Systems Governance

An Overview on a New Trend Applied to Societal Systems

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Systems Governance: An Overview on a New Trend Applied to Societal Systems

Systems

Engineered Systems

Feedback Control

Societal Systems

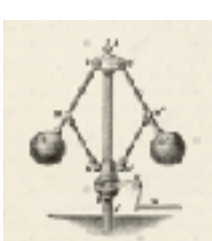
Power harness and control

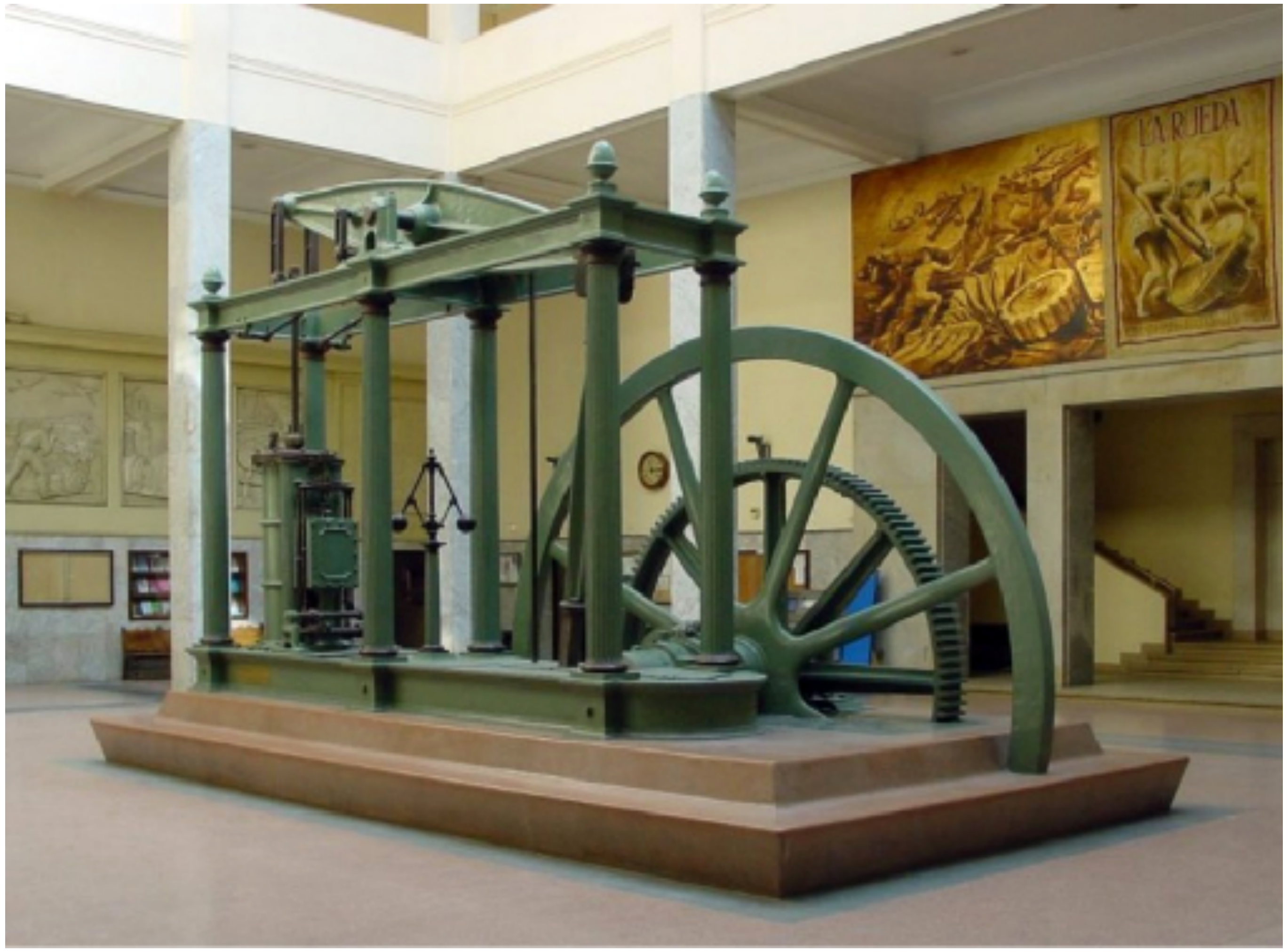
Computation capacities

Sensing capabilities

All these capabilities are exponentially growing since the industrial revolution

Governance

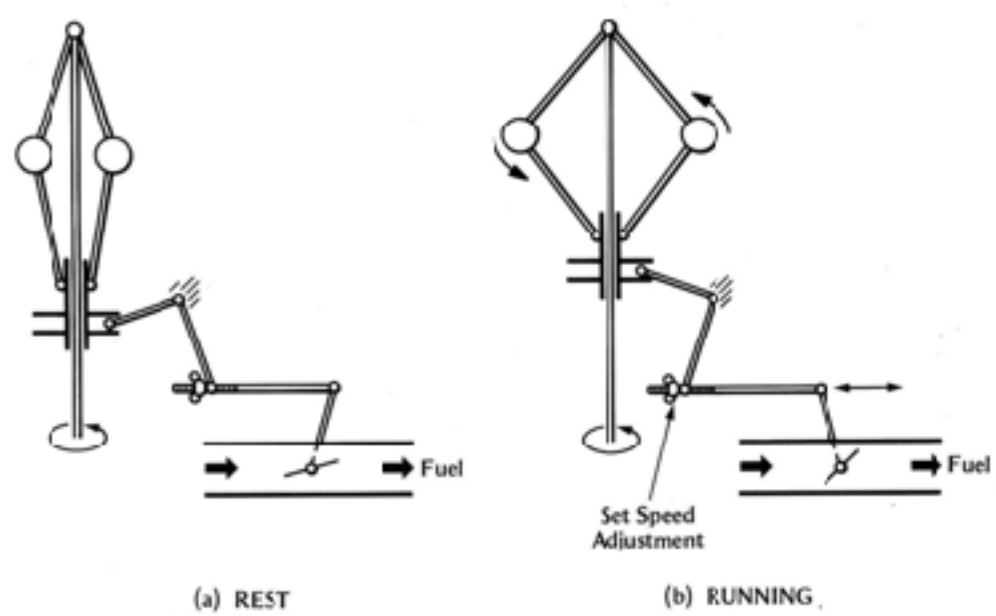


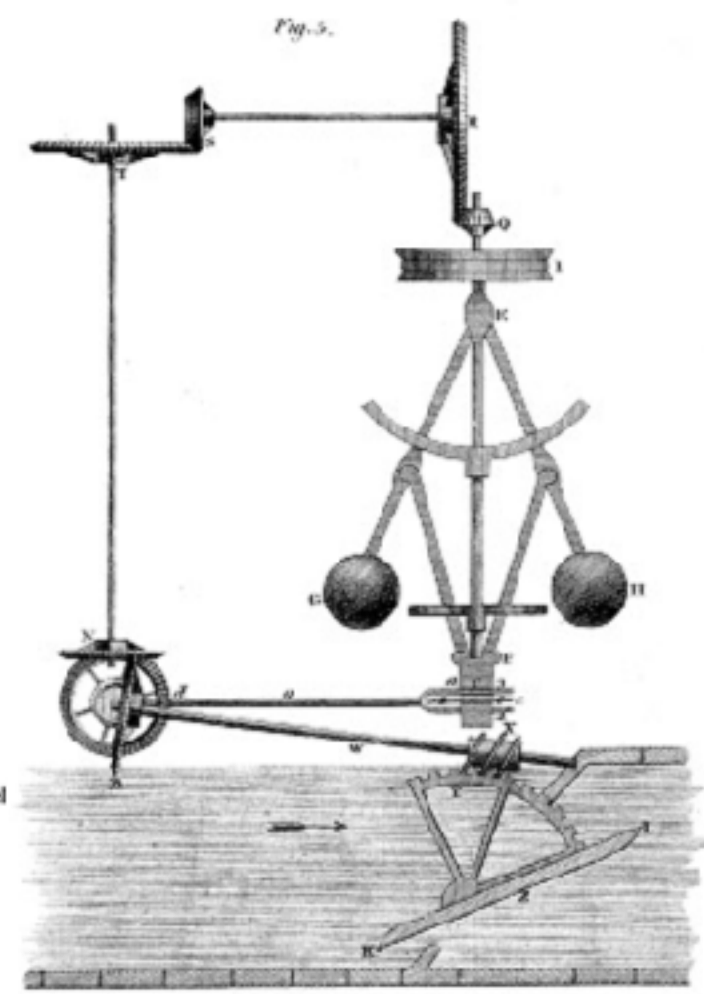


Governance

Boutlon and Watt
Steam Engine

Flyball Governor: runs at a constant speed regardless of any changes in systems environment!





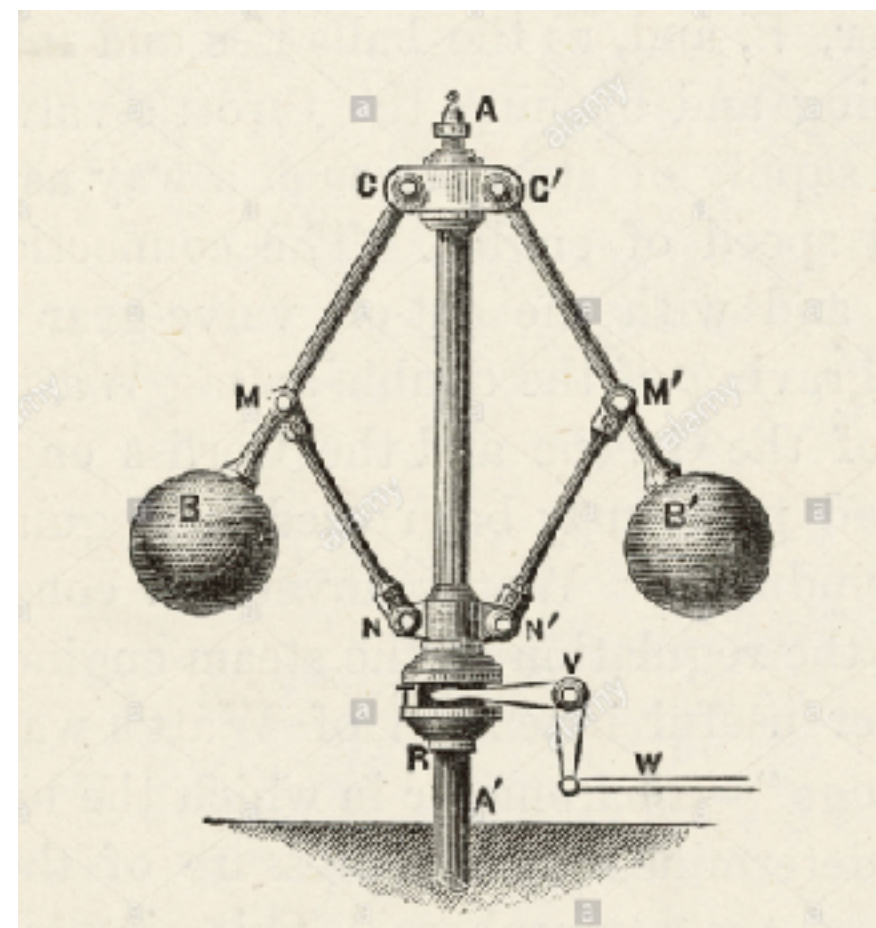
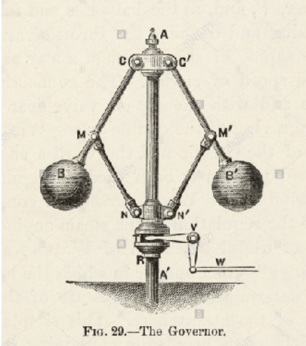


FIG. 29.—The Governor.



A genius Solution with lots of shortcomings in responding effectively in face of sudden **fluctuations** and **oscillations**.

Why not bringing the same concept to a new context?

The case of Governing Fake News

(Ehsanfar and Mansouri, 2017)

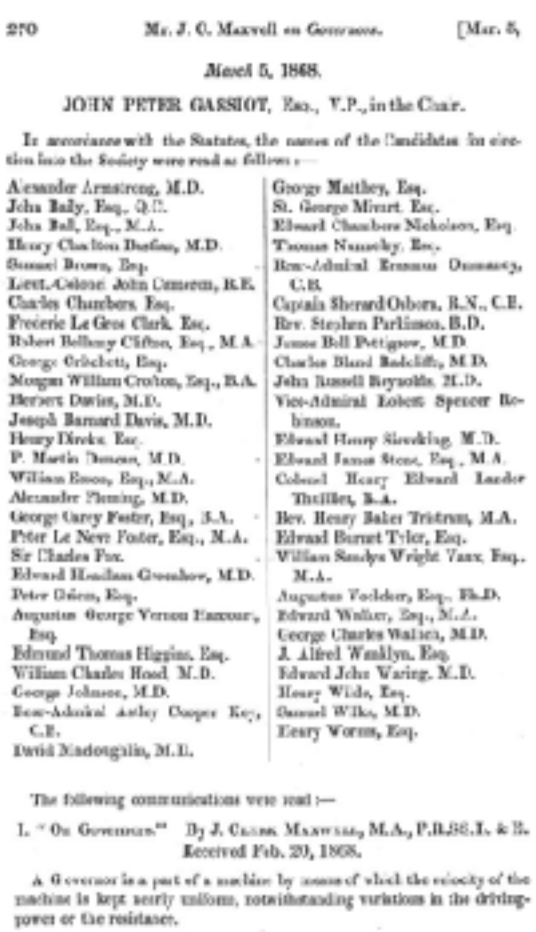
On formulating pay off and mathematical modeling of fake news dissemination.

$$p_v(M) = \begin{cases} 1-c \\ 1-a-c \end{cases} \quad p_d(M) = \begin{cases} 1 & if\ M \geq k \\ 1-a & if\ M < k \end{cases}$$

$$p_v(k) = \begin{cases} 1-cf \\ 1-a-cf \end{cases} \quad p_d(k) = \begin{cases} 1 & if\ k \geq M \\ 1-a & if\ k < M \end{cases}$$

Regular agents: $\overline{P_v}(k)$ $\overline{P_d}(k)$

Fake news agents: $\overline{P_v}(M)$ $\overline{P_d}(M)$


270 Mr. J. C. Maxwell on Governors. [Mar. 5,

March 5, 1868.

JOHN PETER GASSIOT, Esq., V.P., in the Chair.

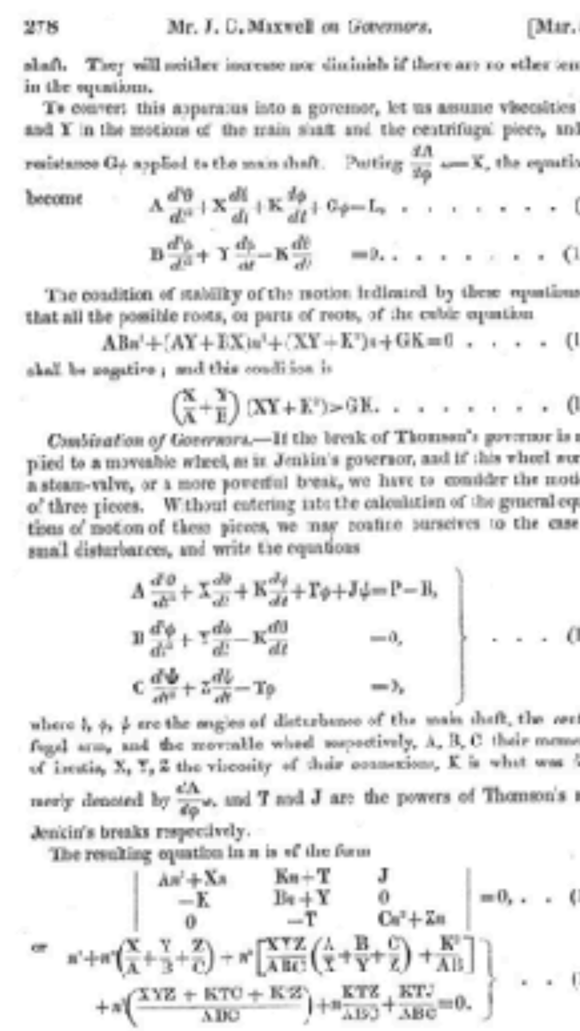
"On Governors." By J. Clerk Maxwell, M.A., F.R.SS.L. & E. Received Feb. 20, 1868.

A Governor is a part of a machine by means of which the velocity of the machine is kept nearly uniform, notwithstanding variations in the driving-power or the resistance.

James Clerk Maxwell

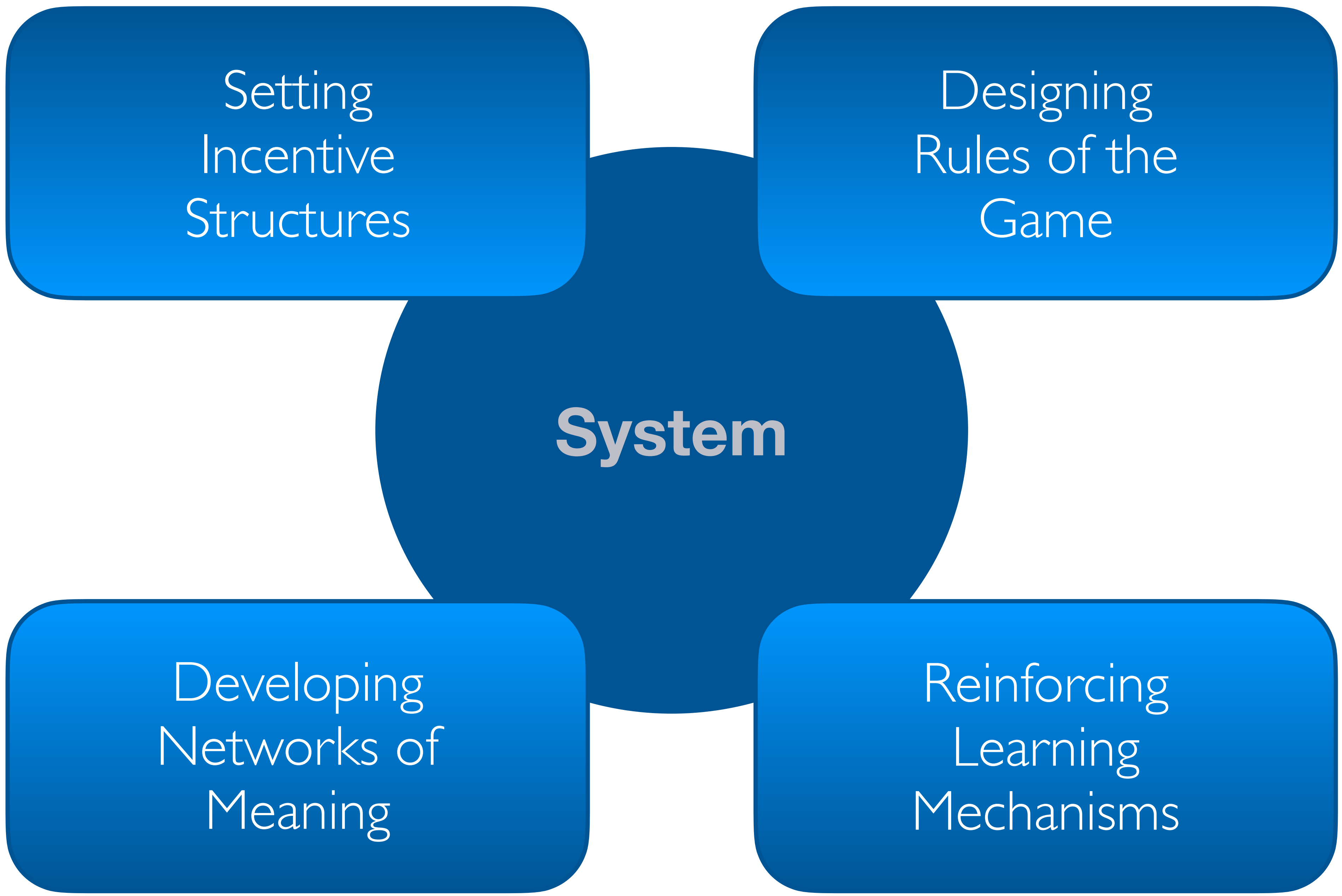
On stability of governors using mathematical models, which lead to a the new field of **Control Theory**.


1868.] Mr. J. C. Maxwell on Governors. 277

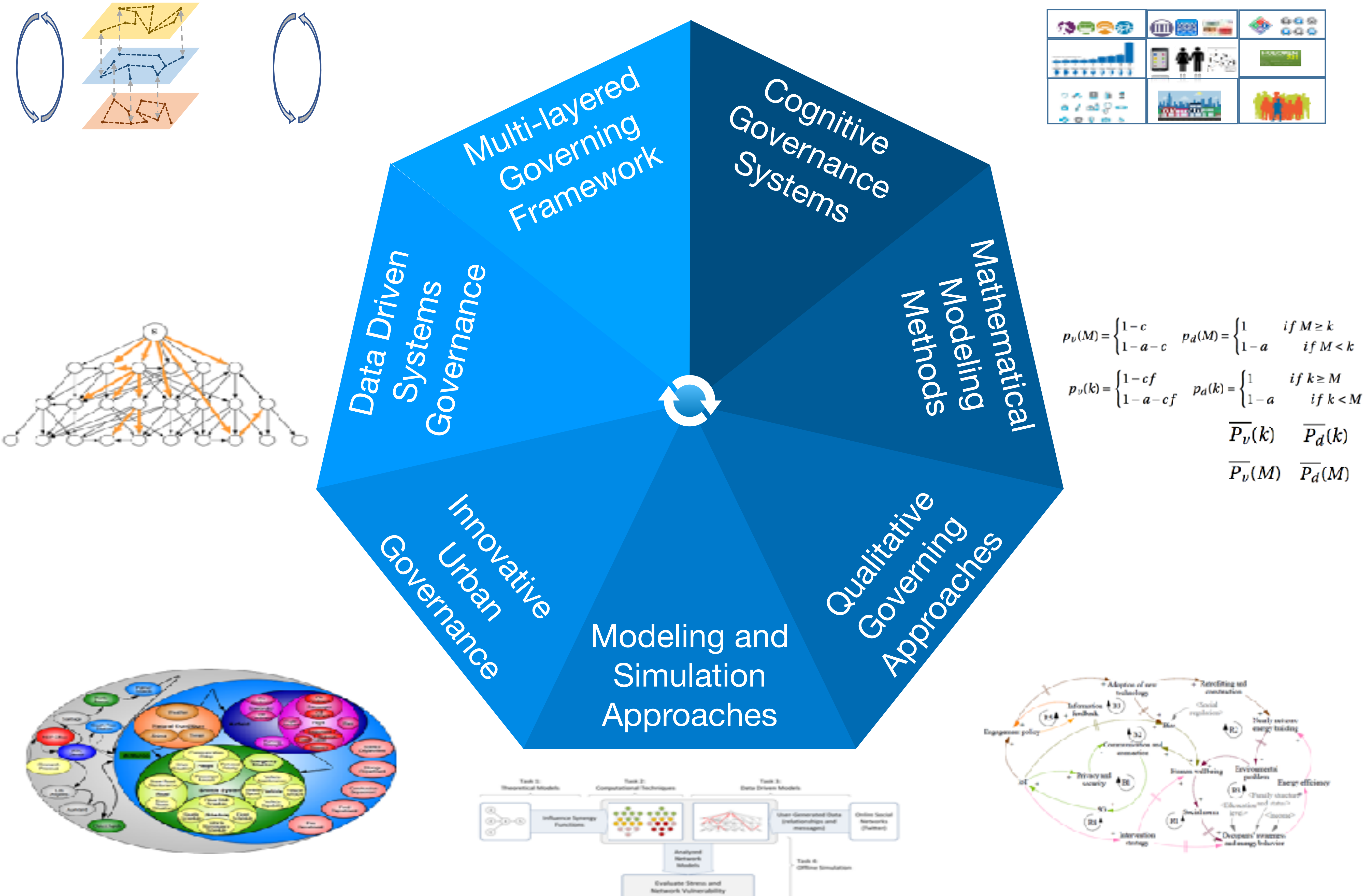

278 Mr. J. C. Maxwell on Governors. [Mar. 5,

Governance of Societal Systems

Implementation of governing policies through:

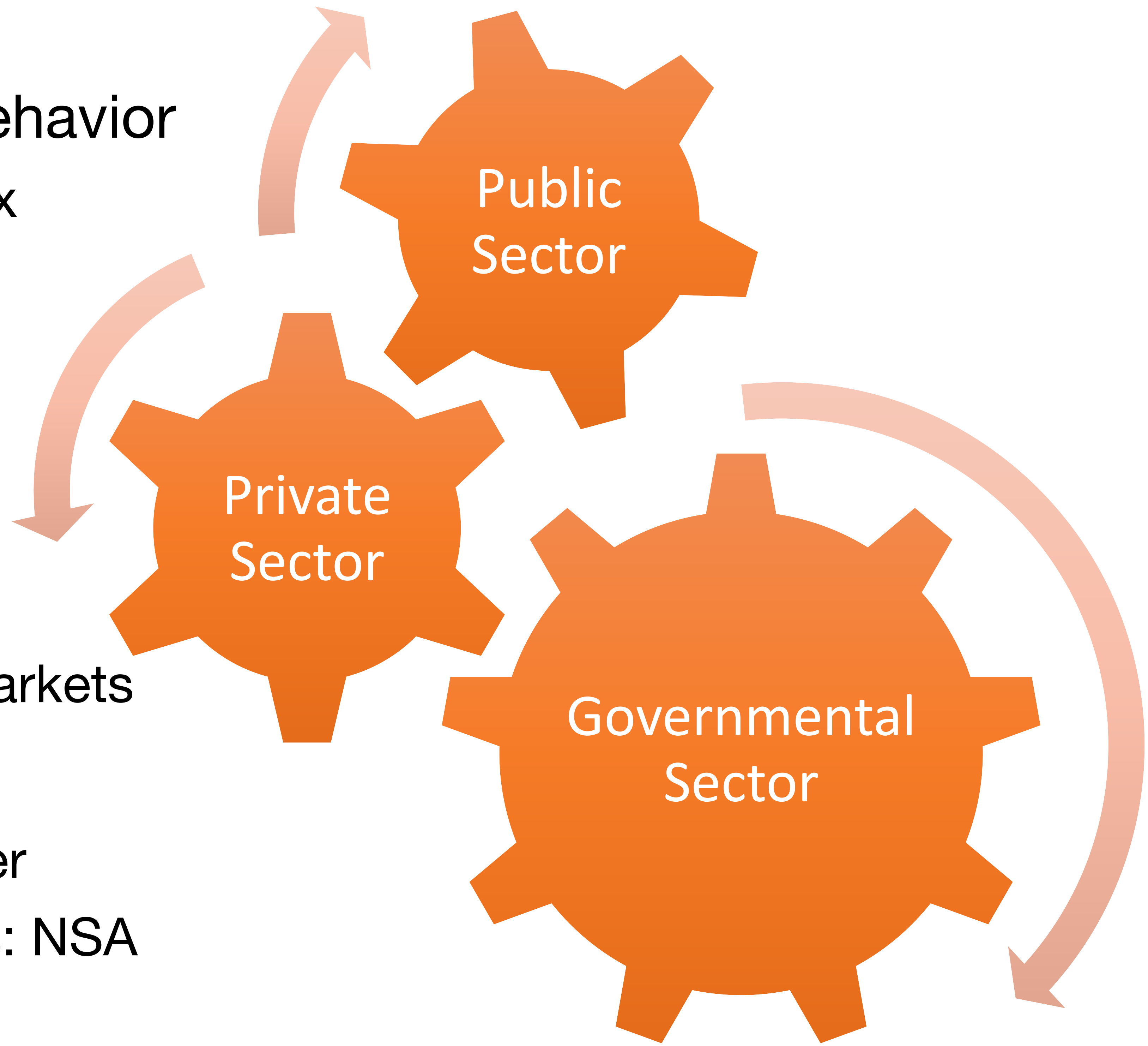


Understanding the Nature of the Beast



Trends in Data Science Approach to Governance

- High frequency data analytics
  - Financial systems
- Discovering patterns of behavior
  - Topological analysis: Netflix
  - Relational analysis: Target
- Users profiling
  - Marketing
  - Politics
  - Policymaking
  - Designing products and markets
- Conceptual analytics
  - Influencing behavior: Twitter
  - Text/Voice/Pattern analysis: NSA



Cities as Complex Systems

Holistic approach

Equilibrium and dynamics

Patterns and processes

Paradoxes and conflicts

Behavioral patterns

Collective actions

Agency and emergency

Connectivity and diversity

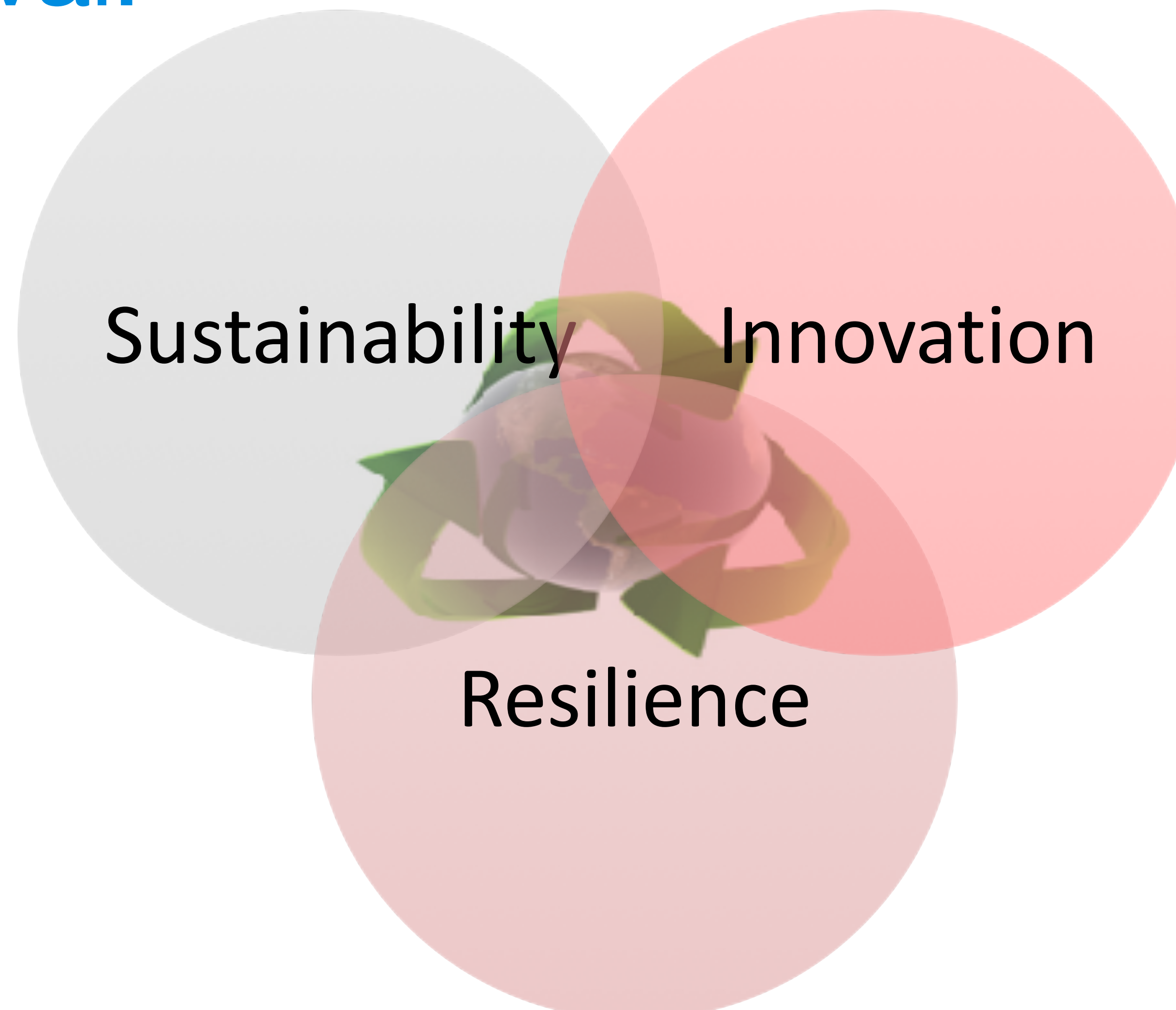
Autonomy and belonging

Competition and collaboration

Accessibility and segregation

Cities as a Platform for Transactions

Change is necessary for survival!



- Technological advancements
  - Transportation
  - Healthcare
  - Energy
  - Finance
- Disasters
- Maintenance
- Environmental concerns

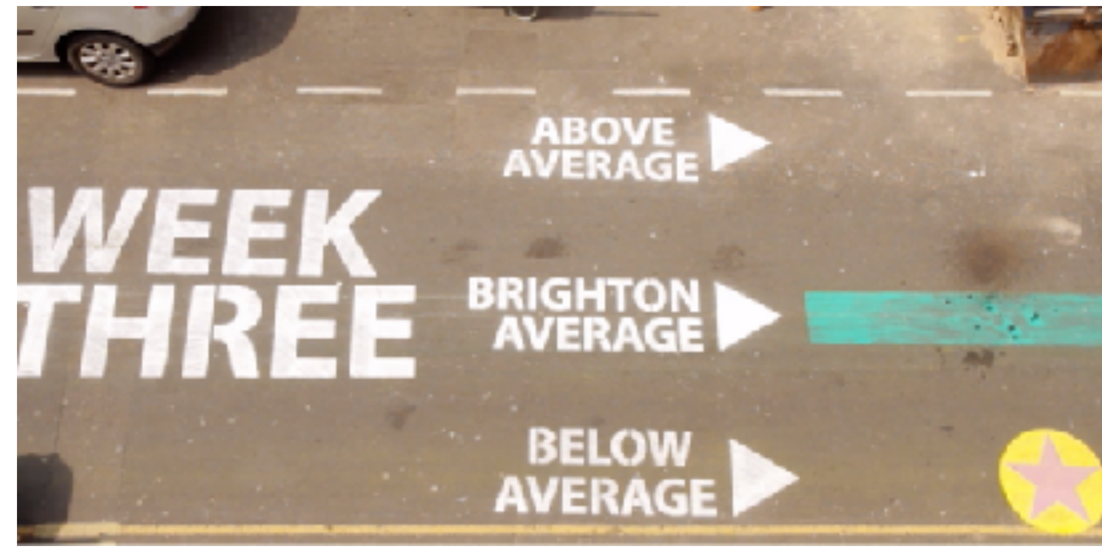
Influencing Behavior: Transportation Systems

Successful cases around the world

- Trans Millennia project in Bogota to incentivize bus riders
  - Flexible development and protection of public interest
- Bikers’ lane project in Bogota
  - Allocating budget based on public need
- Sunday project in Bogota
  - Closing down a part of city to traffic for encouragement of pedestrians
- Copenhagen protective plan for bikers
  - 37% of all work related commutes are on bikes and the number of bikers has doubled in 10 years (by 2010)
- Paying attention to cognitive sciences
  - Horizontal sight senses
  - Feeling of belonging
  - Sensations of public joy

Influencing Behavior: Energy Systems
Case of Tidy St., Brighton

- Using a non-technological approach:
  - Self-reporting on the site
  - Street visualization
  - Door-to-door training
- Application of simple principles:
  - Communal engagement
  - Peer pressure as an incentive force
  - Public education on consumption
- Emergence of technology:
  - Using sensors and digital visualization
- Study patterns of social behavior:
  - Influence the collective action
  - Engagement and interaction



Sensing and Action: Smart City
Case of Rio De Janeiro

- Human-centric city sensing:
  - Cameras and sensors all over the city
  - Situation room with relevant representatives
  - Crisis management
  - Social assistance
  - Security and safety
  - Utility services monitoring
  - Infrastructural services monitoring
  - Integrated and real-time operation

Hoboken: A Urban Governing Lab

- Hoboken is the perfect candidate to experiment with a full-scale smart city implementation across all aspects of urban living.
- The strong institutional support of the City government is key to the success of the project.
- First project of this scope in the U.S.

<u>Fact Sheet</u>

- Population (2011): 50,060.
- % change since 2000: +29.8%
- Median resident age: 31.2 years
- Median household income (2009): $112,174
- Median NJ household income (2009): $68,342
- Per capita income (2009): $75,941
- Median home value (2009): $579,045
- Cost of Living Index: 132

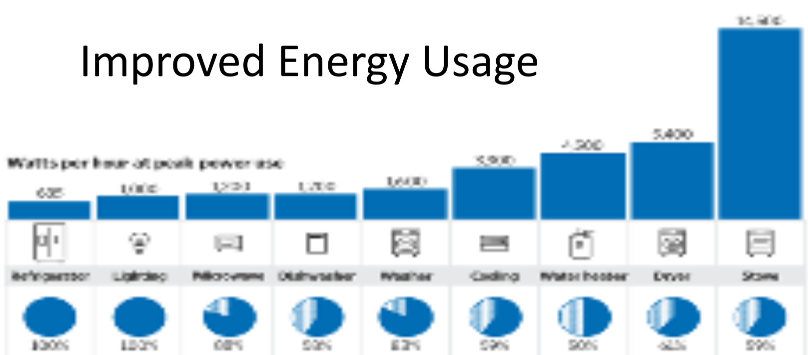
Sensing, Analyzing, and Learning

Improved Commuting Decisions

Improved Urban Governance and Participation

Improved Disaster Preparedness

Improved Energy Usage



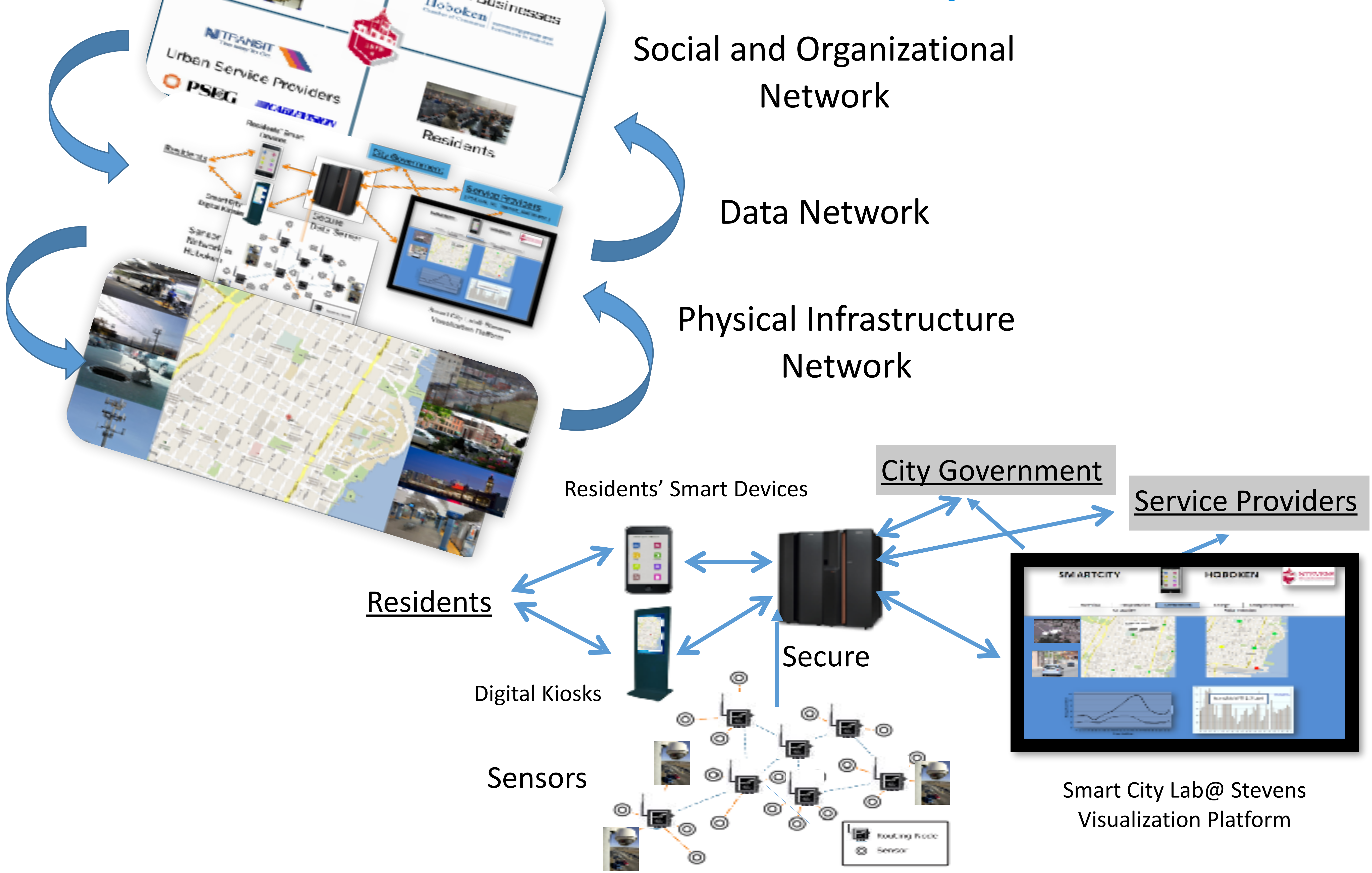
Improved Urban Services

Strengthened Healthcare Delivery and Public Health

Strengthened Local Economy and Solutions Exchange

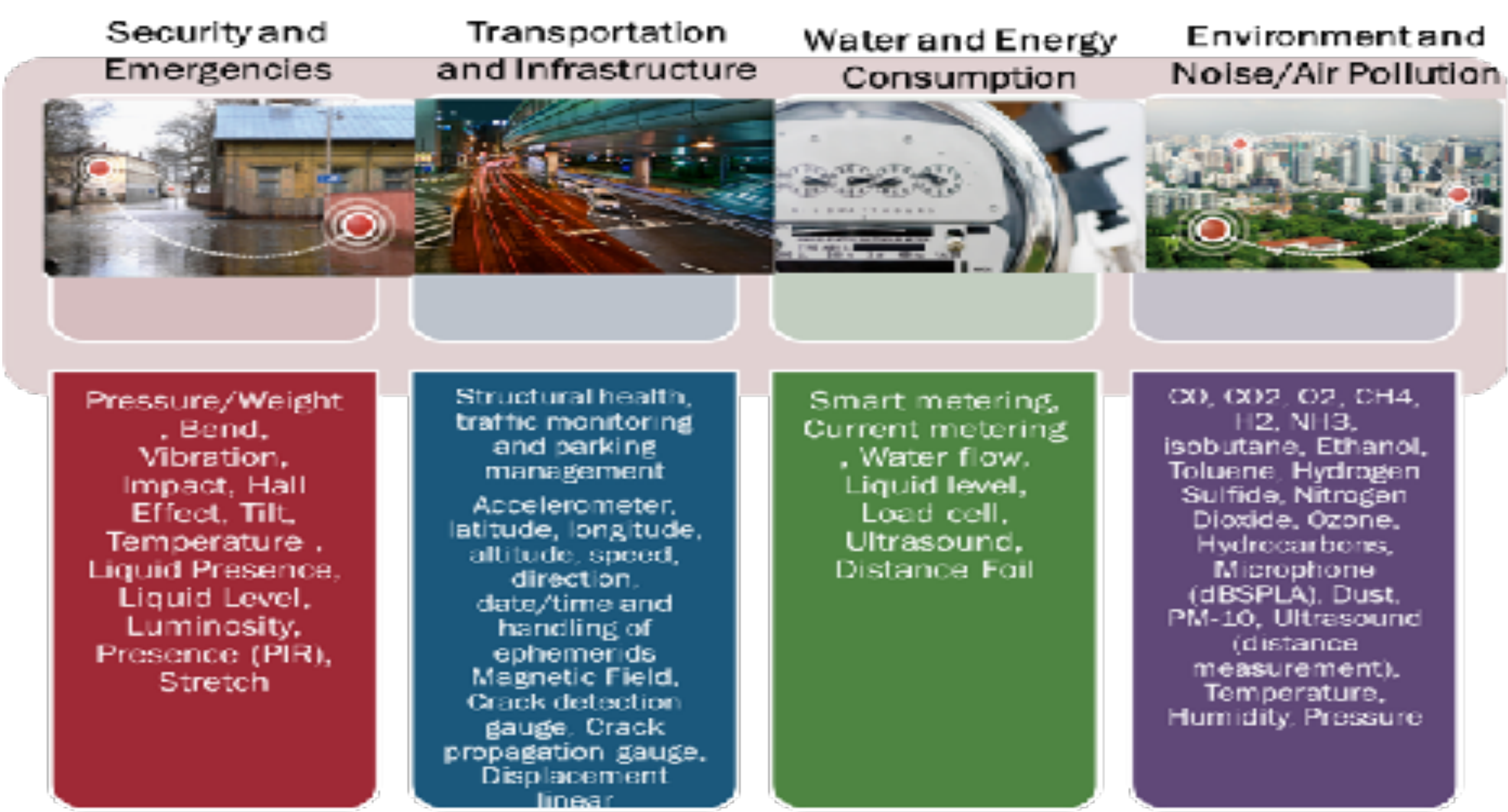
Strengthened Community

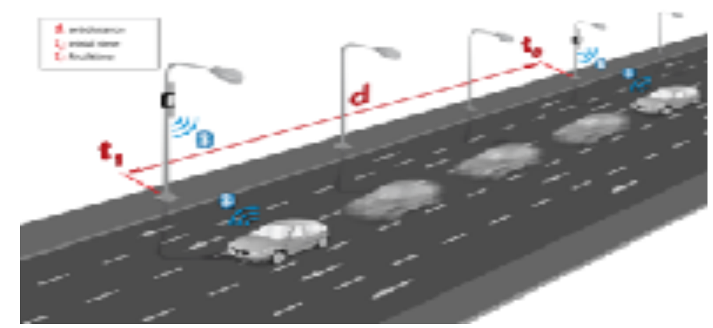
Multi-Layered Smart City Architecture



Plot


Zone A
Zone B
Zone C
Zone D


Security and Emergencies
Transportation and Infrastructure
Water and Energy Consumption
Environment and Noise/Air Pollution
Pressure/Weight, Bend, Vibration, Impact, Hall Effect, Tilt, Temperature, Liquid Presence, Liquid Level, Luminosity, Presence (PIR), Stretch
Structural health, traffic monitoring and parking management
Accelerometer, latitude, longitude, altitude, speed, direction, date/time and handling of ephemerids, Magnetic Field, Crack detection gauge, Crack propagation gauge, Displacement linear
Smart metering, Current metering, Water flow, Liquid level, Load cell, Ultrasound, Distance Foil
CO, CO2, O2, CH4, H2, NH3, isobutane, Ethanol, Toluene, Hydrogen Sulfide, Nitrogen Dioxide, Ozone, Hydrocarbons, Microphone (dBSPLA), Dust, PM-10, Ultrasound (distance measurement), Temperature, Humidity, Pressure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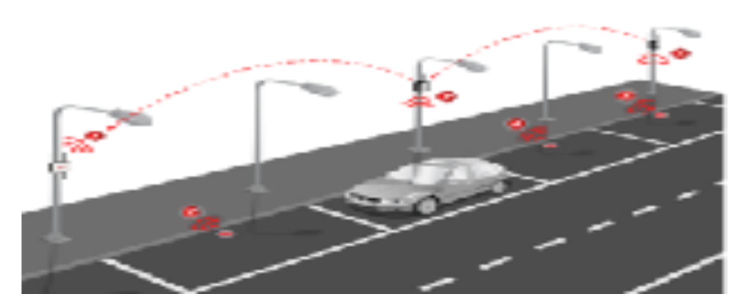


Smart Cities App

Open Source Platform with more than 35 Smart City functionalities for use and customization by any city

App

Individual Data

- Transportation Choices and Parking Behavior
- Energy consumption and Household Carbon footprint
- Emergency and Disaster Situational Data
- Crime and emergency (fire, medical) reporting
- Urban infrastructure issues
- Lifestyle choice data and Innovations Exchange Data

Sensors

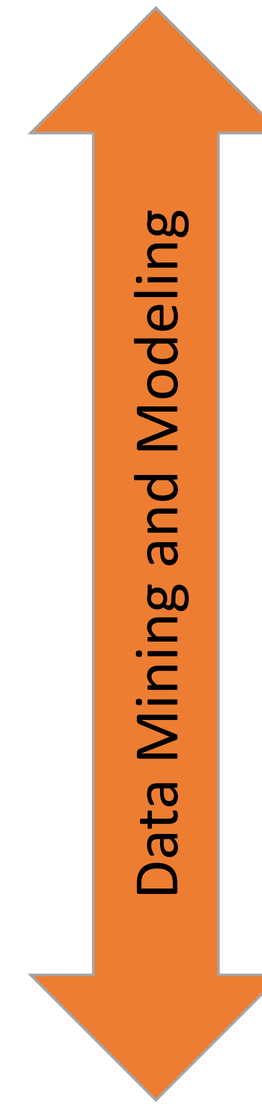
Real-time Data

- Traffic conditions
- Transit conditions
- Pedestrian flows
- Air Quality, Noise and GHG Emissions
- Flooding data
- Abnormal Activity

Archival

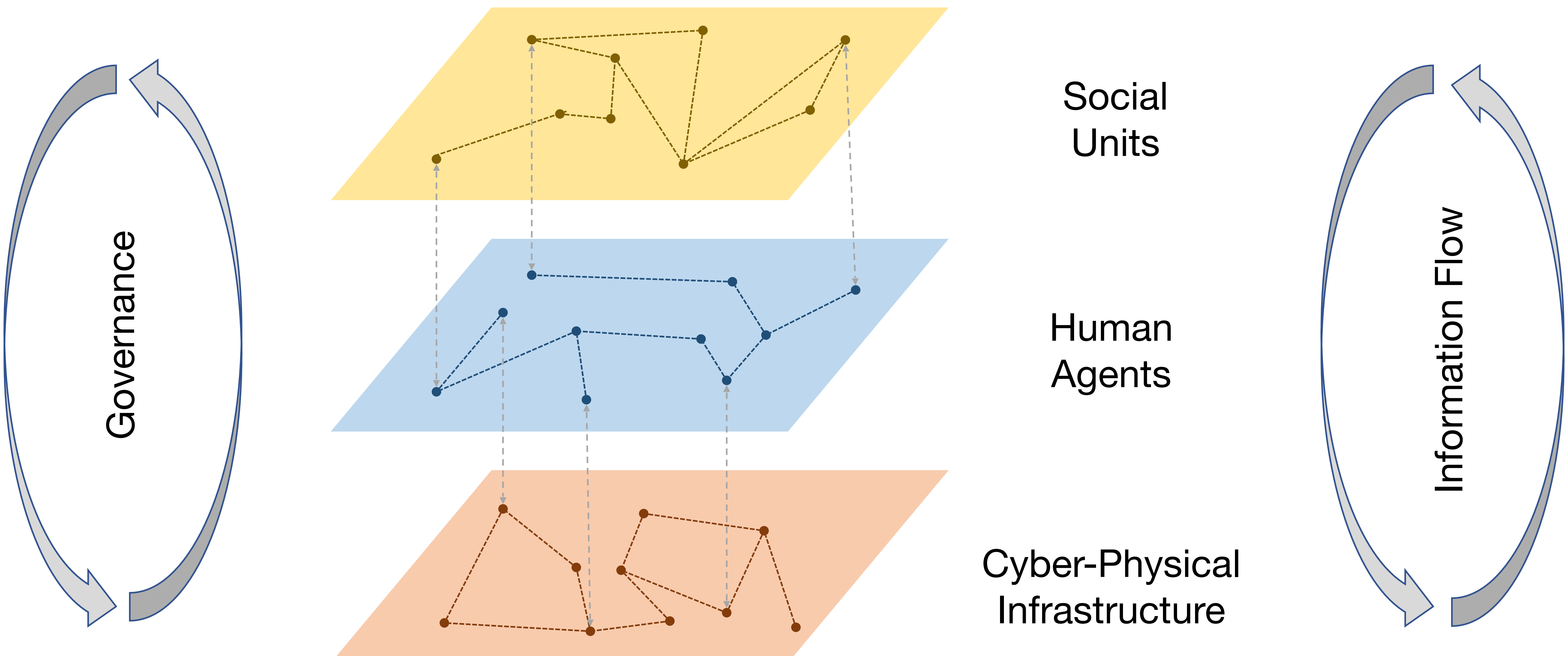
Historical Data

- Parking and accident data
- Fire and Police department reports
- Emergency planning data
- Flooding data (historical)
- Energy consumption data
- Health data
- Urban infrastructure maintenance data
- Startup and commercial activity data



Multi-layered Governing Framework for Urban Systems

Dynamics and Hierarchical Structure



(Wang and Mansouri, 2020)

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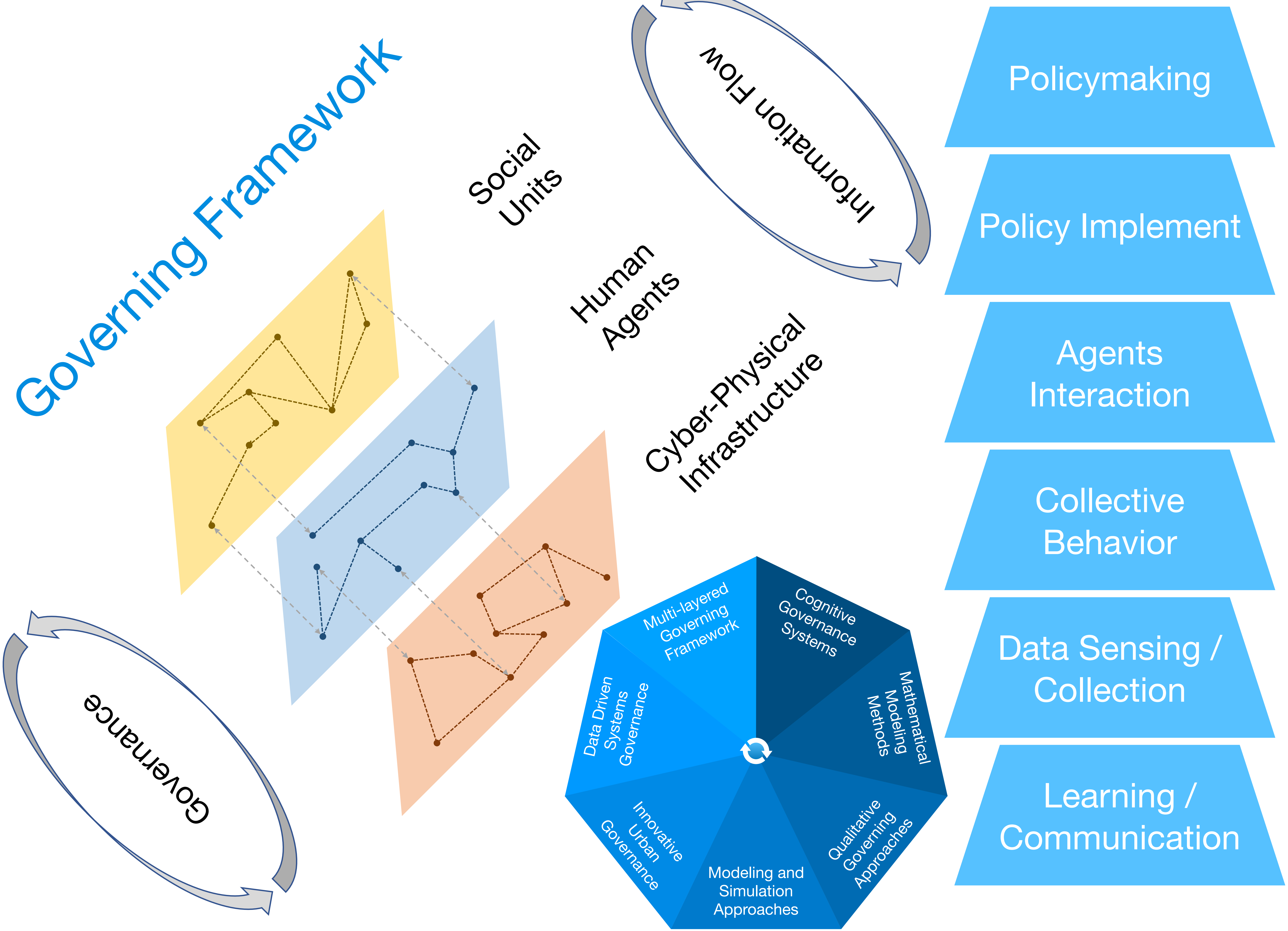
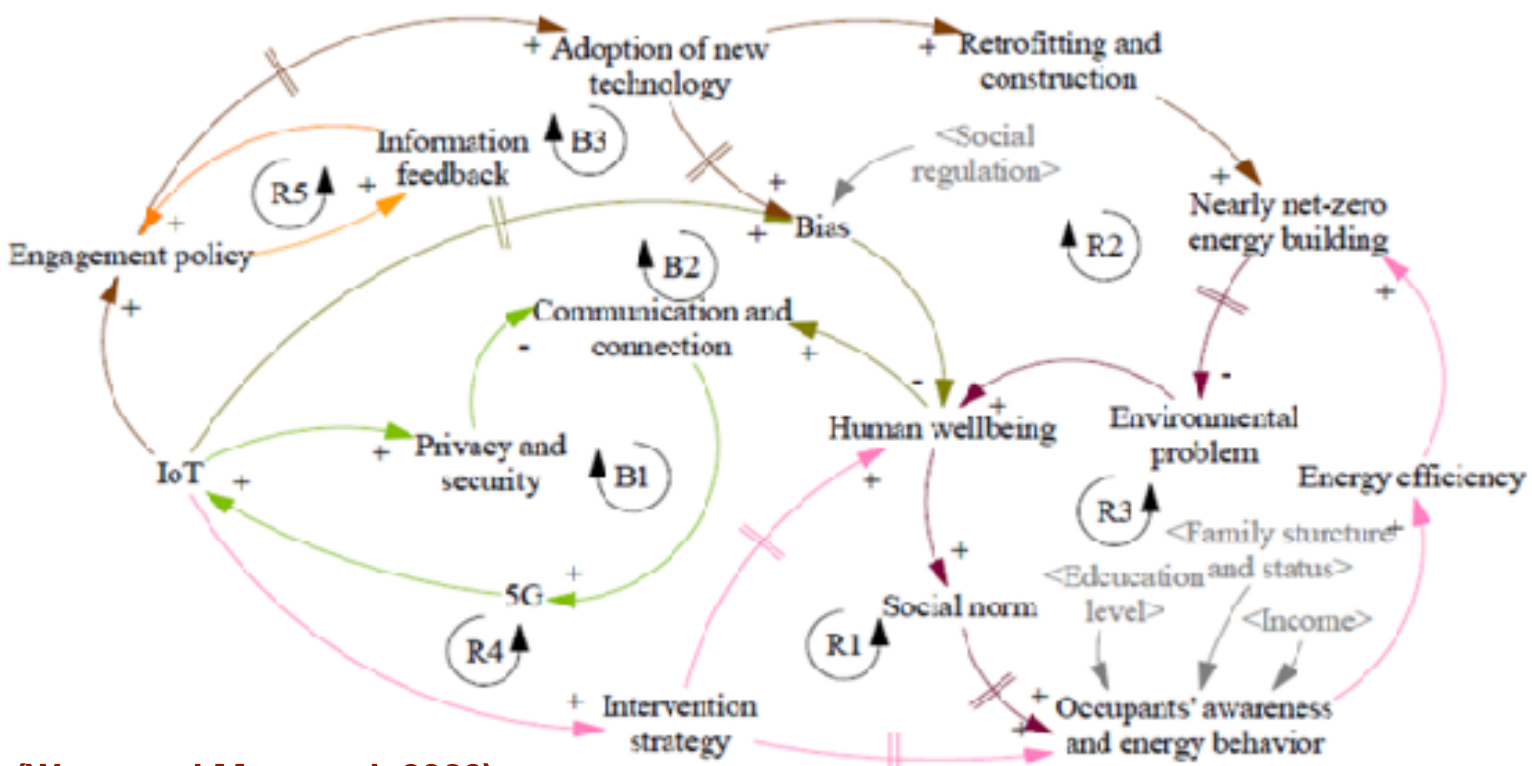
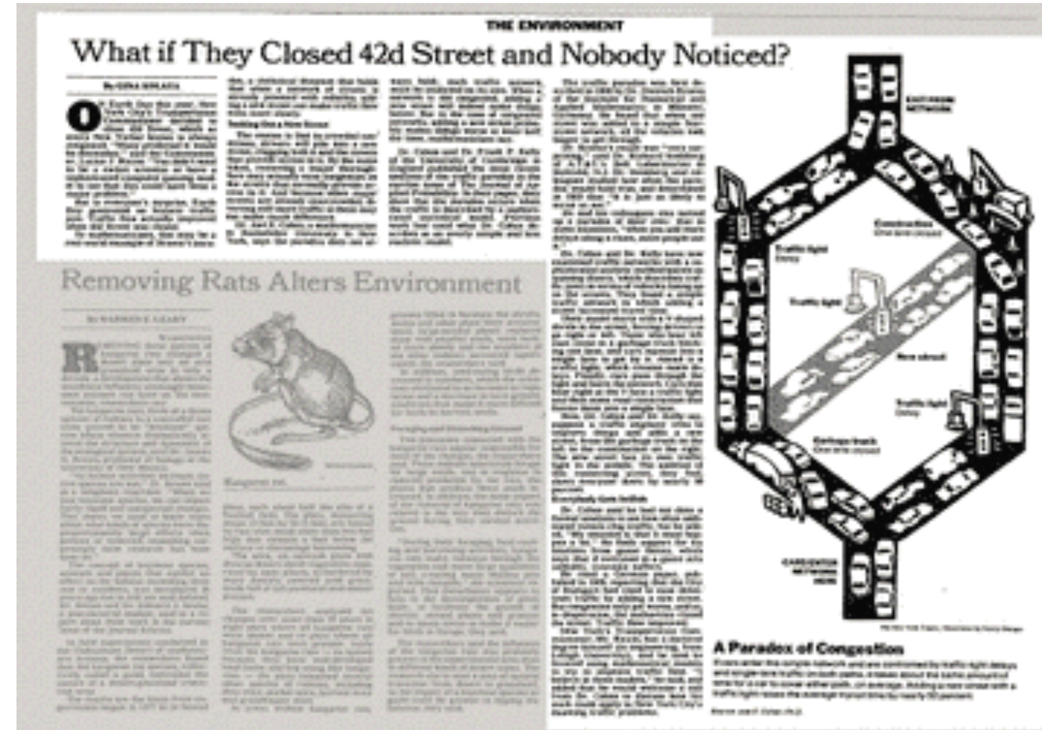


The case of Transportation: *Advanced Traveler Information Systems*



(Wang and Mansouri, 2020)



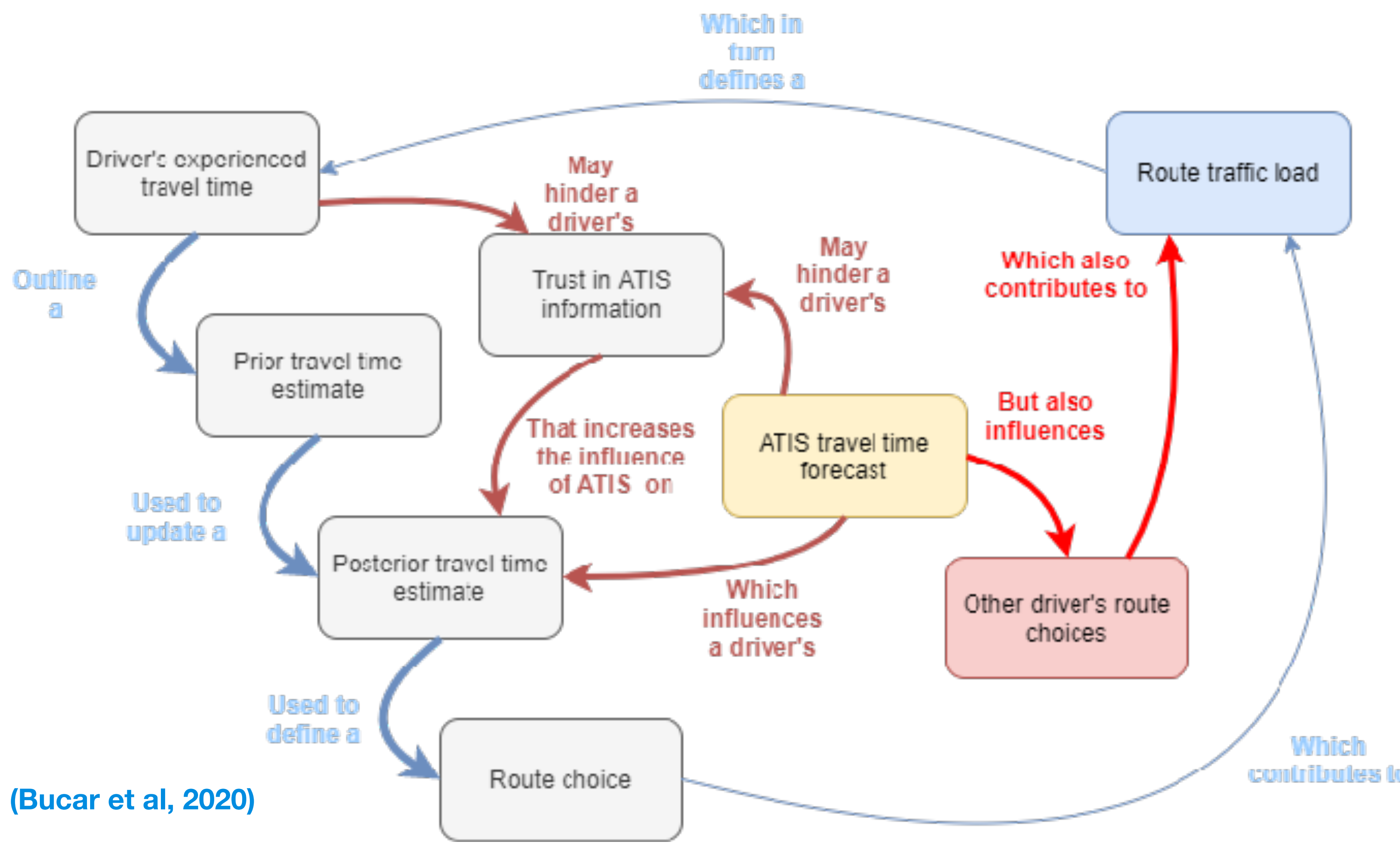
THE ENVIRONMENT

What if They Closed 42d Street and Nobody Noticed?

Removing Rats Alters Environment

A Paradox of Congestion

- A shared dynamic causal theory on collective behavior, policy, and technology: **The case of Energy Systems.**
- Social vs selfish equilibria: The Price of Anarchy
- Flash Crowd Effect: The Drawback of Perfect Information

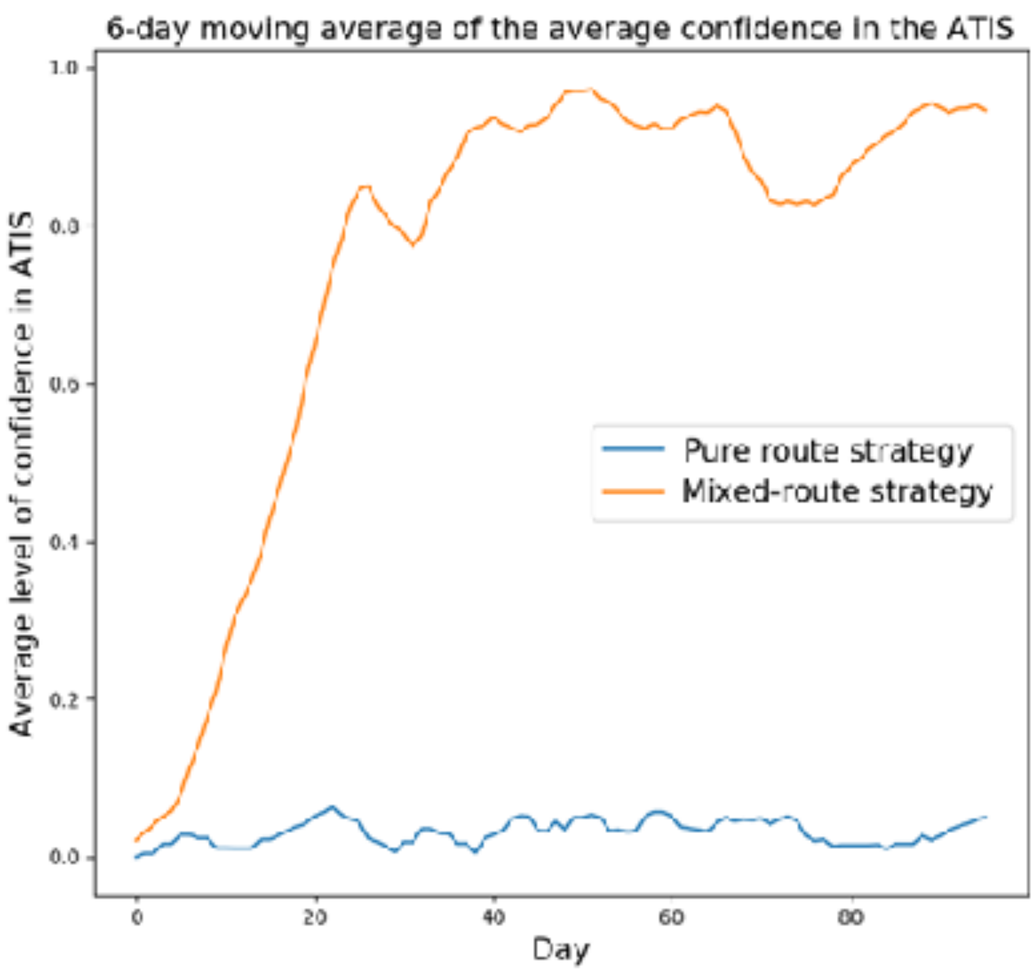


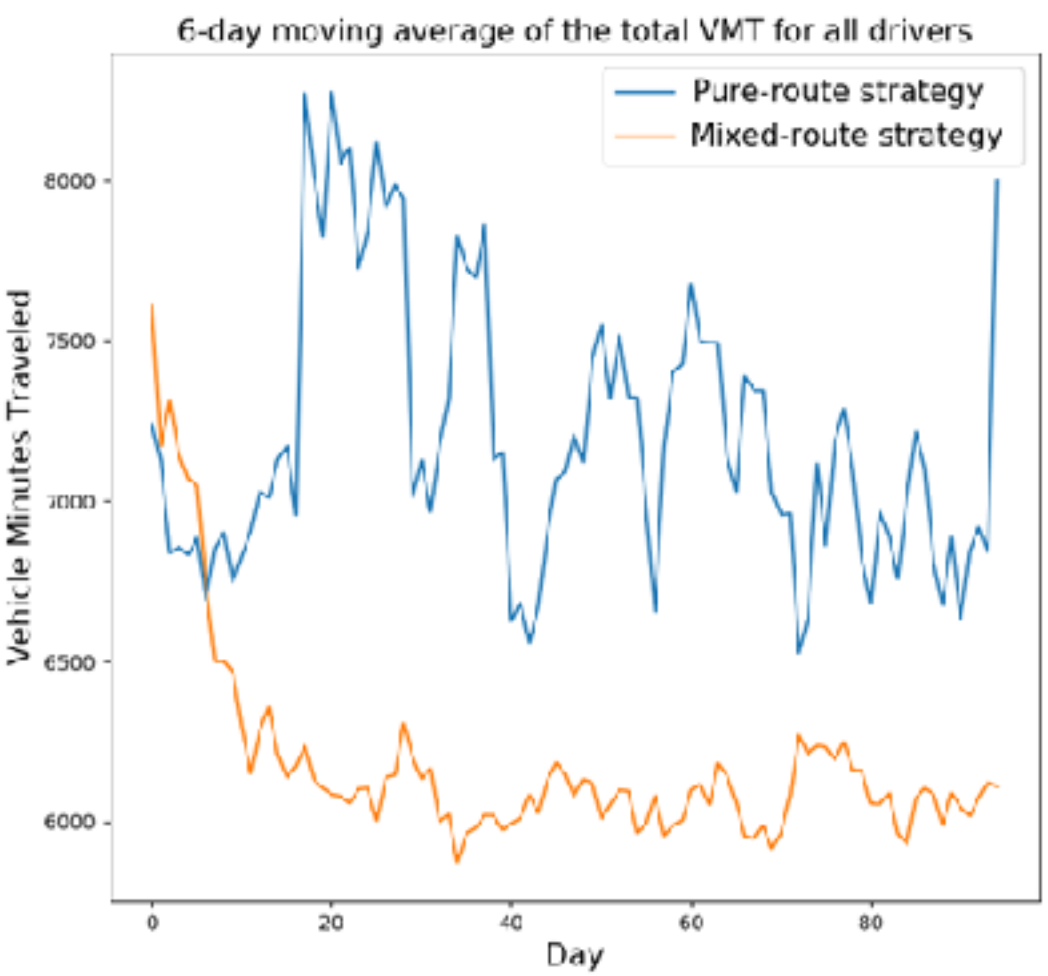
(Bucar et al, 2020)

Simulation Results

Pure shortest-path route choices within ex-ante ATIS may lead to:

1. Decreased levels of trust in ATIS predictions
2. Increased delays for all drivers

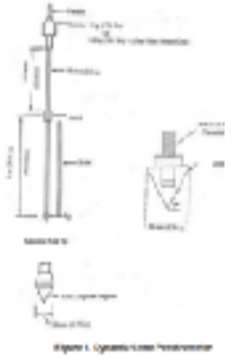
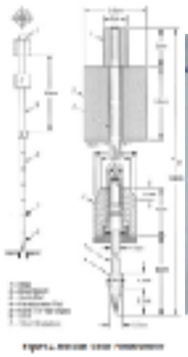


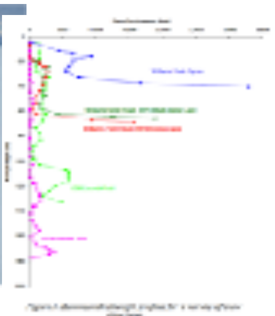
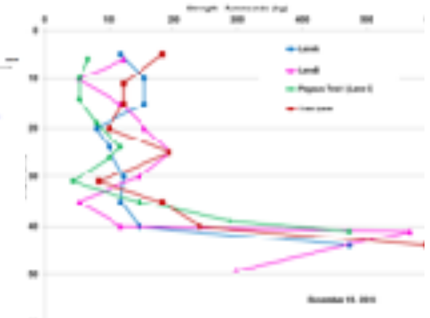
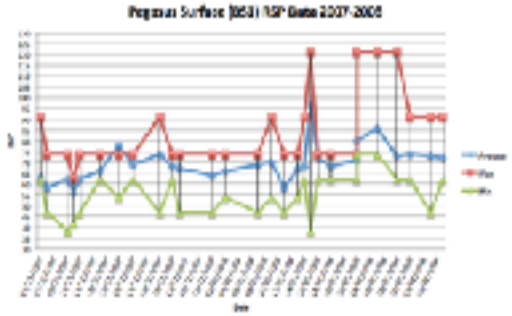


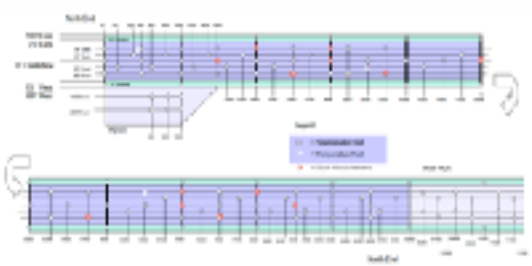
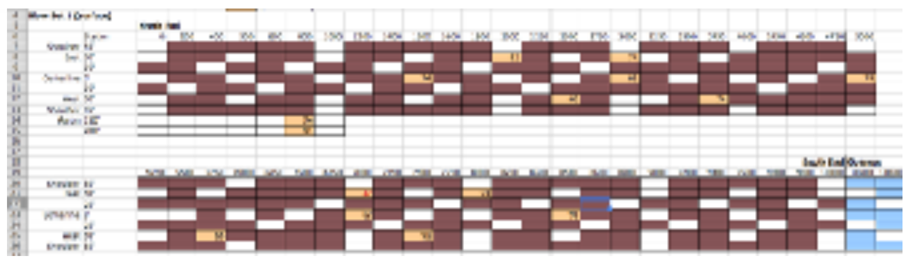
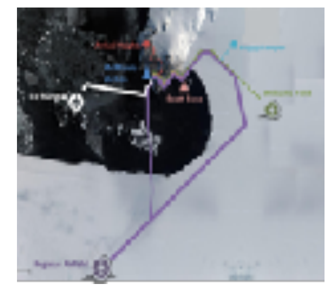
(Bucar et al, 2020)

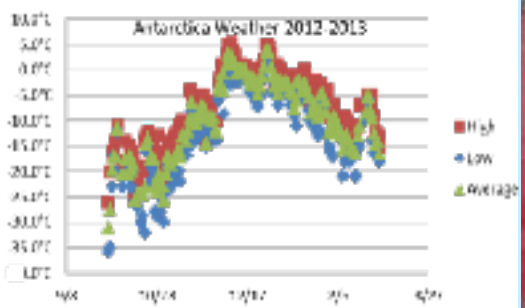
Antarctica: A Different Kind of Complexity

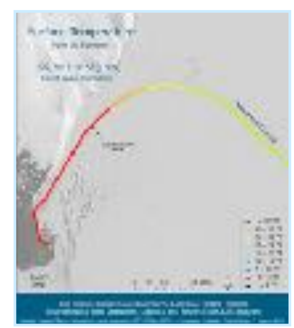
Virtual Journey

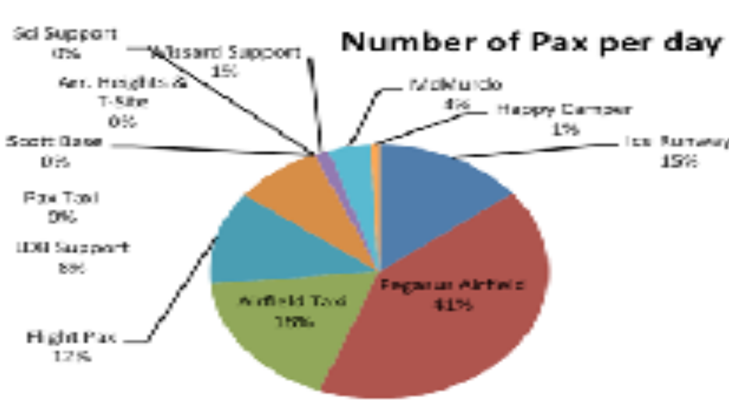





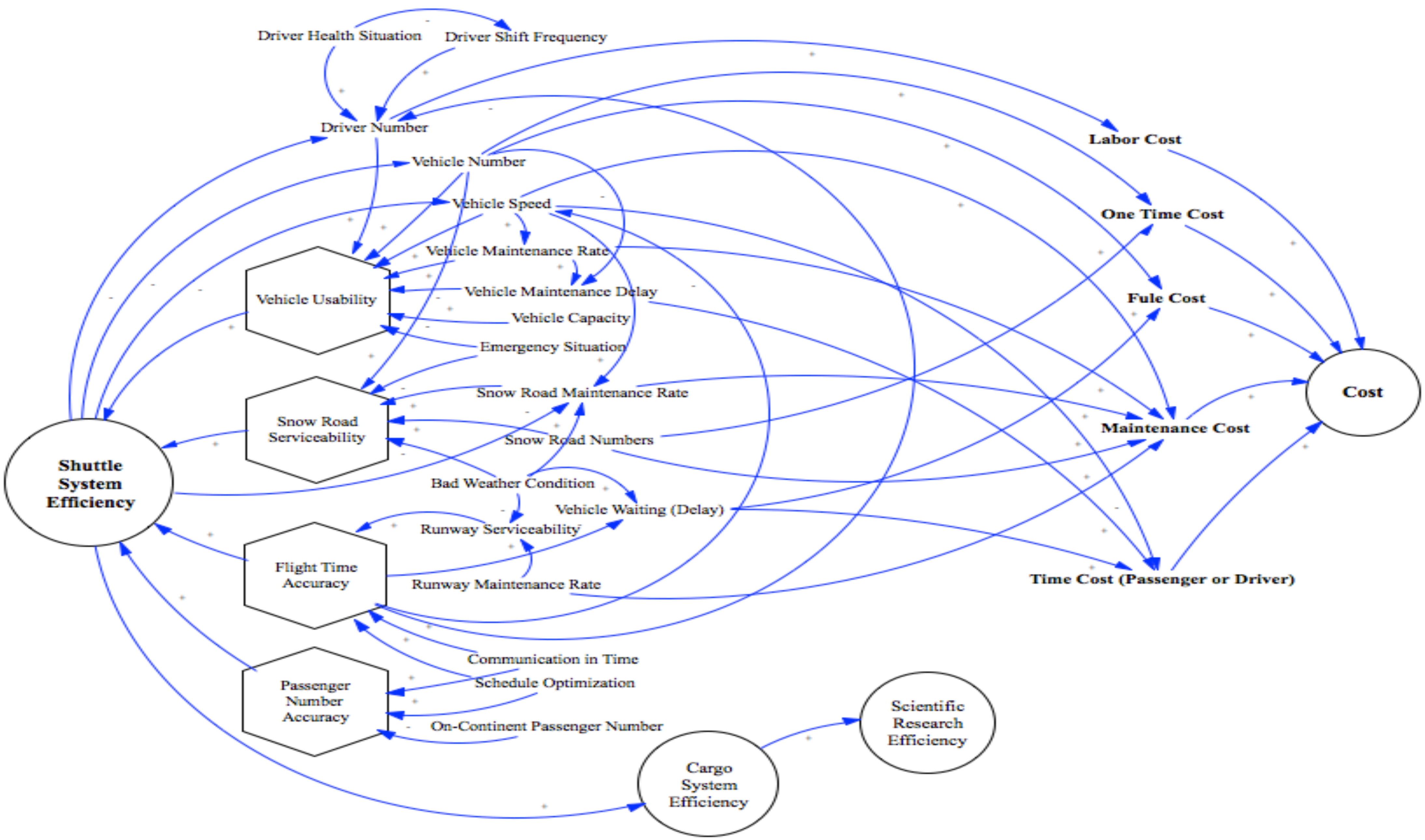




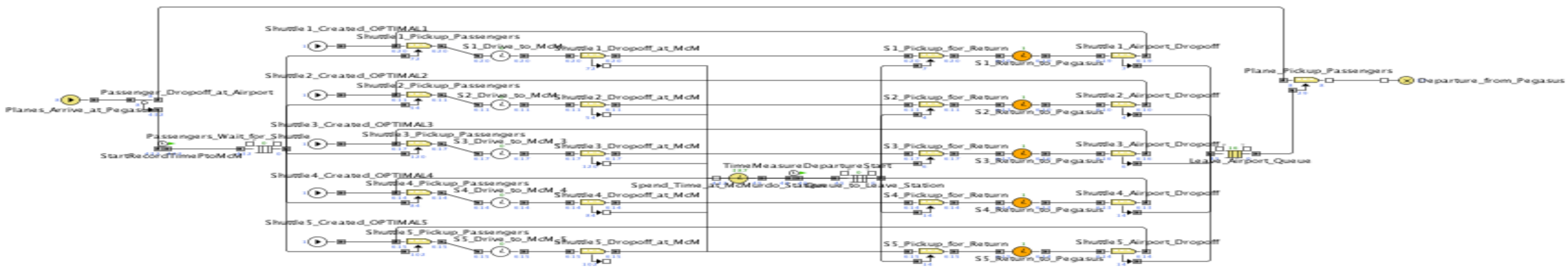
	MP 12	MP 10	MP 6	MP 4	MP 2	MP 0.5
Saturday, November 12, 2011	1	4	1	0	0	0
Wednesday, November 16, 2011	3	3	2	0	0	0
Wednesday, November 23, 2011	3	3	1	1	0	0
Monday, November 28, 2011	0	0	0	1	0	0
Friday, December 02, 2011	0	2	1	3	2	0
Tuesday, December 06, 2011	4	6	2	2	0	4
Wednesday, December 07, 2011	10	0	0	4	0	4

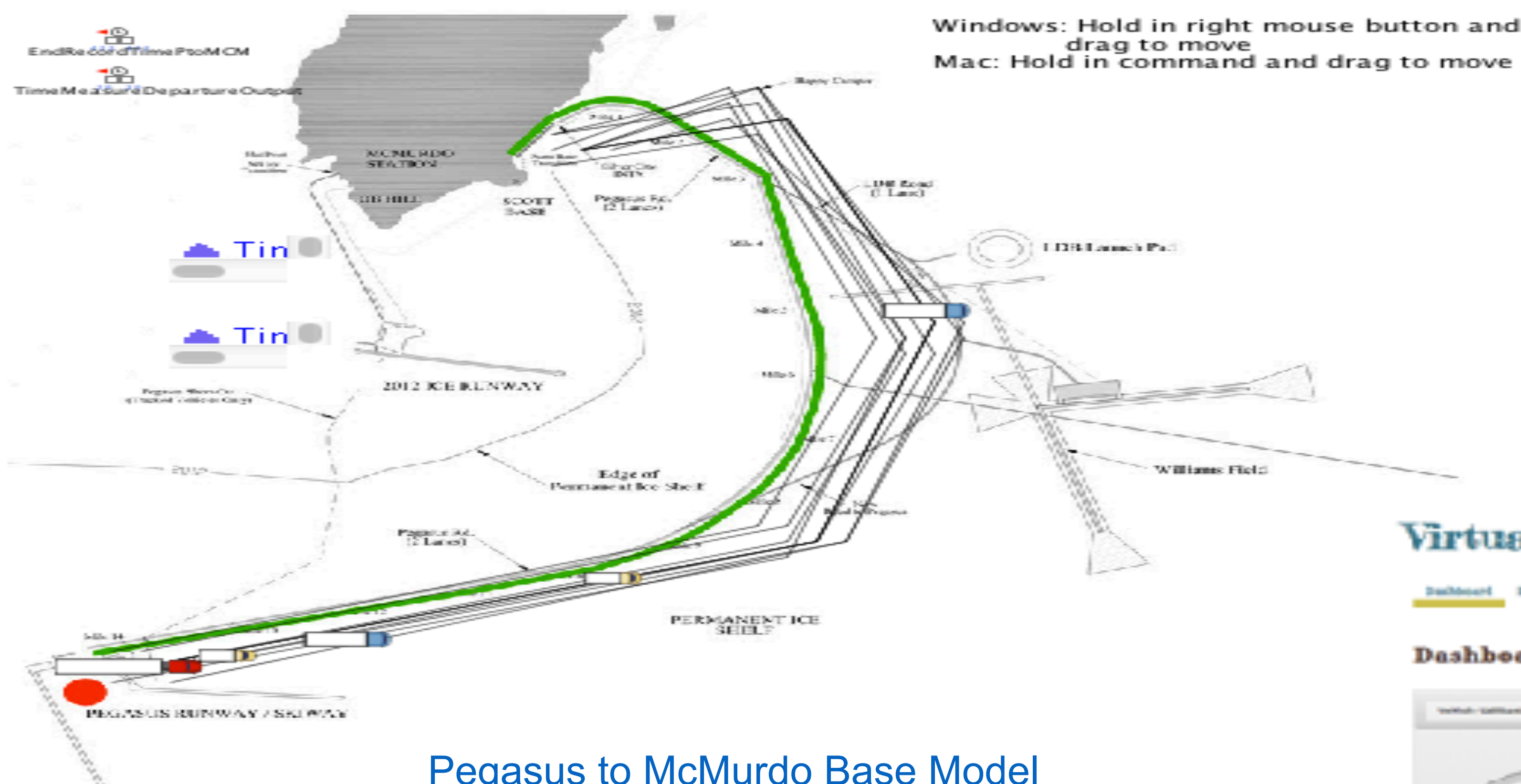


Conceptual Modeling



Simulation Results and Dashboard





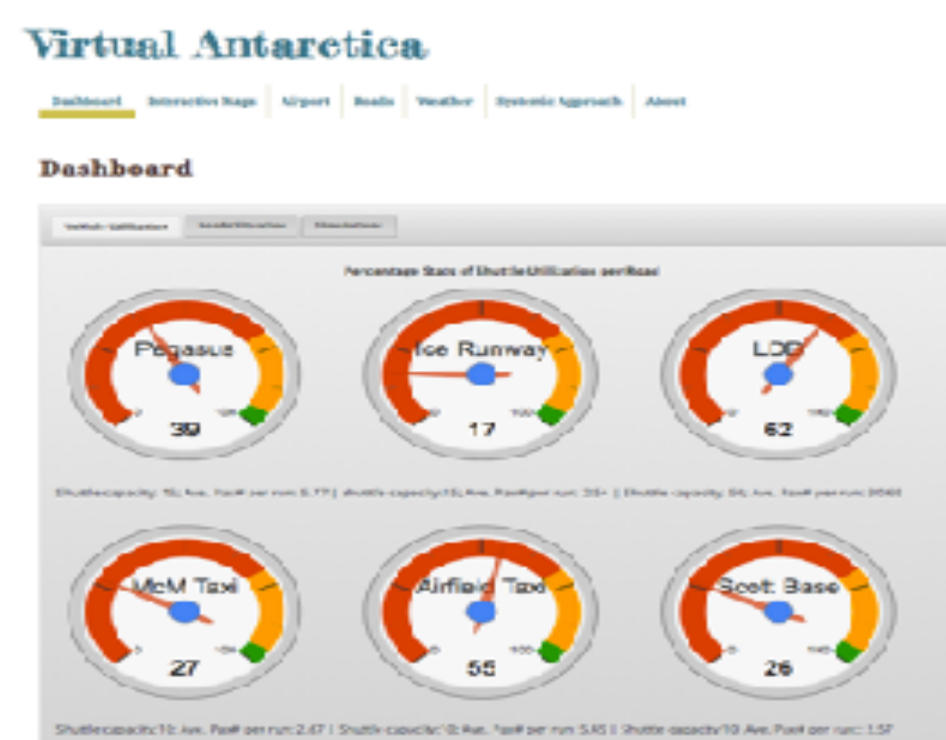
[Pegasus to McMurdo Base Model]

Pegasus to McMurdo Optimal

Pegasus to McMurdo Standardized Shuttle Model

Pegasus to McMurdo 4 Shuttles

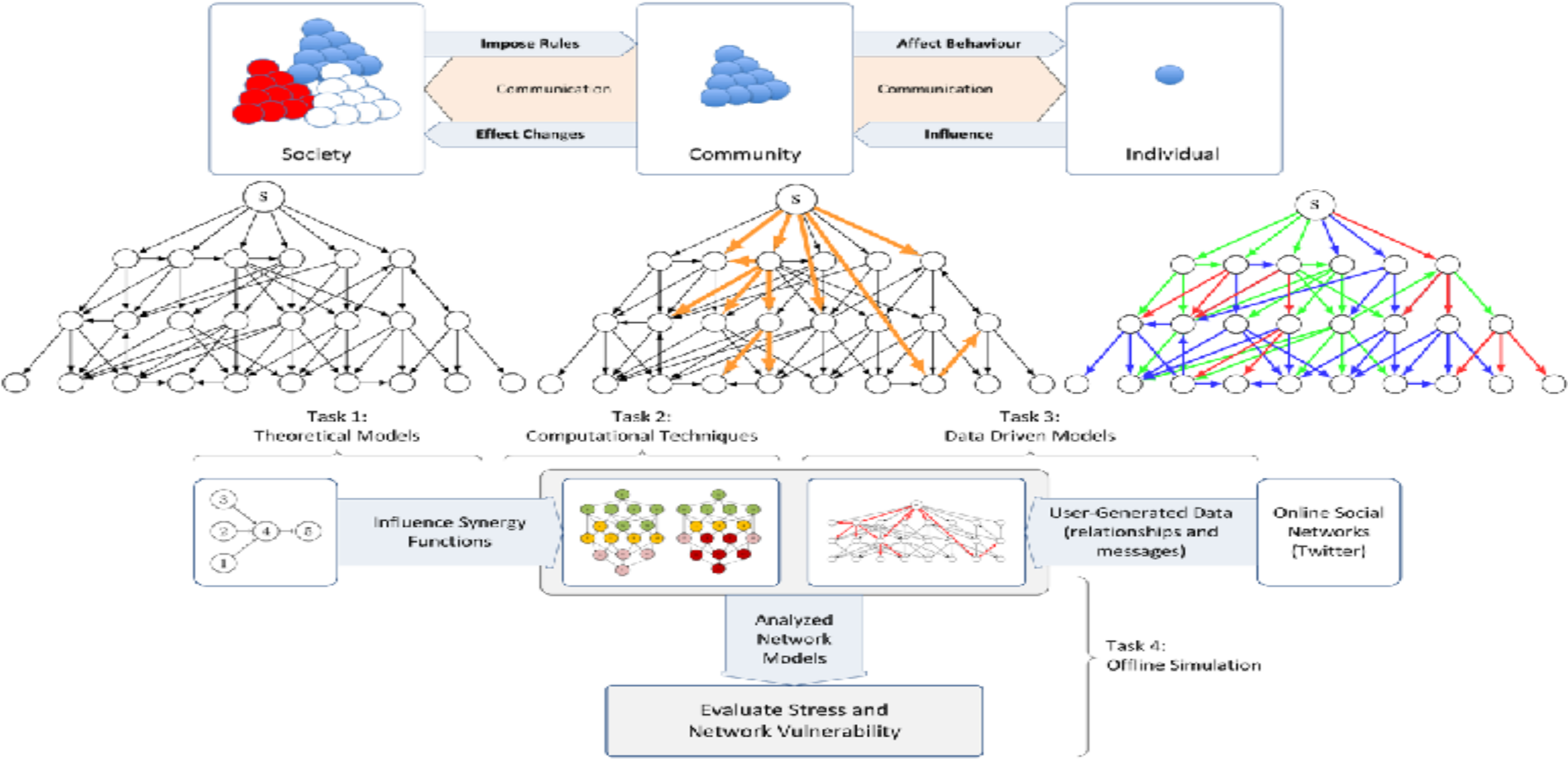
Pegasus to McMurdo 6 Shuttles



Smart City Lab @ Stevens

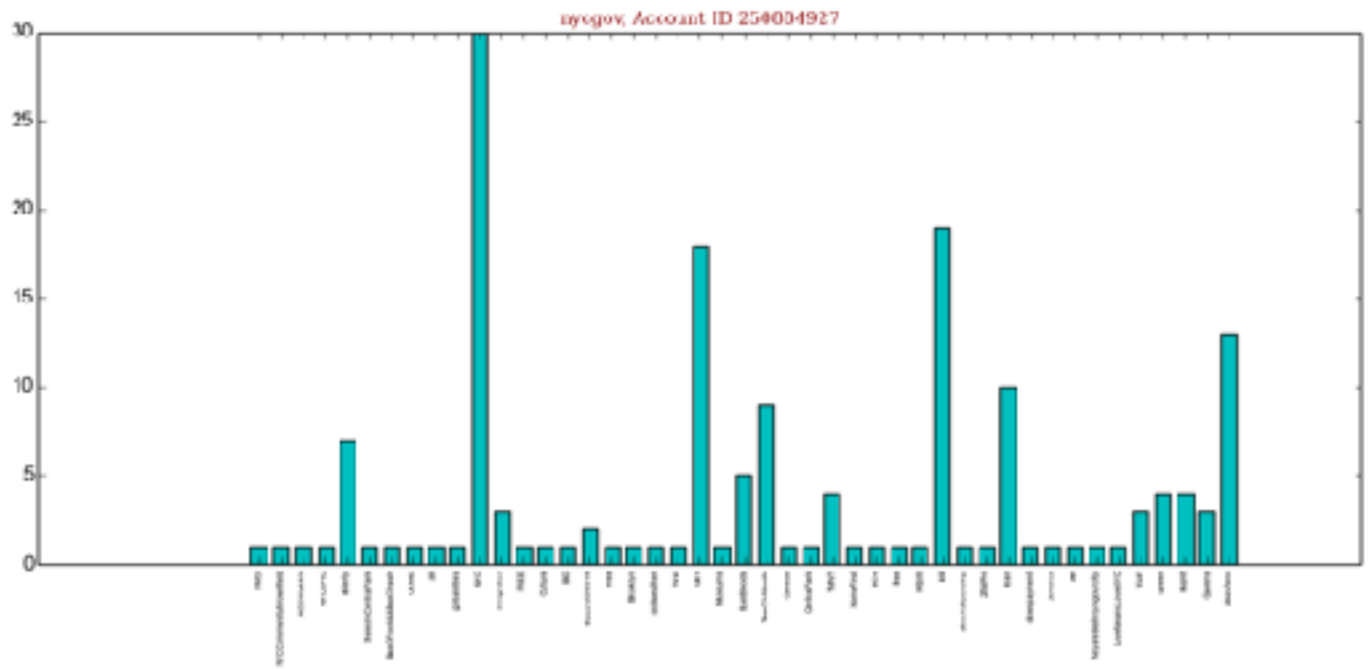
- Urban visualization platform and command center

Influencing Human Behavior in Social Networks



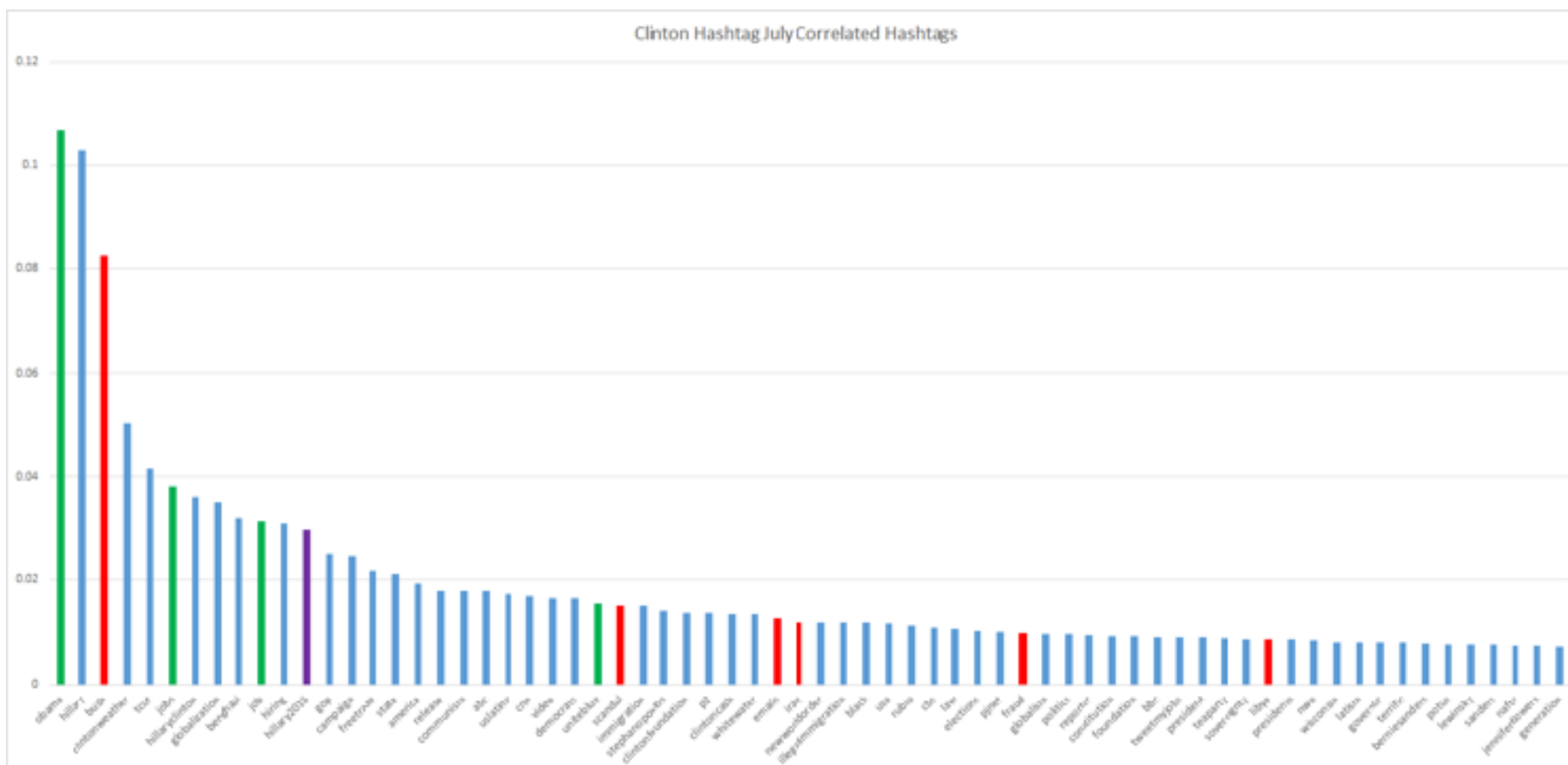
NYC Hashtags Analysis

The graph is for the “nycgov”, which is the official account of NYC municipality.



- This is a graph of hashtag (keyword) used in reference to an official account.
- These hashtags represent the general ideas in users’ minds about the important issues.

- In this graph the hashtags associated (used in the same tweet) with Clinton are listed.
- Using the hashtags in the same tweet indicates a relation between hashtags (keywords).

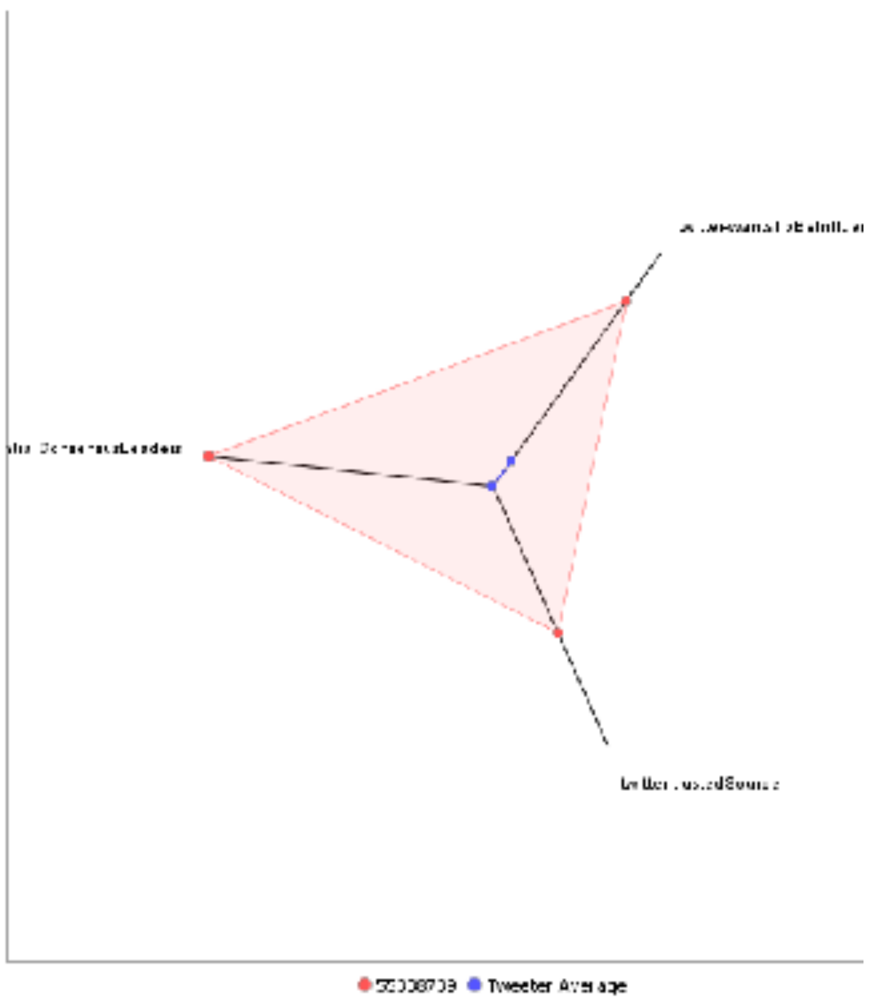


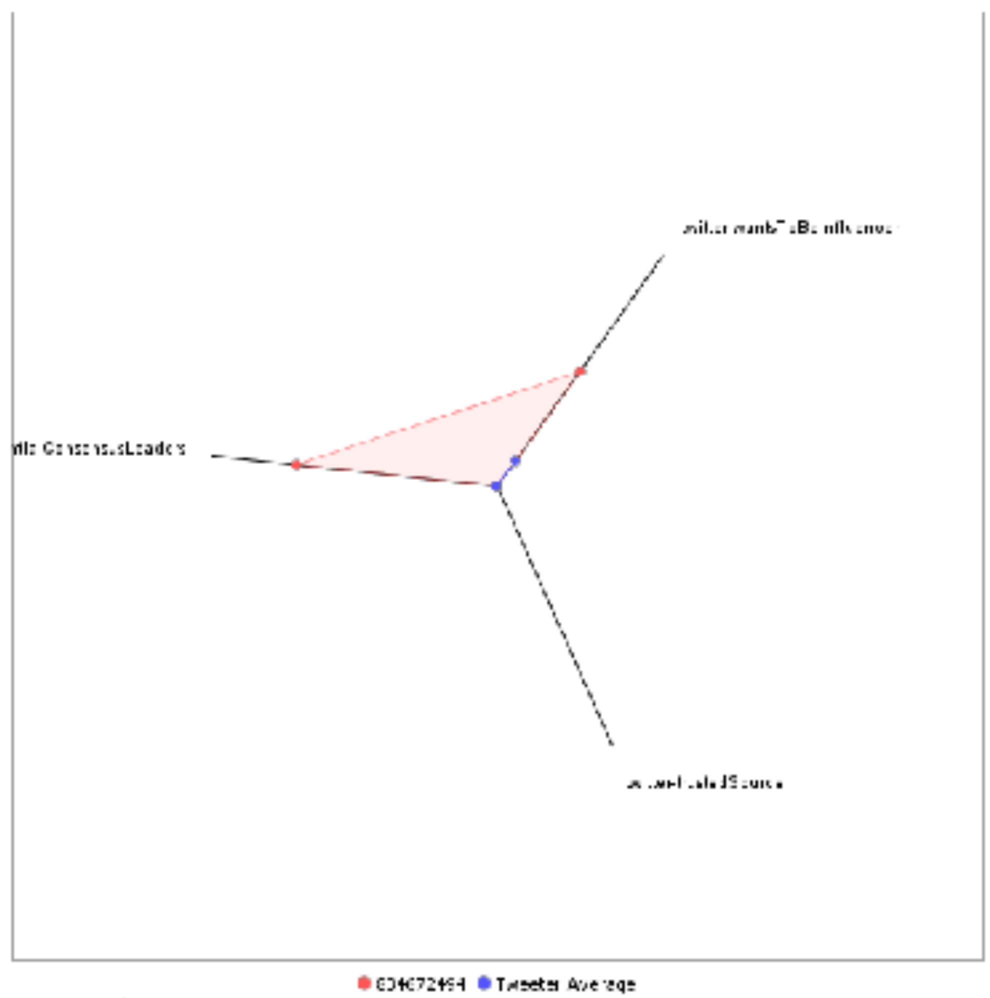
Following specific topic 2015

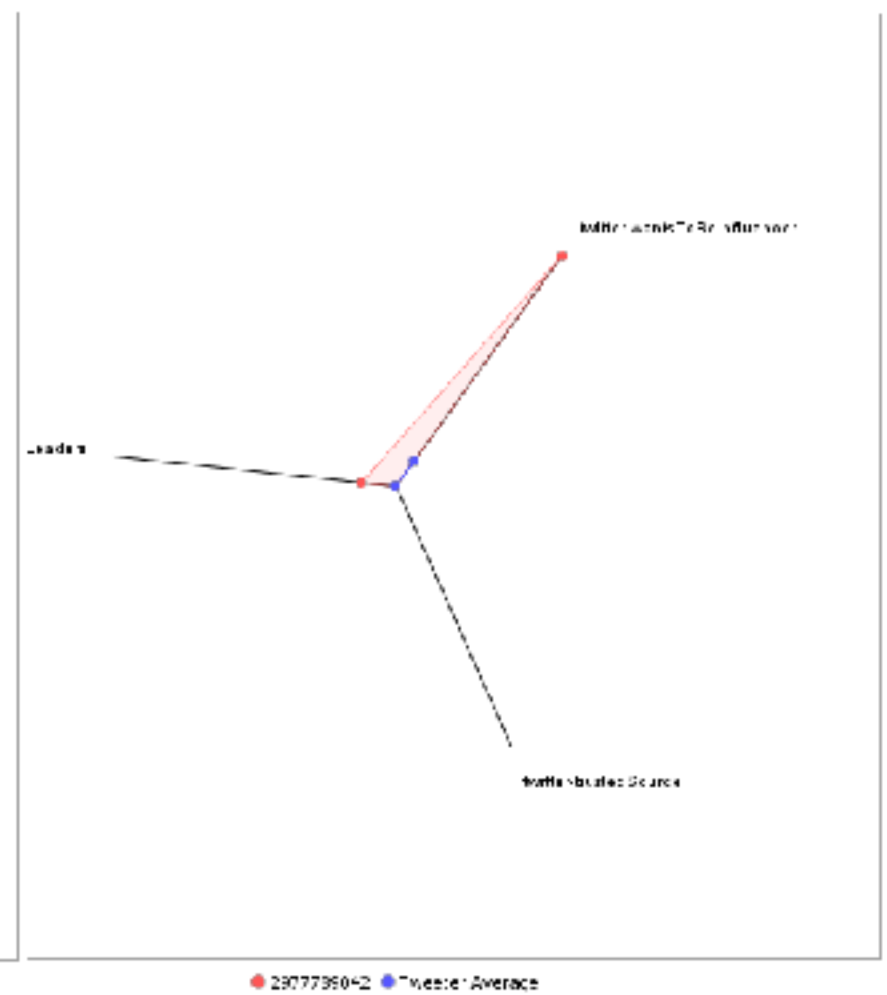
Top right: **Wants to be influenced** (high in degree) – Follower of lots of similar hashtags.

Top Left: **Consensus Leader** (high out degree) – Is followed by many on similar hashtags.

Bottom Right: **Trusted Source** – has high number of retweets with respect to the same hashtags.

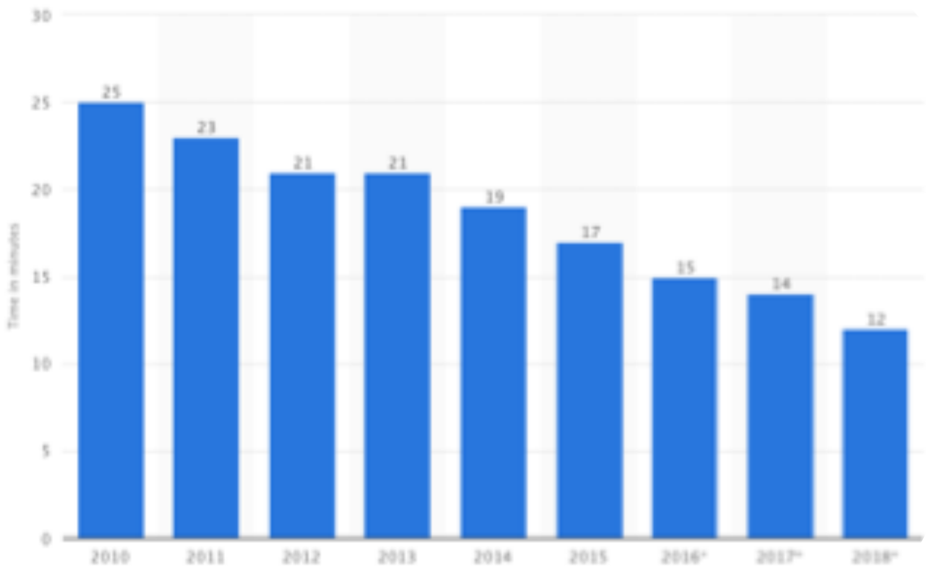




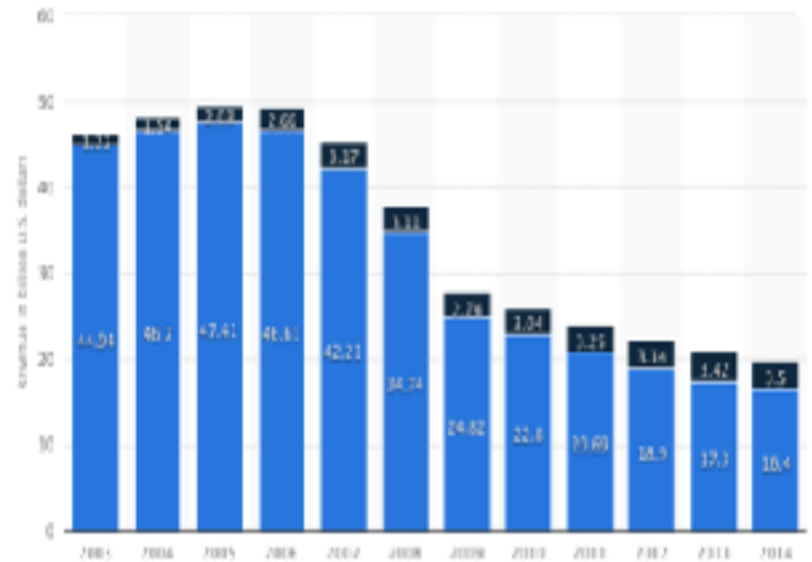


(Vesaghi and Mansouri, 2015)

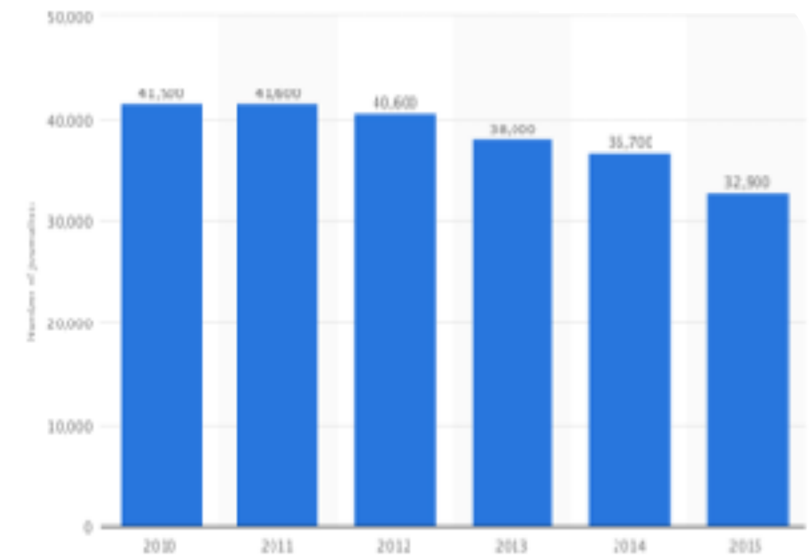
Information Governance
Case of Fake News



Time per Day

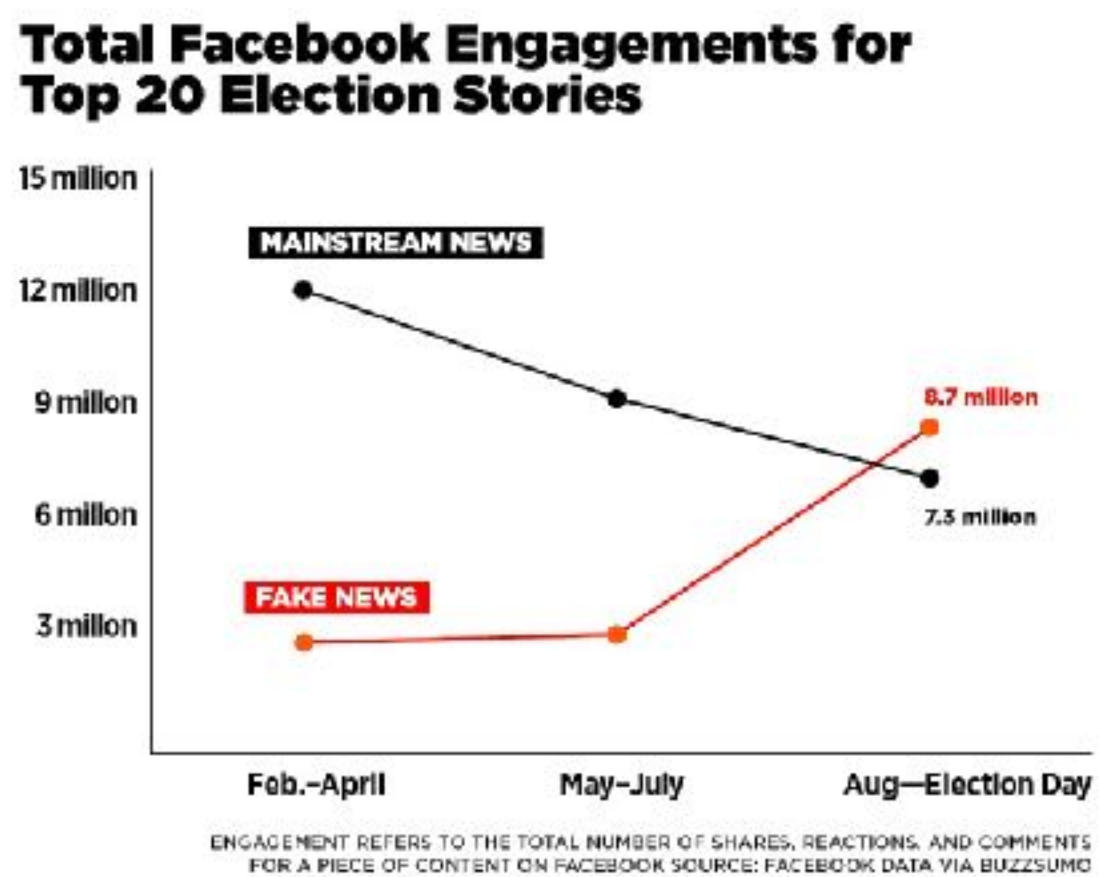


Revenue

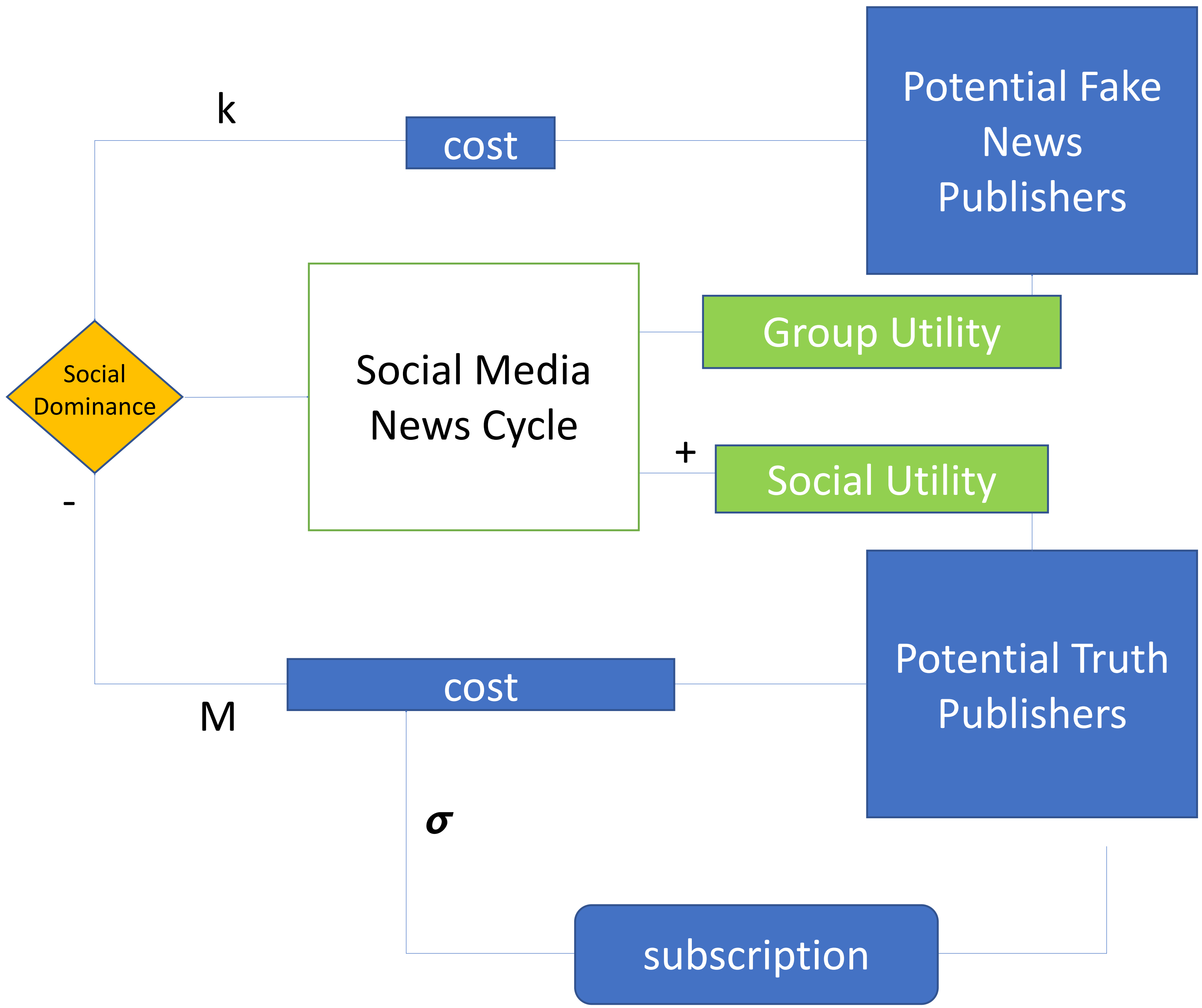


Journalists

(Ehsanfar and Mansouri, 2017)



Incentivizing Dissemination of Truth in Social Networks



- Truth vs Fake news in social networks
- Individual cost of authentication collective benefits of dominance
- Collective cost and individual benefits of failure
- Public good and volunteering
  - Game theoretic model
  - Volunteer's dilemma
- Model equilibriums
- Results

(Ehsanfar and Mansouri, 2017)

$$p_v(M) = \begin{cases} 1-c \\ 1-a-c \end{cases} \quad p_d(M) = \begin{cases} 1 & if\ M \geq k \\ 1-a & if\ M < k \end{cases}$$

$$p_v(k) = \begin{cases} 1-cf \\ 1-a-cf \end{cases} \quad p_d(k) = \begin{cases} 1 & if\ k \geq M \\ 1-a & if\ k < M \end{cases}$$

Regular agents: $\overline{P_v}(k)$ $\overline{P_d}(k)$

Fake news agents: $\overline{P_v}(M)$ $\overline{P_d}(M)$

Mathematical Models

Regular Users

$$\overline{P_v}(k) = \sum_{M=k-1}^{N-1} \binom{N-1}{M} x^M (1-x)^{N-M-1} (1-c) + [1 - \sum_{M=k-1}^{N-1} \binom{N-1}{M} x^M (1-x)^{N-M-1}](1-c-a) + \sum_{M=k-1}^{N-1} \binom{N-1}{M} x^M (1-x)^{N-M-1} (\frac{\sigma}{M+1} - \frac{\sigma}{N})$$

$$\overline{P_d}(k) = \sum_{M=k}^{N-1} \binom{N-1}{M} x^M (1-x)^{N-M-1} + [1 - \sum_{M=k}^{N-1} \binom{N-1}{M} x^M (1-x)^{N-M-1}](1-a) - \frac{\sigma}{N} * \sum_{M=k}^{N-1} \binom{N-1}{M} x^M (1-x)^{N-M-1}$$

“Fake news” Users

$$\overline{P_v}(M) = \sum_{k=M-1}^{F-1} \binom{F-1}{k} x^k (1-x)^{F-k-1} (1-cf) + [1 - \sum_{k=M-1}^{F-1} \binom{F-1}{k} x^k (1-x)^{F-k-1}](1-cf-a)$$

$$\overline{P_d}(M) = \sum_{k=M}^{F-1} \binom{F-1}{k} x^k (1-x)^{F-k-1} + [1 - \sum_{k=M}^{F-1} \binom{F-1}{k} x^k (1-x)^{F-k-1}](1-a)$$

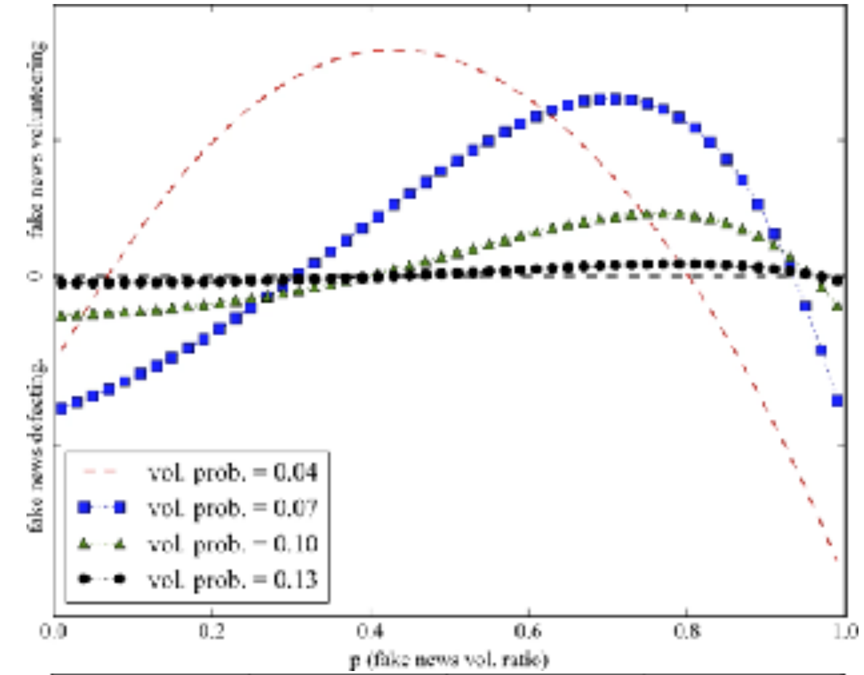
Fake news expected payoff:

$$\overline{P_v} = \sum_{M=0}^{F} \binom{N}{M} p^{*M} (1-p^*)^{F-M} \overline{P_v}(M)$$

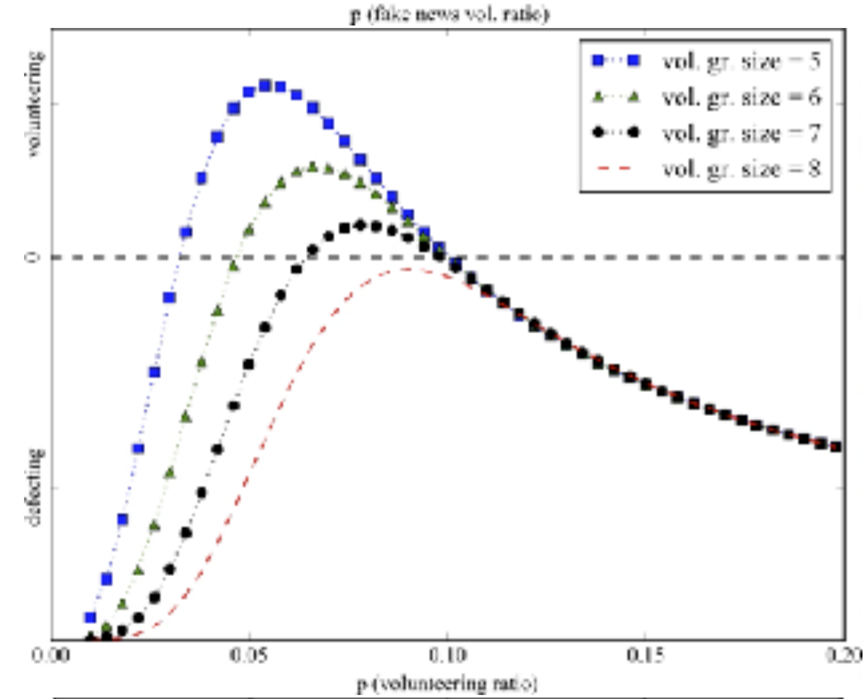
$$\overline{P_d} = \sum_{M=0}^{F} \binom{N}{M} p^{*M} (1-p^*)^{F-M} \overline{P_d}(M)$$

(Ehsanfar and Mansouri, 2017)

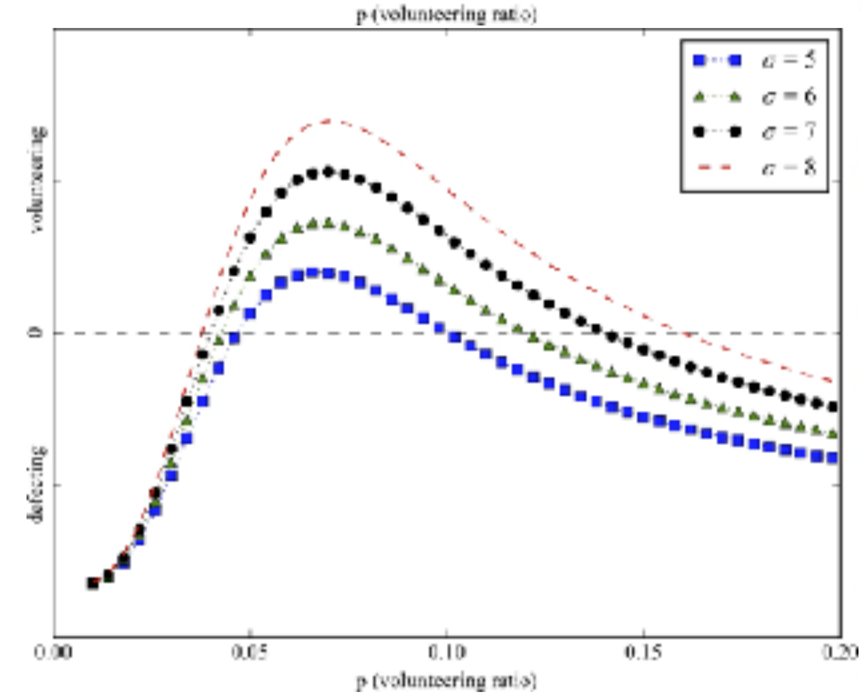
- Maximum volunteering probability among regular users
- Lowering potential net payoff by the primary equilibrium
- Elastic stable secondary equilibrium points
- Elastic secondary equilibrium range



- Maximum group size for feasible volunteering
- Two sets of equilibrium points
- Inelastic equal equilibrium points
- Elastic equilibrium range



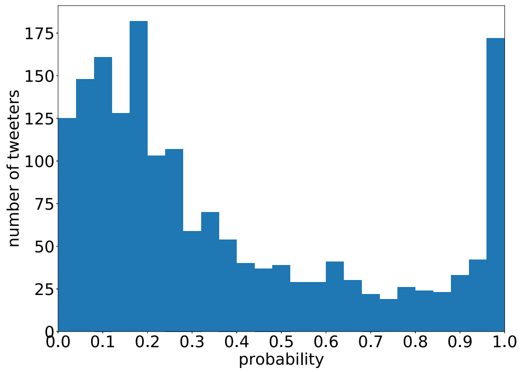
- Minimum reward for feasible volunteering
- Two sets of equilibrium points
- Elastic stable equilibrium points
- Inelastic equilibrium range



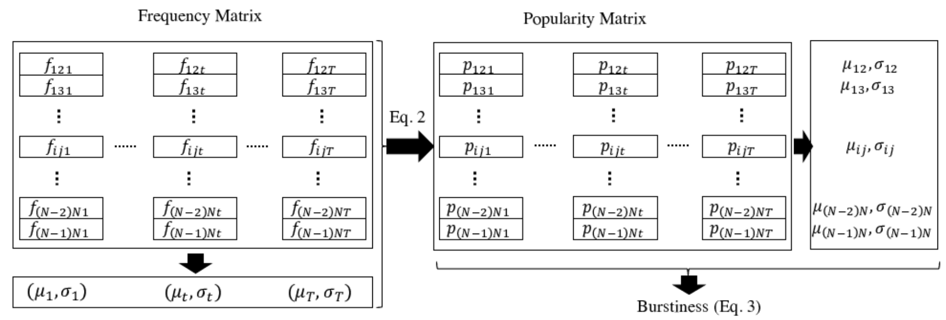
(Ehsanfar and Mansouri, 2017)

Data Driven Models

Influential Users and Clustering Content



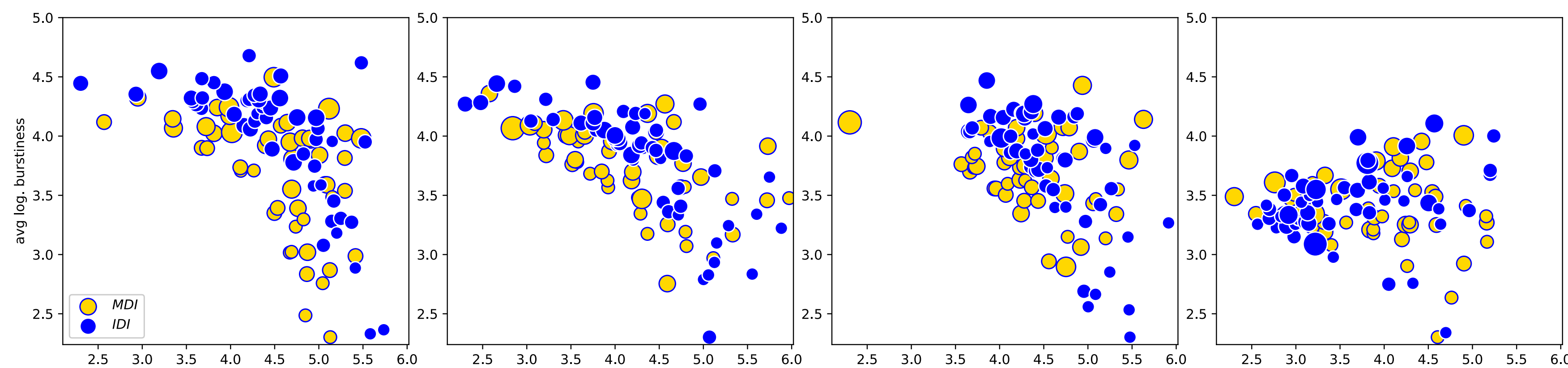
Interaction-Driven	Media-Driven
• Responsive • Interactive • Creative	• Suggestive • Reactive • Circulative



- Network Model of Terms
- Popularity Matrix
- Burstiness Matrix
- Relevance Adjacency Matrix
- Content Clusters

Popularity vs Burstiness Time Frame Granularity

(Ehsanfar and Mansouri, 2017)



Daily Time Frames
- Higher granularity
- Dominant IDI

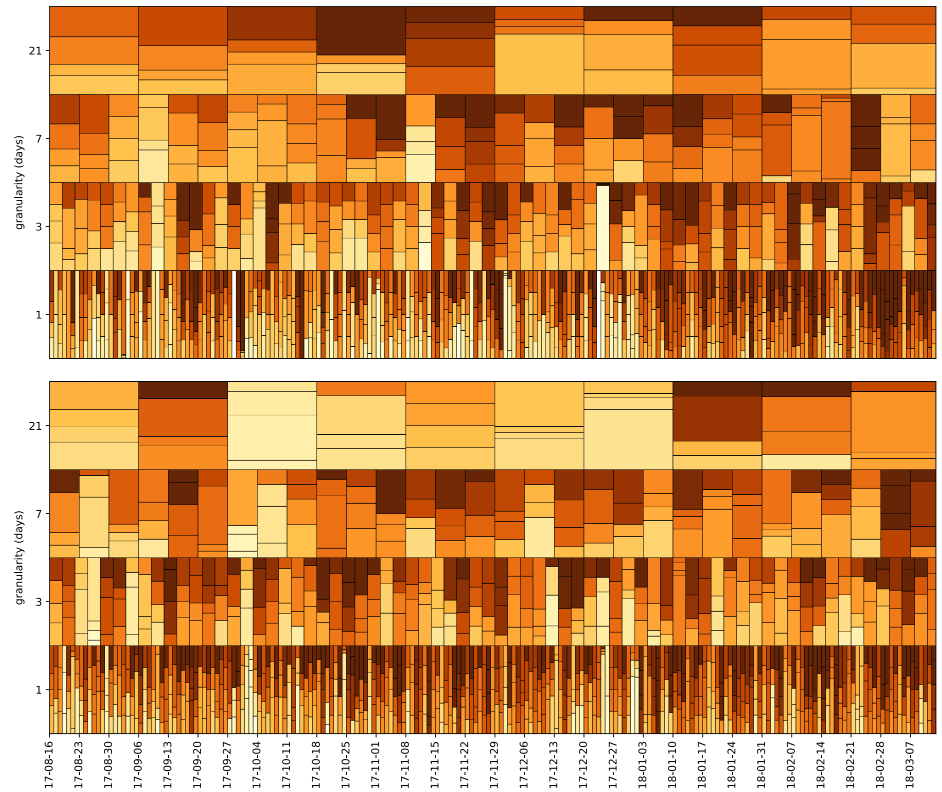
Monthly TF
- Lower Granularity
- Dominant MDI

Data Visualization Approach

Temporal Map of Clustered Topics

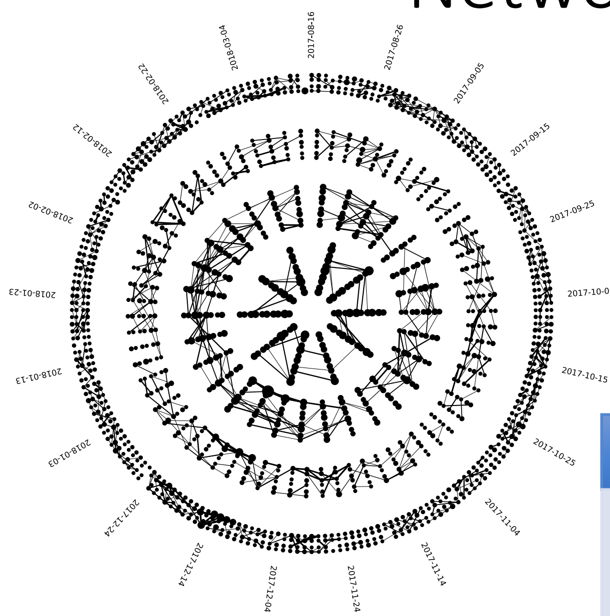
MDI
- Longer content TF
- Consistent
- Subjects: Political

IDI
- Lower contentTF
- Dynamic
- Subjects: Social/Economical/ Life Style

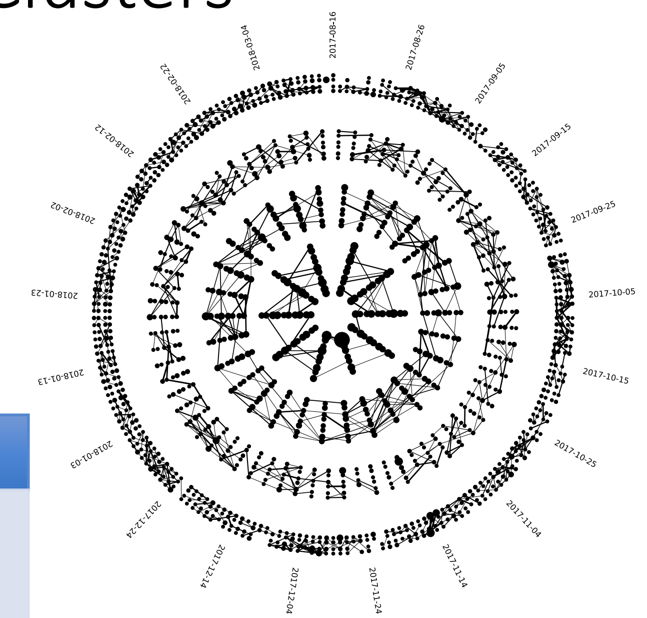


Networked Model of Clusters

(Ehsanfar and Mansouri, 2017)



MDI	IDI
• Temporal: • Higher-level connection • Hierarchal: • Stronger connection	• Temporal: • Lower-level connections • Hierarchal: • Weaker connections



Theoretical Approach:
Time to Dominance

Mathematical Model

Effects of:
Network
History
External Influence

$$U(i,j,t) = \alpha U_N + \beta U_E + \gamma U_H$$

$U_N(i,j,t)$: *Ratio of agent j friends who chose option i*

$U_E(i,j,t)$: *General ratio of agents who chose option i*

$U_H(i,j,t)$: *Ratio of how many times agent j chose option i in the past*

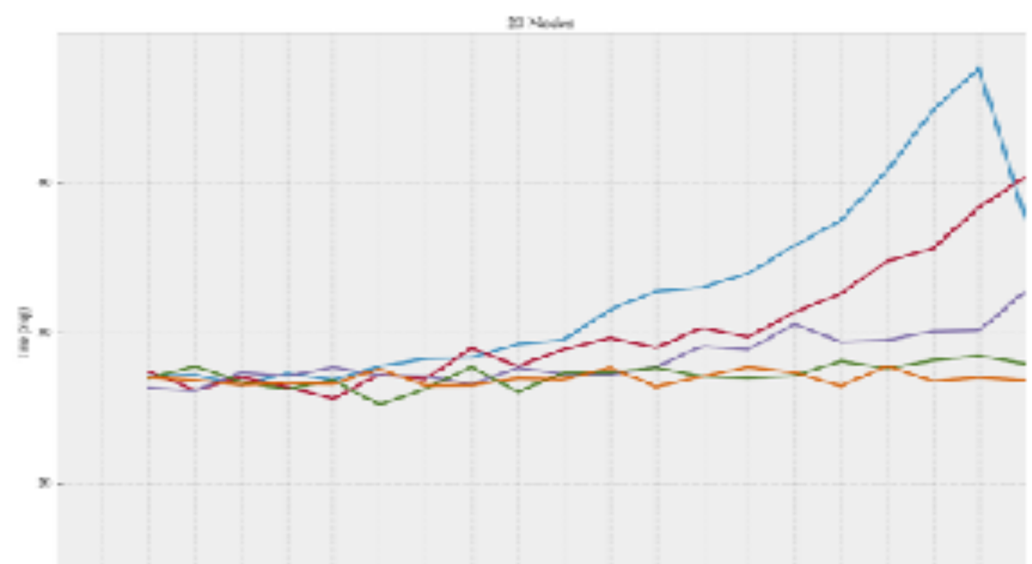
Network vs. History

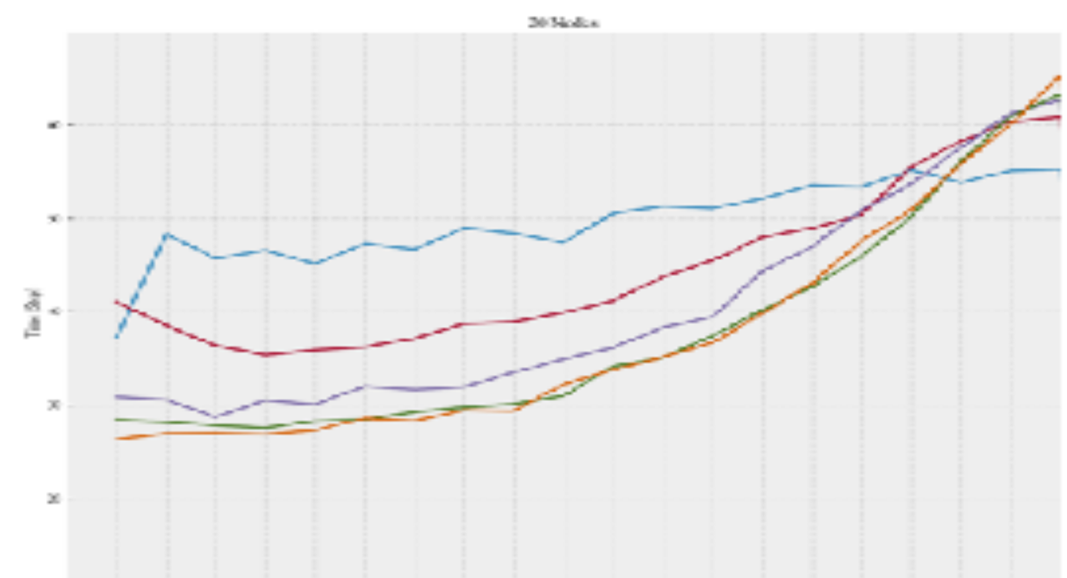
- Social Networks
- Uber

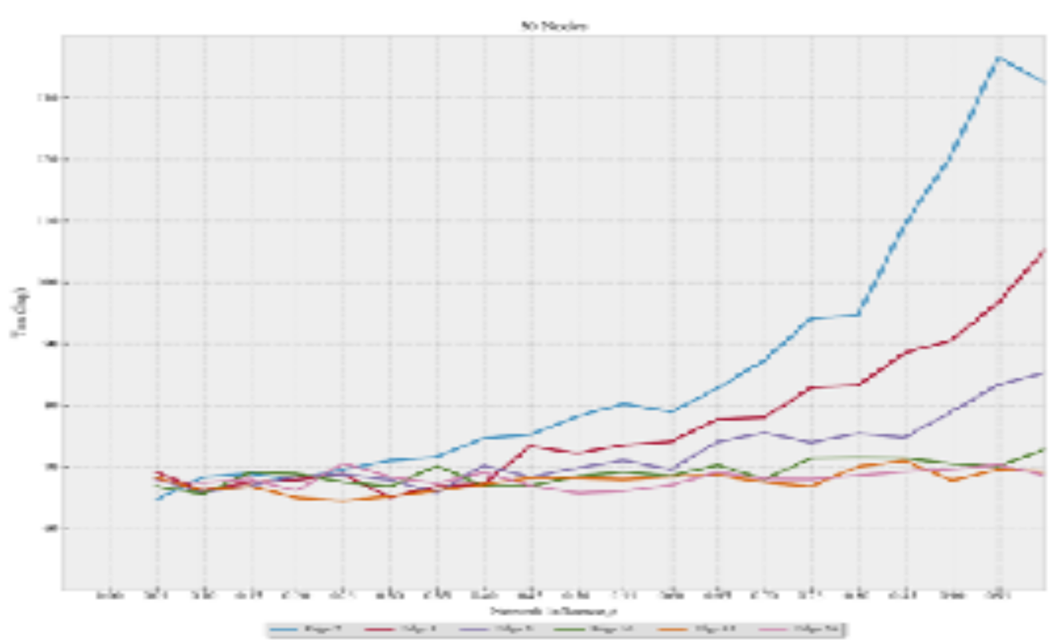
(Vesaghi and Mansouri, 2020)

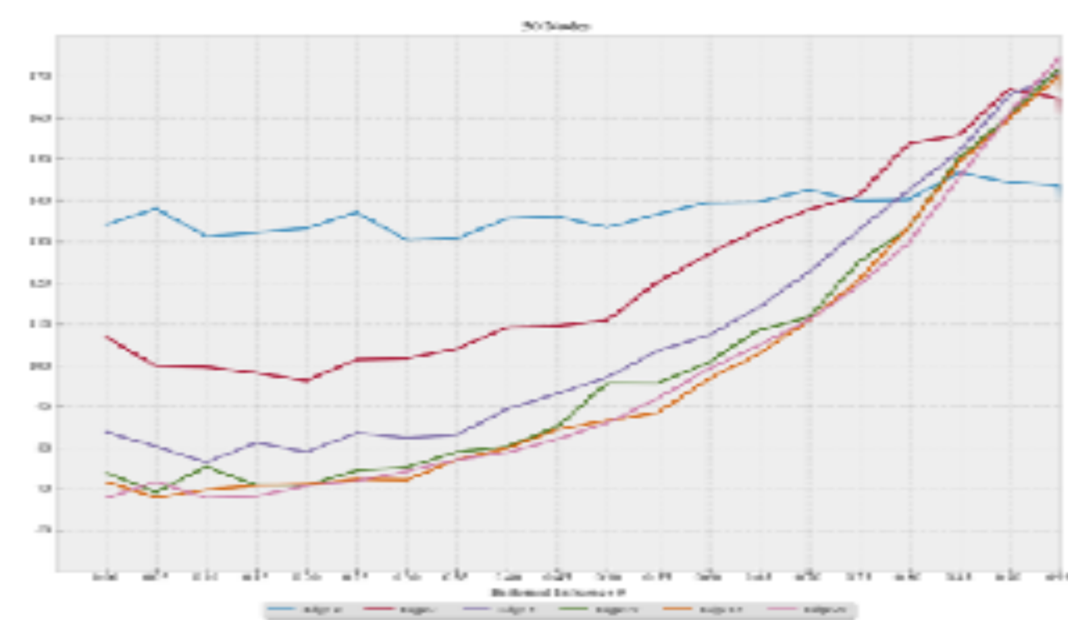
Network vs. External Influence

- VHS vs Betamax
- Wireless family plans
- Game consoles
- Back lives matter



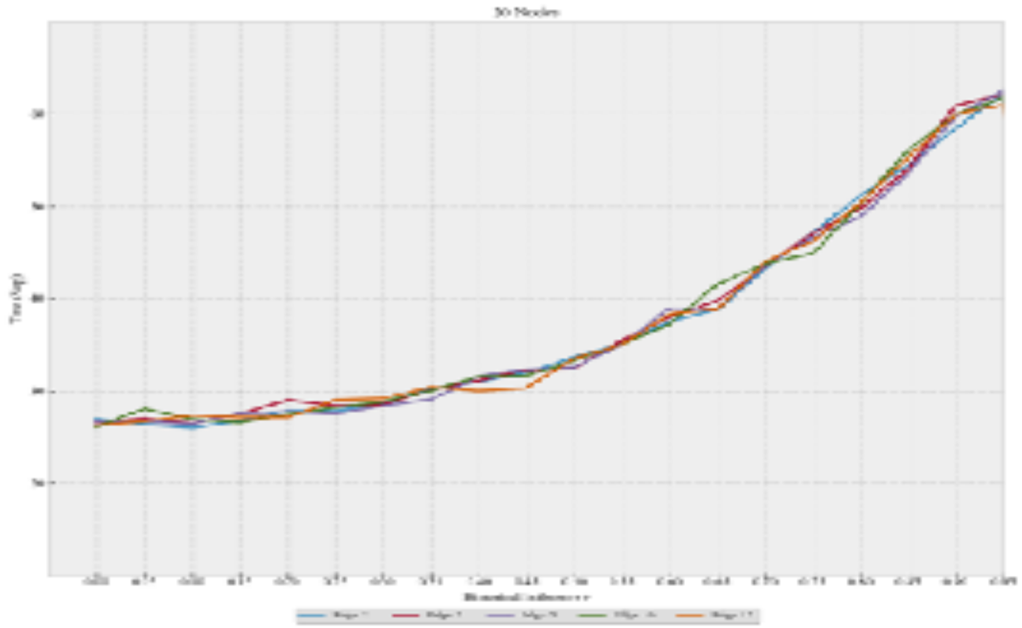


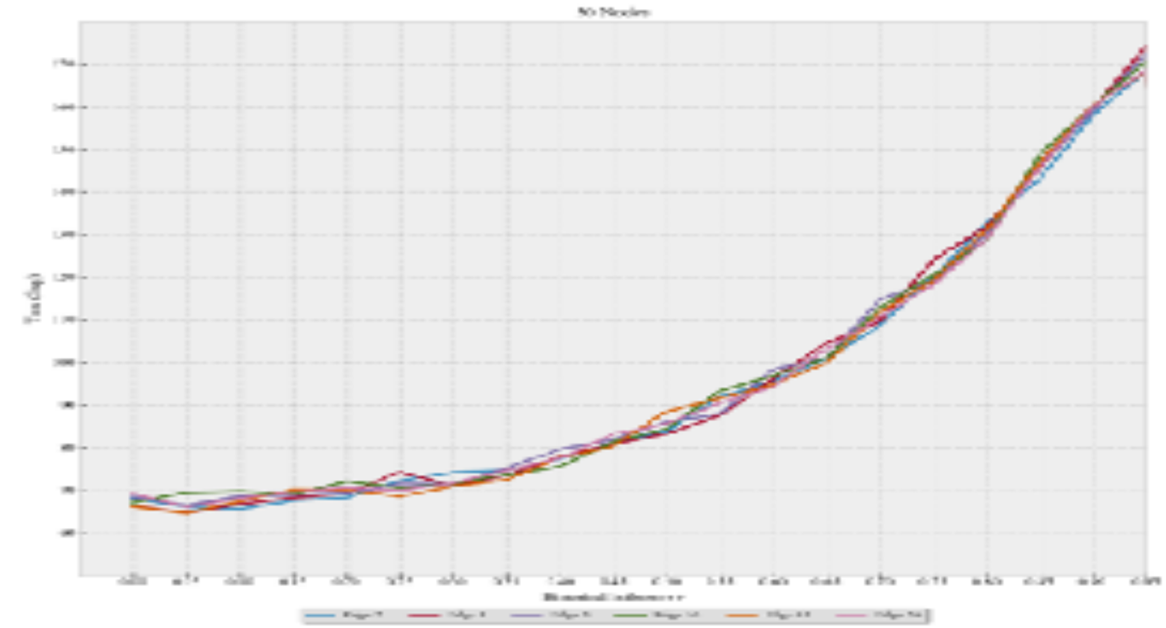




History vs. External Influence

- MS vs. Mac
- Bank vs. ATM





Effect of Initial Conditions (Diversity)

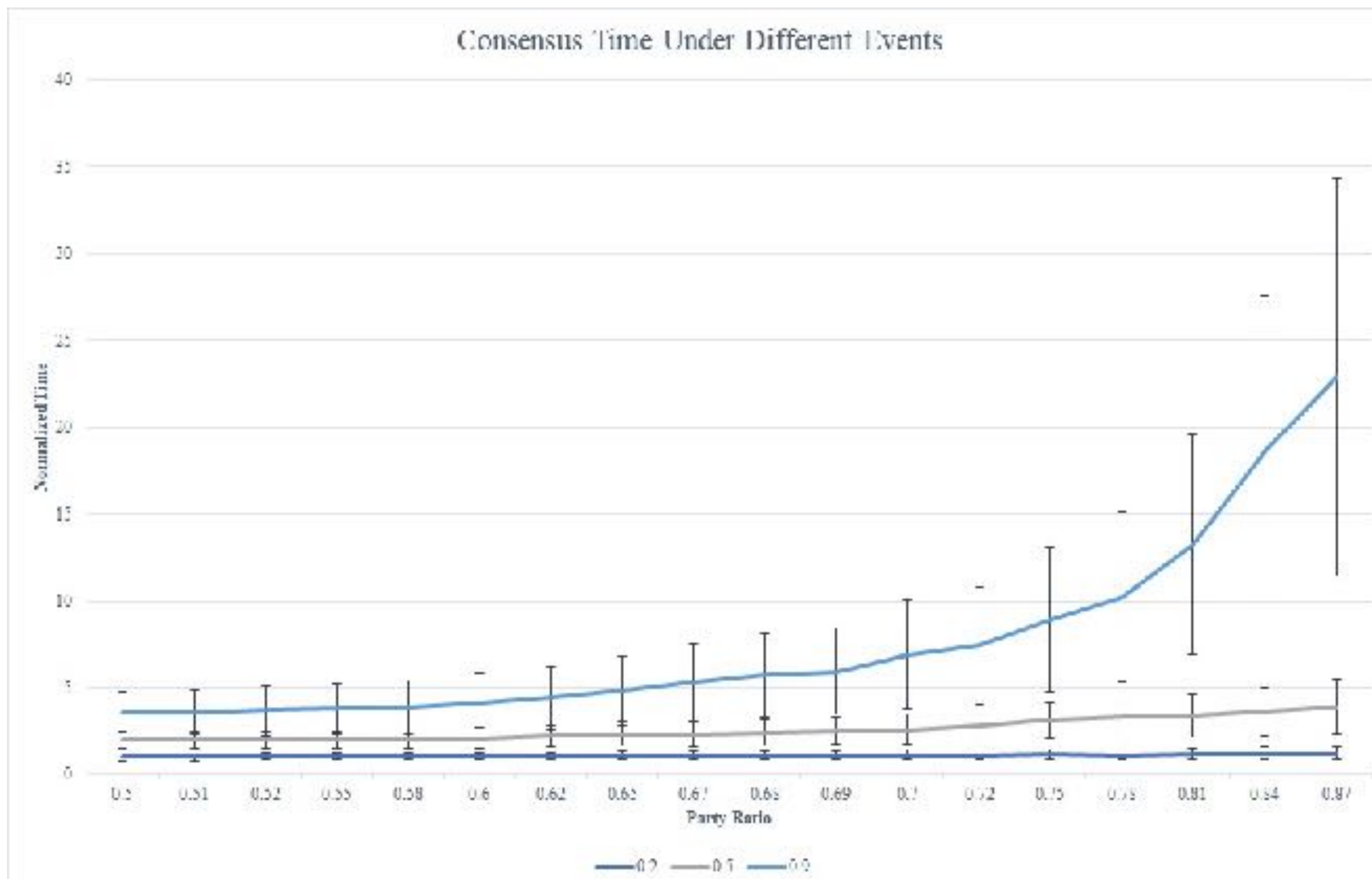
(Vesaghi and Mansouri, 2020)

Partisanship or Party Ratio:

$$\Phi = \max_{i}\left(U_N(i, j, t)\right)$$

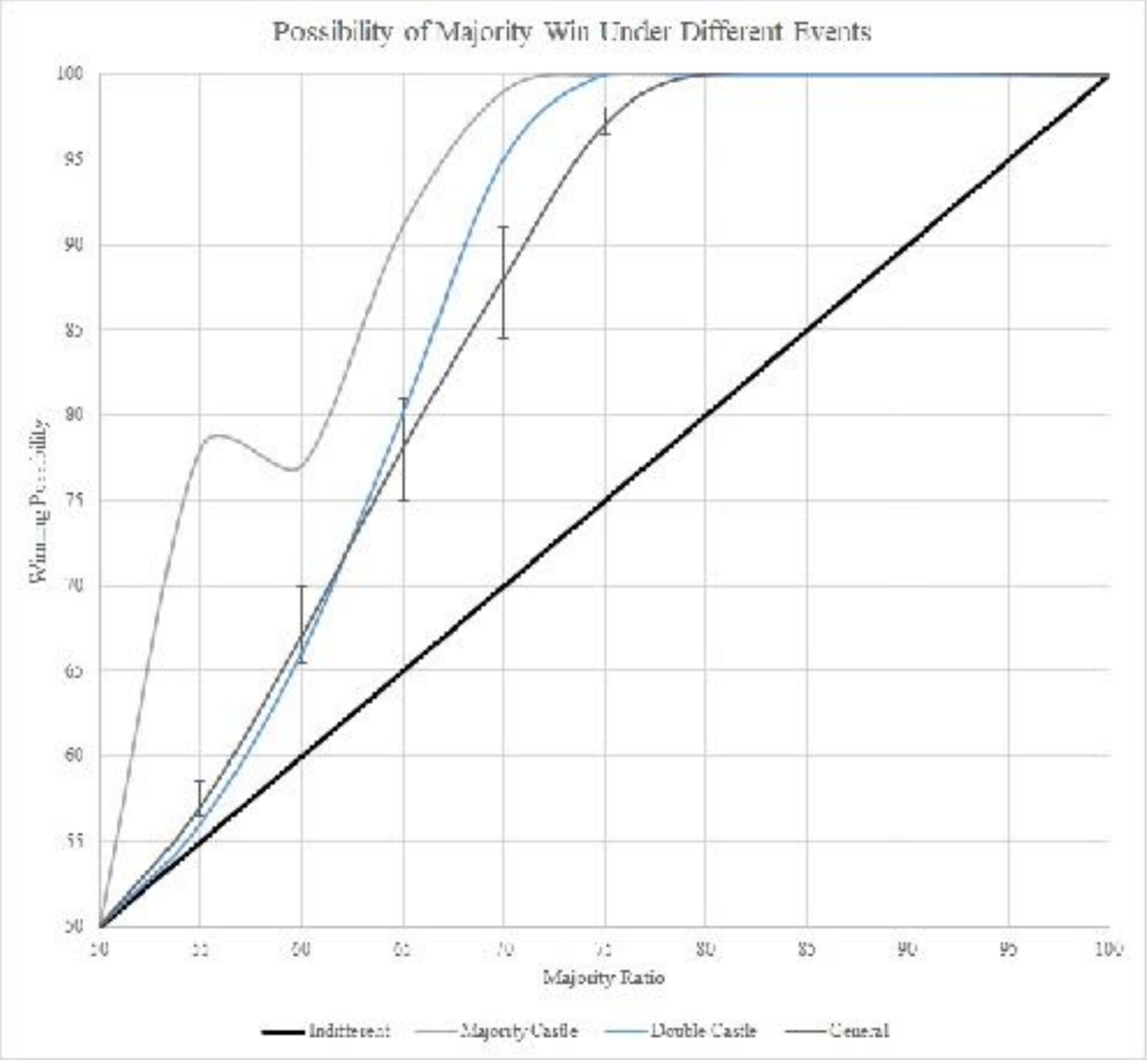
Highest ratio of an option that is chosen by agent j friends.

- Interracial marriage (1880-1960) and gay marriage (1990-2010)



Effect of Different Events (Fortification)

- Gridlock in politics (One Castle)
- Climate change debate (Two Castle)
- Women right to vote (One Castle)



Comparison of Network effect vs External effect vs History effect:

1- The results are consistent over different network structures (Node, edge, …)

2- Increasing the network effect increases the consensus time.

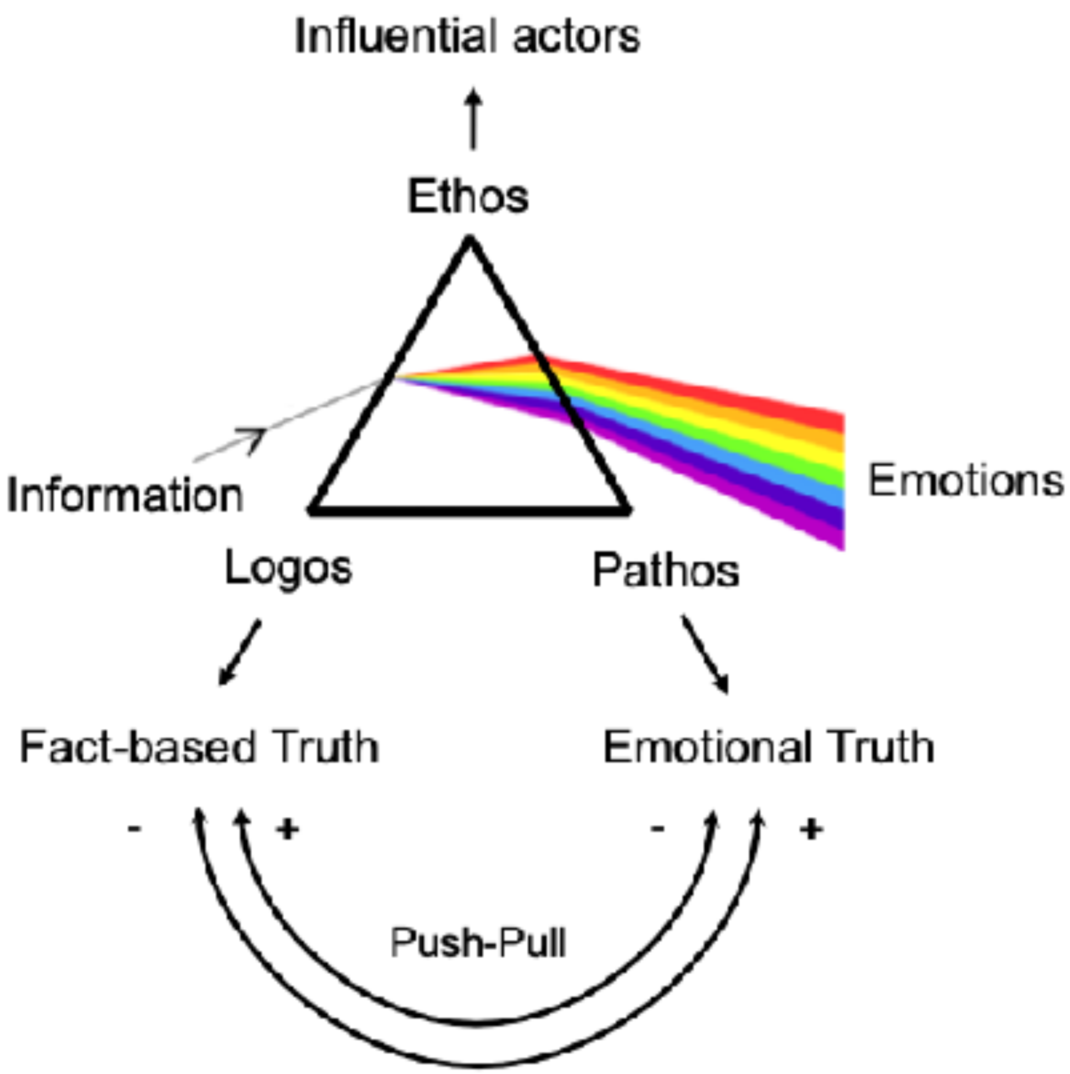
3- Increasing the history effect increases the consensus time.

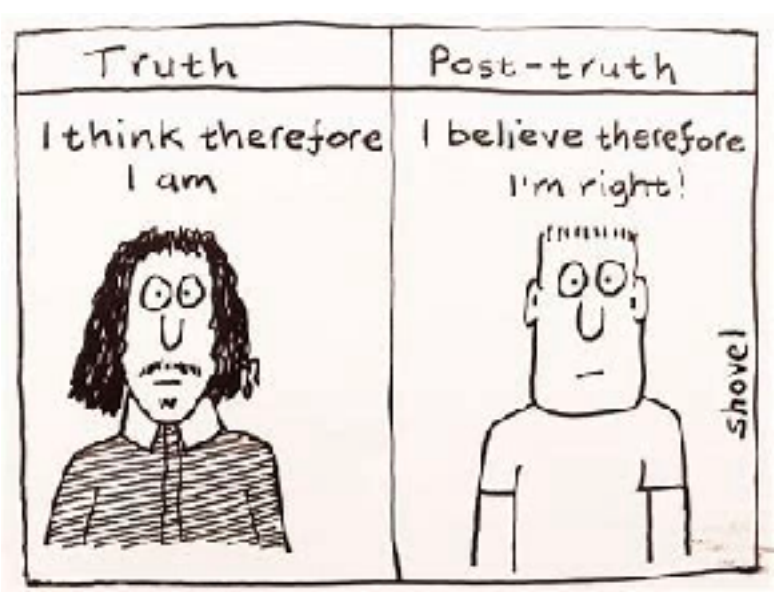
4- Decreasing diversity increases the consensus time.

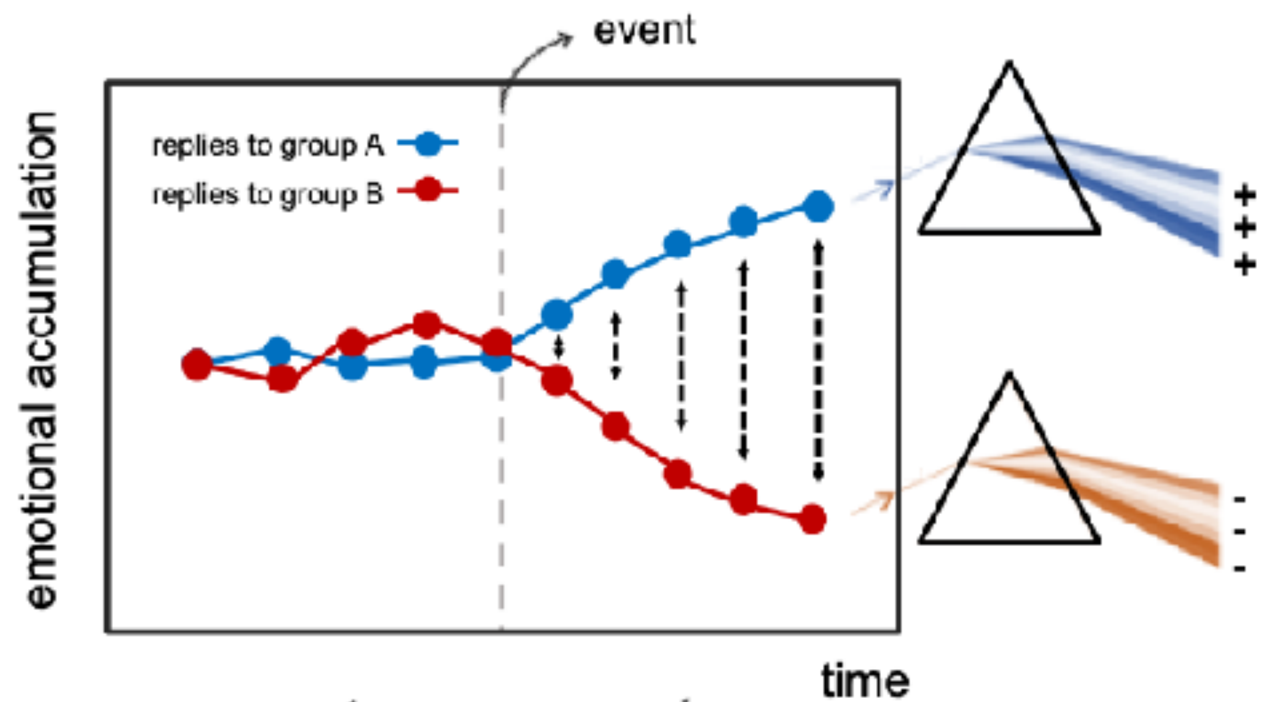
5- Forming Castles increases the probability of majority to dominate.

(Vesaghi and Mansouri, 2020)

The Emotional Factor in the Post-Truth Era







$$CS_t^{T_a} = \sum_{i=1}^{t} sen_i^{T_a} \qquad CS_t^{T_b} = \sum_{i=1}^{t} sen_i^{T_b}$$

$$p_t^{T_a,T_b} = \left| \frac{CS_t^{T_a}}{N_t^{T_a}} - \frac{CS_t^{T_b}}{N_t^{T_b}} \right|$$

where:

$$N_t^{T_a} = \sum_{i=1}^{t} r_i^{T_a} \; ; \; N_t^{T_b} = \sum_{i=1}^{t} r_i^{T_b}$$

The dilemma of being true

(Borrelli et al, 2020)

Thank you for your attention!