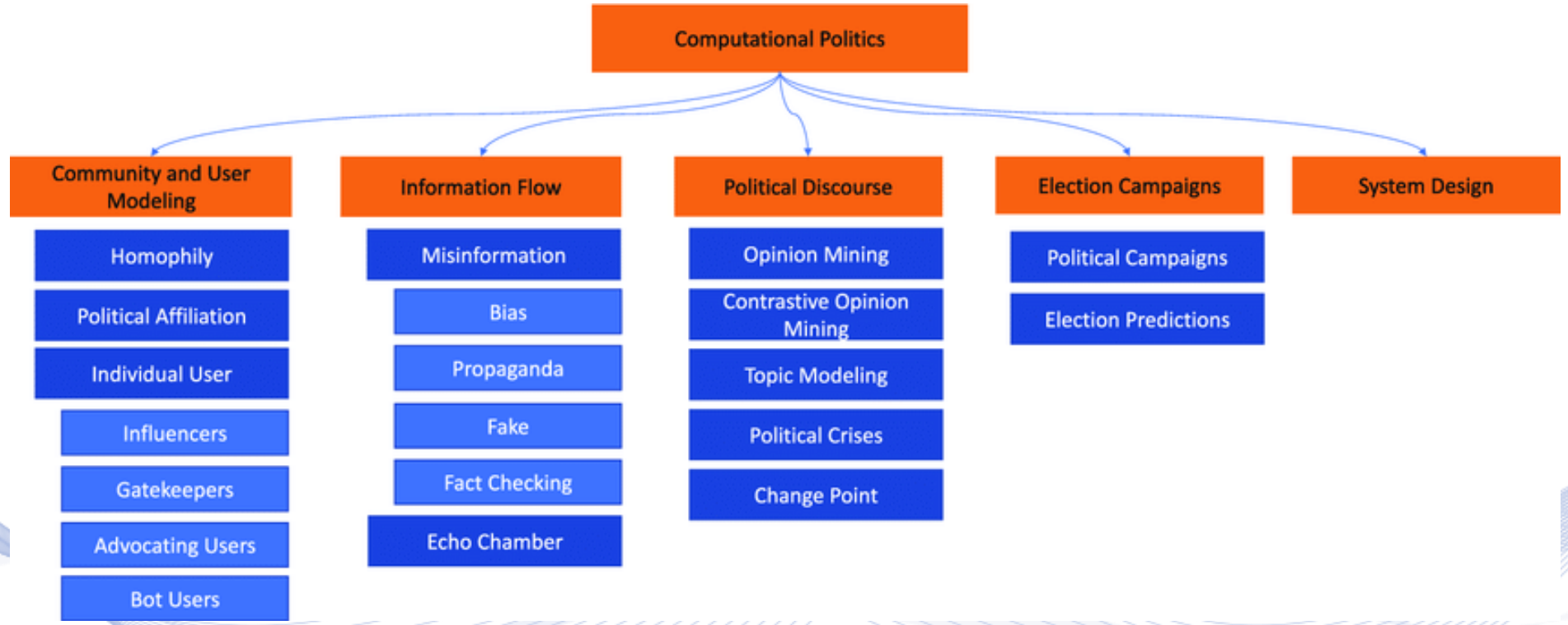
# Computational Politics Topics

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

# Computational Politics Topics




[HAQ2021]

# Political System Modeling

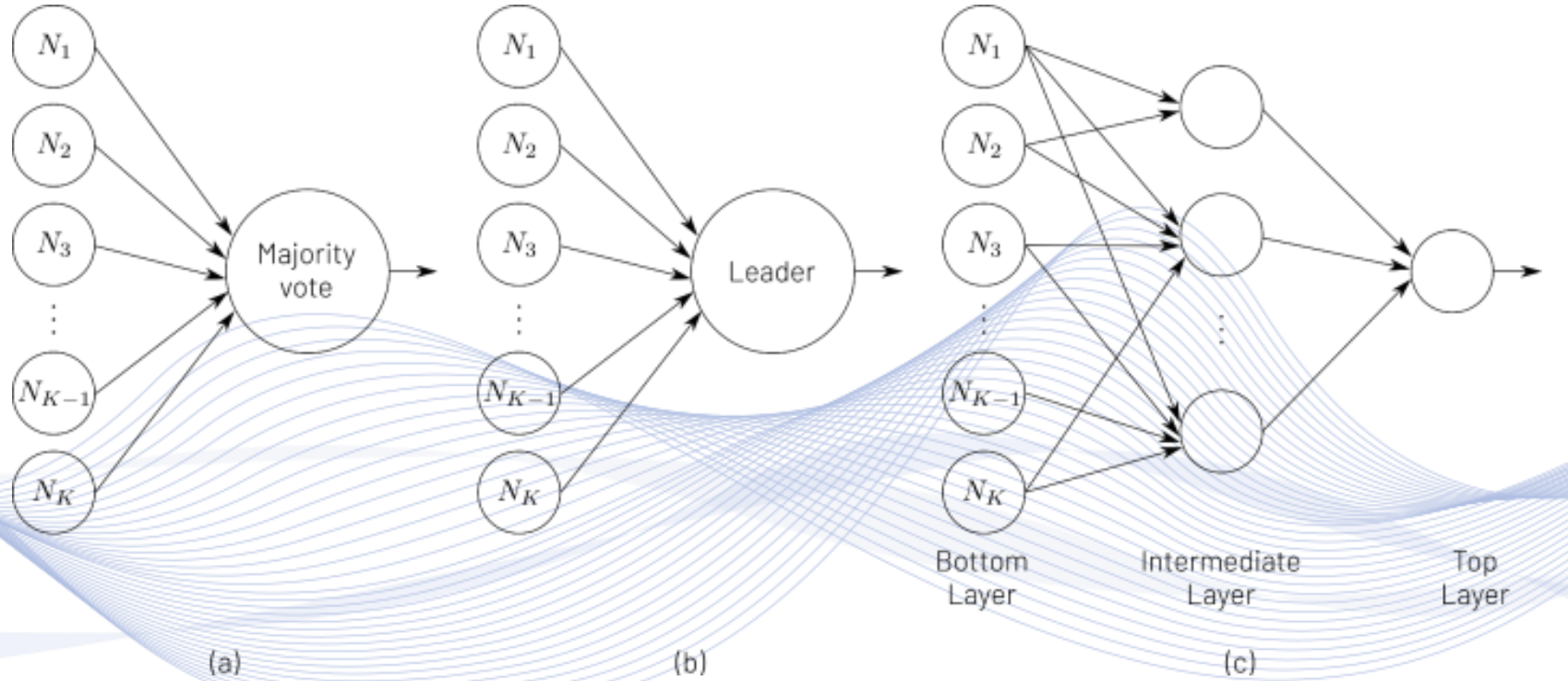
Political System Modeling accurately represents the entities of a political system and their relationships.

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

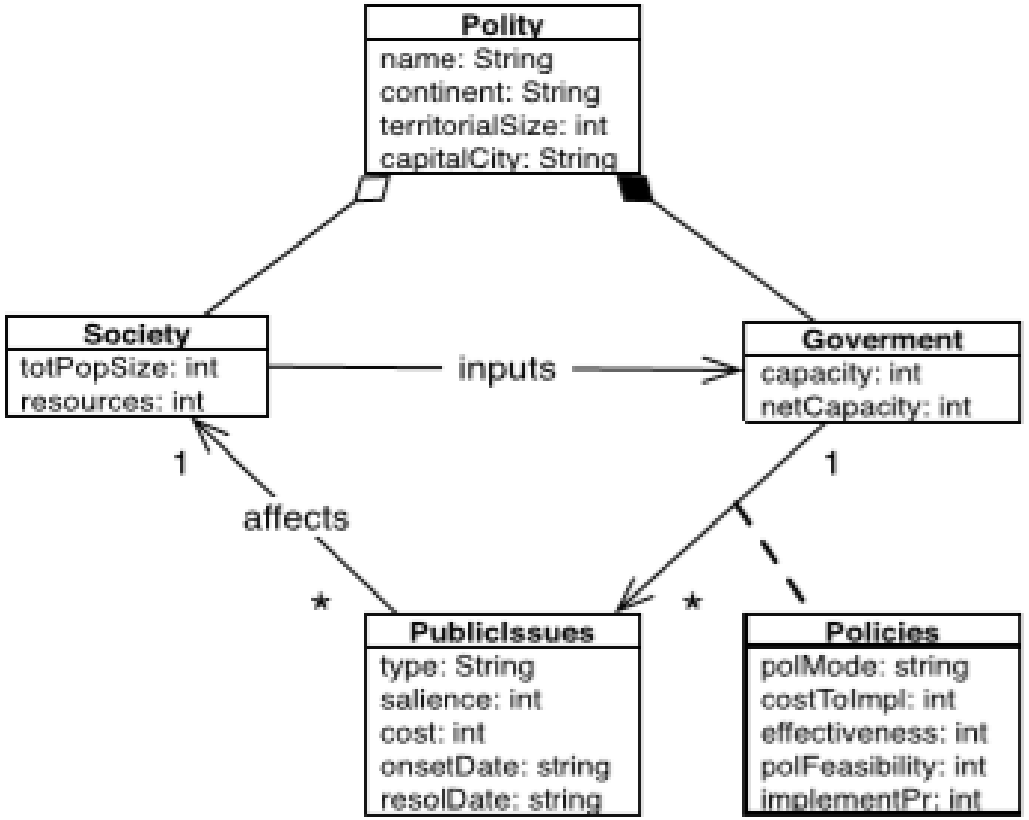
Political systems are complex and hence difficult to model.

- 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.

# Political System Modeling

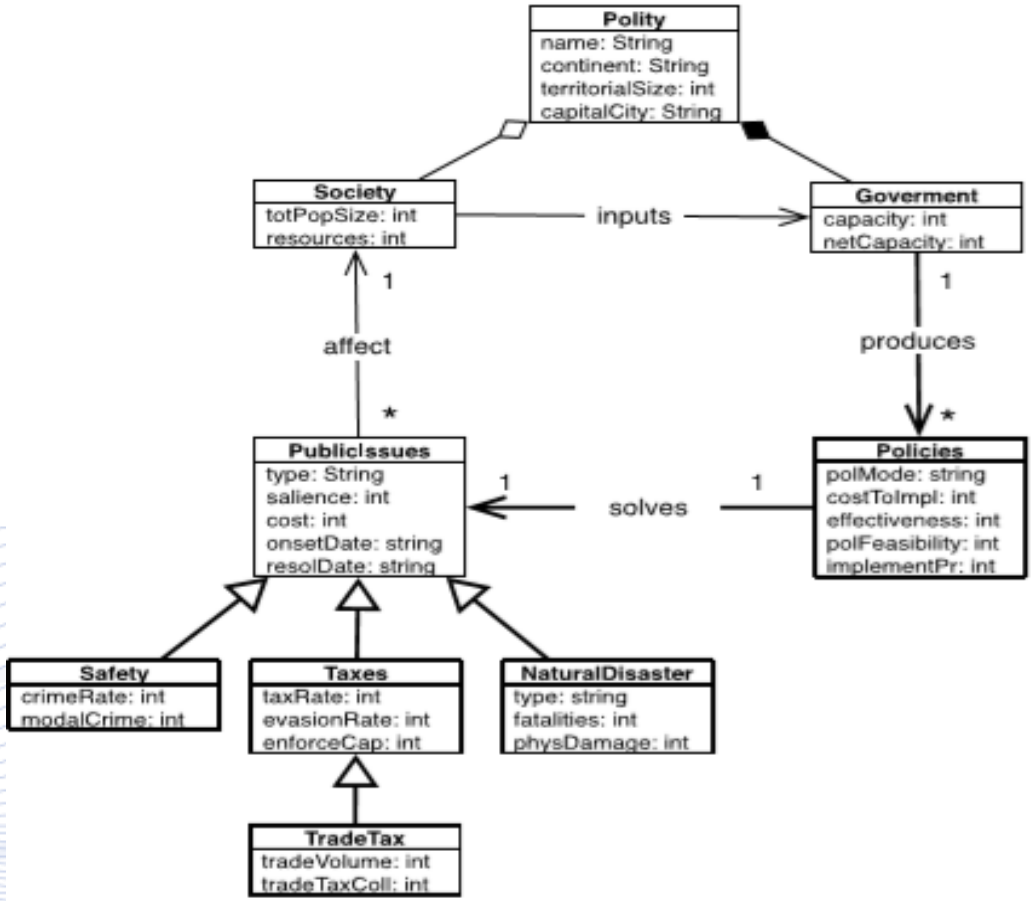
- A sequence diagram dynamically represents the relationships between the entities and the different conditions that occur because of the interactions.
- This type of diagram contains the social entities, their conditions and the interactions between them.
- Through a sequence diagram, the way governments 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

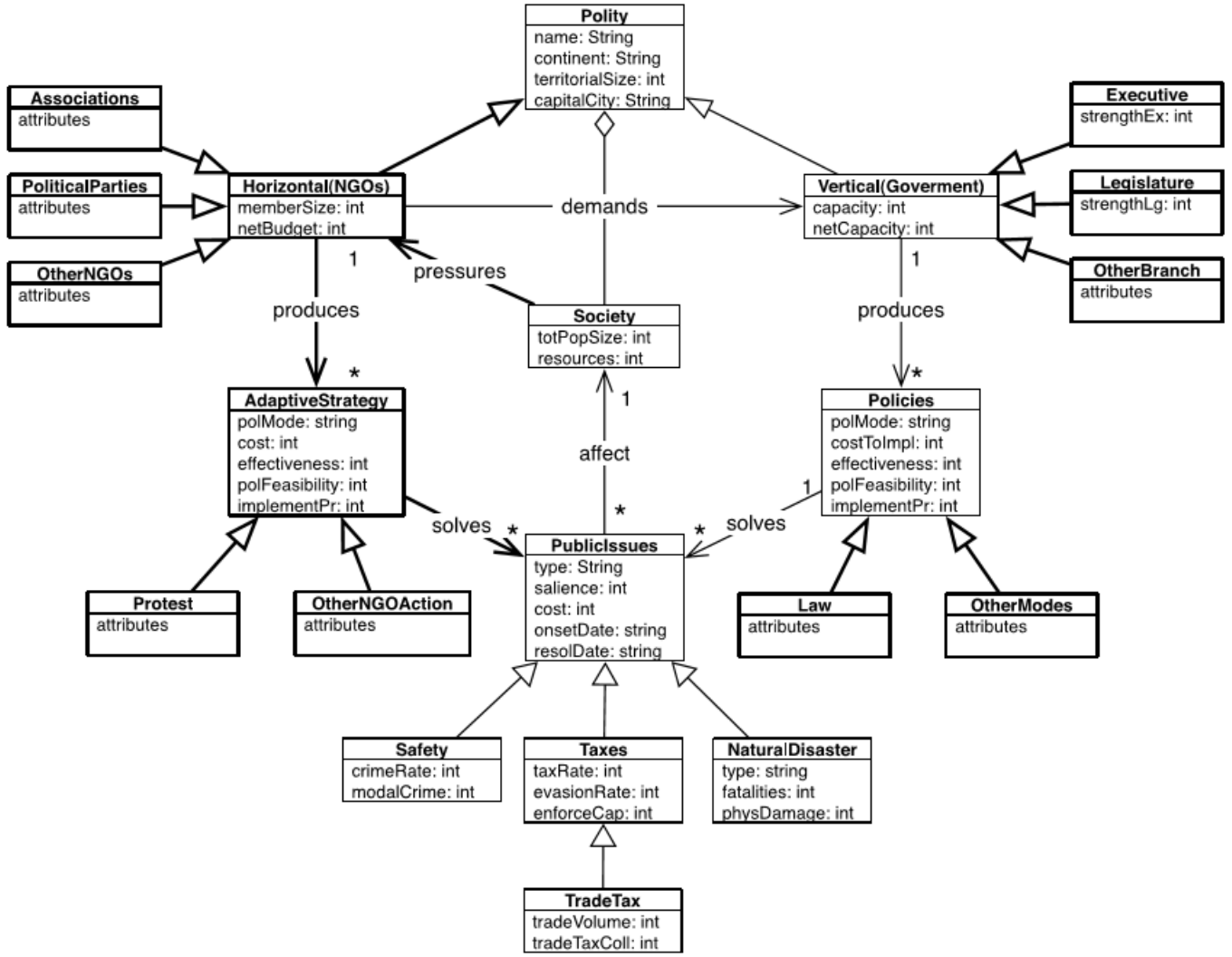



The SimPol medium-resolution model [CIO2009].

# 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

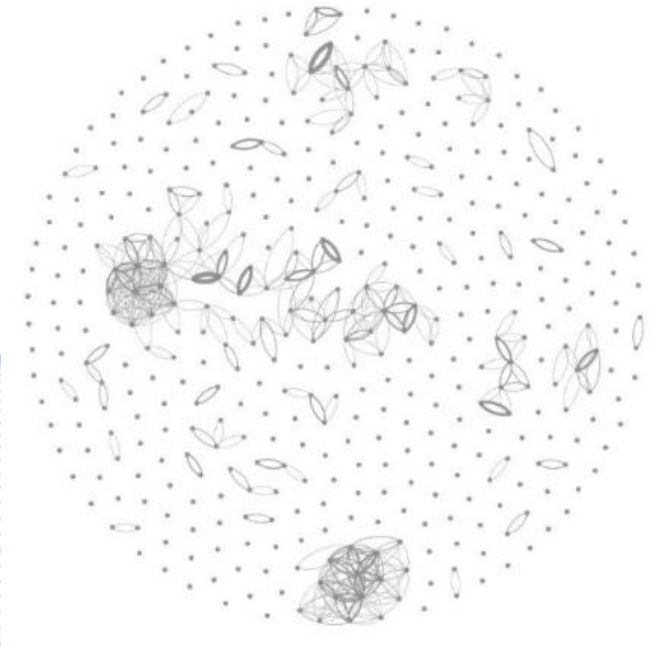
- Individual citizen as well as citizen group/community modeling.
- Formation of citizen communities
  - Virtual online communities.
- Significant aspects concerning citizens' online behavior:
  - ***Homophily***: tendency to form connections with people who are politically similarly minded [GER2013].
- Virtual communities facilitate ***information spread*** by citizens to citizens:
  - Electronic ***word of mouth***.

# Community and Citizen Modeling

***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.



# Community and Citizen Modeling

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 Roma 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].

# 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.

# 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.

# Social Bots and Politics

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

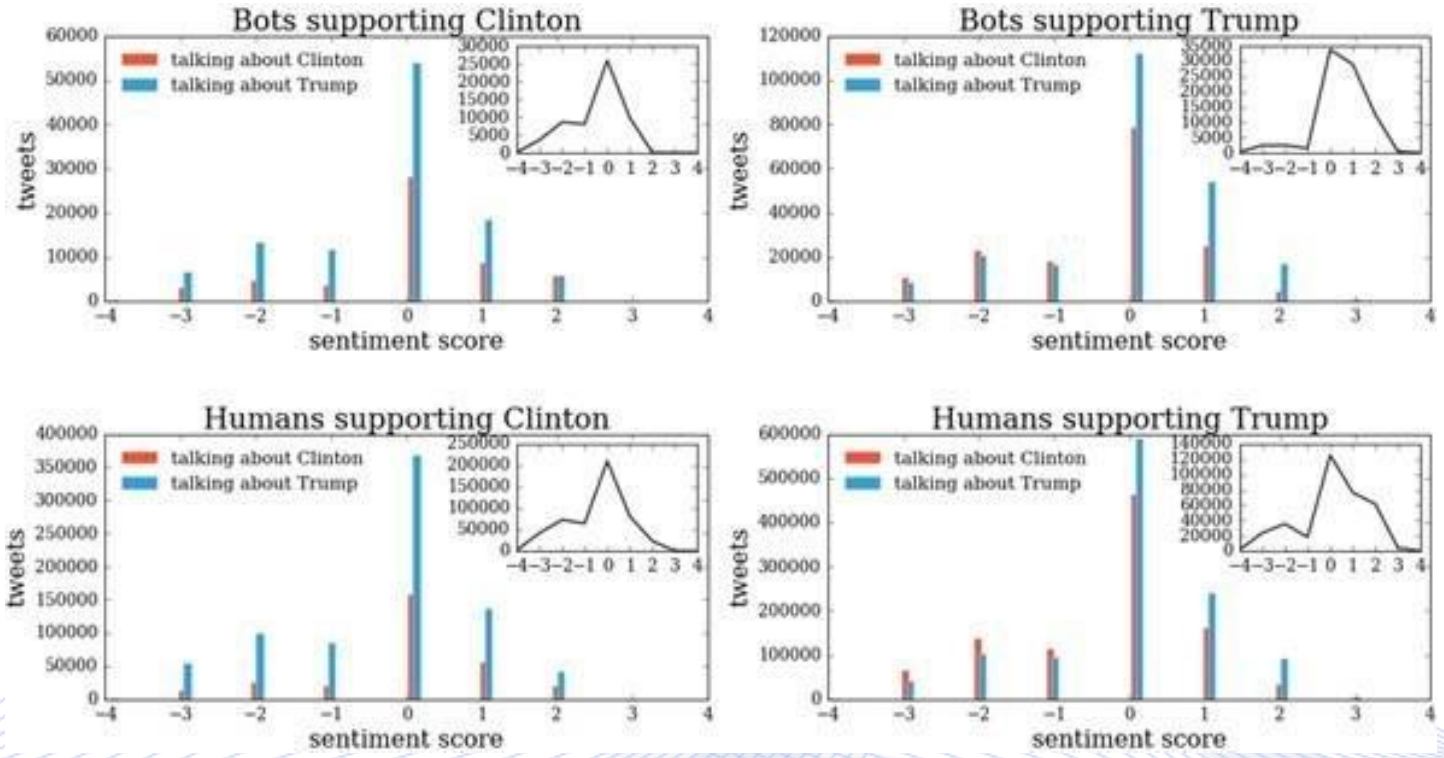
- A list of hashtags and keywords was created.
- A large dataset of 20.7 million tweets having these hashtages was collected.

- 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.

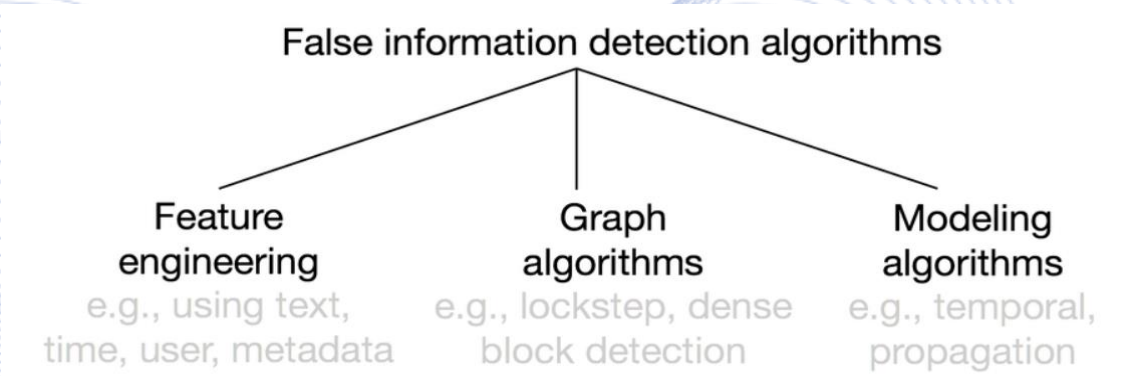
# Social Bots and Politics




[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

***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].

# 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:

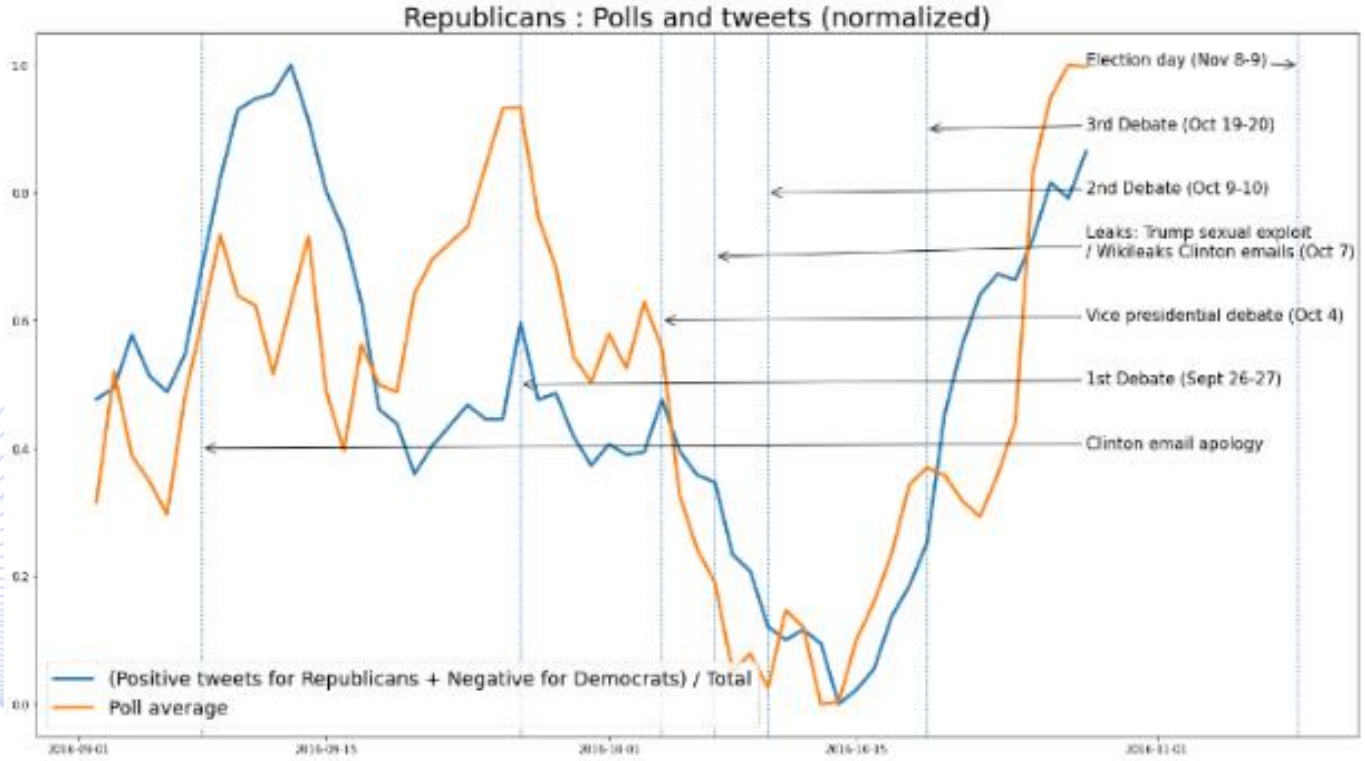
- opinion polls
- political campaign design and execution
- political campaign analysis.

- 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?

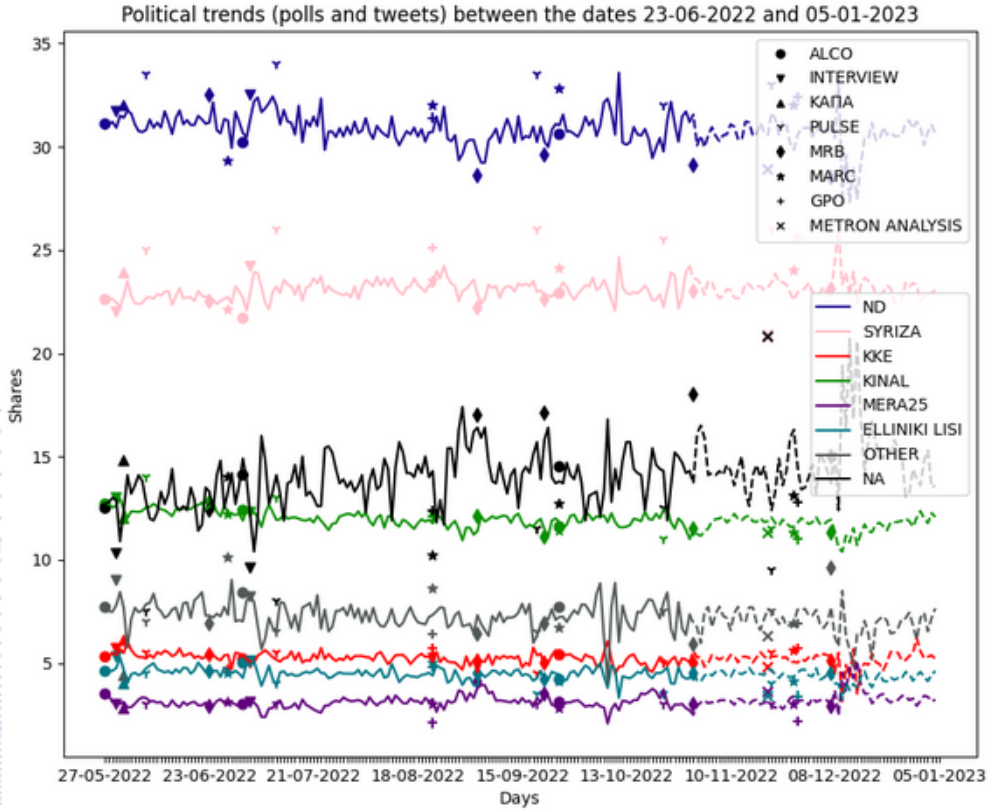



Poll and tweet sentiment trends for Republicans in the 2016 presidential election in USA.

# Election Campaigns

***Time series analysis and prediction***

- Forecasting election results through tweet sentiment analysis.




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

# Political History

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

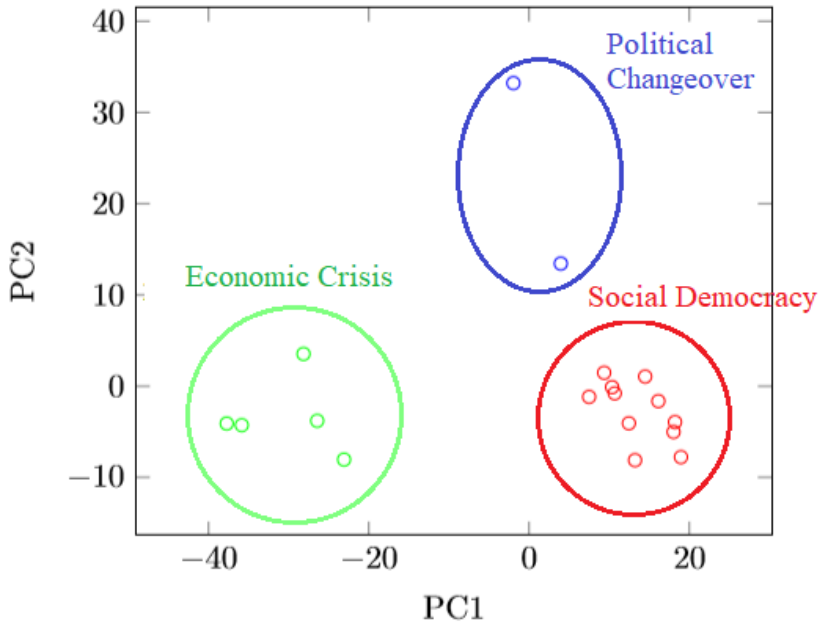
- Identification of major political periods and their major characteristics.
- Identification of major political players in each period.
- Quantitative analysis of political alliances and competition.

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

# Greek Political History

***Visualization of the recent Greek political history.***

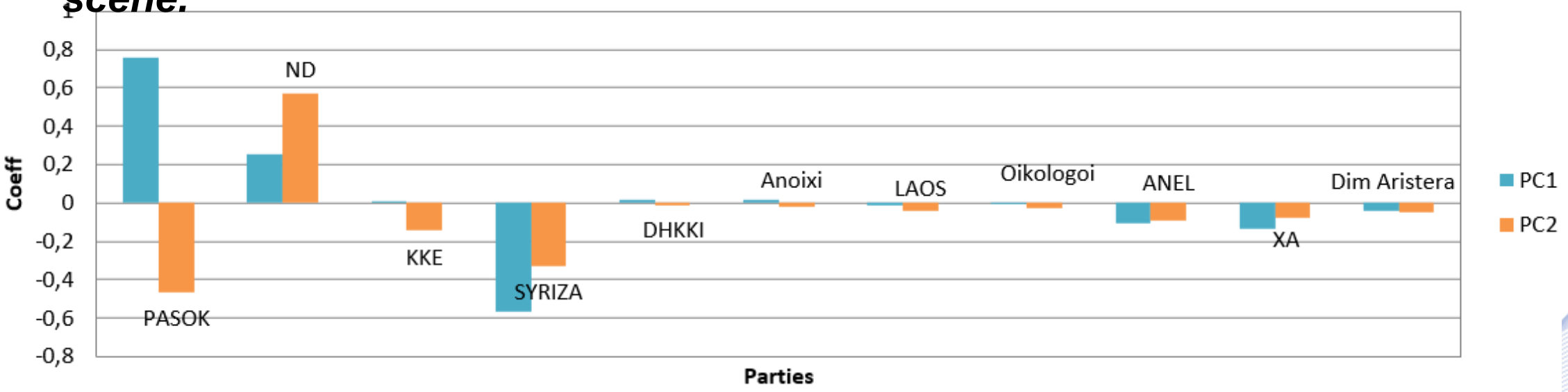
- There were elections in Greece in the period 1974-2019.
- 31 Greek parties that participated even once in these elections.
- ***Principal Component Analysis*** of election results.




Greek election result clusters revealing the 3 political history periods 1974-2019.

# Greek Political History

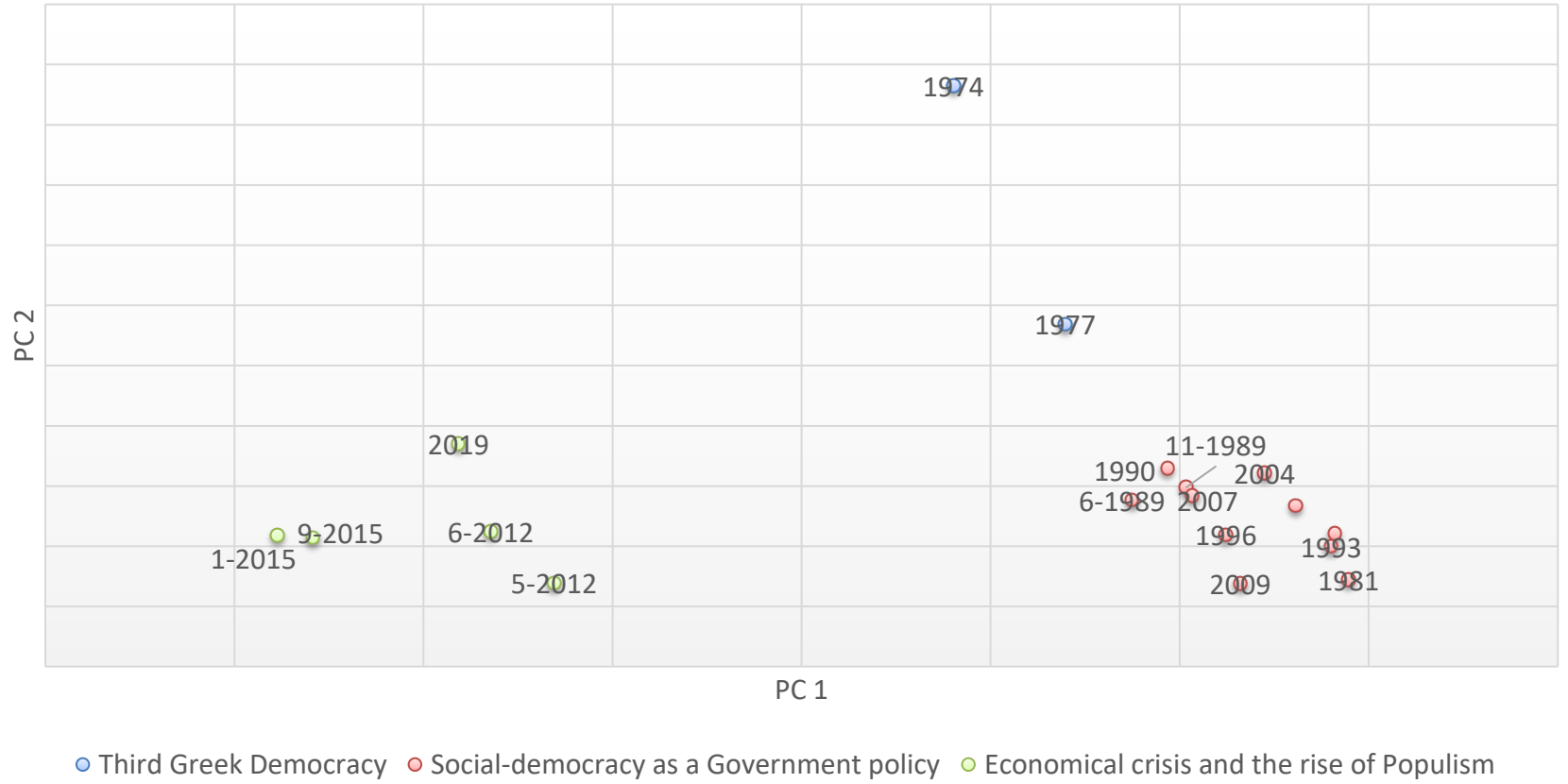
***Principal components of the Greek political scene.***




- The first dimension (PC1) shows a negative relationship between New Democracy (ND) and SYRIZA parties.
- The second dimension (PC2) describes a negative relationship between a) ew Democracy (ND) and b) PASOK, KKE and SYRIZA parties.

# Greek Political History

PCA on national election results

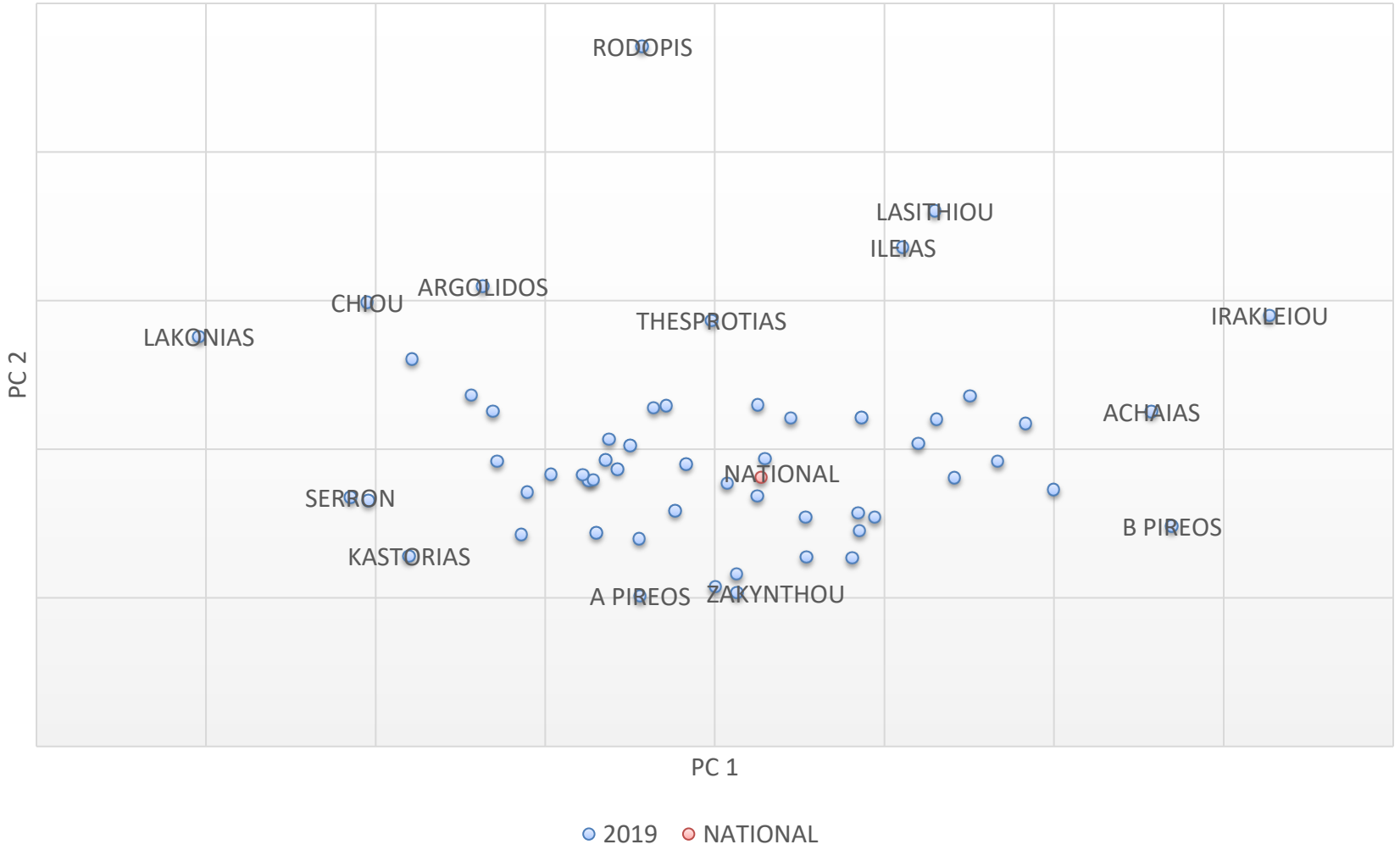


# Greek Political History

- 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.

# Greek Political History

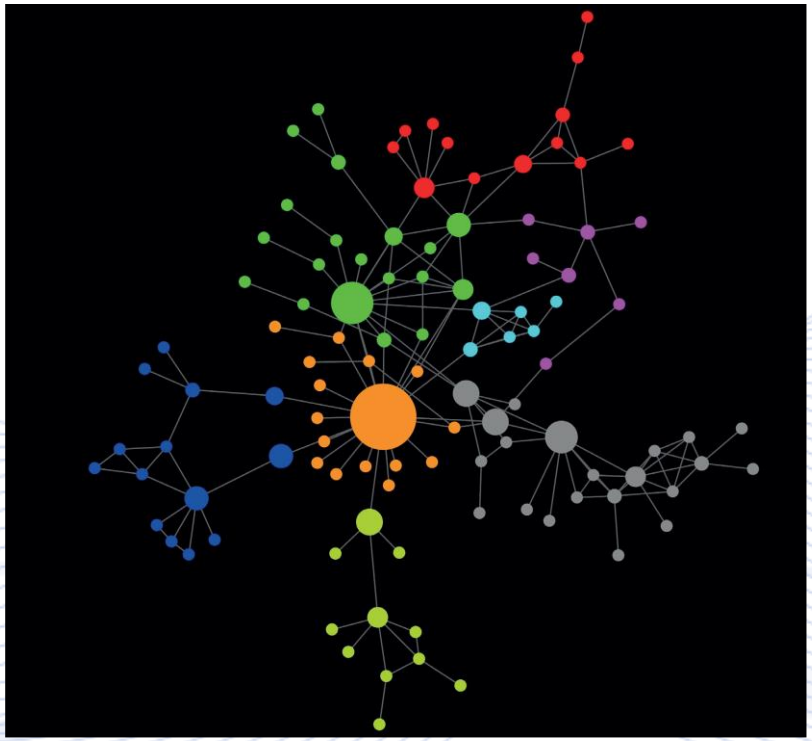
Vote distribution in 2019 (electoral districts with labels outliers).




Artificial Intelligence & Information Analysis Lab

# 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.

# Economics and Politics

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

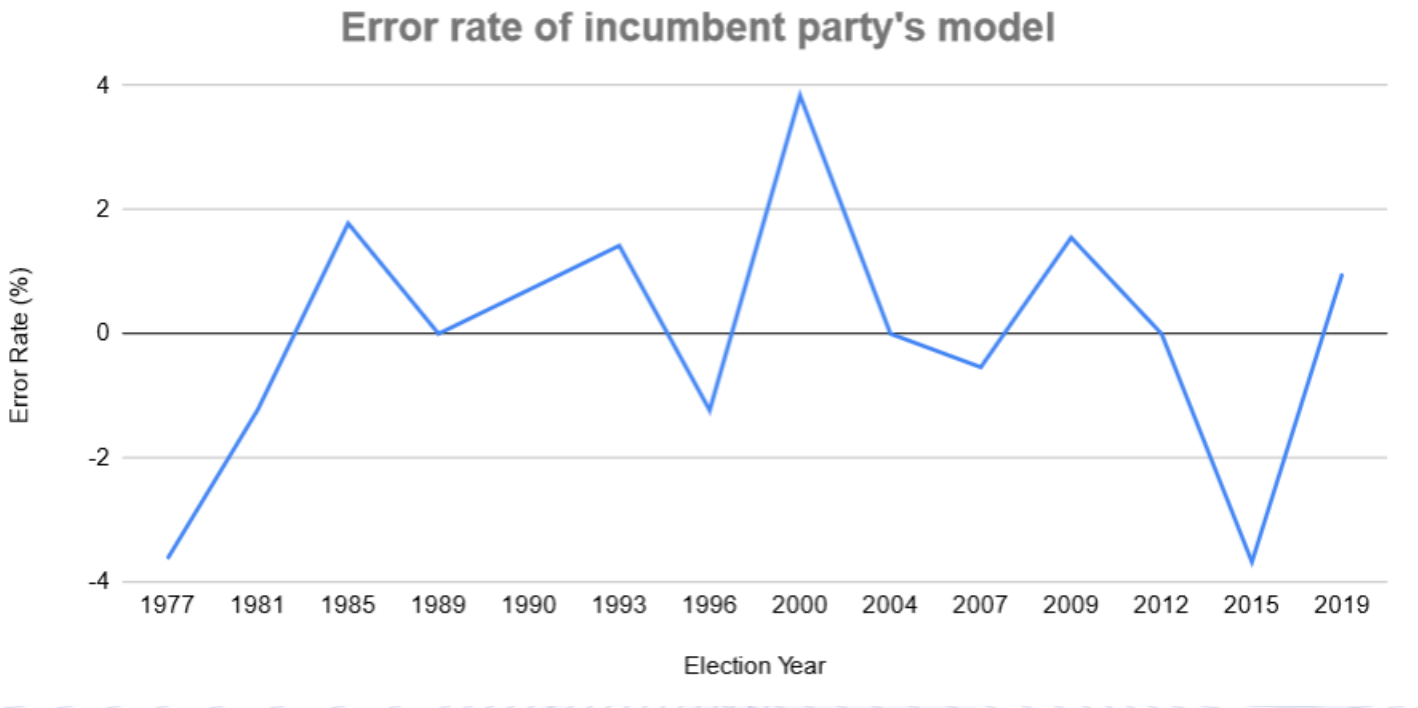
$$V_t = 21.37 + 0.419V_{t-1} - 5.56D89_t - 3.263D02_t - 12.5D10_t - 0.29r_tV_{t-1} + 1.498g_t + 0.266p_t.$$

- $V_t$: 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***: $e(t) = (V_{ot} - V_t)/V_t,$

- $V_{ot}$: true number of votes.

# Economics and Politics




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

# Economics and Politics

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

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

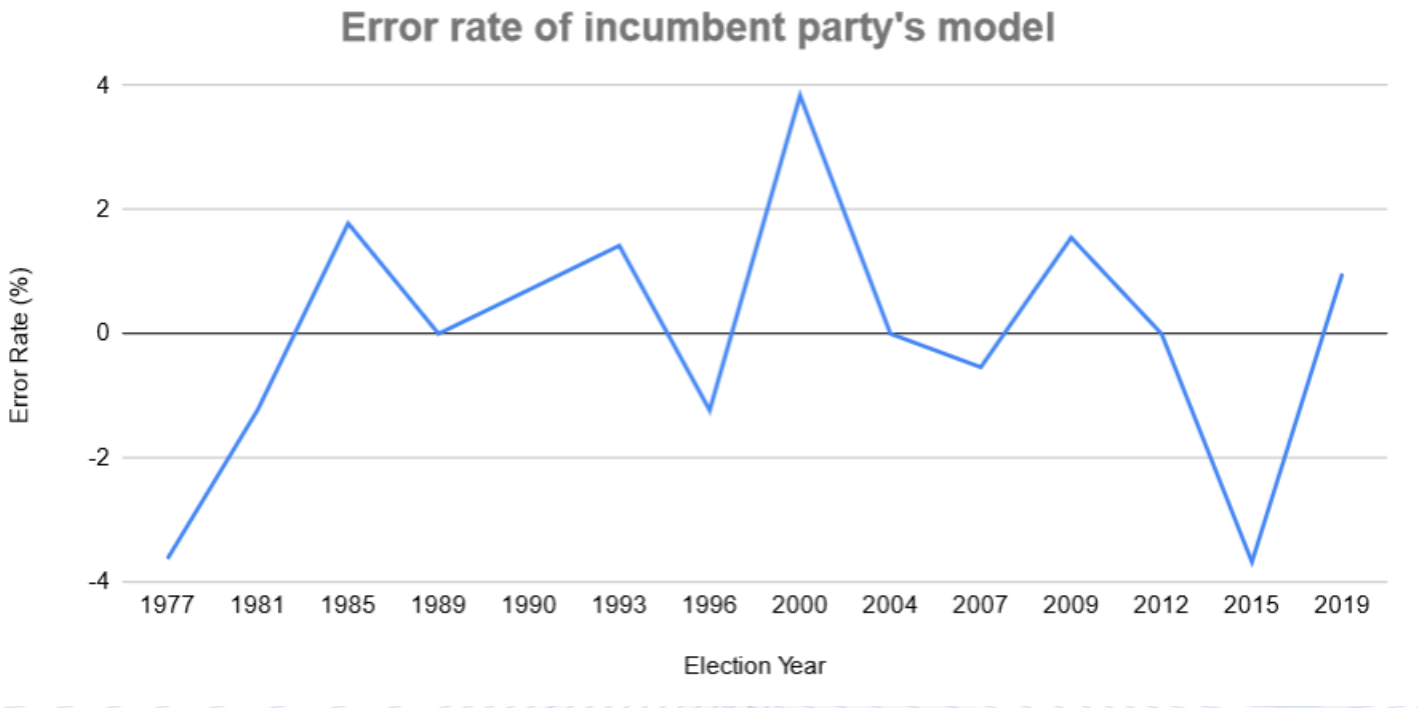
- $V_t$: number of ND party votes.
- $D89_t, D10_t$: dummy variables for the years 1989 (political turmoil over corruption) and 2010 (debt crisis).

- $g_t$: per capita GDP growth rate.

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

- $V_{ot}$: true number of votes.

# 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.

# Computational Politics

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

# 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

Thank you very much for your attention!

More material in
http://icarus.csd.auth.gr/cvml-web-lecture-series/

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