A Context Aware Approach for Promoting Tourism Events: The Case of Artist's Lights in Salerno

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Keywords: E-Citizenship, Context-aware Computing, Adaptive Systems.

Abstract: This paper introduces a Context Aware App for the tourism. This app is based on a graphical formalism for the context representation: the Context Dimension Tree. The aim is to propose a Context Aware approach that acts as dynamic support for the tourists, equipped of a mobile device which reacts to a change of context adapting user interface, according to his/her current position and global profile. For example, the system can guide the tourist in the discovery of a town proposing him/her events mainly interesting for the user. A case study applied to a Christmas event in Salerno, an Italian town, has been analyzed considering various users (Italian tourists, foreign tourists, etc.) and an experimental campaign has been conducted, obtaining interesting results.

1 INTRODUCTION

The adoption of Future Internet (FI) technology and of its most challenging components like the Internet of Things (IoT) and the Internet of Services (IoS), can constitute the basic building blocks to progress towards a unified ICT platform for a variety of applications within the large framework of smart cities projects (Atzori et al., 2001; Colace et al., 2015c). In addition, recent issues on participatory sensing, where every day mobile devices like cellular phones form interactive, participatory sensor networks enabling public and professional users to gather, analyze and share local knowledge (Hernandez-Munoz et al., 2011; Colace et al., 2005), seem to fit the smartness requirements of a city in which also people have to play an active role. Eventually, the cloud computing technologies provides a natural infrastructure to support smart services (Colace et al., 2015a).

One of the fields that can take great advantages from such technologies is tourism (Schaffers et al., 2011). In this scenario, persons (citizens, tourists, etc.) and objects (cars, buildings, rooms, sculptures, etc.) equipped with appropriate devices (GPS, smartphone, video cameras, temperature/humidity sensors, etc.) constitute a particular social network in which all the mentioned entities can communicate (Komninos et al., 2011).

Exchanged and produced data can be exploited by a set of applications in order to make the system "smart". From a more general point of view, the social network can be seen as composed of a set of Single Smart Spaces (S3) (indoor museums, archaeological sites, old town centers, etc.), each needing particular ICT infrastructure and service that transforms the physical spaces into useful smart environments. Here, one of the most challenging and interesting research problem is to model context awareness in a S3 and design context aware applications able to provide useful data and services depending on the current context occurrences (Colace et al., 2015b; Colace et al., 2014).

Context is not just a simple profile that describes the surroundings of data. Rather, context is better described as any piece of information that can be used to characterize the situation of an entity such as a person, a place, or any other relevant object/aspect in the interaction between a user and an application. In this paper, we try to give an answer to the problem of the context representation using the Context Dimension Tree formalism (Bolchini et al., 2006a; Bolchini et al., 2009).

On the basis of what has been previously described, this work will be organized in this way: in the following paragraph, we will describe the concept of context and how it can be declined in a modern way thanks to the use of new technologies. Then, we will introduce a context-based approach able to give, inside

a Christmas event in a little town, services and contents useful for the user. Some experimental results will be presented in the last part of the paper.

2 MOTIVATING EXAMPLE

In this section, we describe a typical application in the tourist domain in order to better understand the main features of the proposed system. In particular, we consider a tourist that during her/his vacation in Campania desires to see Artist's Lights Christmas event in Salerno, a beautiful town located in the South of Italy.

Some of the features of context-aware systems are given below:

- contextual sensing: ability to sense context information and present it to the user;
- contextual adaptation: ability to execute or modify a service automatically at runtime based on the context;
- context resource discovery: ability to discover and use resources and services related to the current context;
- contextual augmentation: ability to supplement digital data with the user's context.

In particular, to be considered smart, the environment related to the Artist's Lights event should provide a set of smart services for:

- suggesting the visit of the most important Christmas lights;
- having information about the Christmas lights in Salerno;
- accessing to proper multimedia guides describing the Christmas lights that are in Salerno;
- recommending special visit paths (Il Mito, Il Sogno, Il Tempo, Il Natale);
- monitoring the weather condition;
- showing the timetable of the transport services located in Salerno;
- saving the visit in a multimedia album and sharing it with friends.

For improving their effectiveness, these services and contents have to be furnished to the user in the right context and at the right timing. Therefore, it is important the context awareness of the framework and the opportunity to use it by mobile devices (Colace et al., 2015d). Another important feature of the system is the ability to suggest resources that usually are not considered as mainstream.

In order to give the most suitable contents to the users, in this paper we introduce a context aware system able to tailor data and services depending on the context and the users' needs.

Data about resources and services are collected from a knowledge base built by a group of experts and collecting information from the various social networks.

In the next paragraphs, more details about context awareness and the application of the proposed approach in real context will be furnished.

3 CONTEXT AWARENESS

The term context has been defined by many researchers. One of the most cited definitions of context is the definition of Dey et al. (1999) that defines context as "any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves."

We accept the definition of context provided by Dey et al. to be used in this research work, because this definition can be used to identify context from data in general.

The originators of the term context awareness are Schilit and Theimer who in 1994 introduced and defined Context-aware computing as *"the ability of a mobile user's applications to discover and react to changes in the environment they are situated in"* (Schilit et al., 1994).

Pascoe et al. (2000) describe context awareness as the ability of the computing devices to detect, sense, interpret and respond to aspects of a user's local environment and the computing devices them selves.

Dey and Abowd have refined these definitions into a more general definition what a context-aware system is. In this definition they use context in the definition of a context-aware system. Since context has already been defined and classified in the above it is logical to use these elements in the definition of context awareness: "A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task".

If we wanted to classify the context awareness categories, we could consider that presented in Bisgaard et al. (2004):

1. Presentation of information and services to a user, is the systems ability to select appropriate information and services according to the current context and make these available to the user at the correct time.
2. Automatic execution of a service, is when the system automatically performs actions and updates

the system according to events in the context.

3. Tagging of context to information for later retrieval, is applying information to the context so that the information may the retrieved later when the user enters the same context again.

Context-aware systems are changing over the years since its introduction, several existing context-aware systems were reviewed.

Based on the characteristics, existing context-aware systems are broadly classified into four categories, namely the first generation, second generation, third generation and fourth generation of context-aware systems (Meena et al., 2014).

Examples of first generation context-aware systems are tour guide, shopping assistant, phone call forwarding and location information providing.

The main focus during this generation is acquisition of location from the sources. This systems are named location based service systems.

The second generation context-aware systems initiated focusing on achieving more number of context-aware applications starting from homogenous devices to heterogenous devices.

Third generation of context-aware systems begins to focus on context knowledge sharing among the network. It concentrates on markup languages, for example Web Ontology Language (OWL).

Fourth generation of context-aware systems are working in ambient environment.

What are the mobile context-aware applications for?

In this section we will describe some systems and ideas behind the applications.

One of the very first attempts to make a context-aware system is the CyberGuide (Abowd et al., 1997) which was created back in 1996. The CyberGuide was intended to work as a citywide guide system which could lead people to the sites which they wished to see and also provide a local mobile guide inside the different attractions around the city. Once inside a museum or a similar site the CyberGuide functions as a personal tour guide which leads the user around the exhibit and based on knowledge of the user's location provides information about the pieces of art in the vicinity.

SenSay (Siewiorek et al., 2003) is one example of a context-aware system that attempts to adapt to dynamically-changing environmental and physiological states. The system relies on a sensor network that utilises a person's mobile phone as a primary source of context information, although the use of applications (e.g. calendars, task lists) and body-embedded sensors was also targeted.

AnonySense (Shin et al., 2010), a privacy-aware

architecture for collaborative pervasive applications that use mobile sensing. Mobile sensor data is anonymized before its use by any of the applications.

SOCAM (Gu et al., 2004) is a service oriented ontology based context-aware middleware. It supports semantic representation and reasoning of context. It also divides context into upper and lower level ontologies such as interpreted context through physical world, and memory and battery status respectively. It allows adaptability by listening, detecting and invoking events for application services.

GeoNotes by Espinoza et al. is a system for abstracting location information for location-aware applications (Espinoza et al., 2001). The system architecture is constructed to support shared information for mobile devices, exactly to leave notes atspecific places for other users to be read. A user creates notes and sticks it to certain places, where other users can read them. Notes can be targeted at a single user or a whole user group. Vice versa a specific user can create and apply filters to perceive only a subset of the notes associated to a certain place.

In the following paragraph, we will present an approach to the management of the context and the contextualization of its associated contents and services.

4 CONTENTS AND SERVICES CONTEXTUALIZATION

In order to make contextualized queries, it is necessary to define a model for the representation and management of the context itself, which allows filtering the resources obtained, on the basis of contextual parameters (user position, user profile, user friends, etc.): this operations are made through the Context Dimension Tree (CDT) (Tanca et al., 2006).

Therefore, the result shows itself like a well-organized information that presents a general introduction about the place reached by the user, according to his/her interests and enriched with the experiences shared by similar users, and a list of the main suggested attractions about the near places visited by the friends.

In particular, CDT is used to be able to represent, in a graphic form, all possible contexts that you may have within an application. CDT plays a fundamental role in tailoring the information space according to the user's information needs, as well as an analysis of relevant features of context models. It is thus important to notice that this notion of context is strictly connected to the considered application and is not

meant to model the general knowledge concerning one or more areas of interest, a situation where a data schema, or a domain-ontology may be better suited (Bolchini et al., 2006b; Colace et al., 2015e).

CDT is a tree composed of a triad <r; N; A> where r indicates its root, N is the set of nodes of which it is made of and A is the set of arcs joining these nodes.

A dimension node, which is graphically represented by the color black, is a node that describes a possible dimension of the application domain; a concept node, on the other hand, is depicted by the color white and represents one of the possible values that a dimension may assume. Each node is identified through its type and a label.

The children of the root node r are all dimension nodes, they are called top dimension and for each of them there may be a sub-tree. Leaf nodes, instead, must be concept nodes. A dimension node can have, as children, only concept nodes and, similarly, a concept node can have, as children, only dimension nodes. In addition to nodes, you can use other elements: the parameters, which may arise both from a dimension node (graphically represented by a white square) and from a concept node (white triangle), submitting them to particular constraints. In fact, a concept node can have more than one parameter, while a dimension node can have only a parameter and only in case it has not already children nodes. The introduction of parameters is due to their usefulness in shaping the characteristics that can have an infinite or very high number of attributes. For example, a node representing Cost dimension risks having a high number of values that should be specified by as many concept children nodes. In a similar case, it is therefore preferred to use only one parameter, whose value will be specified in each case. Leaf nodes, in addition to concept nodes, can also be parameters. In general, each node has a parameter corresponding to a domain, dom(nP). For parameter nodes connected to concept nodes, the domain can be a set of key values from a relational database, while in case of parameter nodes connected to dimension nodes, the domain is a set of possible concept nodes of dimension.

Therefore, CDT is used to systematically describe the user needs, and to capture the context the user is acting in. It plays a fundamental role in tailoring the target application data according to the user information needs. Once the possible contexts have been designed, each must be connected with the corresponding view definition. In this ways, when the context becomes current, the view is computed and delivered to the user (Parent et al., 2007).

In fact, through the CDT, it is possible, after analyzing the domain of application, to express the size characteristics and values they can take in a graphical way by, respectively, dimension nodes and concept nodes or parameters.

The assignment to a dimension of one of its possible values is a context element. The context element can be considered the main feature of the application, by which a context can be decomposed. The moment you make the formulation of the context, you must specify all the context elements that are part of it and that enable its creation. Any context is expressible by an "and" combination of the context elements to which they are peculiar.

By definition, you can begin to understand how you will create views based on data relating to each context; in fact, they will be built starting from the portions of the database and then from the partial views, associated to the context element that takes part into context information.

The CDT elaboration is composed of methodologies and phases to obtain contextual resources. The methodology has been realized in order to manage the database and to carry out reductions of their content based on the context. The purpose is to help the designer in the definition of all contexts relevant to the considered application and, later, in the association to each context of the portion of the database containing the relevant data about the context.

The methodology consists of three main phases, which we will see in detail later: design phase of the CDT, definition phase of partial views and composition phase of global views (Annunziata et al., 2016).

1. Design phase of the Context Tree: in this phase, the CDT is designed to identify significant context elements for the considered application. In fact, it focuses on the definition of contexts and on the elements that compose them. These contexts must be identified and shaped, indicating particular elements that characterize each of them. As it has been said, it is available a special tool called CDT to make context design. Various CDT were made for specific environments in order to represent and manage a multitude of different contexts and in order to identify, represent, preserve and make available cultural points for each type of user.

2. Definition phase of partial views: after the definition of all the contexts and their context elements, in this step a different portion of the database is associated to each context element, containing the relevant data for it. In practice, the goal is to find the appropriate value for a given dimension, in order to obtain, by means of the

values of all the dimensions, a valid query and specific to the context in which the user is located.

3. Composition phase of global views: this is the phase where you have the automatic generation of views associated with each context, which is made starting from partial views associated with context elements. After the creation of the global views of the contexts, the answers to questions that will be asked to the system will be developed from these views and, in particular, from the view associated with the context in which you are located when the query is performed.

In particular, once defined the values for each dimension, you can use all the information obtained in order to identify the right context and offer contextual resources for the user.

In figure 1, it is shown a general designed CDT, called *Meta CDT*, which is the starting point for the design of a specific CDT that can be exploited in contextual applications (Colace et al., 2015d).

You may note six top dimensions, which correspond to the questions of the 5W1H method: Location (WHERE), Role (WHO), Time (WHEN), Situation (HOW), Interest (WHAT) and Utilization (WHY).

In particular, there are two types of users and eleven categories of interests. In this case, as shown in figure 2, a partial view could be related to dimension

"Role": once logged in, the application is able to recognize the user and to know more precisely whether he/she is, for example in tourist areas, a resident or a tourist. Thus, the value "tourist" of dimension "Role" is a partial view for the current context: using this knowledge, you can exclude certain resources, not suitable or useful to the tourist role.

A context element is defined as an assignment d_name_i = value, where d_name_i indicates a possible size or undersize of CDT (it is the label of a dimension node), while value may represent the label of one of the concept nodes that are children of the considered dimension node or the value of a parameter referring to one of these concept nodes or the value of a parameter referring to the considered dimension node.

For example, these assignments are possible context elements:

Interest = "tourism", Location = $locationID (for example, ID = 3), Role = $userID->role (for example, ID = 15), Utilization = "holiday". A context is specified as: $\wedge(d\_name_i = value)$: it is defined as an "and" among different context elements.

Several context elements, combined with each other by means of an "and", damage, therefore, the origin of a context (Casillo et al., 2016a).

For example, a possible framework that can be obtained from the previously seen CDT, through the context elements that we have listed, is:
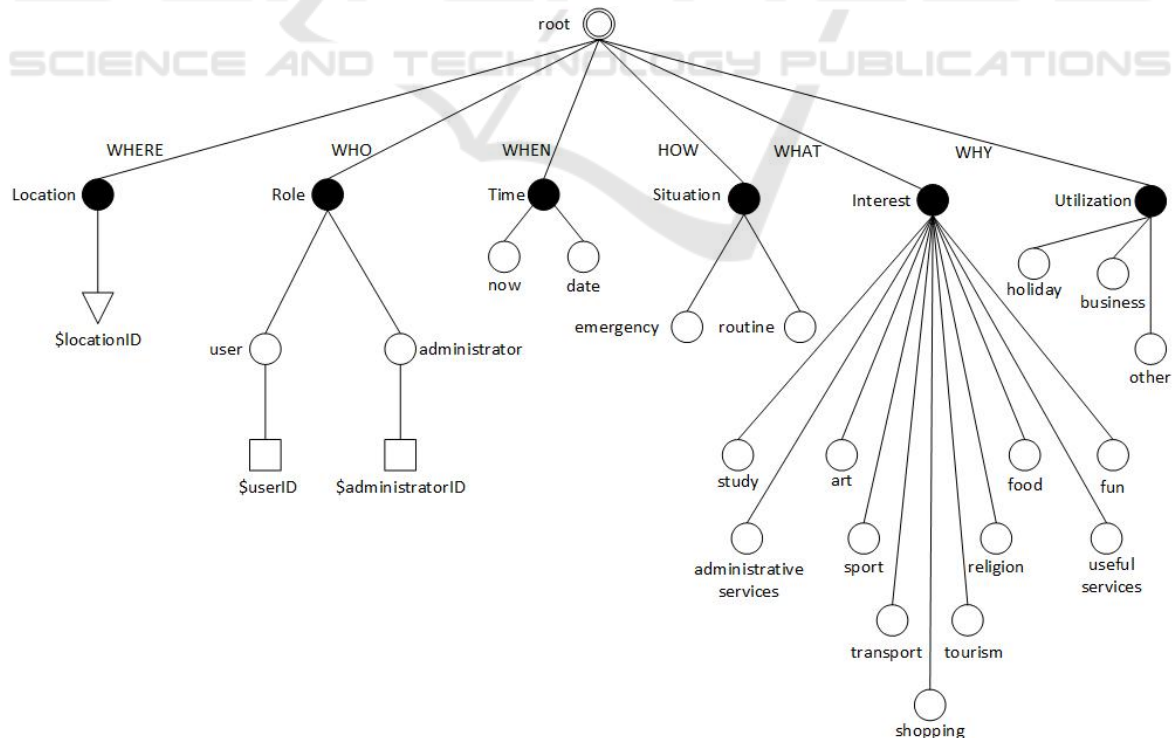

Figure 1: Meta Context Dimension Tree.

$$C = (Location = \$locationID\ (ID=3)) \wedge (Role= \$userID\text{-}>role\ (ID=15)) \wedge (Time = "now")$$
$$\wedge (Situation = "routine") \wedge (Interest = "tourism") \wedge (Utilization = "holiday")$$

The context is defined as a user, interested in tourism, who uses the contextual app on vacation, in a called place.
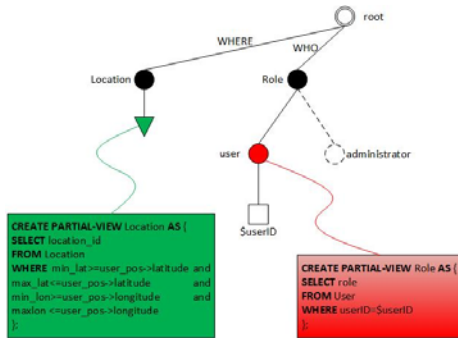

Figure 2: Example of Partial Views.

5 A CONTEXT AWARE APP FOR CHRISTMAS TOURISTS

In this section, we will present Smart Artist's Lights, a contextual app designed and implemented according to what was described previously. In particular, we have thought to apply the approach in the context of Artist's Lights Christmas event, that every year is held in Salerno (Regione Campania in Italy) and that involves hundreds of thousands of tourists.

From November to January, with light installations, some by local artists exclusively for Salerno, scattered through the main streets and in the most beautiful and attractive corners of the city center.

In this phase, we have collected the services and contents potentially useful for the citizens and situate them on the map defining the activation zones (figure 3).
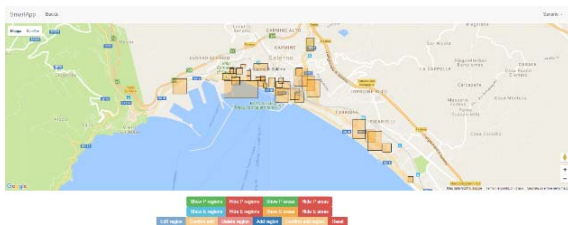

Figure 3: Definition of the activation areas of services and contents.

Moreover, we have defined the different typologies of citizens (tourist and expert user) associating them to a previously established set of services and contents. Having the town a series of Christmas contents, we have developed services and contents in support of them too.

All information about places of worship and shops has been uploaded, for any building or area of potential.

The App has been developed with hybrid technologies (Ionic Framework and Apache Cordova) to allow an easier publication both in Android and Apple environment (figure 4 and figure 5).
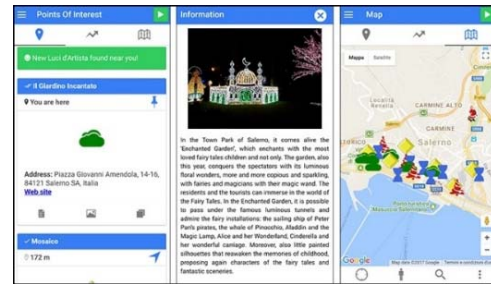

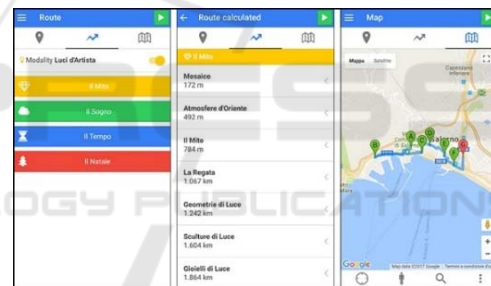Figure 4: Screenshots with some features of contextual application.

Figure 5: Screenshots with other features of contextual application.

The experimental phase aims to evaluate the proposed contextual model. Initially, the App has been presented to the population in November 2016. They have been involved overall about 1000 tourists between 18 and 60 years old. During this event, the app has been installed on the mobile devices of the tourists.

After having interacted for some days with the application, the participants have then answered on the basis of the Likert scale to fourteen statements, divided into four sections. To every question present in the section, five possible answers have been associated: I strongly agree – I agree – Undecided (Neither agree nor disagree) – I disagree- I strongly disagree.

The questionnaire in detail is the following:
Section A: App – Context
- A1. The App gives the user tailor-made contents

and services in the right place.

- A2. The App allows the user to know several item of the Artist's Lights.
- A3. The App supplies services according to the interests selected in the user profile.

Section B: App Lights – Further aspects

- B1. Information about each item of Artist's Lights is very useful.
- B2. The contents, such as descriptions and images, are of high quality and represent one of the strong points of Artist's Lights.
- B3. The services associated to the items allow a higher immediacy than a classic research on the Internet.

Section C: App – Functionality

- C1. The plan itinerary service allows easily realizing an itinerary in the Artist's Lights according to the user's preferences.
- C2. The explore surroundings service is very useful to know what there is nearby and eventually reach them.
- C3. The functionality of QR code in inner environments can be well used.

Section D: App – Future developments

- D1. It would be interesting to have a higher integration with the main social networks.
- D2. It would be interesting to insert the available time in the plan itinerary service.

Table 1 presents a synthesis of the answers of the participants to each declaration.

Table 1: Experimental results.

Likert Scale	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
A1	303	580	92	15	10
A2	487	422	55	20	16
A3	418	512	55	9	6
B1	315	562	70	35	18
B2	294	502	132	42	30
B3	440	514	27	11	8
C1	596	366	24	6	8
C2	387	493	79	24	17
C3	331	519	95	33	22
D1	458	478	27	19	18
D2	367	435	117	47	34

As shown in this table, of the 1000 participants who have interacted with the application, many agree and/or strongly agree that the system gives appropriate contextual information about the place, further aspects and functionality are very useful and future developments are interesting. Instead, only in few cases, the participants do not are particularly satisfied.

As can noticed from the figure 6, users show great appreciation for the app. In general, they appreciated the proposed contents and services.
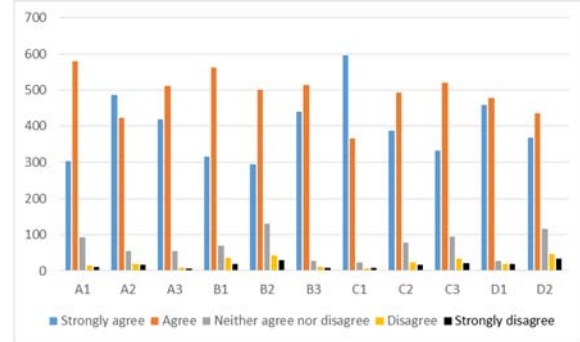

Figure 6: Graphic analysis of experimental results.

6 CONCLUSIONS

This paper proposes the use of a Context-Aware Approach for the selection of the most suitable services and contents for a user in a certain context. The system is based on the concept of Context Dimension Tree, a graphical formalism able to model a context by the approach of the 5W1H method.

The propose approach has been implemented in an App that furnishes services personalized for the needs of the user according to the context where he/she is. The App bases its 'contextual' functioning on the adoption of the CDT that is able to shape the context and the actions to implement.

It has been developed for the Artist's Lights Christmas event and the results have been satisfying. The following activities have as purpose the application of the proposed methodology to more complex environments, for dimension and number of potential places to manage.

ACKNOWLEDGEMENTS

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