Categorization and Matching for Drone-based Services

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Abstract: The exchange of supply and demand in drone-based services would benefit from the shared use of an online platform. Such a platform would need to offer two important opportunities. One is to share the service with other users, and the other is to receive offers from all providers interacting on the platform, who optimize their investments by sharing their own resources and technologies. The purpose of this position paper is to propose a categorization and matching algorithm on which to base this platform. The platform will aim to facilitate the sharing of services provided through the use of drones. The algorithm will match demand and offer, and will evolve through the use and the application of all participants (operators, users, lenders of shared resources). The platform, currently in development, could be the first web-based system in Europe to offer this model.

1 INTRODUCTION

Over the past few years, the scientific community's interest in drones has increased. A growing number of researchers worked on the construction and use of human-friendly drones. The cost reduction of electronic components and their miniaturization allowed the commercialization of drones at reduced prices and thus contributed to their development (Floreano and Wood, 2015). These devices are able to fly into three-dimensional (3D) physical space on their own, without causing damage to objects and people.

The drones are widely used for aerial video footage and found wide application in many civilian activities: location control, crime monitoring, observation of quality crops or surveillance of buildings under construction.

(Boyle, 2015) suggests that the demand for drones is relevant especially at this time of global economic crisis and austerity. The market for drones is rapidly expanding: the venture capital funding to drone companies in 2014 were over 108 million USD among 29 different companies, and the estimated 2019 turnover for the Unmanned Aerial Vehicles (UAV) market worldwide is of 8.4 billion USD.

In our project we want to design and implement an innovative marketplace for the sale, use or rental of drones. This application must take into account the possible users, resources, service providers and applications connected with the use of drones (industrial, agricultural, environmental, tourism, etc.). Each user or resource involved in the platform belongs to a specific category. In the first analysis we can identify the following categories: utilities, drivers, vendors, projects, technology, resources and services. Next to this more formal categorization, we think to manage knowledge through integration with a folksonomy in which users are protagonists in information control (Mathes, 2004) (Vander Wal, 2007).

In this sense we want to develop the platform with a high level of innovation and attention for users.

The product is, therefore, the service of an online platform created with state-of-the-art software engineering, in compliance with the latest standards for usability and scalability.

In the platform, demand, offer, cooperation and purchasing groups can interact thanks to resource sharing and to an algorithm that categorizes and matches demand and offer.

The paper is structured as follows: Section Two shows an overview of resource categorization, while in Section Three we propose our approach. In Section Four we describe the platform we propose for matching demand and offer on drone-based services. Lastly, Section Five includes the conclusions and some reasoning about our work.

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2 RELATED WORK

Our main goal is to identify the correlations among users, tags and resources. An efficient approach is used by (Mika, 2005), extending the basic model of an ontology with a social dimension that includes actors, concepts and instances of concepts. The authors constructed a graph that takes into account the relationships between tags and users and simultaneously between tags and resources. Through network analysis they were then able to infer implicit categorization of resources.

Even (Koçak et al., 2013) studied some connection methods of meanings about the collective market and they developed a mechanism of public participation to market conventions. They analyzed data from markets on eBay to discover implications.

An interesting approach can be found in (Donsbach et al., 2012), showing a user interface where users can tag items in an electronic catalog and get recommendations suited to particular tags. The tags and tag-item assignments created by each user are stored in association with the user; once a user has assigned a tag to a number of items, it is possible to obtain recommendations that are specific to this tag. These recommendations may be generated in real time by a service that identifies items that are related to the items associated with the tag.

In (Tseng et al., 2012) a system which allows a user to define a relational tag is described. The relational tag describes how a first item is related to a second item within an identified qualifying context.

In (Saoud and Kechid, 2016) a new customized approach integrating a social profile into a distributed search system is proposed; this approach exploits the social profile and the different relations between social entities. This method can enhance a query expansion, customize and improve both the source selection and the result merging process in distributed information retrieval systems.

A new method to categorize mobile apps, a search-based annotation paradigm influenced by machine learning techniques, is the one proposed by (Chen et al., 2016). This system facilitates the search of preferred apps.

A work of integrating sentiment information to address the problem of the personalized tag-based search in collaborative tagging systems is presented in (Xie et al., 2016). A market system in fact may be influenced by recommendations that measure relevance between user and resource. This folksonomy-based market should help users find their preferred products. It is relevant to understand user behaviors and preferences, and we can employ user-generated tags to discover their perceptions and feelings about the resources.

On the other hand, (Sarwar et al., 2000) developed a recommendation algorithm for an e-commerce system that connects a formal categorization of ontologies with user preference. The results of this approach have allowed an improvement of user experience.

Lastly, (Heidinger et al., 2010) describe a system which enables people to share experiences and recommendations regarding the privacy practices of data collectors. The basis of this system is a folksonomy in which a user community tags web sites on the Internet with privacy-related labels. The system helps to assess the privacy practices of service providers, and adapts well to a wide range of privacy threats.

3 THE PROPOSED APPROACH

The aim of our work is the creation of a categorization and matching algorithm based on content and tags entered by users so that it can be easier to share the variety of services provided by drones. An analysis process will grasp key concepts from content entered into the demand/offer side. The process will also extract and manage qualitative content and relations included in the information in the system, using service search methods based on semantic content.

The result will be the creation of models of concepts and categories that will support users in finding the information they need, relevantly and quickly. It will lead to the creation of a knowledge management system in which all elements will be identified not only as structured information, but also according to a folksonomy logic, with users participating in knowledge building (Ibba and Pani, 2016). The elements will also be available for full-text search.

The matching algorithm is based on a tagging system that allows sharers and users to label the product/services on offer. This algorithm also takes into consideration the statistical and terminology relations between the description of a product/service by a sharer and its perception by users or searches. In all cases, the content is created through the use of tags or keywords for searches. User-generated content (UGC) is thus used to improve the presentation of content in the platform, also by using geolocalization metadata. In this way, each user will be able to quickly find the most suitable product/service for their needs, context and purpose in a complex system. The algorithm makes it possible to pair the right

resource with its user. Moreover, a collaborative recommendation algorithm will be applied to tags and user-generated content. The aim in doing this would be to consider the relevance and quality of resources. The purpose of the algorithm is thus to classify and filter tag-described resources according to user profile, usage context and destination.

The algorithm will be created following two main guidelines:

- the possibility to pre-filter resources by importance and complexity level. The pre-filtering configuration parameters can be changed with time as new content enters the system;
- the needed flexibility to manage products/services that can be used in several application fields.

The algorithm will thus be based on some fundamental parameters:

- the description of resources with content analysts, which will be needed to identify the product/service on offer, but also users' opinion on that resource. The opinions will come from a collaborative tagging;
- an User Context Profiling, which analyses the information associated with users and entered during registration or use of products/services;
- a matching module, calculating the statistical correspondence of a resource against the needs of a specific user (only resources above a set threshold are considered relevant);
- an User classification module, identifying the similarity among users;
- a Sharer classification module, determining the similarity among sharers;
- a classification and filtering module to evaluate statistical and terminology relations between the self-introduction of a product/service made by a sharer using tags, and the perception of the same product/service, made again using tags, by users;
- a Resource Ranking model that introduces users to the best products/services.

From content published on the platform, it will be possible to use algorithms to monitor and classify the appreciation levels of users on any interest macro-category, and the reception of a specific service.

Moreover, it will be possible to gather information on the nature of social interactions among users through the analysis of the social network.

4 PLATFORM FEATURES AND TARGET MARKET

A wider analysis of the drone industry, including the professional profiles that use them, casts light on a market employing tens of thousands of people. The number of jobs is still to be split among the different professional fields where drones are used to provide services.

The market is on the rise thanks to the emerging needs of a user base that demands innovation, and that providers try to target through technological and structural features, such as sensors and software for the analysis of increasingly specific data, or the reduction in component size, or again the development of bespoke applications for agriculture, environment, and safety. This complex ecosystem is burdened by legal, practical and technological issues, which do not facilitate the market. The biggest hurdle is still the pulverization of providers, which confuse the users.

In such a context, the platform currently in development aims to become the first platform in Europe for services provided through drones. Connecting to the platform would be all one needs to have a professional, customized drone service.

The online platforms will allow anyone to find qualified solutions that fit with the time and budget requirements in the complex drone industry, where aerial specialists coexist with professionals coming from many different fields.

The owners of drones, specialised equipment, or drone-related services, could showcase their offers in this channel, which will allow them to:

- acquire new users;
- interact with colleagues and users;
- remarkably increase profits by developing new offers.

Since the first design phases, we have thought of placing much care on the system interoperability feature, a very important requirement for systems executed in Cloud environments. This non-functional feature, the use of open-source components and an Agile approach of XP-programming type, make the platform become a system extremely susceptible of upgrade maintenance, which strongly determines the success of this kind of initiatives.

Only companies with competent in-house resources that have the right complementary skills for this kind of activity can create and ensure such a system.

The platform is based on an optimization / matching algorithm and on suitable tools and technologies for evolving the business of the many

operators and companies that gravitate around the drone industry. It makes it possible for demand and offer to meet, further developing an already growing market. In the platform, demand (all those needing a drone-related service) and offer (all those providing drone-related services) interact freely, liven up the marketplace, share information, and enter self-referenced profiles.

The service we propose has the aim of managing this ecosystem, which is experiencing a tumultuous, disorderly evolution. It will do that thanks to the insertion of a matching algorithm into a model driven by the only attractor and developer for demand/offer: sharing.

Our vision is that the platform will become the main one in Europe in the shared drone-related service industry on the long term. Specifically, the means through which a user can express interest in an offer, a request or a partnership is the creation of a "project". A project is a public advertisement, whether it be an offer, a request, or a cooperation ad. It has a title, a description and some other non-required metadata.

The metadata include the choice of one or more items from a pre-existing categorization (to classify the ad, for example as precision agriculture), or from a pre-existing skill list (to point out the skills needed, or the skills offered in an ad). There is also a free tagging system, and advertisements can be geolocalized.

A project is one of the ways in which users create new data on the platform. The user data created within the platform are as follows:

- Profile, i.e. data entered in the user profile;
- Project, which could be the offer of a service / product, a request for a service/product, or a cooperation advertisement to offer or request a service with the participation of other users;
- Proposal, that is users' responses to a project (for example, a quotation for a service request, or an expression of interest to an offer);
- Rating, through which one user rates the quality of another user's performance;
- Searches, that is the searches made within the platform (such as those made with keywords);
- Comments, i.e. how users interact with the platform, entering text to interact with other users.

All these users could contribute to identify the preferences of each user.

In the following high-level diagram, the main modules of the algorithm are shown. They make use of the user data container (created according to each user's interactions with the platform) and from a resource container, formed from some user data (in particular by the projects) and representing the shared tools or professional services.

5 CONCLUSIONS

In this position paper we proposed a categorization and matching algorithm on which to base an online platform. The platform will aim to facilitate the sharing of services provided through the use of

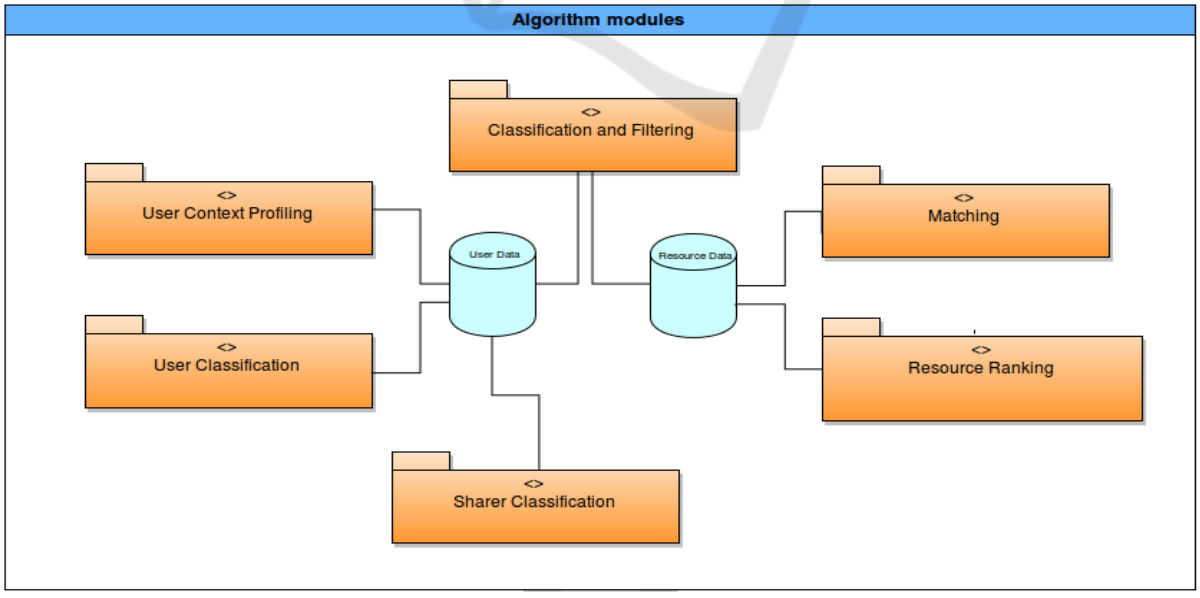

Figure 1: Algorithm modules.

drones. Connecting to the platform will be all one needs to do to have a professional, bespoke drone service, customized for any necessity or location.

The platform will make it possible to immediately find qualified solutions in the complex drone industry, where aerial specialists coexist with professionals coming from many different fields.

The target of the system will mainly be the owners of remotely piloted aircraft systems of any kind, specialised peripheral devices, and professional services related to drones. These people could display their offers through this shared channel. The benefits to be gained from this would be remarkable, as an operator could acquire new customers, interact with colleagues and users, and increase their profits by developing new offer plans.

Thanks to a wider, more competitive, and more collaborative offer, aerial services operators will see an exponential growth in opportunities, and will be encouraged to continuously propose new solutions. On the other hand, users could benefit from new opportunities by saving or by forming purchasing groups. These actors will be able to use a tool specific to the drone domain. It is an industry with such particular characteristics that it needs a bespoke platform to set offers and create interactions that would have been ineffective in general demand/offer matching tools.

REFERENCES

Boyle, M. J. (2015). The race for drones. In *Orbis*, Vol. 5, Issue 9.1, pp. 76-94.

Chen, N., Hoi, S., Li, S., Xiao, X. (2016). Mobile App Tagging. In *Proceedings of the Ninth ACM International Conference on Web Search and Data Mining*. ACM, pp. 63-72.

Donsbach, A., Gregov, A., Few, J. D., Lehman, J. D., Brownell, J. T. (2012*). Recommendations based on item tagging activities of users*. U.S. Patent No. 8,122,020, Google Patents.

Floreano, D., Wood, R. J. (2015). Science, technology and the future of small autonomous drones. In *Nature*, Vol. 521, Issue 7553, pp. 460-466.

Heidinger, C., Buchmann, E., Böhm, K. (2010). Collaborative data privacy for the web. In *Proceedings of the 2010 EDBT/ICDT Workshops*, ACM.

Ibba, S., Pani, F. E. (2016), The Challenge of Integrating Instagram with a Taxonomy for Content Management. *Future Internet*, 8.2: 16, 2016. DOI: 10.3390/fi8020016.

Koçak, Ö., Hannan, M. T., Hsu, G. (2013). *Emergence of market orders: Audience interaction and avanguard influence*. Organization Studies, Sage Publications.

Mathes, A. (2004). *Folksonomies - Cooperative Classification and Communication Through Shared Metadata*. In: Computer Mediated Communication – LIS590CMC, Graduate School of Library and Information Science, University of Illinois Urbana-Champaign.

Mika, P. (2005). Ontologies are us: A unified model of social networks and semantics. In *International semantic web conference*, Springer Berlin Heidelberg, pp. 522-536.

Saoud, Z., Kechid, S. (2016). Integrating social profile to improve the source selection and the result merging process in distributed information retrieval. In: *Information Sciences*, Vol. 336, pp. 115-128.

Sarwar, B., Karypis, G., Konstan, J., & Riedl, J. (2000, October). Analysis of recommendation algorithms for e-commerce. In *Proceedings of the 2nd ACM conference on Electronic commerce*, ACM, pp. 158-167.

Tseng, W. M., Frank, M. R., Goldstein, M. L. (2012). U.S. Patent No. 8,103,614, Google Patents.

Unmanned Aerial Vehicle Market Profile and Forecase (2013). Executive Summary, Teal Group.

Vander Wal, T. (2007). Folksonomy Coinage and Definition. http://www.vanderwal.net/folksonomy.html

Xie, H., Li, X., Wang, T., Lau, R. Y. K., Wong, T., Chen, L., Wang, F. L. Li, Q. (2016). Incorporating sentiment into tag-based user profiles and resource profiles for personalized search in folksonomy. In *Information Processing & Management*, Vol. 52, Issue 1, pp. 61-72.