Research Challenges of Dynamic Socio-Semantic Networks

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Abstract. A general model of a socio-semantic network is presented in terms of state-transition systems. We provide some examples and indicate research directions, which seem to us the most important from the application point of view.

Keywords: social network, semantic network, socio-semantic network

1 Model of a socio-semantic network

1.1 Social network

A social network is usually modeled as a weighted multi-graph

$$G = \{V, E_1, \ldots, E_k; \pi, \delta_1, \ldots, \delta_k\},$$

where

- V represents members of the network,
- $E_1, \ldots, E_k \subset V \times V$ denote different relations between the members, e.g. being a friend, follower, relative, co-worker etc.
- $\pi : V \to \Pi$ is a *user profile* function, which stores personal information about the network members.
- $\delta_i : E_i \to \Delta_i$ $(i \in \{1, \ldots, k\})$ keeps parameters and details of the corresponding relation.

1.2 Content

The model of the content has a very similar definition. It is a multi-graph

$$C = \{T, R_1, \ldots, R_m; \theta, \gamma_1, \ldots, \gamma_m\},$$

where

- T stands for the set of all elements of the generated content, e.g. posts, comments, evaluations, tags etc.
- $R_1, \ldots, R_m \subset T \times T$ denote different relations on the content, e.g. being a reply on, have the same subject, etc.
- $\theta : T \to \Theta$ stores parameters of the content;
- $\gamma_i : R_i \to \Gamma_i$ $(i \in \{1, \ldots, k\})$, similarly, keeps parameters and details of the corresponding relation.

1.3 Authorship and other relations between the users and the content

The basic connections between the social graph and the content are defined by the authorship relation A,

$$A \subset V \times T.$$

One can also consider other kinds of connections of this kind, but usually all of them could be modeled via introducing a new type of content. For example, the relation *John is interested in post "Announcement"* could be modeled by introducing a new content node *interest evidence*, which points to "Announcement" (use the corresponding relation R_i here) and is authored by John.

1.4 The context

Before we turn to description of the socio-semantic network dynamics there is one more important parameter not to be missed. It is external context, Ω, which may include different parameters like project or campaign phase, flag for a bank holiday, or a maintenance status of the network.

2 The socio-semantic network dynamics

Now, when all the components of the network have been defined, the list of possible system updates, which determine the network evolution, is rather evident:

- addition of new members to V;
- changes in user profiles π;
- updates of social relations $E_1, \ldots, E_k$ and their parameters $\delta_1, \ldots, \delta_k$;
- creation and update of content nodes in T, (also affects the authorship relation A);
- changes in properties of and relations between the content nodes $\theta, \gamma_1, \ldots, \gamma_m$;
- changes in context Ω.

3 Examples

3.1 School or a training center

A training center usually has a standardized set of reading materials, textbooks, tasks, assignments and exam tests. At the same time, the students' network evolves permanently. In terms of the definition above one can say that the content part of this socio-semantic network is rather stable while the social network is very dynamic.

3.2 Research or analytic team

This example resides on the opposite side of the spectra. The team (the social network part) is rather stable while the content is actively processed and generated.

3.3 Fixed term project

A targeted crowdsourcing project or a collective intelligence venture provide an example of a dynamic socio-semantic network, which is created from the scratch and is aimed at solving a particular task or a problem. New content is generated and new members join the network at all stages of its lifecycle.

4 Research challenges

Assume that we have all necessary data about the network dynamics available. In all the examples mentioned above one can identify two principal tasks for analysis:

- Given all the data about the users activities and the content discover the right people (knowing, capable, skillfull etc.)
- Given all the data about the social network dynamics and the content evolution discover the right texts (interesting, influential, prominent etc.)

Many promising approaches and useful algorithms have already been developed during the last decades [1–4], several new ideas are implemented in the Witology platform [5]. Some have proved to be quite efficient, although most of them are based on fairly simple mathematical tools. Still, the field is rather in its rudimentary phase. We believe that the next breakthrough lies in interdisciplinary research covering sociology, psychology, linguistics and other related fields.

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