Digital Society Social Interactions and Trust Analysis Model

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Abstract

During unprecedented events such as COVID, the fabric of society comes under stress and all stakeholders want to increase the predictability of the future and reduce the ongoing uncertainties. In this research, an attempt has been made to model the situation in which the sentiment "trust" is computed so as to map the behaviour of society. However, technically, the purpose of this research is not to determine the "degree of trust in society" as a consequence of some specific emotions or sentiments that the community is experiencing at any particular time. This project is concerned with the construction of a computational model that can assist in improving our understanding of the dynamics of digital societies, particularly when it comes to the attitude referred to as "trust." The digital society trust analysis (D.S.T.A.) model that has been provided is simple to configure and simple to implement. It includes many previous models, such as standing models, schelling models of segregation, and tipping points, in order to construct models for understanding the dynamics of a society reeling under the effects of a COVID pandemic, miss-information, fake news, and other sentiments that impact the behaviour of the different groups.

Keywords: Trust Models, Covid-19, Sentiments, Digital sociology

Introduction

The emotions and sentiments are expressed as memes, cartoons, videos [1], [2], [3], [4], movies, articles, tweets, phrases, songs, images and many myriad ways that society endorses at a given time [5], [6]. The elements of expression of society are communicated and propagated through multiple mediums of media and languages including mixed languages such as Hinglish. Collectively all these elements become what a postmodern market refer to as "market sentiment" [7] . A term, which refers to how people feel about investments, stock(s) or markets. When referring to the financial state of the economy, this term is typically used with a negative -- connotation. However, computer scientists and sociologists are attempting to determine the sentiment of the public through the use of sentiment analysis in a similar and same manner. When a society, a nation, or a significant portion of the population is subjected to unanticipated, unexpected, and inexplicable stimuli that are otherwise incomprehensible, sentiment analysis becomes vital. A high degree of entropy and anxiety [8], [9] is created in the masses by events such as war, epidemics, famine, and climatic disasters, as well as by any type of socio-political decision that has an impact on a large threshold of population. Today, the speed with which this anxiety spreads is as fast as sending a single tweet post [Figure 1].

Figure 1: Digital Societies

One of the most difficult aspects of dealing with pandemics such as Covid -19 is dealing with the issue of trust. There are rumor mills in operation, pseudoscience are being promoted [10], [11], and various forms of misinformation and fake news start gaining ground [12], [13] . They are primarily propagated through digital media and have an impact on the entire social and mental status of society as a whole. There is a pressing need to develop tools that can recreate conditions similar to those that are currently occurring during the Covid-19 era of time [14]–[17]. Different communication tactics that help to create trust in society should be compared, and the tools should be able to aid users in appreciating the deep relationships between different types of communication and people's sociological behaviour should be available [17]–[20]. When developing a model, it is important to emphasize the facts that must be obtained on the influence of communication during future epidemics to develop a comprehensive communication planning tool that will help to eliminate distrust in the community. The effectiveness of such simulation

66   models can only be successful if the pulse of the society is captured and understood. Research

67   shows that this can be done by conducting sentimental analysis of the text that is publicly available

68   on media platforms such as Twitter etc. Most importantly the analysis must be conducted in the

69   colloquial languages that are spoken and written in specific geo-location.

70   Models should be parameterized based on the current empirical data collected in the context of the

71   pandemic. Each individual has different characteristics (such as attitude and different levels of

72   social media access) and reacts differently to the same situation, and perceives their environment

73   (such as proximity to the epidemic), reacting differently to different situations. All such parameters

74   must be considered while building the model. The simulation model or mathematical model should

75   have features such as demonstrating two-way communications i,e the influence between digital

76   communication and epidemic and vice versa. Lastly, it must help the users to build a decision

77   support system that appropriates multiple psychological/social [21] models that help to reduce

78   friction and improve trust in the society. An explorative analysis of this expected model shows that

79   no single equation model or single approach model will be useful in building a comprehensive

80   model [21], [22]. Hence, in the context of the problem undertaken here following models and

81   approaches seems to be relevant as per the contemporary literature survey.

82

83   Related Work

84   There are numerous techniques that researchers and social scientists equipped with computer

85   algorithms utilize to better comprehend complex themes such as trust, social divisions, behaviour

86   and equilibrium in digital groups, and phenomena such as the spread of diseases in societies.

87   Contemporary literature frequently cites a model known as Schelling. The Schelling model helps

88   to model society based on racial, income, ethnicity, cults and income segregation criteria.

89   However, the model can also be altered with custom rules, premises or principles to model groups

90   of people. This model generally helps to establish facts about why people segregate or group

91   themselves in a particular way. The degree of segregation or grouping impacts the speed at which

92   a trust travels, especially when the unprecedented events happening such as covid-19 pandemic.

93   Granovetter [23],[24], is yet another model that has been extensively used by social scientists to

94   understand the collective behaviour of groups based on specific criteria or some kind of rule. The

95   Granovetter model has been used for understanding the collective behaviour in terms of

96   equilibrium that society has at any given time. Research shows that based on threshold or criteria

97   large groups unintentionally make decisions that overall impact the characteristics of a
98   group/society. In episodes of trust won or lost, people accept unknowingly things they never
99   intended. This alters the future of 'collective trust' invested in specific premises, according to
100 research. People lose or gain confidence and trust with respect to issues in life-based on the
101 evaluation of their peers. The standing ovation model [25] exactly helps us to model this kind of
102 behaviour, especially peer pressure to behave in a certain way. Similar to the standing ovation
103 model the 'Identification Model' mentioned by [26], [27] gives a framework to understand the
104 identity based group dynamics. Why do people identify with a cause such as a dog lover, caste,
105 creed or any such kind of identity? In such cases also the flow of 'trust' depends on the collective
106 behaviour of the group with which the people individually identify themselves. Besides many
107 types of human races, colour and education. People also identify themselves with concepts such
108 as Anti-Vaccination [28] or Pro-Vegetarian. Trust in such cases can be assessed by building
109 identification models [29], [30] .
110 The degree of trust an individual feels ultimately aggregates for the total behaviour of the society.
111 The rational choice theory or the model based on rational Actors Model/Aggregation Models [31],
112 [32] assumes that individual actions lead to aggregate social behaviour. Individually, the theory
113 predicts the agent will choose the action (or consequence) they favour. Percolation models [33],
114 Susceptible (SIS) [34], Tipping point analysis help us understand the spread of pathogens [35]–
115 [37], Contagiousness and many phenomena such as biological adaptation, technology life cycles
116 etc. The inflection model helps to identify when a phenomenon goes from convex (f''(y) at a given
117 point is greater than zero: f''(x) > 0) to concave or vice versa. Trust becomes highly fragile and
118 fragmented in the society and positive communication with masses of the symbols of authority in
119 society needs action to stabilize the dynamics of society. Useful in the context of the current
120 corona-virus kind of situation and its impact on the social fiber.
121 These events are highly improbable and are rare but when they occur, they bring drastic changes
122 in the dynamics of the society. Some of these events can be predicted in advance and many of the
123 aspects remain unobservable. In such cases, Trust in the digital society can be modelled using the
124 Markov principles. The Markov Model attempts to explain a random process that is dependent on
125 the present event but not previous observations [38]–[40]. The Markov Chain Model are generally
126 applied for fully observable dynamic systems and the Hidden Markov model for partially
127 observable systems. Probabilistic or stochastic models seek to predict the behaviour of a

128   randomized independent process. Markov Models, on the other hand, attempt to explain non-

129   random processes. Equation-Based Models [41] , Model-based on identified mathematical

130   relationships (input variables and output). Trust can be modelled using mathematical equations by

131   considering trust as a function of other factors.

132   Since we are interested in using feedback-control principles to design machines that are capable

133   of responding to changes in human trust level in real-time to build and manage trust in the 'human-

134   machine' relationship and 'human to human relationship'. This study gives an illustration of how

135   this mechanism can be modelled.

136   It must be noted with good degree of attention that sensationalism sells. Media headlines are

137   designed to make us take subjects such as covid-19 deaths too seriously. So, the masses pay more

138   attention to what the television reporters are saying. No one questions or doubts the errors and

139   fallacies in media articles, tweets, or news commentaries. It is a situation where the 'trust' of

140   society takes new manifestations and shapes. Hence, the focus of this study is to study the 'tinkle

141   down effect '(*Percolation modelling [33], [42]*) on society in terms of 'trust' in the society. The

142   expression of people in any form (tweets, posts, demonstrations etc.,) is the stored value of the raw

143   emotions and current sentiment of the masses. Generally, there are two kinds of models that are

144   used by researchers for understanding the spread of epidemics i.e. equation-based models and

145   agent -based models. This section cannot ignore a comparative analysis with respect to the work

146   done here. For better clarity, it must be noted that this research work aims at understanding the

147   changes in the dynamics of the society when the disease spreads and is not the study of 'How

148   disease spreads in the society. This study is entirely focused on raw emotions and sentiments that

149   prevail during such times. If a series of tweets conversation discusses multiple topics related covid-

150   19 and Vaccinations etc. The study does not attempt to find '*evidence or no evidence of trust'* in

151   people regarding vaccinations [43]–[47] but in general how people consider statements and actions

152   as truth worthy for them to follow them (*Tipping point modelling [48]*) .It can be inferred from

153   the summary that no single model or approach can satisfy the current complex situation. The

154   behaviour models are ideally suited to understand covid 19 and sentiments associated with it.

155   However, multiple simulation modelling approaches such as Monte-Carlo [49], [50] are also

156   useful.

157   In order to work in this domain, the current generation of researchers use a large number of

158   simulators and tools. OpenModelica, OpenSimulator [51], Opensim , Anylogic [52], [53] , and

159 other simulation frameworks are among the most well-known. When it comes to analysing
160 internet-based information, python and the 'R' libraries linked to natural language are heavily
161 utilised [54]

162

Digital Society Trust analysis (D.S.T.A) model

164 In this section, a discussion on how the sentiment of society can be decoded from the text such as
165 tweets is discussed. At the same time, this section illustrates the steps in the construction of a new
166 qualitative model analysis framework referred to as the **Digital Society Trust analysis (D.S.T.A)**
167 **model.** The section further discusses the inverse problem of modelling, or simply the rules and
168 laws that govern the behaviour of the digitally enabled person in terms of trust as a sentiment or
169 emotion that he/she feels as events such as COVID-19 pandemics occur.

170

Variables:

S.No	Variables	Description	Usage
1	*'p'*	Digital society	Population of the Digital Society
2	*'r'*	Set of dynamic rules	Rules that guide the thinking/behaviour of Individual
3	'cp*c*'	Collective cognitive apparatus'	How to know the world.
4	Pp	Perception Apparatus	Interface between what we know The world around us
5	'ev'	Events Happening in due course of time 't'	Events can be of two types Mediocristan, Extremistan
6	N	Size of population	Total size of the population
7	'pt'	Type of Digital individuals in population 'p'	Three types of populations {indifferent , positive ,negative}
8	'tr'	Trust	Trust of a digital society member may be positive, negative, or neutral.
9	'sdic'	It is a dictionary of	This variable represents a dictionary of

		emotions.	emotions technically representing bag of words of raw emotions that are associated with trust.

172

173   **Table 1: D.S.T.A Simulation Parameters.**

174

Assumptions and Axioms:

176   1) It is assumed that at a certain point in time, 't,' the digital society 'p' maintains a balance of
177   observable laws and regulations that keeps neutral perceptions ('pc') and emotions ('tr') with
178   positive values.
179   2) The mental network or cognitive structure of the digital society is steady; there is no mass
180   event/hysteria or some mass degree of psychological shock functioning in the society at this time.
181   3) The balance of the digital society shifts when the dynamics of the norms and regulations change
182   as a result of occurrences such as Covid. Each individual is impacted, leading to changes in the
183   society as whole.

184

Construction of the Model:

186   1) Digital society as an 'institution' expresses itself on the internet based on a set of dynamic
187   rules '*r*' that build the society networks and at the same time guide the thinking and
188   behaviour of an individual (Agents) [55],[56] . These set rules are apparent and move over,
189   they in fact are embedded in the cognitive apparatus of each individual **p***i*. Dynamic
190   rules/laws are by definition a cognitive process by which an individual assimilates 'How
191   to interpret the world around it' and at the same time 'How to act in it' or respond to it. It
192   is assumed that these laws/rules are encoded within the individual's cognitive structure.
193   Hence, the full population '*p*' has its own collective apparatus that defines the fabric of the
194   society. The rules/laws at the individual level may not be observable. But, when the actions,
195   objects and events are recorded and are subjected to data mining analysis associated rules
196   start to appear [Figure 2].

197

198   **Figure 2: Model for Understanding Sentiments**

199

2) The 'collective cognitive apparatus', 'cpc' [57], [58] of population 'p' builds a perception
   ('pp' = {positive, neutral, negative}). Perception is an interface between what we know
   and the world around us. The perception has anchored sentiments /emotions such as trust
   ('tr' = {positive, neutral, negative} which drives the actions of each individual. Perception
   is, in fact, the application of the rules/laws assimilated in the mental mind. Perception of
   an individual can be judged with help of Topic Modelling or simply by analysis of 'content
   /topics/subjects' it responds to on the internet.

3) As mentioned in the earlier that at any given time 't', the digital society maintains an
   equilibrium of observable laws/rules that maintains neutral perception '**pc**' and emotion
   such as trust 'tr = neutral' and at the same time the mental network or cognitive structure
   of the digital society is stable.

4) The perceptual apparatus of the individual is a tacit knowledge that guides the thoughts
   and actions but at the same time it is difficult to linguistically express - it's something we
   'just know', but can't express. This tacit knowledge of the individual about its
   environmental impacts the emotions to which it is attached such as trust'tr'.

5) Emotions [59] are the reasons 'why rules/laws are to be followed and acted upon'. Emotion
   is not just a state that would be archived with the transformation of sense-data into a motor
   activity, but it is an axiomatic core of an individual that determines the value of judgment
   to act upon certain stimuli in the environment. Emotions are linguistically expressible in
   different forms of words, phrases, tweets, and many other long and short forms of content
   and principle empirically testable. They have different potentialities, for example, low
   trust, medium trust or high trust intensities or activations with which the individual may
   act. Emotions are a kind of Ipso facto to give a sense of urgency to act, a kind of motivation
   to do something in response to the exposed environment. Technically emotion analysis is
   different from sentiment analysis. Emotions are complex raw states such as fear, happiness
   etc., while sentiment is an organized form of emotions and is expressed as positive,
   negative, or neutral. The focus of this research work is to study the organized state of
   emotions and perceptions that a digital society has in times of events such as Covid-19.
   For this research work, it is assumed that linguistic mental maps of individuals can be

230   ground for identifying the potentiality of the sentiment in terms of low, medium and high.

231   The linguistic metal maps of sentiments can be constructed with a *bag of words* (b.o.w)

232   approach. The bag of words represents a specific sentiment dictionary ***'sdic'***. With the

233   help of distance metric (distance from a specific linguistic metal map of current sentiment),

234   a 'consequentialist reasoning' can be constructed for knowing the state of sentiment in

235   which the digital society is included.

236   6)   The equilibrium of the digital society changes as the dynamics of the rules/laws change

237   due to an occurrence of event '**ev**' of type = {Mediocristan, Extremistan [60], [61] }'. In

238   other words, the events bring structural and systematic changes into society. An event may

239   bring a 'multiplicative' impact or no significant impact. The multiplicative impact is a

240   situation when, for example, coronavirus spreads from one person to another at such a

241   speed and it leads to unintended changes in the psyche of society. This changes the

242   previous equilibrium of the society defined or assumed. Modelling methods such as

243   Standing Ovation [62] and Segregation models [63] also intend to study such phenomena.

244   However, in this model, we introduce the concept of Mediocristan, Extremistan to

245   understand the sentiments of the digital communities and collectives.

246   Mediocristan Figure 3b, as defined has a thin tail graph when plotted and affects the

247   individual independently of the community. Technically, extremistan affects many

248   individuals. As a result, extremistan brings systemic consequences that mediocristan does

249   not. Multiple events, including diseases, are constantly associated with Extremistan Figure

250   3a. They may be non-lethal (for example, the flu), but they become remnants of

251   Extremistan.

252

253   **Figure 3 (a) Extremistan   Figure 3 (b) Mediocristan**

254

255   To understand the degree or intensity of a particular sentiment such as trust 'tr' in a population

256   '**p**'. It is critical to understand the nature of the event and the consequences it is generating. The

257   simulation output of the model is given in Figure 4. The parameters for running the simulation are

258   shown below in Table 1.

259   When generating the population 'p' of the digital society, the simulation uses default values of 1000

260   as the starting point. It is built by applying uniform random distribution to construct the cognitive

261 equipment of the collection of agents (total digital society). It is determined what kind of
262 understanding each individual agent has about his or her socio-economic circumstances by
263 assigning a value to each individual digital agent 'pi' and a perception 'Ppi' of each agent is built.
264 Those who are not oblivious to changes in the socio-economic environment are assigned a higher
265 trust level in this scenario. The population that has chosen to take role in constructing the
266 alterations in the environment is finally chosen for inclusion in the simulation and will be the first
267 to begin. By employing a uniform distribution model *($X \sim U(a=0, b=1)$,where a ,b are lower and*
268 *upper value)* , three levels of trust (low, medium, and high) are assigned, and the initial equilibrium
269 is calculated and represented graphically in Figure 4 showing the zeroth iteration. When the
270 D.S.T.A simulation is running, the society goes through a number of transformations as a result of
271 events such as covid, no-covid, or some rare type of event that has a significant impact on the
272 society.

273

274 **Figure 4: Movement of Trust Sentiment in the digital society due to Covid**

275

276 The output obtained by the simulator is depicted in Figure 4. Figure 4 depicts eight different
277 simulated scenarios. The initial trust equilibrium is represented in the first iteration '0', and as the
278 discourse begins because of the advent of some event such as Covid-19 or the Ukraine-Russia war,
279 there is a great deal of motility and emotion runs at a high level. People begin to create new groups
280 or clusters because of the high degree of entropy that has been activated. Individuals and groups
281 begin to change their behaviour in a variety of ways, which leads to polarisation in the society
282 because of the changes. Throughout the simulation, as the various (Factors of Change) events
283 unfold and trust levels fluctuate, a new equilibrium research is conducted after the conclusion of
284 iteration number 7. If dialogues (Tweets) between the digital agents are exchanged regularly
285 (Number of Conversions exchange Threshold = 10), the collective behaviour, attitude, and
286 precipitation in response to environmental stimuli are influenced more. The accumulation of
287 entropy because of events such as covid-19 causes the trust equilibrium to shift as users begin to
288 influence one another's behaviour, as can be seen in the graph below. For example, the suggested
289 model includes the theory of probability and makes use of structural equations to better
290 comprehend the dynamics of digital society in terms of confidence.

291

Results

293 The innovative computational model given here is an interaction between events and conceptual

294 'agents' in both space and time, resulting in dynamic patterns and potentially constantly producing

295 behaviour as per the social conditions. Not only do the models allow for variation in agent choices,

296 but also in their behaviour. The suggested model's agents' behaviour is "tunable" on multiple

297 dimensions, ranging from hyper-rational in terms of trust sentiment and hyper-informed in terms

298 of how it is empowered to act and interpret happenings such as the covid-19 epidemic to basic and

299 naive. However, the current work must be evaluated in the backdrop of the Standing Ovation

300 model. The SOM is a good metaphor for social circumstances in which agents make binary

301 judgments such as sending to private schools or not and interacting locally. In real life, outcomes

302 are usually open-ended, or least, variable. Generally, binary exposures (true or false, pregnant, or

303 not pregnant) are limited in their impact on society hence, the models are limited in this sense. The

304 Granovetter Model [64] has been improvised multiple times with the help of *graph theory* [65]

305 and *Probability theorems*. The foundation is the computation of the strength of ties and

306 relationships. A concept that is useful in the context of understanding 'Social Fabric and trust in

307 society [66]. The proposed model incorporates the computations as well related to this. However,

308 the proposed approach allows us to compute the strength of the tie with help of 'tweets or content

309 expressed by the users. The suggested model involves the detection of tipping points [67], which

310 is a critical component. In addition, it seeks to discover reference points when a small change in

311 the "market sentiment or social sentiment" parameters results in a significant shift in the raw

312 emotion of trust. As a result, the current study highlights the mechanisms by which

313 information/rumor diffusion happens and the points at which the dynamics of trust alter in

314 situations such as COVID-19.

315

Conclusions and future work

317 The principle of the diffusion of information and the principle of social change shows the impact

318 of trust on the behaviour of thousands of people. The role of 'trust' as a sentiment in the diffused

319 network of information highways has been investigated for digitally empowered people.

320 However, it should be noted that the outcome of such a study depends on a large number of

321 dynamic variables. Hence, this research effort has its limitations, but it's also important to highlight

322 that, to some part, the model's resilience is determined by the person who is looking at it. Because

323 of the ease with which computational modeling may be used, researchers can readily adjust the
324 assumed behaviors and parameters to find the important elements driving the results. At the same
325 time, it can be observed from this proposed model that it has several advantages in terms of
326 flexibility and effectiveness in understanding the social conditions, perceptions and sentiments
327 using 'content expressions' of the people.

328 The purpose of this research is to lift information above the noise. It tries to blend vivid storytelling
329 and persuasive arguments. By describing experiences with vivid and emotive tales and
330 explanations, you can influence individuals to view events and facts differently. This dynamic has
331 the potential to unite as well as polarise social groups. The model attempts to comprehend this
332 truth within the framework of what may be observed using social media settings. The meaning that
333 individuals ascribe to information varies according to the social groupings to which they belong.
334 Successful information campaigns can be rooted in or targeted towards existing social groups.
335 Leaders and authority figures have a significant influence on how information is interpreted and
336 presented. As a result, this study is also relevant for policymakers who want to uplift the 'trust' in
337 society in a positive manner.

338 For future studies, it is recommended that extension of this model to include more parameters and
339 events that do not follow extremistan or mediocristan pattern may be done. The current study
340 attempts to deal with many random and uncontrollable variables; the accuracy of such models
341 degrades as time length increases. Hence, there will be a need to redo such studies in light of new
342 circumstances and irregularities that may come up in the future.

343

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523

Figure 1

Digital Societies

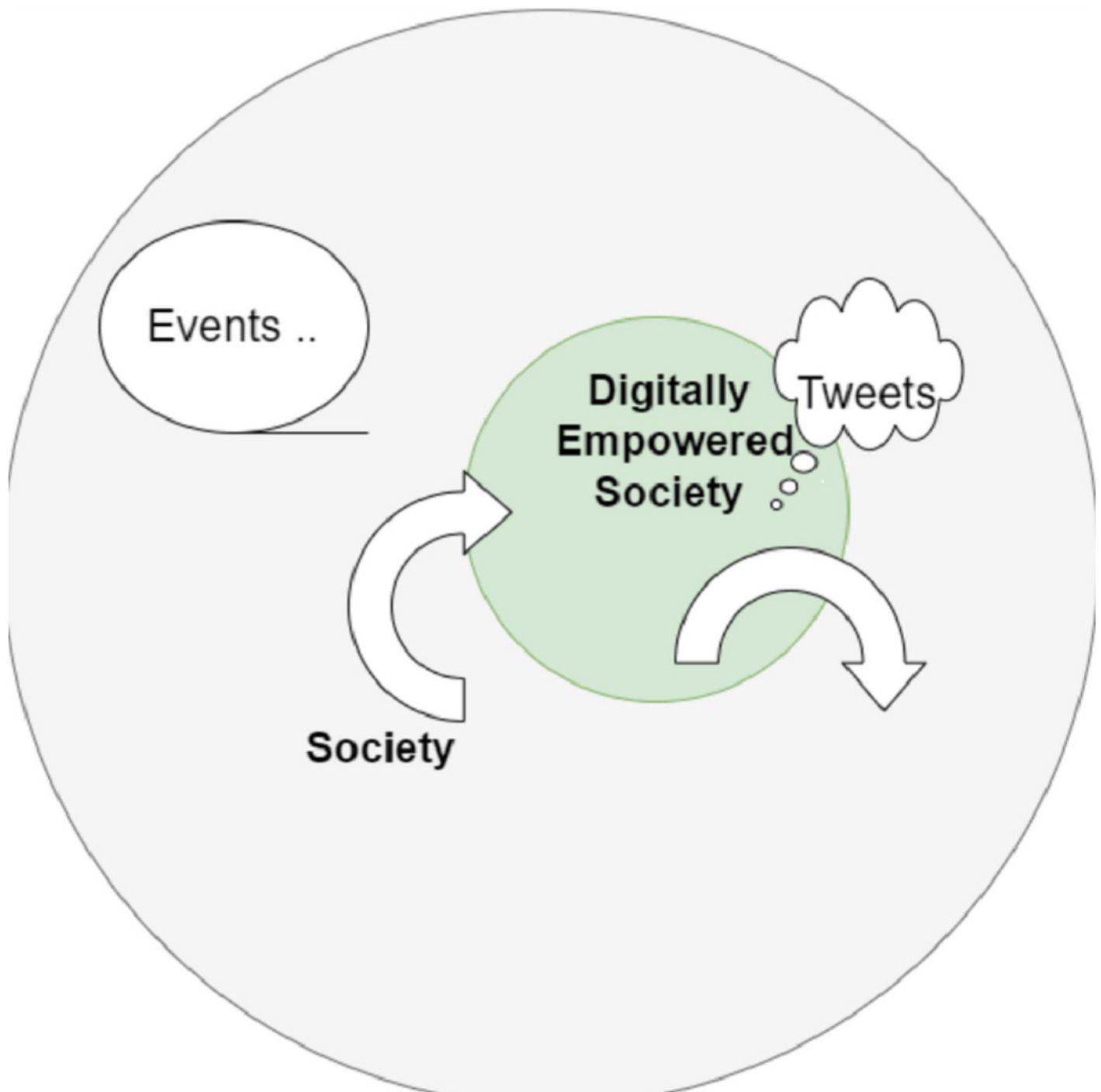



Figure 2

Model for Understanding Sentiments

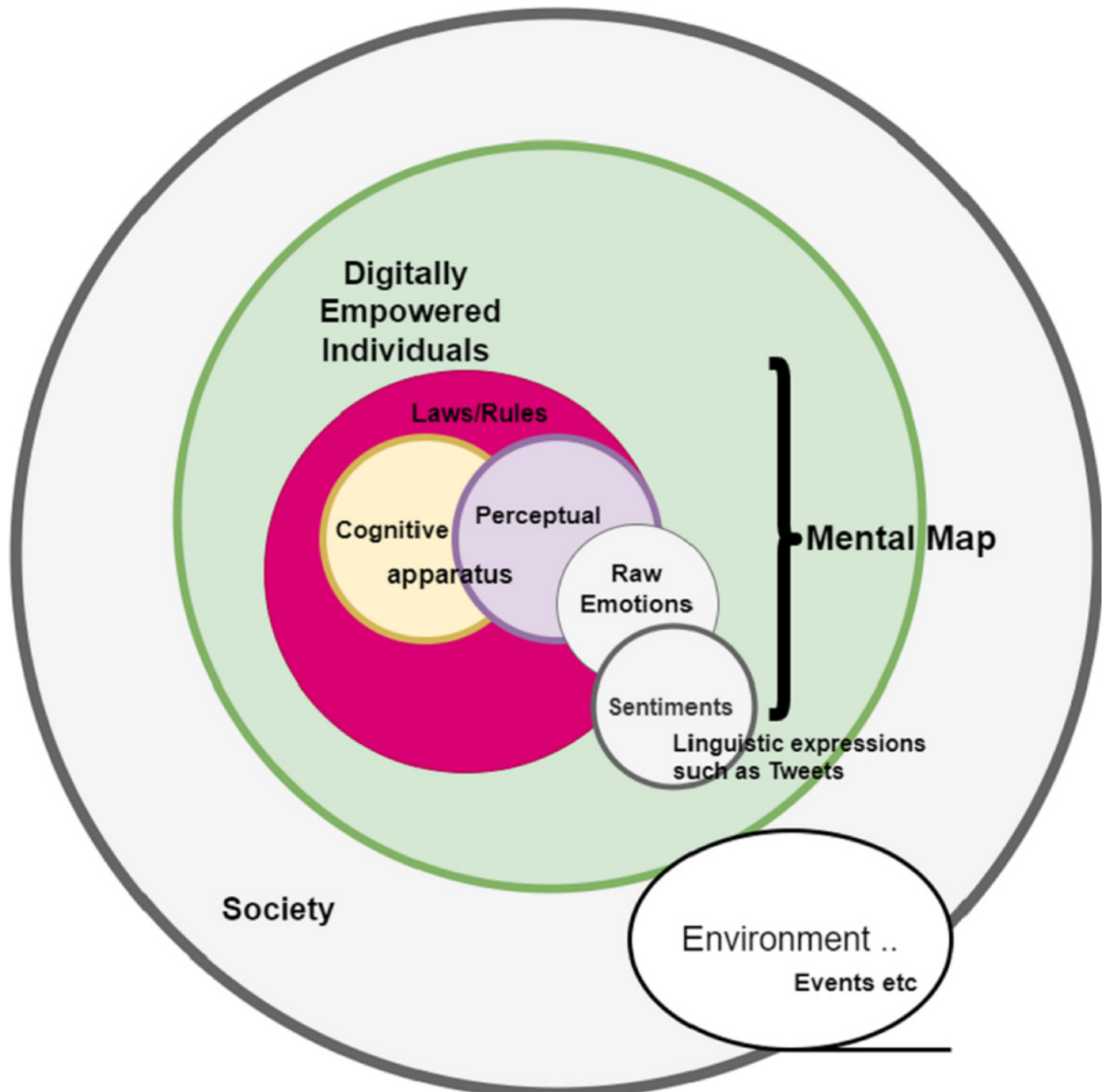
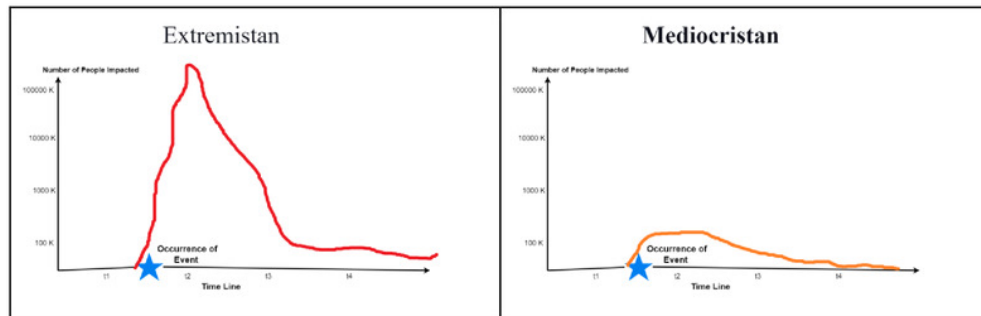
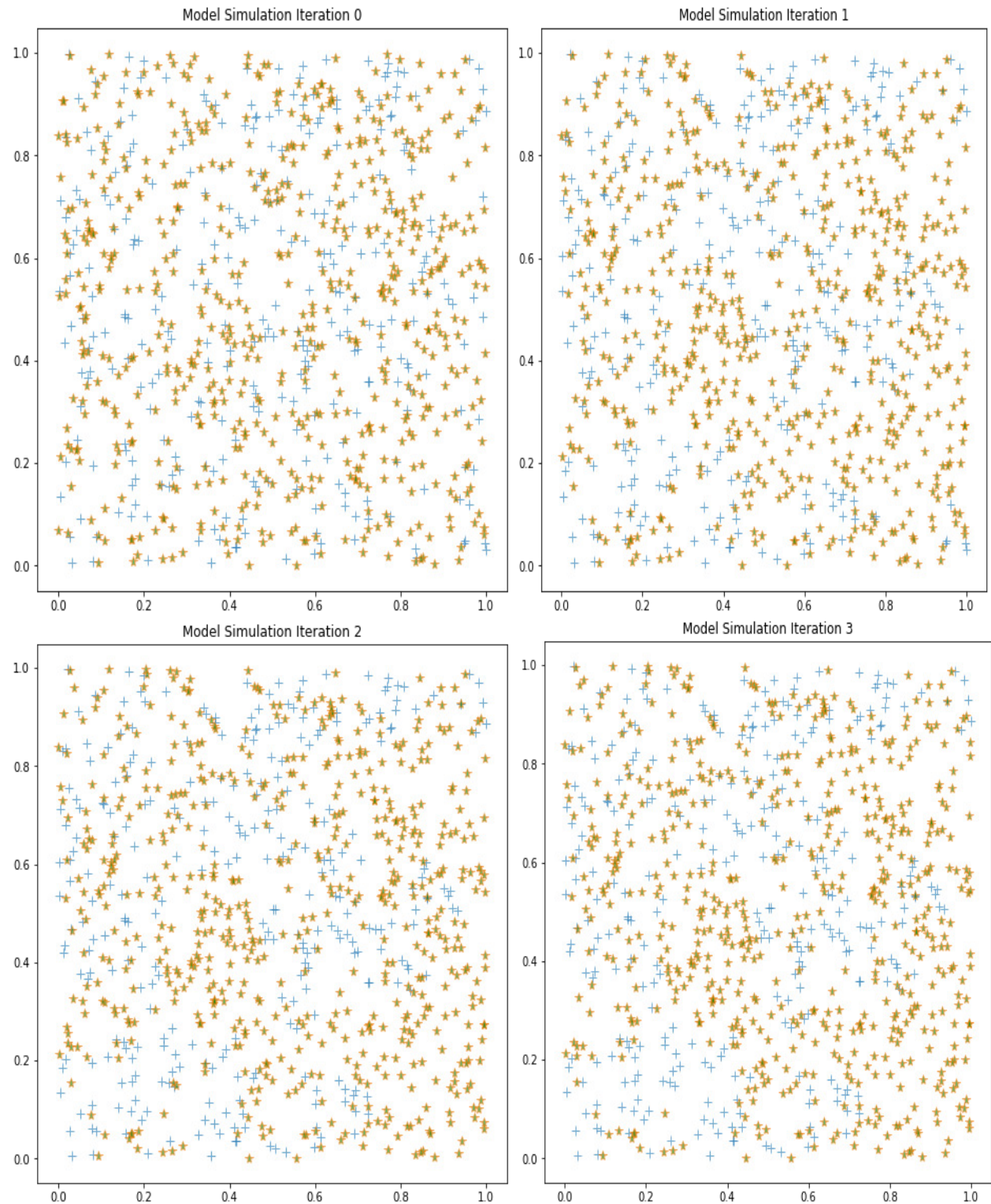
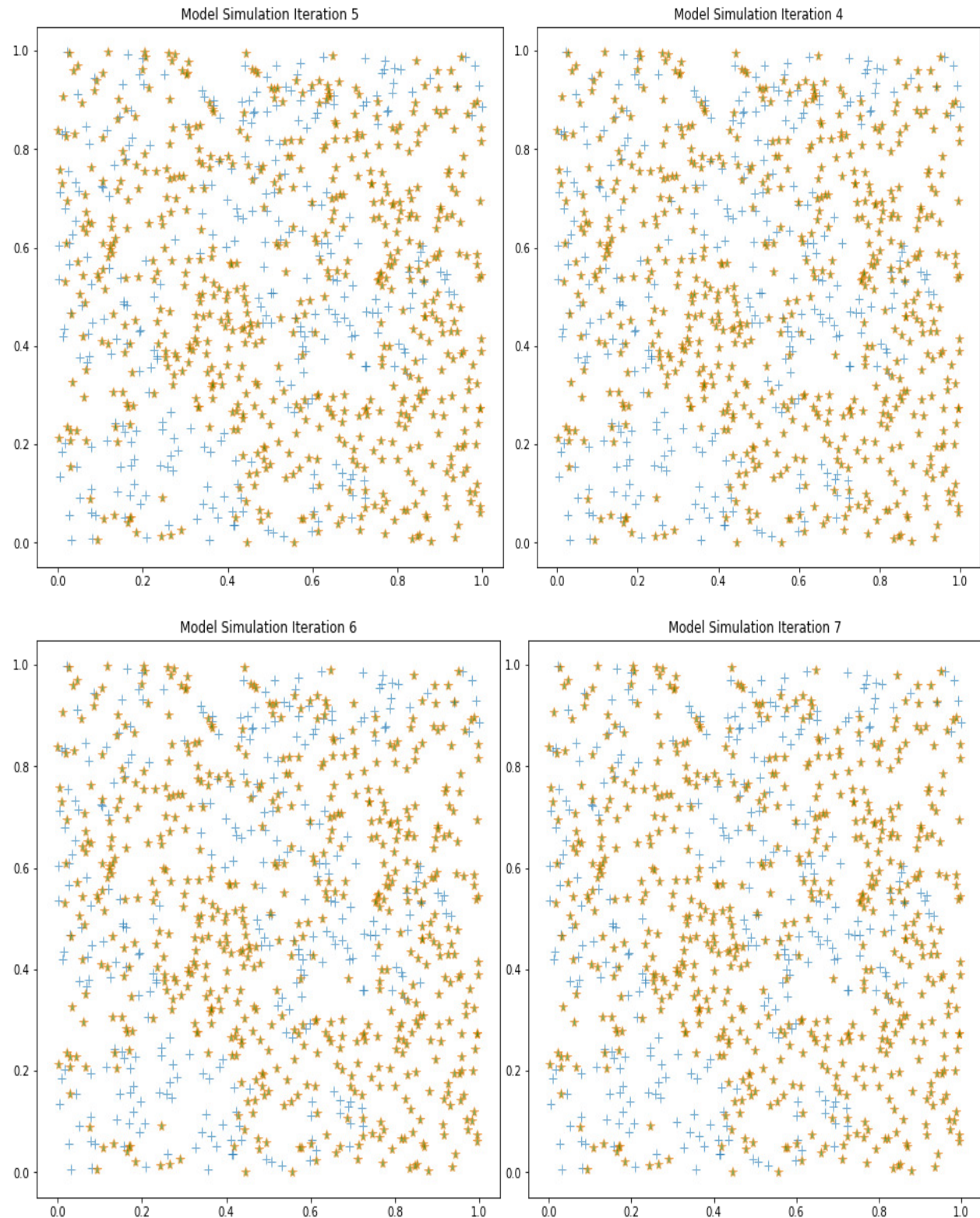



Figure 3

a) Extremistan b) Mediocristan

Movement of Trust Sentiment in the digital society due to Covid

Simulation Parameters

S.No	Simulation Parameter	Value	Mathematical Expression
1	Population size (Twitter Agents) 'n'	900	'n'
2	Cognitive apparatus 'c'	{Indifferent, Positive, Negative}	agents = [TwitterAgent for i in range(n)] c = uniform_randon(1,3)
3	Perception 'p'	{Positive, Neutral, Negative,Indifferent}	agents = [Cognitive_Apparatus 'c' for i in range(n)] If! ='Indifferent' , c = uniform_random(1,3)
4	Levels of Trust Identified Using Rule Mining 't'	{Low,Medium, High}	agents = [Cognitive_Apparatus 'c' for i in range(n)] If! =disinterested , assess_trust_levels()
5	Distribution of Trust Levels in Population	Balanced	for each agents agent_trust_level = rand.uniform(assign_trust_levels())
6	Factors of Change Probability	{Mediocristán = [Covid,No Covid], Extremistan={Rare Event}}	for each agents update_trust_level chg_prob = compute_probality_event(Mediocristán&Extremistan)
7	Number of Conversions exchange Threshold	10	It is the number of messages that have been exchanged with time to influence the behaviour of the other.
8	Number of Iterations of simulation	100	Number of Rounds the simulation will run

9	Termination Condition	-	while True:
			compute_initial_equilibrium
			count += 1
			no_change_equilibrium = True
			for agent in agents:
			old_trust_level = agent.trust_level
			agent.ChangeFactor(agents)
			if agent.trust_level != old_trust_level:
			no_change_equilibrium = False
			if no_change_equilibrium :
			break