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The exSIOCInt Ontology: A SIOC Ontology Extension

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Abstract: The Semantically-Interconnected Online Communities (SIOC) ontology, created in 2004, its goal is to interconnect the Social Media (SM) on the web to make data understandable by machines and to standardize the users' profiles, the interactions, etc. in a common format to ensure the storage and the exchange between the sites. This format is understandable by software agents allowing inferring automatically relationships between users, sites, topics, etc. However, its set of concepts is quite related to forums (the more popular SM at the SIOC creation moment), so, an extension to fully cover the most actual popular SM seems essential.

Key words: SIOC, exSIOCInt, unified semantic model, social media, inferring, automatically

INTRODUCTION

Introduction and motivation: The lack of the semantic technics on the social web generates a set of problems and limits (Breslin *et al*., 2006):

- The SM search engines are limited to syntactic matching and don't exploit data on other SM
- A topic can be discussed complementary on multiple SM
- Topics can be connected physically by hyperlinks but not semantically. So, the search engines can't exploit the topics links
- People can waste time waiting for help concerning a topic that is already discussed on another SM (e.g., a person searching for a carpooling on Facebook while a similar carpooling is already discussed on Twitter)

To resolve the cited problems, Harth *et al*. (2004) have conceived the SIOC Ontology to interconnect the SM on the web. The SIOC goal was to make data understandable by machines and to standardize the user's profiles, the interactions, etc. in a common format to ensure the storage and the exchange between the sites. The data format is understandable by software agents allowing inferring automatically relationships between users, sites, topics, etc.

Initially, the SIOC concepts and properties were identified thanks to an analysis performed on existing discussion systems. We remind that SIOC was created in 2004, a period where the forums were the more dominant discussions systems which justify the fact that the SIOC vocabulary is often related to the forums notions. Later, SIOC was improved by adding new concepts and properties and by extensions (Berrueta *et al*., 2018; Bojars *et al*., 2007; Breslin *et al*., 2006, 2009, 2011; Champin and Passant, 2010).

Extending SIOC by exSIOCInt (extended SIOC for Interactions) our objective is to improve its potential to offer a model of storage for the different SM to ensure interoperability between the different SM and to enhance automatic inferences.

MATERIALS AND METHODS

The SIOC ontology and limits: Created on 2004, the SIOC ontology was proposed (Harth *et al*., 2004) to describe information from online communities. Our main objective is to provide a model for the SM storage using ontologies potential of reusability, interoperability and modularity. We have already discussed the USM (Unified Semantic Model) idea to aggregate and analyze OSN by El-Kassiri and Belouadha (2014, 2015 and 2017). The USM reuse many ontologies which SIOC is part of.

The SIOC module: Harth *et al*. (2004), we preserve 10 lasses from the SIOC to be part of the USM:

- UserAccount: a FOAF OnlineAccount sub-class linking the FOAF module to the SIOC module, it presents a user online account
- UserGroup: presents a set of regrouped UsersAccount according an objective or an interest This class can't be mapped to the FOAF: group modelling an agents group (organizations, persons or groups). So, it's possible to deduce a FOAF: Group from a UserGroup and not the inverse

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- Space: presents a data hosting space like a web site, a desktop or a file share
- Container: a high level abstract concept reflecting any element conceived to contain shared items on the web
- Item: models any shared item on a container on the web
- Site: a space sub-class modelling a data space accessible via. the web
- Forum: a container sub-class modelling a forum. It's a public virtual web space of discussion and exchange about a specific topic
- Post: a sub-class of both the Item class and the foaf:Document class. It design a shared message (text, image, etc.) by a UserAccount on a forum
- Thread: a container sub-class presenting a discussion thread constituted from posts and items
- Role: a UserAccount function in a particular resource like forum or site. It can be a moderation or administration function or a set of access privileges

We have given up a unique class named community. It presents an online community constituted of people, resources, sites, etc. it's an implicit information not directly declared on social media but deducible, so, we did not save it. The SIOC properties are:

UserAccount: Description properties. The avatar property links a user to an Image. The email property informs which email address the user uses especially for the concerned account. The owner_of property defines the resources (weblogs, image gallery, etc.), belonging to the user propriety. The subscriber_of property defines the containers which the user subscribes for. The follows property links an account to other accounts followed by the user. The member_of defines the users groups (UserGroups).

Containers description properties: There are three properties: the has_parent property links a son container to his father container. The has_space property links a resource, especially a container to his space. The has_host property associates a forum to his hosting site.

Items description properties: The has_creator property defines for an Item his UserAccount creator. The content property defines the item's textual content. The attachment property associates it to the attached document URI. The topic property assigns a tag or a category (SIOCT classes) to define its interest domain. The addressed_to property links it to his destination (UserAccount, email, etc.). The has_discussion property associates it to a thread. The has_modifier property defines UserAccounts having modify it. The has_reply property expresses that an item was shared as response to another. The sibling property links an Item to its twine that can belong to another container or have another language or topic.

Roles description properties: There are two properties. The function_of property defines the UserAccount having this role and the has_scope property defines the resource (site, container, forum, etc.) under its emprise.

Instances description properties: There are two properties. The name property attributes a name to any class instance and the ID property attributes a unique ID. We have ignored some properties to have a clear description of implicit data without redundancies. Per example, the administrator_of property because it can be presented thanks to role class and its two properties. Statistics can be deduced, so, the relative properties were abandoned (e.g., num_authors, num_items, num_replies, etc.). The researchers think that, the versioning and dating properties proposed by SIOC are insufficient because it concern especially the earliest or the latest interaction so, they didn't keep it and replace it in the extension proposed (exSIOCInt) (Fig. 1).

The SIOC limits: Based on an analysis of the more popular actual SM (Fig. 2), we have raised a set of new concepts that we have mapped to the SIOC concepts. The mapping results demonstrate that the identified concepts are not covered by SIOC except the modification, the subscription and the following notions (Table 1).

The second finding is that SIOC does not really take in consideration the time coefficient. Except for the Item creation, the user's interactions are not specified in the time. Therefore, to use the USM as a storage model, it is important to integrate the time dimension to track the user's behavior evolution over the SM.

The third finding is that the identified interactions must be modelized as classes to be able to present related properties like who has made it and when.

The fourth finding is that, there are redundant concepts and properties making the ontology complicated and voluminous.

The exSIOCT ontology: The exSIOCInt ontology is conceived according the ontological reengineering concept by extending the SIOC ontology.

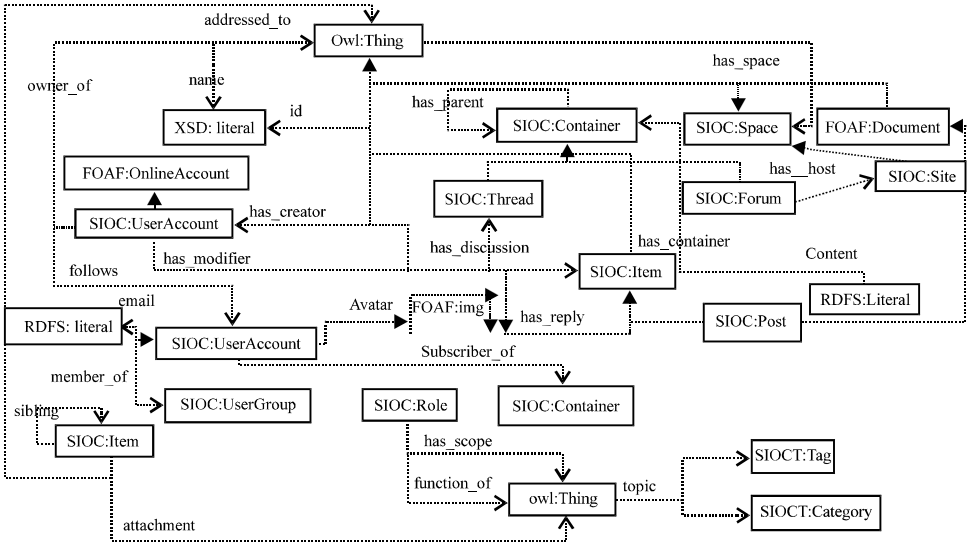

Fig. 1: View of the SIOC module

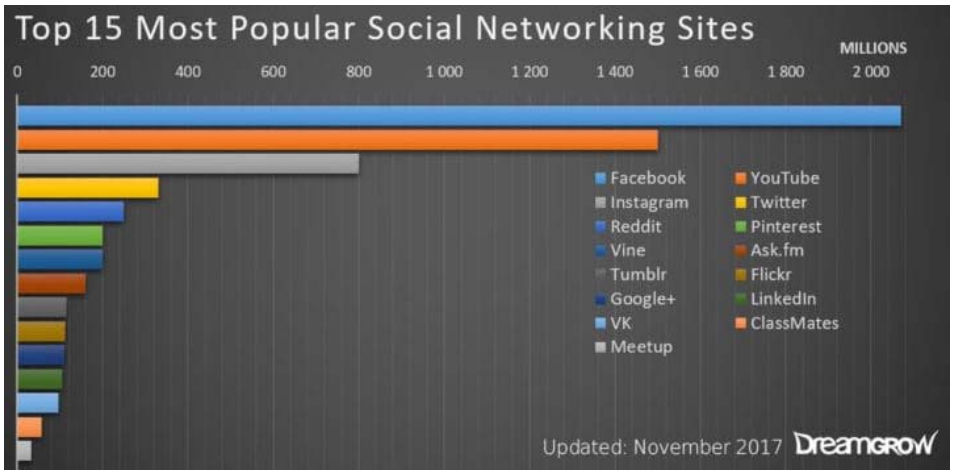

Fig. 2: The most popular social media on 2017 (Kallas, 2018)

The online interactions modeling in the module of social web description is primordial, especially, for the OSN analysis. The interactions timing is also important to monitor the OSN evolution. To fill the absence of these concepts types in the SIOC module, exSIOCInt enriches the USM ontology by a set of new classes and properties. The main class is an abstract class named interaction. This class is linked to xsd: date by the created property to indicate the online interaction date and to SIOC: OnlineAccount by the has maker property to indicate the interaction source. It's also specialized by four sub-classes: iteminteraction, containerinteraction, socialinteraction and roleinteraction to distinguish between interactions on an item on a container, a UserAccount or a role. Each of these subclasses is modelized by a set of subclasses and properties that we present in the following.

To describe the containers interactions, the container interaction class was specialized by the sub-classes: visit, subscribe (this class replaces the subscriber_of property), churn and ModifyConfidentialityStatus. The three first classes permit identifying and monitoring a user interest for a container and its topics. The ModifyConfidentialityStatus informs about the sequential updates of the container confidentiality. Two other properties were added to complete these classes: has ContainerInteraction associates the container class to the ContainerInteraction class and new_Confidentiality_

Table 1: Mapping of users online activities concepts

Extracted concept from the OSN corpus	SIOC equivalent
Reply	Inexistent
View	Inexistent
Taggin	G inexistent
Like	Inexistent
Dislike	Inexistent
Cite	Inexistent
Share	Inexistent
Modify	SIOC:has_modifier (property)
Visit	Inexistent
Subscribe	sioc:Subscriber_ of (property)
Churn	Inexistent
Modify confidentiality	Inexistent
Status	Inexistent
Private message	Inexistent
Follows	SIOC:follows (property)
Trust	Inexistent
Recommend	Inexistent
Add friend	Inexistent
Remove friend	Inexistent
Grant role	Inexistent
Revoke role	Inexistent
Modify role	Inexistent

Status links the ModifyConfidentialityStatus class to the ConfidentialityStatus class to indicate the new container status.

The exSIOCInt module proposes other classes to describe the items interactions: reply, view, tagging, evaluation with its two sub-classes named like and dislike; cite, share and modify with its sub-classes that are ModifyContent, ModifyLanguag and ModifyStatus. The ModifyLanguage allows expressing the twin items notion expressed in SIOC by the sibling property. These classes need adding other properties like:

- hasItemInteraction to link items to its interactions
- replyWith to associate an item to reply class
- citeIn to indicate the item destination of the cite interaction
- hasUsed to link the Tagging interaction to the used tags
- target_container to associate a target container to the share interaction
- item_new_version to associate the item resulting to the ModifyContent interaction
- translated_version to associate the item resulting to the ModifyLanguage interaction
- expressed-in to link an item to its language expressed by a xsd:string
- new_status to link the new status to the ModifyStatus interaction

Concerning the SocialItnteraction sub-classes, there are seven:

- PrivateMessage to modelize the action of sending a private message
- Follow to express the desire of an account to follow another account actualities
- Trust to express an explicit trust from an account to another
- FriendShip with its two sub-classes AddFriend and RemoveFriend and Recommend to express that an account recommend the skills of another one

The properties associated to these classes are: has_concernedUser to precise the SocialInteraction target account has_content to indicate the sent item in a PrivateMessage interaction and has_ recommendationScope to indicate the exfoaf:skill subject of recommendation made by an account to another.

The exSiocInt module view dedicated to the role interactions proposes three sub-classes for the RoleInteraction class: GrantRole, RevokeRole and ModifyRole. This view gives information about trust and reputation and its evolution over time. The RoleInteraction class uses the property has RoleInteraction to associate it to the concerned role when the role_new_version property links the ModifyRole class to a second role to express that the second role is the result of the first role modification.

RESULTS AND DISCUSSION

exSIOCInt uses; Facebook case study: The exSIOCInt and SIOC are USM modules. We have conceived the USM to provide a model of storage of the SM to ensure interoperability between the different SM to enhance the search engines on SM to aggregate data from the different SM and to analyze the SM data.

By interoperability, we mean be able to exchange data between the SM (e.g., sharing on Facebook a video from YouTube, sharing on Twitter a post from Facebook, etc.) and representing their semantic relationships.

By enhancing the search engines, we denote allowing a semantic research using the semantic relationships between topics, persons, topics and persons and between SM to give results that are more precise.

Besides, the social networks aggregators (e.g., Seesmic, FriendFeed, Hootsuite, etc.) can exploit the USM to track and aggregate data from different SM. Samely, appropriate applications can use the USM to aggregate data from different SM like Facebook, Google+ and Twitter via. APIs available for developers like Graph API (https://developers.facebook.com/blog/post/2017/07/18/graph-api-v2.10/), Google API (https://developers. google.com/api-client-library/java/) and Twitter API (https://dev.twitter.com/overview/api).

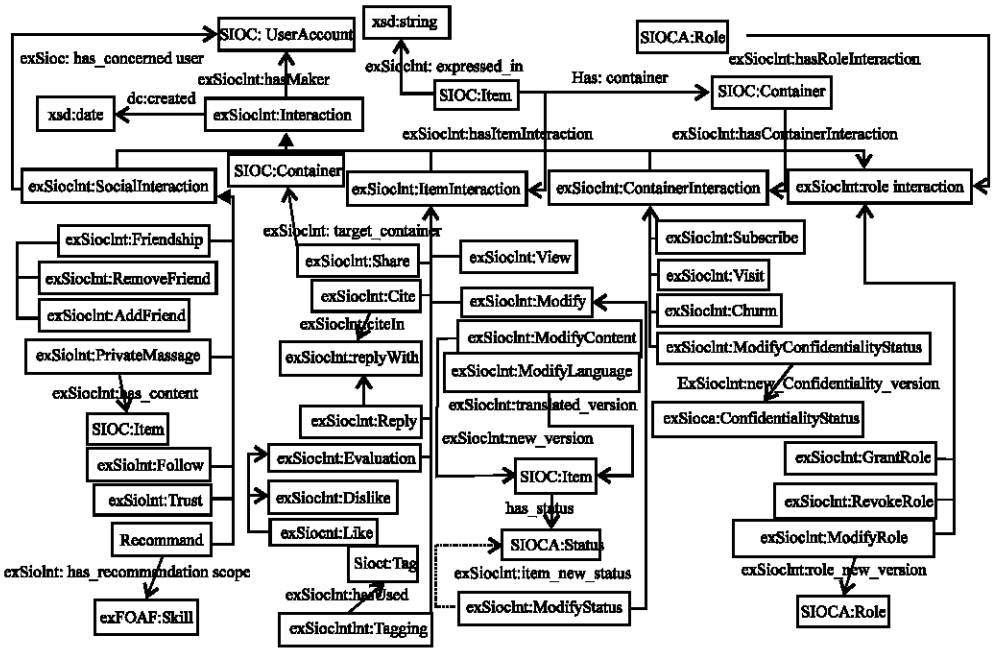

Fig. 3: Synthetic view of the exSiocInt module

At another hand having standardized data according a format understandable by machines will allow inferring new knowledge that can enhance the social mining.

In this study, we have chosen Facebook to apply our model because it's the leader SM at the moment of redaction of this study (Fig. 3). So, we have used the Facebook graph API to instantiate the USM ontology. These social media data are generated in JSON (JavaScript Object Definition) format. The JSON format is a generic simple text data format, derivative from objects notation JavaScript and used to represent structured information in Web applications.

The objective of this step is testing the ability of the SIOC in complement of exSIOCInt to ensure their objectives. It's defined a scenario taken from Facebook graph API explorer presenting a sharing posts is given as:

The shared posts information extracted from the Facebook graph API:


```
{
"created_time": "2017-09-22T10:55:00+0000"
"from": {
  "Asmae El kassiri"
  "id": "1451960389"
}
"story": "Asmae El Kassiri shared walad al hay's post"
"id": "1451960389_10213393394616619"
:reactions": {
  "Date": [
      {
        "name": "khadija El Kassiri"
        "Id": "699020183612208"
      }
      {
        "name": Chaimae salfi"
        "id": "134283243975037"
      }
      {
        "name": Hanaa Ait ahmed"
        "id":
      }
      {
        "name": "Soukaina rafik"
        "id": 484083848416884"
      }
      {
        "name": Imane Sanon"
        "id" 2879599618216088"
      }
  ]
```


The scenario transformation to the USM ontology is given using the exSIOCInt module in Fig. 4. Generally, if we use the USM as a model of storage for Facebook, the relationships between the shared items on the different pages on Facebook (user's home page, social pages and the group pages) and between items and their creators will be defined semantically. So, if a user is looking for a topic, the search engine will be able to sort the more recent posts by relevance inferred from the occurrences number of the topic in the more popular pages (pages having grand number of subscribers) and shared by the more close or popular users. The close users are the direct friends or users having a small geodesic of neighbors separating them to the user having exploited the search engines. The popular users are the users having a grand number of followers and their posts are popular (having

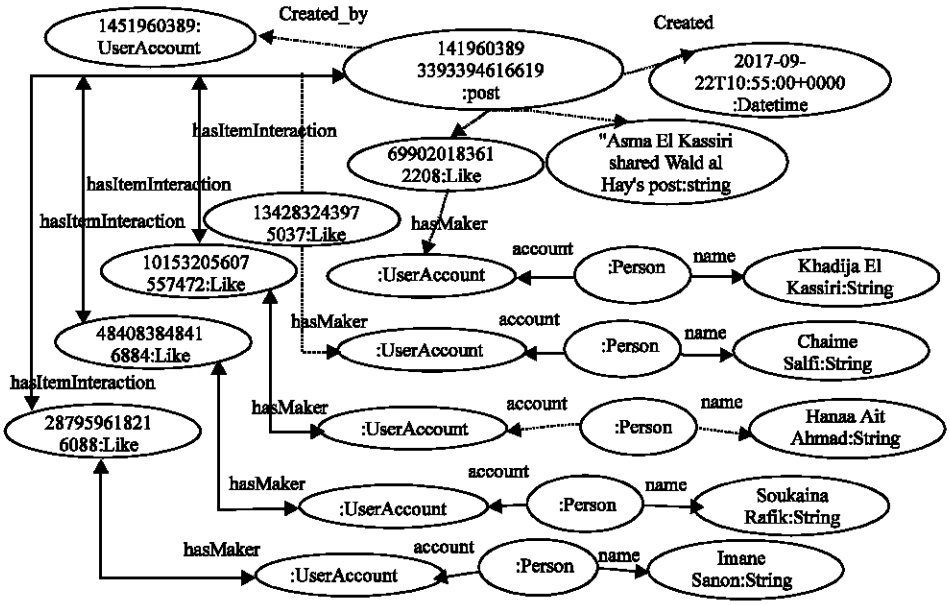

Fig. 4: The posts interactions JSON file transformed into the USM ontology

a grand number of interactions like comments, shares, likes, dislikes, etc.). The close users and the popular pages can be inferred thanks to the USM ontology.

CONCLUSION

This study addresses the problem of the ontologisation of the SM to follow the web trends towards a semantic web. The objective is to provide a model:

- To storage the SM
- To allow aggregation data from different SM for tracking and analyzing social data
- To ensure the interoperability between the different SM to allow to the users restoring his data at moving from SM to another
- To make search engines on the SM more intelligent and able to extract answers from other SM by exploiting the semantic relationships between the SM, the shared items, the persons, etc
- To standardize the social data format making it understandable by software agents allowing inferring implicit knowledge.

The modularity is an advantage of ontologies allowing the flexibility of creating, modifying and reusing ontologies. Therefore, we have decided to reuse the SIOC ontology as a module of the USM. As explained before, SIOC is more adapted to modelize the Forums and discussions. So, to follow social web trends and actualities, Facebook is the leader SM at the moment of redaction of this paper), we extend SIOC by the exSIOCInt ontology, a module specialized on interactions that can perform a user on SM. This module is another part of the USM.

RECOMMENDATIONS

In this study, we have detailed the module SIOC and its extension exSIOCInt, its classes and properties, its role and utility. In next studies, we will represent the other SIOC extensions: SIOCT (SIOC Types) and SIOCA (SIOC Access) and our proposed extension to align it with the actual SM.

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