SocialSensor: Sensing User Generated Input for Improved Media Discovery and Experience

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ABSTRACT

SocialSensor will develop a new framework for enabling real-time multimedia indexing and search in the Social Web. The project moves beyond conventional text-based indexing and retrieval models by mining and aggregating user inputs and content over multiple social networking sites. Social Indexing will incorporate information about the structure and activity of the users' social network directly into the multimedia analysis and search process. Furthermore, it will enhance the multimedia consumption experience by developing novel user-centric media visualization and browsing paradigms. For example, SocialSensor will analyse the dynamic and massive user contributions in order to extract unbiased trending topics and events and will use social connections for improved recommendations. To achieve its objectives, SocialSensor introduces the concept of Dynamic Social COntainers (DySCOs), a new layer of online multimedia content organisation with particular emphasis on the real-time, social and contextual nature of content and information consumption. Through the proposed DySCOs-centered media search, SocialSensor will integrate social content mining, search and intelligent presentation in a personalized, context and network-aware way, based on aggregation and indexing of both UGC and multimedia Web content.

Categories and Subject Descriptors

I.2.6 [**Learning**]: Knowledge acquisition.

Keywords

social indexing, sensor mining, news, infotainment

1. CHALLENGES AND GOALS

The emergence of Social Networks has fundamentally changed the way in which information is gathered and provided. It also had vast impacts on the relationships of traditional information providers with their audiences. From a previously mainly unidirectional relationship, there has been a shift to a culture of exchange and sharing. A selected few, e.g. established outlets such as news agencies or media organisations, are no longer the only ones who decide what is reported when and how. Their monopoly on the means of information production and distribution has fallen, or is in the process of being undermined.

This changed relationship, as well as a new way of reporting about events as they occur, could be witnessed very strikingly during the Tsunami that affected large parts of South-East Asia in late 2004, and the London bombings of July 2005 [1]. Within hours of the events occurring, those at the scene were producing photos, videos and texts. This was quickly passed on and shared, and subsequently distributed to large audiences via traditional media channels and organisations.[1] These are just a few selected occasions in which content posted on Social Networks set the news agenda, at least in the initial moments of events, and proved to be significant components in the reporting process.

Ever since, content provided by ordinary people, so-called "citizen journalists" or individuals with particular agendas that is posted or shared on Social Networks such as Twitter, YouTube, Facebook, MySpace or Flickr, to name but a few, has increasingly made it into the channels and services of traditional information providers such as news organisations. New and affordable publishing and distribution tools for ordinary citizens such as Social Networks, blogs, or services such as Storify, have made this possible. Social Networks have more and more become an

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[1] The BBC's Head of News in 2005, Richard Sambrook, gives the following account of events: "Within six hours we received more than 1,000 photographs, 20 pieces of amateur video, 4,000 text messages, and 20,000 e-mails. People were participating in our coverage in a way we had never seen before. By the next day, our main evening TV newscast began with a package edited entirely from video sent in by viewers." See http://www.nieman.harvard.edu/reportsitem.aspx?id=100542.

integral part of the communication mix for all kinds of aims, for example (political) campaigning, awareness-raising and the like.

The challenge for traditional information providers is to use these new content authoring and provision methods and channels offered by Social Media to their fullest advantage: to embrace it instead of feel threatened by it. And use it in both the process of information gathering as well as the distribution of information.

To get the most out of content residing in Social Networks, a number of challenges still exist or are as yet unsolved. From an information provider's perspective, this includes - but is not limited to - the following aspects: (a) *Verification*: ensure that the content posted in Social Networks is accurate / true; (b) *Filtering*: according to particular needs / interests; (c) *Sensing*: discover trending topics and what is "up and coming" in order to guide further investigation; (d) *Analysis*: analyze particular trends and tendencies according to specific questions; (e) *Visualisation*: present search results in an attractive, easy to understand way; (f) *Cross-platform issues*: enable searches across different Social Media platforms; (g) *Speed*: time is money, all processes need to happen quickly and efficiently, without being at the expense of accuracy; (h) *Legal*: copyright/ownership rules need to be adhered to and solved in a timely and user-friendly way; (i) *Attribution*: content needs to be attributed to sources, without compromising contributors' privacy, and guaranteeing their protection; (j) *Business*: transactions (e.g. of posted content) must be ensured in a safe and fair manner that is legally binding; (k) *Linguistics*: searches should work across different languages; (l) *Usability*: tools and interfaces should be intuitive and easy to use.

SocialSensor[2] is a 3-year FP7 European Integrated Project aiming to tackle some of the challenges outlined above and offer solutions as well as improvements. In the project framework, new techniques for analysis, aggregation and real-time search of user-generated content will be developed, in order to extract useful information and make it available for use in different applications. Innovative solutions from the fields of information extraction and retrieval, social network analysis, user modelling, semantic web services, and media adaptation, delivery and presentation, will compose a software platform that crawls and analyses multimedia UGC from the social web, combines it with professional content, and makes it searchable for professional users, but also recommends, delivers and presents it to media consumers depending on their context and their personal profile. To achieve this, crucial issues have to be tackled, such as the sheer data volume, its heterogeneity and low quality.

The resulting multimedia search system will be showcased and evaluated in two use cases: (a) news, and (b) infotainment.

The news use case targets two end user groups: (a) news professionals that are interested in leveraging UGC in their work, (b) casual online and mobile news readers. With respect to professional usage, different scenarios will be supported, such as discovery of emerging trends and topics, aggregation of UGC with professional content, analysis of massive amounts of social data for new insights and profiling of news portal users and recommendation of relevant content. Casual news readers will benefit from innovative features, such as real-time discovery of news items, proactive delivery (push) of relevant content to user based on their context, and socialisation of user with other news reader through ad hoc social networking.

[2] http://www.socialsensor.eu

The infotainment use case targets at individuals attending large events, such as festivals, expos, etc. The use case is centered on the principle that the different aspects of a user's context can constitute valuable cues for proactive search and discovery of relevant media content. By leveraging the user's context for search, especially in mobile settings, the physical surroundings of a user act as a lens on the social media content that relates to her current activities, location, and physical social ties. SocialSensor will deliver a platform supporting diverse usage scenarios, such as context-triggered multimedia search, proximity-based real-time activity recommendation, facilitation of social networking aspects, and real-time interaction with the event acts.

Providing real-time social indexing capabilities for both of these use cases is expected to have a transformational impact on both sectors. The subsequent chapters outline some of the research challenges on which SocialSensor focuses, as well as expected results.

1.1 Sensor Mining

Improving the user experience on the Web goes through the automatic understanding of information streams. SocialSensor attempts to bring new mining techniques for intelligently merging the content coming from different sources in one fundamental object, DySCO, which is fed through an analysis of the large, heterogeneous, and continuously evolving data. Our vision is that the social dimension, if correctly used, can reinforce the mining process through: (a) the availability of more information in the network and (b) the fact that social interactions represent mainly human interactions providing an implicit understanding of users, which is a key lacking dimension in most existing mining strategies. We propose to mine both the structure and the content of the social dimension of the Web as well as their combination. From the content perspective, we consider the extraction and the tracking of topics and their trends, the identification of the corresponding real objects and events, as well as the opinion transported in social streams. A heavy investment is put on the understanding of social structures and the association of roles to users and objects in the network as well as influence and information propagation, feeding the different other processes. Finally, trust is investigated to ensure a certain quality degree in the analysis and construction of the DySCOs. To realize this, SocialSensor improves statistical models to make them support the new constraints imposed by the social Web eco-system. These models and techniques include (extensions of) topical model [2], frequent item sets mining [3], clustering [4] (see Section 2.2), dynamics of social networks and community detection [5] (see Section 2.3), natural language processing techniques [6], and relevance and ranking modelling [7].

1.2 Semantic Middleware

The semantic middleware of the SocialSensor platform allows ad hoc networked users to seamlessly discover, compose and share semantically relevant multimedia data and services. For this purpose, it includes components for (a) semantic peer-to-peer selection and composition planning of data services that are relevant to a given query, (b) semantic query answering over continuous streams of potentially inconsistent social data, and (c) intelligent caching, pre-fetching and web-based sharing of data in ad hoc formed user groups. The top layer of the SocialSensor middleware architecture thus is concerned with the scalable semantic reasoning on and coordination of services and data in varying context, while the layer below provides the functionalities

for content-centric, delay-tolerant transport of semantic service descriptions, media data from service calls, and text messages within mobile networked user groups.

1.3 Social Search

The overall purpose is to capture, represent, index, and search from social and web sources to provide relevant, and context-aware results for multimedia and text content in a real-time manner. The concept of DySCOs is central for social search due to the need for bridging between the context-based search needs of information consumers and the indexing and aggregation requirements stemming from the use of DySCOs as a content and information organisation layer. DySCOs therefore need to be generic enough to support different types of contexts particularly in social media. Social media has significantly changed the nature of breaking news, changing the emphasis on being the first to break new stories to verifying/cataloging content [8]. The search component will use web analytics to examine user behavior and feed this information to a search algorithm which will provide real time context aware search to meet user needs (e.g. verifying content). Support for search will be provided by indexing low level multimedia content using social media to provide links between content. Indexing data extracted from different sources will be aggregated (e.g. providing journalists with a single and unambiguous view over the content retrieved). These components will support multimedia filtering and content.

1.4 User Modeling and Presentation

In order to reflect different information needs of users, a user and context model for long-term profiling and short-term activities is created and algorithms and tools for personalised information delivery and recommendations based on user feedback are developed. A personalized presentation of the data extracted and represented in DySCOs through Sensor Mining and processed via the Semantic Middleware is provided by means of intuitive interaction metaphors for 3D interaction and object manipulation in Web-based 3D virtual environments.

2. RESULTS

2.1 DySCO Definition

Currently, online content is indexed and searched at an atomic level, i.e. each content item is processed and indexed independently of the rest of the collection. SocialSensor will attempt to extend this paradigm by performing indexing and search over composite objects relating to a common topic of interest. Such composite objects are called DySCOs. The benefit of using DySCOs over single items is that it will be possible to extract aggregate knowledge/inferences by analyzing them as a collection. In addition, performing the indexing at a collection-level could enable richer representation of contextual information with respect to content, i.e. the indexing mechanism will be able to access contextual information about content items. In this sense DySCOs can be defined as composite objects centered around a particular topic of interest that encode contextual and inferred information about collections of content items that are detected to be related to the given topic of interest.

DySCOs and their attributes are created as a result of Sensor Mining (Section 1.1) processes. Indexing of DySCO fields and relations is task for the Social Search (Section 1.3) line of work. Transfer, composition, and packaging of DySCOs take place in the Semantic Middleware (Section 1.2). Querying and retrieval of DySCOs is taken care of by Semantic Middleware and Social Search. DySCO-based recommendation takes place in the context of Social Search and User Modelling (Section 1.4).

DySCOs can be specified along two dimensions: (a) internal DySCO decomposition, and (b) inter-DySCO relations. Internal decomposition pertains to describing what the fields that a DySCO consists of are. These fields are primitive, i.e. they cannot be DySCOs themselves. The inter-DySCO relations dimension specifies relations between DySCOs, i.e. a DySCO is related to another one, a DySCO is temporally contained in another one, etc.

2.2 Landmark and Event Detection

In [4], a Sensor Mining framework exploiting the content dimension of Social Web was presented for automatically extracting landmarks and events in large photo collections by means of clustering photos into groups related to a single topic/object of interest, and then classifying the extracted clusters into landmarks and events. The proposed framework consists of the following four analysis steps: (a) creation of a graph encoding the similarities between pairs of images, (b) clustering of the images by means of community detection on the graph, (c) classification of the resulting clusters into landmarks and events, (d) post-processing of the clusters.

In the first step, similarities between photos are computed by combining (visual) content- and text-based similarity, by extracting SIFT features and producing co-occurrence similarity graphs respectively. Once the similarity graph is derived, an efficient community detection approach is applied to extract more densely connected sets of nodes. A resulting set of photo clusters is available for further analysis, while a significant number of photos are discarded (i.e. not assigned to any cluster). For each photo cluster, a set of features is extracted that are subsequently provided as input to an SVM or kNN classifier for classifying the cluster as depicting a landmark or an event. The resulting classification accuracy was found to be superior to previous methods [4].As a last step, landmark and event clusters are post-processed in order to derive human-friendly textual descriptions by aggregating the textual metadata of the photos contained in them. Each cluster is assigned a title by computing the most frequent term sequence across the titles of its photos. For each cluster, a convex hull and a time interval are computed based on the geotagging and timestamp information of the individual photos. The aggregate information extracted are helpful in the context of presenting the clusters to users interested in exploring the content collection, e.g. in the case of the ClustTour application presented in 3.1.

2.3 Social Interaction Analysis for Identifying Influencers

Human social interactions result into construction of social interaction networks. Information contained in these social interaction networks is used to enrich DySCO-centered streams with derived social information, such as influence. The influence in a social network is defined as the ability of persons to make their social relatives act similar to them when deciding on something. The work done in this area aims at approximating influence, or a part of it, thanks to features and measures or metrics on a social network.

Our method separates the computational resources calculation into smaller steps so that a coarse measurement can be quickly

provided based on rapidly obtainable information, such as number of friends/followers. Other factors include the creative activity of the user, the number and type of reactions to their interactions, the frequency and reliability of their interactions and their friend's reactions. Third parties can also weight the results according to their own assigned user priorities. These metrics are refined gradually as additional information from social graph is obtained and processed. This resolves the primary challenge to provide useful social metrics on-demand in a timely fashion over a massive amount of dynamic social data.

Generic user's influence is advantageously complemented by influence per topic or a set of keywords, derived from content and context of interactions. As the topics extracted from highly dynamic streams might rapidly evolve, we may observe drastic changes in users' influence scores.

2.4 Social Search Needs

From recent research [9], we have defined the concept of 'information expeditions'– the final goal is well known, but there are a variety of ways to get to the top. A typical example in journalism is a breaking news story (e.g. an earthquake) which is to be reported. Significant amounts of information must be handled very quickly by the journalist, from a wide variety of sources. Some sources may be trusted; others may need to be checked. The advent of social media enables the development of new tools which allow the journalist to verify information at speed – time pressure is considerable and accuracy is essential (publishing incorrect information can be damaging). These 'information expeditions' can be realized through a base information retrieval system for indexing text, such as Okapi [10]. This will handle the documentary content required by journalists. Using data collected by sensors on social media to create DySCOs, low level multimedia content (e.g. video and images) will be indexed. Evidence from these difference sources can then be aggregated to create a seamless search experience for the user. A journalist can try out various routes in their 'information expedition'. In the earthquake example there is an explosion of activity on social media sites. Context is essential to derive user trust, e.g. spatio-temporal context can be used to check the geographical location of the user and/or content. The journalist can check the source for popularity, images accuracy or change direction in the middle of the 'expedition' as other material comes online, from new users. Trust may grow in some information republished either by volume (e.g. retweets) or by authority (a previously trusted source). Aggregated search from a wide variety of content can support this kind of information behavior.

3. DEMONSTRATIONS

3.1 ClustTour Application

The current paradigms of browsing through collections of user contributed photos are ineffective for the exploration of very large photo collections due to the fact that they provide neither a high-level overview of the collection nor a structured means for exploring it. To this end, ClustTour [11] provides a new means of browsing photo collections related to landmarks and events of the real-world using spatio-temporal analysis and photo clustering. ClustTour, a both web (www.clusttour.gr) and mobile application, enables a two-level hierarchical exploration of large photo collections. The starting point for the content exploration process is a city (currently a list of 31 cities is included in the demo). Once a city is selected, the application provides an overview of its areas, derived via spatial clustering of the collection photos positions. The next step in the exploration process involves the selection of an area. This leads to a fine-grained view of the surrounding landmarks and events area and identified by means of the analysis framework discussed in Section 2.2. Each landmark or event is associated with a set of photos related to it. Browsing the photos in the form of clusters and providing a map-based interface to enable their exploration has proven a very intuitive means of content exploration and discovery. ClustTour also provides for each city and for each area, a list of the most important "time slices", i.e. time windows (e.g. time interval within a day, date interval) that are characteristic for this city/area.

3.2 Influence Demonstrator

The Influence Analysis Component performs live influence calculations for social applications on request, through a REST API. In order to illustrate the calculation, an influence dashboard is developed which provides specific characteristics of social network users: their general influence, their specific influence per topic, a live effect of their friends and interactions on the influence score and their position within their communities. During the demo, users will be able to view their own influence according to their history of interactions on Twitter, and watch it evolve as they add new interactions during the Open Days event.

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