

A TAXONOMY SCHEMA FOR WEB 2.0 AND MOBILE 2.0 APPLICATIONS

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Abstract: In recent times, much attention has been given to the Web 2.0 phenomenon and related notions such as Social Computing, Social Media and User-Generated Media. However, whenever Web 2.0 is mentioned, it is usually surrounded by vague and ambiguous concepts and definitions, mostly a complex mixture of technical and business aspects. This paper proposes to shed a light in such a fuzzy environment by proposing a taxonomy schema for Web 2.0 applications using as main categorizing criteria the type and characteristics of interaction permitted or facilitated by the applications. The proposed taxonomy schema is then extended to the Mobile 2.0 scenario by discussing the possible implications of mobility applications.

1 INTRODUCTION

In recent times, a number of trends in information and communications technology led to the emergence of a phenomenon commonly referred to as Web 2.0. A consensus on how to precisely name and define the phenomenon is still far away – and given the numerous aspects it encompasses, maybe it will never be achieved. Even so, these terms are commonly employed as catch-all expressions for a myriad of interactive applications that support and facilitate collaboration, community formation, content production and sharing by users, and social interaction. Examples include blogs, forums, content aggregators, social networks, and content communities (Constantinides & Fountain, 2008).

In addition to the lack of consensus on definition, there is also much confusion about the underlying characteristics of the Web 2.0 phenomenon and how to categorize its applications. Indeed, much of the published research on the topic has to do with specific and single practical applications, without a great concern for the larger picture or for how applications relate to each other.

The situation is even more chaotic when considering the extension of the Web 2.0 phenomenon to the wireless technological domain. Not only there are less articulated efforts to define and understand Mobile 2.0, but also systematic research about its applications is scarce.

In light of these considerations, the objective of

this paper is to propose a taxonomy schema for Web and Mobile Social Computing applications that uses as main categorizing construct the type of interaction permitted or facilitated by the applications.

2 WEB 2.0

Recent years witnessed an undoubted paradigmatic shift in the Web: from a linear structure of one-to-many content production, distribution and consumption to a participatory structure based on open, inclusive, collaborative and customizable applications that allow users to collectively create, share, evaluate and use digital content. This change was enabled by the wide availability of broadband Internet connectivity, including continuous connectivity through wireless channels, and the increase on processing power and memory capacity in personal computing devices, including mobile handsets (Parameswaran & Whinston, 2006).

The result of this paradigmatic shift is a complex and multi-faceted phenomenon, frequently called Web 2.0 (O'Reilly, 2005; Oberhelman, 2007; Levy, 2009), but also known as social computing (Parameswaran & Whinston, 2006), Social Media (Constantinides & Fountain, 2008) or even User-Generated Media (Shao, 2009). The multi-faceted nature of this phenomenon become evident when one considers these varied nomenclatures as efforts to highlight the multiple aspects of the phenomenon

at hand. Similarly, the fact that many sources define Web 2.0 by examples of applications (Oberhelman, 2007; Cox, 2008) is evidence of its complexity.

2.1 Technological Approach

A frequent common ground in attempts to understand Web 2.0 and its impacts is O'Reilly's (2005) set of principles. Firstly, O'Reilly (2005) proclaims that the web should be viewed as a platform to develop services. He states that the web should be understood simply as a channel for the services, as content become central in giving services a competitive edge.

Services, on the other hand, should be designed so they can be openly mixed and assembled, in a culture of constant experimentation. This is reflected also in the "permanent beta" motto, meaning constant and continuous improvement and dynamic change (based above all on user feedback). Still regarding service design, O'Reilly (2005) posits that it should focus on delivering a rich user experience, a clear reference to user empowerment.

Furthermore, services have to be designed in a way that their performance – and consequent value – improve automatically the more it is used, capitalizing on data access and network effect. This requires, understandably, intense and active user participation in the form of a collective intelligence, and the emphasis of individual, unsegmented consumers described by Anderson (2006).

At the same time, this means Web 2.0 users are considered content producers themselves. This is the reasoning behind the emergence of interest in User-Generated Content (UGC), that is, content publicly accessible, resulting from a reasonable amount of creative effort and generated outside the traditional and professional practices (Wunsch-Vincent & Vickery, 2007).

Following O'Reilly's (2005) line of reasoning, it is natural to view applications as the fundamental constructs of Web 2.0. This is, after all, a very practical solution for the problem of defining such a complex and multi-faceted phenomenon, with so many real-world implications. Indeed, many works on Web 2.0 involve the study of single applications (Barsky & Purdon, 2006a, 2006b; Eijkman, 2008; Fu et al., 2008; Parker, 2008; Scale, 2008; Wyld, 2008; Hearn et al., 2009).

According to Shao (2009), two important common characteristics of Web 2.0 applications make them specially appealing. Firstly, they are easy to use, having great usability, requiring little input and generating significant gratification. Secondly,

they allow users to be in control by being highly customizable and allowing interaction without time and space constraints.

For the purposes of this paper, a comprehensive but non exhaustive list of Web 2.0 technologies drawn from Anderson (2007), Levy (2007), and Parameswaran & Whinston (2006) includes: blogs, wikis, RSS, social bookmarking, content tagging, social networks, content sharing, syndication and/or aggregation, and thematic communities.

2.2 Social Approach

As Hendler & Golbeck (2007) note, O'Reilly's (2005) view of Web 2.0 is strongly biased towards technology, putting services and UGC on its core. Another approach would be to consider the social aspect of the phenomenon (Parameswaran & Whinston, 2006; Constantinides & Fountain, 2007; Shao, 2009), a notion whose roots can be traced back to views about the Web itself: "more a social creation than a technical one" (Berners-Lee, 1999, p. 123). This supports the observation that the Web 2.0 movement is not based on fundamentally innovative technologies, but on the innovative way user interaction is allowed by these technologies (Constantinides & Fountain, 2007).

In this sense, the fundamental construct of the Web 2.0 become the users themselves and, more importantly, the relationships and interactions among them. As Barsky & Purdon (2006a) put it: "Web 1.0 was almost all about commerce, Web 2.0 is almost all about people".

Nevertheless, these two approaches should not be seen as contrasting. Indeed, a common feature of both is the strong and decisive focus on interaction. After all, as Shao (2009) pointed out, the participatory culture characteristic of Web 2.0 means that users do not only consume content, they directly interact with and enrich it.

On the other hand, users directly interact with other users in a much larger scale than before, to the point of constructing and maintaining social relationships and, in the process, coming up with new and innovative content.

3 WEB 2.0 APPLICATIONS TAXONOMY SCHEMA

If the defining concept for Web 2.0 is interaction, it is then only natural to use it as a categorizing construct for a taxonomy schema involving Web 2.0

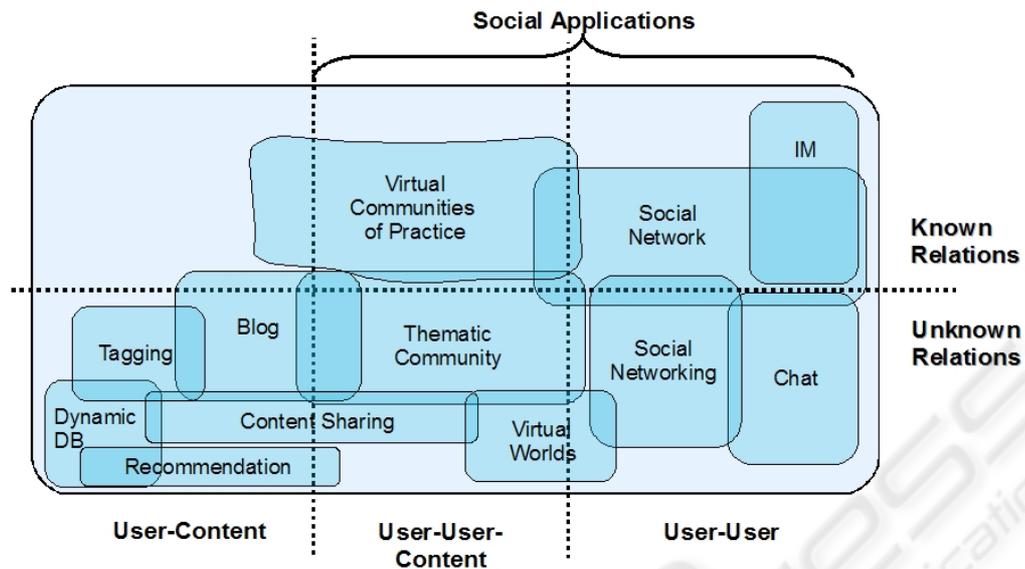


Figure 1: Visual representation of the proposed taxonomy schema.

applications. Interaction is a wide concept, though, so it is necessary to specify which aspects of interaction are relevant for classification purposes. The first one is the main *interaction focus*. Evidently, the centre of the interaction is always the user. In the Web 2.0 paradigm, user interactions can be focused on digital content (user-content), other users (user-user) or content and other users simultaneously (user-user-content).

User-content interaction can be distinguished between passive and active. While the former means basically passive *consumption* of pre-generated content (usually from professional or semi-professional sources), the latter involves direct involvement with the so-called dynamic content, i.e., content created and/or augmented by users. Active user-content interaction is a fundamental characteristic of Web 2.0 applications.

Similarly, user-user interaction can be further distinguished by *interaction continuity* and *user familiarity*. Interaction between users can be expected to be continuous and sustained or instantaneous and transient. While the former is a precondition to maintain social relationships, the latter is characteristic of practical communication interactions. Moreover, users involved in interaction can previously know each other or not, determining the type of user familiarity and, of course, the purposes and characteristics of the interaction itself.

The proposed taxonomy schema for Web 2.0 applications uses as its main categorizing criteria the type and characteristics of interaction permitted or facilitated by the applications.

Figure 1 shows a visual representation of the proposed taxonomy schema. The horizontal axis shows the three types of interaction focus considered (user-content, user-user-content, and user-user), while the vertical axis shows the two possibilities of user familiarity. The fact that application types overlap in the visual representation is an indication that real-world applications usually mix and share characteristics of more than one application type, as prescribed by O'Reilley's (2005) Web 2.0 principles.

3.1 Dynamic Content Applications

Dynamic Content Applications (DCA) permit or facilitate interaction between user and content. However, contrary to the traditional web user-content interaction paradigm where users passively consumed content pre-generated, Web 2.0 content applications are focused on the active aspect of the interaction and the dynamic aspect of content. In this approach, users are more than content consumers, as they actively interact with content in order to transform and enrich it.

However, using DCA, users usually transform and enrich content in relative autonomy and isolation. The resulting dynamic content is then consequence of indirect interaction by many individual users, not a direct collaborative effort. This is not to say that there can be no user-user direct interaction, only that it is much less emphasized than user-content interaction, and tends to be mostly indirect, like rating a news piece of commenting on someone else's blog post.

According to the proposed taxonomy schema, the following applications can be classified as DCA: tagging applications (also known as social bookmarking, such as Digg and Delicious); dynamic databases (Google Maps, housingmaps.com and iGoggle, for instance); recommendation systems (like Amazon and Netflix); content aggregation and sharing (such as YouTube and Flickr), and blogs (e.g., Blogger or LiveJournal).

Interaction focus centered on dynamic content instead of social interactions is evident in Cox's (2008) analysis of Flickr, one of the most representative and popular DCA. He points out that although Flickr has elements of social network site, such as profiling and group membership, "in general Flickr is not very interactive – not very social".

3.2 Social Content Applications

Social Content Applications (SCA) differ from DCA in the sense that users do not actively interact only with dynamic content, but also with each other during the process of content transformation and enrichment. Thus, the focus here is on the social content, i.e., content collectively produced, shared and/or transformed by users' interactions. Regarding interaction continuity, a defining characteristic of SCA is that they may allow for sustained user-user interactions. This means that some level of community formation is supported. However, the main objective of these communities of users is not to foster social relationships, but to promote collaborative production, use and sharing of content. Thus, sustained interactions are not a required characteristic of these applications.

In fact, SCA can be further detailed considering user familiarity and interaction continuity. Groupware (including Virtual Communities of Practice and Virtual Learning Systems) involve mostly known users and sustained interactions, usually in work or learning-related contexts, while Thematic Communities centered on specific topics of interest involve mostly unknown users and spot interactions. Finally, a specific type of SCA emerged in the form of Virtual Worlds, the most famous of these being Second Life, but also including massively multiplayer online games such as the popular World of Warcraft (Ducheneaut & Yee, 2009). In Virtual Worlds, the main interaction focus can be said to be evenly distributed between social content (the interactive world, in the case of Second Live, the game itself, in the case of World of Warcraft) and social interactions, as usually there are present features that allow for sustained user-

user interaction such as profiles and list of friends.

3.3 Communication Applications

These are applications focused on user-user transient interactions. In this category are included e-mail, forums, bulletin boards, newsgroups, mailing lists, chat and instant private messaging, which were already fully developed well before Web 2.0 drivers prompted the surge of user-user interaction (Herring, 2002). Now, these tools can be found incorporated in or complementing other Web 2.0 application types, or even used as is to improve communication efficiency (Hearn et al., 2009; Zimmerman & Bar-Ilan, 2009). A few specific communication technologies however, are typical of the Web 2.0 phenomenon, such as RSS feeds (Wusteman, 2004) and public messages exchanged by members of social network sites (Thelwall, 2009).

Specific Communication Applications are appropriate according to different types of user familiarity. While instant private messaging is mostly used for keeping in contact with known relations, chat rooms are commonly used by users that do not know each other beforehand. Similarly, Social Communication Applications could be further categorized according to aspects like synchronicity, persistence of transcript and participation structure (Herring, 2007), but it does not add value to the proposed taxonomy schema.

3.4 Social Network Applications

In a certain way, these are the most complete Web 2.0 application type, as they usually integrate many functionalities present in other types of applications. The main focus of Social Network Applications (SNA) is social interactions, i.e., user-user sustained interactions, allowing for – even encouraging – the formation and maintenance of persistent relationships.

Boyd & Ellison (2008) defined SNA as "web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system."

Specifically regarding the social connections represented in the list of linked users displayed in profiles, Boyd & Ellison (2008) argue that a distinctive characteristic of SNA is the fact that they are not aimed primarily at building new relationships (what would be understood as "networking"), but at representing and allowing communication within

their existing social networks – usually based on offline connections (Subrahmanyam et al., 2008). While most SNA provide options for communication among users (personal and public messaging tools are almost standard nowadays), privacy, access control and profile visibility settings are among the technical characteristics that vary the most among SNA.

3.5 Social Networking Applications

Applications in this category are very similar to SNA, as their main focus is also user-user sustained interactions. They also share many of SNA's defining characteristics, such as profiles (usually highly detailed) and list of connections (when present, normally closed). The defining difference is that these applications are used to initiate social interactions with previously unknown users. In other words, they are focused on networking, (Boyd & Ellison, 2008). The most representative Social Networking Application is the dating website (Bishop, 2009), and its distinct features is user search based on profile matching.

4 MOBILE 2.0

The Web 2.0 phenomenon attracted significant interest from the scientific community in the last few years, but the same can not be said about Mobile 2.0. Indeed, it is currently more an industry-related hyped buzzword than an actual well established construct.

Among the few attempts to analyse the Mobile 2.0 concept, some authors state that Mobile 2.0 is the next generation of mobile data services (Jaokar & Fish, 2006). A more prosaic – and perhaps practical – definition would be the extension of Web 2.0 services and applications to the mobile and wireless technological domain (Burns et al., 2007; Griswold, 2007). In this way, most of the considerations made for the Web 2.0 phenomenon are valid for Mobile 2.0.

For instance, it is interesting to note that technical and social approaches to define Web 2.0 are in a certain way replicated when Mobile 2.0 is considered. That is the case for Lugano's (2007) definition of Mobile Social Software (MoSoSo): “mobile applications whose scope is to support social interaction among interconnected individuals”, a software typically open and focused on the user.

Similarly, Jeon & Lee (2008) listed a series of technical trends considered by them as distinct traits of Mobile 2.0 concept. These include full browsing capabilities (implying search and advertising-based business models and flat data rate connections) on smartphones and other powerful computing mobile devices, standard and Mobile AJAX-enabled dynamic content, mixed and assembled open applications, navigation enhanced with RFID and barcode, and emergence of mobile UGC and mobile social networks. Notably, these trends resemble various drivers and characteristics of Web 2.0 already discussed.

However, as Holmquist (2007) and Lugano (2007) point out, Mobile 2.0 applications can not be a simple transposition of their Web 2.0 equivalents; they must exploit the unique characteristics of mobility and mobile devices.

Clarke (2001) mentions four mobile value proposition attributes: ubiquity, convenience, localization and personalization. By ubiquity, he indicates the fact that most mobile devices are constantly connected to the network, resulting in availability at virtually “any time and everywhere”. Similarly, convenience means that mobile users are not restricted by usual time and place constraints, while the localization attribute indicates the ability to easily locate and identify the mobile user. Finally, by personalization Clarke (2001) means the fact that mobile devices are extremely personal, usually directly linked to only one user, with his own preferences and desires for self-expression.

It is clear that these mobile value proposition attributes are aligned with many of the Web 2.0 principles. Localization and personalization, for instance, can be seen as potentially enhancing the user empowerment effect, one of the most innovative aspects of the Web 2.0 phenomenon. Furthermore, the ample diffusion of mobile devices with multimedia capability can intensify the user tendency to create, diffuse and share (Perey, 2008).

5 MOBILE 2.0 APPLICATIONS TAXONOMY SCHEMA

As it was for the Web 2.0 paradigm, interaction can be seen as one of the fundamental characteristics of the Mobile 2.0 phenomenon. Thus, it remains the categorizing construct for the Web 2.0 applications' taxonomy schema translation into mobility. Picking up on the interaction focus considered in section 3, Clarke's (2001) mobile value propositions will be

analysed in order to draw insights for Mobile 2.0.

First of all, it must be considered that the cellphone is an user-user interaction device by nature, be it through traditional voice and video calls, text messaging or instant messaging. These user-user interactions can be further enhanced by mutual awareness provided by localization systems.

Regarding user-content interaction, Lugano (2007) mentions that Mobile 2.0 applications tend to be heavily customizable. Indeed, this Web 2.0 tendency is intensified by the personalization attribute of mobility mentioned by Clarke (2001): mobile devices are extremely personal, and so must be the applications used through them. Adding to that is the fact that many Mobile 2.0 applications may integrate personal information about user identity and address book, rendering these applications extremely personal.

Also the limitations of mobile devices should be considered when examining interaction in the Mobile 2.0 context. Screens and keyboards' small size and the pattern of use of mobile devices, which imply frequent interruptions, can render difficult the tasks of reading and inputting text (Holmquist, 2007; Lugano, 2007). As mentioned by Perey (2008), navigation behaviour in mobile devices is therefore concentrated more on images and keywords and less on browsing, writing and reading. At the same time, limited processing power and battery life are usually mentioned as additional device limitations that may impair user enjoyment, specially when dealing with multimedia content (Holmquist, 2007).

Overall, considering the effects of mobility and mobile device attributes on interaction focus, one may argue that Mobile 2.0 applications tend to emphasize more user-content and user-user-content interactions than user-user interactions (Lugano, 2007). The formers take the form of direct consumption and sharing of multimedia content, taking advantage of mobile devices' multimedia capture capabilities and usually conducted through dedicated keyboard commands. On the other hand, user-user interaction is based on mobile device's natural communication features and can be enhanced by localization and awareness capabilities, although text reading and inputting may be somewhat limited.

5.1 Social Networking Applications

Analogue to Web 2.0 DCA, these applications focus on user-content interaction. However, given the limitations on content creating and editing related to mobile device characteristics, mostly are not pure Mobile 2.0, but hybrid mobile-web applications.

Representative subcategories of Mobile DCA are Mobile Blogging and Mobile Content Sharing. Both benefit from multimedia capture capabilities of contemporary mobile devices. For instance, most web-based blog management systems and content sharing websites can be accessed by mobile applications that allows users to upload multimedia content and even to create and edit blog posts.

Additionally, DCA that make use of aggregated data indirectly collected from mobile users, such as Recommendation Systems and Dynamic Databases, benefit from the integration of data related to user location and identity. Google Latitude, for instance, is an example of such an hybrid mobile-web DCA.

5.2 Mobile Social Content

These are the equivalent of Web 2.0 SCA, the main example being the Mobile Thematic Communities. Characteristic features of Mobile Social Content Applications include the user-content interaction focus, usually with the objective of exchanging knowledge or informative content related to a specific shared thematic subject. User-user interactions are mediated by the content itself in the form of content-related comments, ratings or public messaging/forum, as user profiles and list of connections, which are typical user-user interaction enabling features, are present only in limited form. However, this type of application tends to provide good usability when content upload and consumption is involved.

Groupware and Virtual Worlds are not yet diffuse on the mobile environment, mainly because of device limitations: computing power and screen size (which hinder mostly Virtual World-type applications) and keyboard and screen size (mostly affecting Groupware and other collaborative technologies). However, there are success cases of integrated use of mobile and web-based systems for mobile workforce and collaborative learning systems (Holmquist, 2007; Griswold, 2007).

5.3 Mobile Communication

Just like their Web 2.0 counterparts, these applications focus on permitting and facilitating user-user interactions, specially the immediate type, both between previous known and unknown users. Most one-to-one tools, such as e-mail and private messaging, are aimed at keeping in touch with known relations, while one-to-many tools, like chat and public messaging, are mainly used for communicating with new or unknown relations.

These mobile applications are mostly adaptations of existing web-based communications platforms for the mobile technological domain. For example, there are mobile applications that permit the user to access a traditional web-based e-mail or private messaging client, modified to cope with device limitations.

Localization, presence and awareness features may add value to communication applications by augmenting the usual status (such as “busy” or “away”) and mood indicators (Perey, 2008) with real-time indication of a friend's location and availability. Perey (2008) raises an important point about status indicators in Mobile Communication applications: given the fact that multi-tasking is much more difficult in the limited-screen mobile device, visual indicators for a user's availability to engage in interaction becomes even more important than in web applications. Moreover, traditional mobile communication channels like SMS, MMS, voice and video-calls may be integrated in order to increment communication efficiency.

5.4 Mobile Social Network

In the words of Humphreys (2008), mobile social network applications that “purport to allow people to create, develop, and strengthen social ties” are “much like social network sites on the Internet”. Using the interaction construct, it means that Mobile SNA is aimed at the same interaction focus than Web 2.0 SNA: user-user interactions.

However, a pure transposition may be too simplistic. Humphreys (2008) himself reports differences in structure and use between Dodgeball, a mobile SNA enhanced with localization features, and typical Web 2.0 SNA. Dodgeball is heavily dependent on location-based information, allowing the articulation of social networks around places, not content or people. Similarly, it is interesting to see how users understand the system: “Dodgeball differs from Friendster in that it involves 'real world interactions'”. In other words, according to the users, the location-based component of the Mobile SNA truly facilitates face-to-face interactions, as opposed to virtual interactions that characterizes online SNA. This may be interpreted as an indication of how mobility can impact use and design of Mobile SNA.

Perey (2008), on the other hand, indicates that Mobile SNA interaction focus may be dislocated in the direction of user-user-content interactions. She argues that, given mobile device's characteristics, collective UGC share and consumption tend to be more relevant than social relationships.

5.5 Mobile Social Networking

As with other application categories, also Web 2.0 Social Networking may be enhanced with mobility. All Mobile Social Network applications share the basic characteristics of user-user interaction focus aimed at making new acquaintances and are supported by communication tools. However, the most sophisticated ones build up on detailed profile, closed list of connections and profile matching, and its implementation may be enhanced by localization, presence and awareness features. On the other hand, the most simple and archaic ones are basically just chat rooms, usually with little or no profiling, where interaction may be restricted to as little as text-only communication (Perey, 2008).

6 CONCLUSIONS

In the context of the recent attention given to the Web 2.0 phenomenon and the ambiguousness that characterises it, this paper analyses published research about Web 2.0 in order to identify *interaction* as a common construct among the diverse definition approaches. A taxonomy schema for Web 2.0 applications is then proposed, based on interaction as the categorizing construct. Finally, the concept of Mobile 2.0 is discussed, and the taxonomy schema is extended to Mobile 2.0 applications. Furthermore, some considerations about the implications of mobility characteristics are presented.

The proposed taxonomy schema may be used as a reference framework for empirical studies involving Web 2.0 or Mobile 2.0 applications. It may be particularly useful when comparing applications from both technology domains. Exploratory and descriptive studies are needed to validate the schema, to draw additional insight about using interaction as the classificatory construct, and to test the boundaries of the proposed category types.

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