Modeling Plural Identities and their Interactions

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***Abstract*—We model social structure and interaction among people and societies in terms of plural identities of people who form the society. Plural identities as conceptualized by Amartya Sen in his 2006 book Identity and Violence is presented. Models for information and influence flow in the social structure as well as the mechanism for group actions is presented as a tri-partitie graph.**

I. Introduction

Amartya Sen, a Nobel laureate, in his book Identity and Violence [1], presents the concept of plural identities of the social human being. He defines this concept by listing various categories in which a person may simultaneously belong. For example, a person may, among other things, also be a Muslim, liberal, defender of women's rights, a scholar and a British citizen. He criticizes a very common practice, particularly among politicians and policy makers, of placing people in boxes of singular identities such as characterization based on religion. Such singular characterization result in incorrect local, national and international policies which are harmful for the society. He argues that singular view of a person's identity comes from the lack of exposure to diversity or intentional disregard for it.

In this article, we first attempt to present Sen's concept of plural identities as an undirected bi-partite graph with two sets of vertices: identities and agents. Later we introduce a third set of vertices to model interactions between agents and between identities that are loosely connected to each other.

1) Institutions or classifications that define a person's plural identities such as family, religion, gender, social views are a set of identities.
2) Persons who may have one or more identities form a set of agents.

In our model, agents and identities are connected to each other through undirected edges but there is no edge connecting two identities or two agents directly.

We use the vertex degree i.e., the number of edges a vertex has to measure the size of an identity and the plurality of an agent. An identity with millions of agents connected to it is far bigger than one with 10 agents e.g., country is bigger than family. We conjecture that people living in social isolation have a lower plurality while a truly social person may have a high plurality. We propose that each agent has a finite amount of energy and they may allocate a fraction to each identity to which they have direct edges. For example, a serious mathematician may devote a significant fraction of her energy to study and teach mathematics. We define some terms to describe this model and present the process of information flow within this graph structure in the following sections.

II. Definitions

In this section we have defined some terminologies that may be useful to understand our model.

Weak and Strong Agents: Agents with fewer competing identities or those who have a few related identities, can be influenced more easily compared to those with either several identities or who balance their energy across a diverse and unrelated set of identities. Once the pull from one identity increases, agents of the former kind are more likely to take away and reallocate some of the energy from other identities. We call them "weak agents". The latter kind of agents are less susceptible to such influence and hence we call them "strong agents".

Strength of Ties: We can define strength of ties between agents as the number of walks of length 2 between i and j in the identity-agent bipartite graph.

Super and Sub-identities: For an identity α, let the agents connected to it directly be $\{A\}_\alpha$. Then if $\{A\}_\alpha \subset \{A\}_\beta$, then α is a sub-identity of β and β is the super identity of possibly several other identities.

For example, a person is simultaneously a Shia and a follower of Islam. Similarly all New Yorkers are residents of USA and so are those who live in Boston. Two identities are related if they are both sub-identities of the same identity. We can relax this definition by measuring the overlap between two identities in terms of the number of paths of length 2 that connect them together. Therefore, the identities "US citizen" and "New Yorker" have a high overlap but "New Yorker" is not a sub-identity of "US citizen" although there is a close relation. *Sen complains that sectarian and communal*

violence arises when people focus on the sub-identity and fail to see the corresponding super identity.

Flow of Influence We propose that information in the bipartite graph originates as messages at agents and flows to an identity. The message can then be transmitted to those who have links connecting them to the same identity.

1) At any given time, an agent i, may send a message toward an identity. This message m_i contains some power p_i which is in proportion to the energy e_i that i devotes to this identity. For example, a mathematician may prove a theorem and publish it in a journal.
2) The message m_i, if sent with significant amount of power affects agents j who also allocate similar amount of energy to the identity.
3) If two agents, i and j, send messages m_i and m_j respectively and if the two messages are related, their combined effect is $p_i + p_j$. If m_j refutes m_i, the effect of m_i reduces otherwise m_i is reinforced until the power of m_i reaches a steady state.

Direction and Intensity of Influence: Message m_i sent by i affects all agents j that are tied to the same identity. The order and intensity in which agents are affected is proportional to the amount of energy each agent allocates to the identity. Agents receiving the same message from other related identities are more easily affected. For example, a recent New York Times article notes thatan increasing number of a number of collaborators in acts of terrors are siblings [2] who lived in the same household. Therefore, common identities i.e., such as family and religion compound the influence on siblings so that they choose strategies and actions that are commensurate with the agents to which they have strong ties.

An agent who has acquired higher prestige with respect to an identity, such as a political or religious leader, can send messages with higher power [3]. These agents, often considered as experts, are able to influence others who are weaker or have less prestige or those who consider themselves non-experts [4]. The weaker agents then become the foot soldiers who attempt to recruit others for a group action that the original agent aims to start. Ultimately, the power or pull of the message may receive sufficient reinforcement to recruit more agents and may even start affecting relatively stronger agents. In social and political settings, the agents with higher prestige and hence influence, often take advantage of weaker agents by promoting sub-identities as being of higher importance than the super-identity. Thus, the identity "human", being the universal super-identity, often gets superseded by sub-identities.

III. Connections between Weakly connected Agents and Identities

While the bi-partite graph model explains interactions between agents that have strong ties with each other, it does not explain connections formed between agents that are only weakly connected through super-identities such as gender and language. For example, an agent A in the Ray family hires agent X to baby-sit her daughter C when A and X have only met through an employment agency and hence are not strongly tied to each other.

Algorithmic Connections: When two agents or identities participate in an exchange without having strong ties to each other, we say that they have entered into an algorithmic connection. Algorithmic connections are temporary, opportunistic and necessarily weak. For example, when C grows up and starts being more independent, A would not need $X's$ services as a baby-sitter any more.

We add a new set of vertices to represent algorithmic connections and the resulting social structure is a dynamic tri-partite graph in which each vertex in the third set has at least two temporary edges. We model algorithmic connections as two player games where the players, at equilibrium, receive some payoff based on their actions.

A. Algorithmic Connections between Agents

It has been found that in certain situations such as in academic groups and bargaining for the share of payoffs from collaborative work in academia, individual agents may not choose a strategy that is most beneficial to them due to social dynamics and pressures [5], [6]. Therefore, we define three sub-types of the algorithmic connections between agents,

Full Information: When both parties are aware of the immediate outcome and get fair pay-offs, we say that the connection is fair and agents have full information of their opponents such as in rational games [7].

Asymmetric Information: When one party has more information than the other regarding the cost and payoffs of the interactions, the connection between them is asymmetric. This leads to asymmetric games which has been studied in the context of evolutionary game theory [8].

The payoffs in pairwise interactions in such games are influenced by the strategies of the players [9].

One-sided Information: Predator prey connection [10] is formed when some of the possible costs of the interactions and payoffs are completely hidden from the other agent.

All three types of connections are formed when there is an element of trust. For example, a passenger would not get into a cab unless he trusts that the driver will take him to the correct destination. In addition, the predator-prey connection is necessarily formed only between a strong and a weak agent (or identity).

B. Algorithmic Connections between Identities

Algorithmic connections also connect identities together. For example, when a message m_i, originated by agent i that belongs to identity α is directed toward the identity β which may not be one of $i's$ identities, we say that the two identities form an algorithmic connection. However, for a message to cross the boundaries of an identity, it must start from a powerful agent or accumulate a high enough power due to reinforcement by less influential citizens. For example, a film made by an unknown director may not have the same effect as a film by Morten Tyldum who directed the movie "The Imitation Game". Similarly, due to the lack of power, an ordinary Canadian citizen's message of solidarity with Syrian refugees, may not lead to actual immigration of refugees to Canada but a message from the Prime Minister of Canada has a different impact. However, if a message send by an otherwise less influential agent is resonated by the masses as is often seen on social media such as Twitter, the result can be similar. Thus algorithmic connections across identities or agents that are either weakly connected or seemingly unconnected form either due to an agent who has higher prestige/power or by a collection of agents who reinforce a message that initially arrived at a low power.

IV. Why does Identity lead to group actions?

A group action is highly likely when messages accumulating at an identity become strong enough due to reinforcement from other members. Groups of agents are mobilized by the influential agents by assimilating information coming from various sources to represent a semantic that they prefer. This semantic, is often crafted into messages that impart some knowledge [11] which is then conveyed through an identity to agents that have strong ties with that identity. However, the intended action may not start until there is a consensus among agents, a behavior also seen in swarms of insects [12]. Since humans often rely on experts to guide their actions [4], an agent that enjoys higher prestige and centrality [3] can cause consensus by influencing a group of weak agents or a set of moderately influential agents can resonate each others messages to influence the weaker agents. Group action through such influence is a complex process, which can be appropriately modeled as a stag hunt game with fuzzy strategies and payoffs [13], [14].

V. Conclusion

We have presented a model for plural identities and interactions between agents and identities as information flow through shared identities and games played across algorithmic connections between weakly connected agents and identities. This model of social structure can be used to predict whether a group action is imminent. Further evaluation of the model through simulation in complex networks [3] will be an immediate next step in this work.

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