

Intellectual Tourist Service with the Situation Context Processing

Yevhen Burov¹ Anna Horodetska¹ Myroslava Bublyk^{1,*}

Mariya Nashkerska¹ Victoria Vysotska¹

¹ *Lyiv Polytechnic National University, Ukraine*

*Corresponding author. Email: my.bublyk@gmail.com

ABSTRACT

The proposed approach of modelling and identifying the current situation is illustrated by e-tourism, which is advisable to expand and apply in other areas. Implementing this approach will create intelligent systems and services that respond quickly to changes in the environment. An example of an intellectual tourist service provided for tourists is developed.

Keywords: *context processing, content, intellectual tourist service, online tourism.*

1. INTRODUCTION

Today, tourism has suffered significant losses due to the development of the Covid-19 pandemic, having lost the first positions among the rapidly developing branches of the world economy. World Tourism Organization (WTO) predicted that the annual number of tourist visits increased to 1.6 billion by 2020 [1]. Tourist information systems are a new class of business systems that serve a large number of loosely connected organizations that provide services to tourists, such as airlines, hotels, transport organizations, restaurants and others. Clients of tourist systems are characterized by high mobility both in terms of movement in space and in terms of frequent changes in types of activities [2].

Such properties of the tourism industry as globalism, dynamism and interdependence of services, heterogeneity of data formats, incomplete information are noted and a method of using executive conceptual models that obtain information from the context to make decisions about tourist services in incomplete information is proposed. An important task of tourist information systems today is also the constant support of the client during his journey, providing services in the context of the specific situation in which the tourist is. Solving this problem requires the creation of a mobile intelligent information environment that monitors and identifies the current situation and decides on the relevance, content and scope of the

offered services. In this case, all the information necessary for making a decision by a system is obtained from the contexts of the identified situation, the tourist and his journey.

2. RELATED RESEARCHES

Building such an environment requires solving a number of problems and tasks, in particular, the organization of semantically interpreted access to information, development of methods and technologies for context processing, methods of identifying the current situation and others. These issues are explored in several related fields, such as the semantic web, contextual technology, distributed intelligent technology, decision support technology and others. In particular, a popular area of research in the field of e-tourism, aimed at solving the problems of dynamism and incompleteness of data is the use of methods and technologies of the semantic web [3, 4, 5]. It is often believed that the existing sites have enough information to provide semantically oriented services but lacks only semantic markup. In [6, 7] it is shown that in reality such basic information is often lacking, which is a significant obstacle to the introduction of semantic web services in the field of tourism.

In [8] the application the usage of semantic web methods for construction of dynamic packages of tourist services is considered. Such packages combine

different types of services from different companies. An e-tourism industry ontology has developed, which allows the user to obtain additional information about the place of their trip. To solve the problem of obtaining data from disparate sources, it is proposed to use semantic intermediaries (mediators) that form a hierarchical structure that corresponds to the structure of concepts in the ontology. A web process generates a dynamic service package. At the same time, the system [8] is not flexible enough and does not support dynamic rescheduling of the service package. Moreover, it works only in a manual mode. One of the ways to solve the problem of incomplete customer data is to obtain additional information from the context, the development of contextual services for the provision of services in the field of tourism. The issue of context-dependent services is currently being actively studied. Thus, [9] offers an overview of basic technologies and architecture of contextual services, developed within the research project CONTEXT funded by the European Union. This paper demonstrates the possibility of building contextual services for creating mobile work environments, communication services that are resistant to failures. At the same time, the approach proposed in [9] does not use intelligent, semantically oriented systems, the meaning of the concept of context in it is defined in advance for each application. Similar problems are solved by the scientific direction of artificial intelligence associated with the construction of distributed intelligent systems and environments (pervasive, ubiquitous computing, ambient intelligence) [10]. Today, within the framework of this direction, the construction of mobile computing infrastructure is underway, which is expressed in the development and distribution of mobile computers and services. Some popular services, such as Google Places [11], provide context-sensitive services in the context of a user's current location, reporting important and interesting objects around. At the same time, existing services mainly focus on using only the context of the accommodation or the context of the person (personalization services), and do not take into account what the tourist is doing – and, more generally, the context of the situation in which it is.

The problem of the assessment of such kind of the problem is one of the central tasks of the theory of decision support systems (situation awareness – SA). A correct assessment of the current situation is necessary to make the right decision. The solution of this problem by an expert (accident) is usually carried out in the presence of incomplete, poorly structured, often-contradictory information about the subject area, in constant changes of the state of this area, large

amounts of irrelevant data, as well as strict time constraints [12].

The use of information decision support systems aims to help the offender in the correct assessment of the problem situation by quickly selecting the information, necessary for making a decision and present it in a form, convenient for perception by the expert. One of the most difficult components of this task is to determine which data in the problem area are relevant to the goal or the identified problem. Traditionally, this task is solved by the expert himself, guided by his experience in solving such kinds of problems. At the same time, determining the relevance of human data is really time consuming and expensive. Today, in the theory of decision support systems, the direction of cognitive decision support systems (CDSS) has been determined [13], which aim to formalize the expert experience in the form of significant configurations of subject area parameters that reflect previously identified and solved problems. The formalized experience in the form of appropriate models is used by the decision support system to search for relevant information in similar situations in the future.

In active conceptual modelling systems, formal conceptual models are constantly updated with data from the subject area, providing the expert with actual and relevant data on a certain range of problems in real time [14]. At the same time, an expert, rather than automatic identifying of the current situation usually aim existing decision support systems at supporting decision-making.

The purpose of this article is to develop methods and means of identifying the situation and processing its context for the subject area of tourism services and the practical implementation of these methods by building an intelligent service with processing the context of the situation.

3. ARCHITECTURE OF PROCESSING OF SITUATIONAL MODELS IN INTELLECTUAL SERVICE

The task of tracking changes in the context of a tourist trip requires taking into account the relevance of the changes that taking place and other information in the context of this trip [15]. Determining the relevance of a piece of information is a complex expert task, the solution of which should entrusted to an expert [16]. Thus, the expert predicts possible situations in which a tourist may find himself, determines the rules of their identification and actions that should be taken during certain situations. The

situations defined in this way are formalized in the form of situational conceptual models [17]. The intelligent system periodically checks the facts of the information base for the presence of a situation and automatically initiates actions specified by the model, if the situation is detected [18].

Thus, the situational conceptual model consists of two parts. The first determines the conditions that must meet the facts of the subject area to identify the situation [19]. These conditions are set as requirements for the presence or absence of facts of certain types with given properties. The second part of the situational model is the specification of actions that should be performed when identifying the specified situation [20]. Actions are defined as sets of commands with parameters that are determined based on the properties of the facts of the information base and the context of the situation [21]. An important feature of situational models, the solution of which is reflected in the metadata of the model, is to determine the conditions when and how often you need to analyze the state of the subject area, i.e. to activate the model [22]. It is necessary to take into account both the peculiarities of the situation revealed by the model, in particular the expected probability of its occurrence, and the load of the modeling system [23]. Thus, if you activate the model too often, the simulation system will be overloaded and may not have enough resources to perform other models [24]. On the other hand, if you rarely activate the model, you can skip an important situation and react to it too late [25].

If the system provides the simultaneous processing of many situational models, it is advisable to implement a separate component - the model launch manager [26]. This component reads from the metadata of the models their start conditions, summarizes them and initiates the start of all models according to the defined conditions [27]. The model launch manager monitors the degree of resource utilization of the simulation system, optimizes this use by combining the launch of models that have the same startup conditions [28]. The launch manager determines with what kind of data the models work with and, if necessary, formulates tasks for monitoring services to replenish the information base with such data [29]. The model interpreter functions can also be transferred to the model launch manager. The paper [15] presents the architecture and principles of operation of an intelligent system that uses performing conceptual models. Support of situational models adds new components to the proposed modeling system (Fig. 1). The central component of the modeling system is the ontology of the subject area, which provides a semantic interpretation of all the facts of the

information base [30]. Models are also built on this ontology.

The information base is constantly updated with new facts that reflect the state of the subject area [31]. The sources of such facts are employees, information systems of travel companies and companies that provide travel services, and specialized contextual providers - such as those that provide the location of the tourist in real time, or compare this place with a particular organization or institution, for example, restaurant or museum [32]. A special place among the sources of replenishment of the information base is occupied by monitoring services, which periodically read certain data in the subject area and enter them into the database [33, 34, 35].

In the research [2], principles of processing contextual information for the tourist portal are formulated, and a system that works with the context tourist trip is described [36]. In the case of the designed tourist service, situational models process information that comes from the general context of the tourist, or more precisely - from three parts of this context: the tourist's personal data, his whereabouts and the context of the task the tourist is currently performing [37, 38]. Revealing the problems of determining the components and indicators of intellectual context-aware and situation-aware services in intellectual networks, we may state that most scholars study the influence of several specific factors (economic, social, cultural, political and ecological) [39, 40], the external impact of innovations [41, 42], the influence of information technology in general [43]; or just use a financial approach [39].

4. FORMAL SPECIFICATION OF THE SITUATIONAL MODEL

Each situational model can be formalized by means of ontology. The main task of ontology is the formal reflection of knowledge through their conceptualization. The process of conceptualizing knowledge occurs through the description of only those concepts and objects about which knowledge is interconnected. Formal ontological specification includes terms, concepts and concepts, as well as their systematized definitions and attributes. It also includes the axioms and rules of inference associated with them. Thanks to the ontology, a common vocabulary is formed for users who exchange information about a certain area. Formally, the model of ontology O combines three forms $O = \langle C, R, F \rangle$, where C is defined by ontology O , a limited set of concepts and terms; $R: C \rightarrow C$ is the final set of relationships between concepts and terms; F is a finite set of

functions that interpret or limit, defined ontological concepts or relations O [2, 6-9]. An ontology is often depicted in the form of a graph, where the vertices of the graph are definite concepts; arcs reflect the directions of relationships between concepts, as shown in Fig. 2. Vertices on a graph can be interpreted or not interpreted. Interpreted vertices are marked in dark color on the graph. Solid lines indicate vertical

relationships, and dotted lines indicate horizontal relationships. A finite set of functions of interpretation or axioms determines the structure of the ontology. It is very difficult to automate such a set of functions. Today, this problem is not solved, so consider a new approach to automating the construction of such interpretation functions.

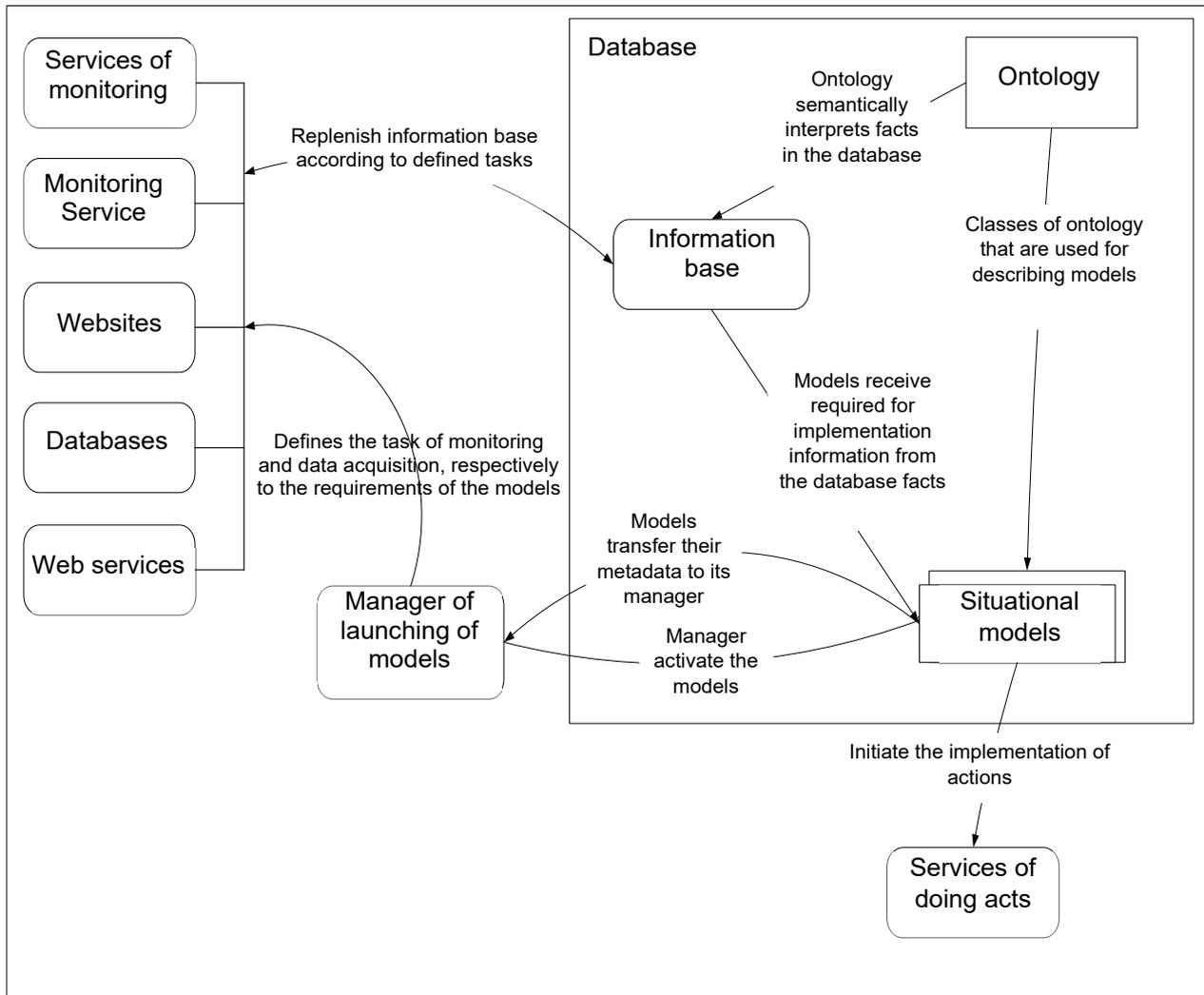


Figure 1 Components of the modelling system.

In the approach, the definition of groups of nouns is through the selection of the basic noun and the consistent refinement of its meaning by adding descriptive nouns and adjectives to the selected noun group. The noun belongs to the concept of ontology through the spelling of the word after its normalization. Clarification of the meaning of a group of nouns is sequential, starting from the last noun of the group to the first, provided that the ontology corresponds to such a combination of words for the term under study. The following combinations of

nouns and adjectives in the noun group are considered in the ontology as subclasses of concepts that have already been recognized in the previous step in the noun phrase. This happens each time a new clarifying noun or adjective is added to it. If the ontology has the concept of a garden and the concept of an apple tree (tree and apples), then the system immediately adds to the ontology the concept of an apple orchard as a subclass of the class garden. The next step in the ontology will be the concept of apple orchard as a subclass of a class of garden

trees (Fig. 3). In determining the role of a term in semantic communication, the place of the corresponding group of nouns relative to the group of verbs in the sentence is important. It also depends on the type of

semantic link in this verbal group. If the noun group is preceded by a verb ending in "-ed + by", then the noun group is also the object of a semantic connection.

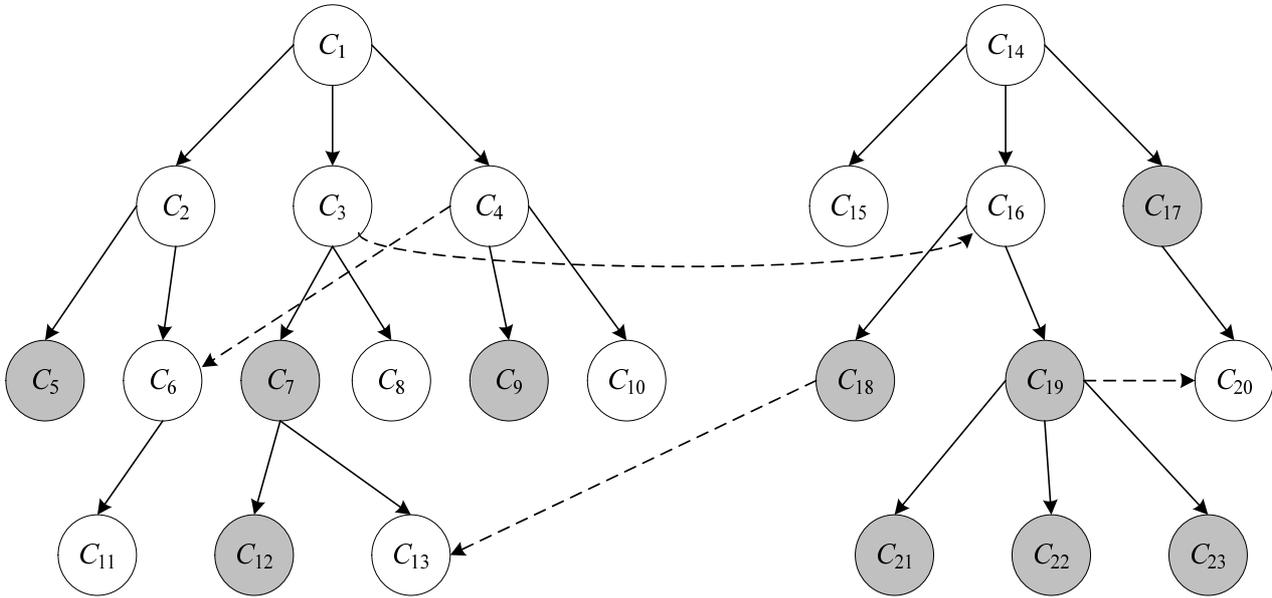


Figure 2 An example of an ontology graph.

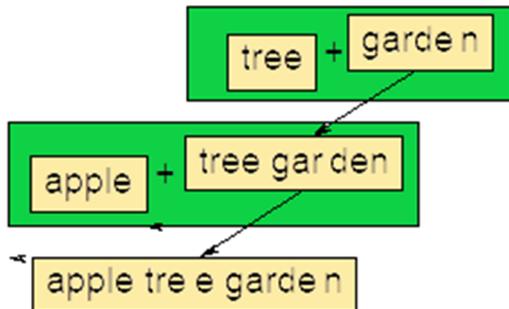


Figure 3 Clarification of terms by the components of the noun group.

To follow the logic of the description of first-order predicates in the formal recording of natural sentences should take into account the type of predicate. Predictive type recognition is helped by a group of verbs and service words in a sentence. This operation requires the use of machine learning techniques for recognition. The input of the system provides the results of parsing a natural sentence with a special syntactic-semantic parser. Such a parser breaks sentences into words related to some meta-semantic connection. A sentence parser consists of a set of triplets: the subject of communication, the object of communication, and the meta-semantic communication of a particular type. These triplets can be used as signs of the presence in a sentence of a semantic link, on the basis of which the predicate should be built as a logical formal representation of this sentence. The essence of the proposed algorithm can be stated as follows: We are looking for the first known verb (LSP gives the

appropriate markup) and the nearest noun before it. In English grammar, this noun is the subject of action. If it is a pronoun, then we look for the subject in the previous sentence according to a similar procedure. Next, we put the found sentence in place of the pronoun. An action is a semantic link or a kind of predicate. It can be not just one verb, but a whole verb group in a sentence. They should also be identified and recorded in the ontology by a single term, such as "is-a" or "is-a-part-of".

The scheme of the situational model consists of the body of the model *BodSit* and the metadata *MtdSit*.

$$ScMdsit=(BodSit, MtdSit). \tag{1}$$

The body of the model determines the logic of the model and the actions it performs.

$$BodSit=(SgSit, AcSit). \tag{2}$$

It consists of the *SgSit* model signature specifications and *AcSit* actions. The signature is a predicate given on the facts Fc_i from the information base *InBd*.

$$SgSit=P(M(Fc_i)|Fc_i \in InBd). \tag{3}$$

The information base is a time base and contains facts that have taken place in the past. We present the signature as a disjunctive normal form of individual statements-predicates Asr_i^j , given on the facts of the base.

$$SgSit=(Asr_1^1 \wedge Asr_2^1 \wedge \dots \wedge Asr_{m_1}^1) \vee \dots \vee (Asr_1^n \wedge Asr_2^n \wedge \dots \wedge Asr_{m_n}^n). \tag{4}$$

An action specification *AcSit* is a set of actions defined in an ontology of types.

$$AcSit=M(Ac_i)|Type(Ac_i) \in On. \tag{5}$$

Such actions can be, for example, loading a web page, or accessing a web service. The most common type of action is the execution of the algorithmic model $MdAlg$ given on the facts of the information base:

$$AcSit = MdAlg(M(Fc_i)) | Fc_i \in InBd. \quad (6)$$

The metadata of the $MtdSit$ model includes several sections, but the most important for the functioning of the situational model is the $ActCd$ activation conditions section, which is passed to the model launch manager for startup scheduling. The condition of activation is the disjunction of conjunctions of atomic predicates, which are true if a certain period has passed, or a certain event has occurred.

$$ActCd = (Cd_1^1 \wedge Cd_2^1 \wedge \dots \wedge Cd_{k1}^1) \vee \dots \vee (Cd_1^n \wedge Cd_2^n \wedge \dots \wedge Cd_{kn}^n). \quad (7)$$

where the atomic predicates Cd_j^i can be:

- The predicate $TimeIntCd(TimeInt)$ is true if a period of time $TimeInt$ has elapsed since the last activation.
- $P(M(Fc_i)) | Fc_i \in InBd$ is an arbitrary predicate given on the facts of the base.
- Reference to the model that is activated and returns a *Boolean* value. Thus, for example, you can set fixed in time moments of activation, or activation with a certain repeat mode.
- Predicates that are tied to certain types of facts-based events, including adding new facts or medications of certain types of facts.

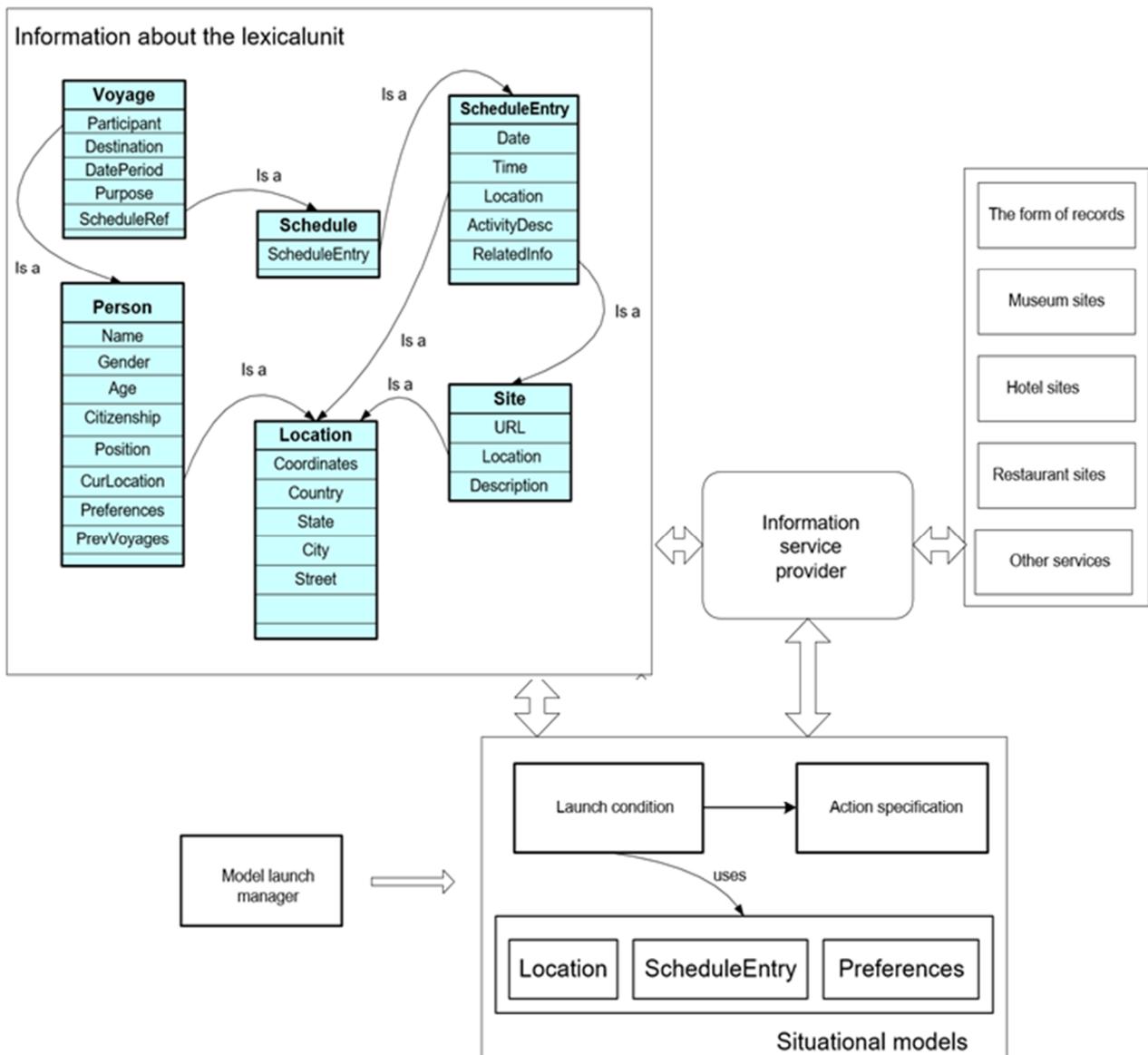


Figure 4 The scheme of obtaining contextual data models.

5. PROCESSING OF SITUATIONAL MODELS IN INTELLIGENT SERVICE

Let's consider in more detail processing of contextual data by tourist service taking into account a situation. As an example, we have developed a tourist information service that provides the necessary supporting information for the tourist depending on the context of the situation and the geographical location of the tourist. The ontology for the service is based on the ontology developed in DERI project (<http://etourism.deri.at/ont/e-tourism.owl>) and is modified by adding new entities and connections. A fragment of this ontology, which displays the contextual data used to solve problems, is shown in Fig. 4. The same figure shows the other structural components of the intelligent service.

The main components of the ontology, the context of which is used in the system are Tour (Voyage) and Tourist (Person). In fact, from the context of the tour they receive information about the participants of the tour, the schedule of the tour, the sights that are schedule to visit during the tour, and the addresses of the providers of information about them. From the context, individual's benefit are received and used in situational models to select information. In addition, a running placement of a person is also obtained from this context, which is also used in the models. The model launch manager activates the models periodically according to the set activation modes. Activated models check for the conditions specified in the models. Such conditions, for example, include checking the correspondence of the running time and the time of the schedule event in the tour, checking the coincidence of the running location of the tourist with the specified location of the object visited in the tour, and others. If necessary, situational models receive additional information from the context of the person of the tourist or tour and use it to make a decision. If the situational model detects the presence of the operating conditions defined in it, then the algorithmic model is activated, which specifies the sequence of actions for performing. In the case of the tourist service, we considered the class of actions, which consisted in providing the tourist with additional information, the task of filling the information for the page of relevant tourist information. In the course of its work, the intelligent service uses the services of external services, which provide information about the location of the tourist, information from the sites of objects visited by the tourist and so on.

6. REPRESENTATION OF THE SITUATIONAL MODEL IN XML

Situational models are created in the Model Editor tool and saved in XML format. Let us consider an example of presenting a situational model for a designed travel service. We consider a simple model that reveals the situation by coincidence of two conditions - the

presence of a tourist near the schedule to visit the object and the presence of visiting this object in terms of the tour at present (Fig. 5). Metadata sections and model bodies are available in the model description. In the metadata section, for simplicity, there are only two subsections - general data and activation mode.

```

<Model>
<ModelMetadata>
<GeneralInfo>
<ModelId> id </ModelId>
<ModelType> SituationalModel </ModelType>
<OntologyURI> www.acme.org/TourismOntology
</OntologyURI>
<InfoBaseURI> www.acme.org/InformationBase
</InfoBaseURI>
<ModelRepositoryURI> www.acme.org/ModelRepository
</ModelRepositoryURI>
</GeneralInfo>
<ActivationInfo>
<Condition>
<ConditionId> cd1 </ConditionId>
<ConditionBd>
CurrentDate () in InBase (Voyage.DatePeriod)
<ConditionBd>
</Condition>
<Condition>
<ConditionId> cd2 </ConditionId>
<ConditionBd> Every (5 min) <ConditionBd>
</Condition>
<Activate> (cd1) and (cd2) </Activate>
</ActivationInfo>
</ModelMetadata>
<Signature>

<Condition>
<ConditionId> sigcd1 </ConditionId>
<ConditionBd>
InBase (Some (Site) .Location) nearDistance
InBase (Person.CurLocation) <ConditionBd>
<Result> InBase (Site) </Result>
</Condition>
<Condition>
<ConditionId> sigcd2 </ConditionId>
<ConditionBd> CurrentTime () nearTime
InBase (Some (Voyage.Schedule.ScheduleEntry.Time))
<ConditionBd>
<Result> InBase (Voyage.Schedule.ScheduleEntry)
</Result></Condition>
<Condition>
<ConditionId> sigcd3 </ConditionId>
<ConditionBd> Result (sigcd1, InBase (Location))
nearDistance
Result (sigcd2, InBase (Location))
<Result></Result>
</Condition>
<Execute> (sigcd1) and (sigcd2) and (sigcd3) </Execute>
<Signature>
<ActionSpecification>
<ActionType> LoadContentfromURL </ActionType>
<URL> Result (sigcd1, URL) </URL>
</ActionSpecification>
</Model>

```

Figure 5 Situational model in XML.

The general data section indicates the model identifier, its type, and links to the ontology, the model repository and the database of facts used. The activation

mode subsection specifies two activation conditions – the model is activated only during the tour and every five minutes.

Suggestor

<p>Want to Jazz[x] Coffee[x]</p> <p>Location Antico Forno Roscioli Via dei Chiavari Roma Italy</p>  <p>Schedule Today: 16:00 - meeting 20:00 - excursion Tomorrow: a trip to the Natural History Museum</p>	<p>Antico Forno Roscioli More info...</p>  <p>Via dei Chiavari, 34, 00186 Roma RM Italy +39066864045 http://www.anticofornoroscioli.it/</p>	<p>Route By car By public transport On foot</p>  <p>Distance: 2.4 km Time: 9 min</p>	<p>Taverna Bavarese Franz Meeting at 16:00</p>  <p>Via di Porta Castello, 23/24, 00193 Roma Italy +39066873921 http://www.tavernafrazz.it/</p>
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Figure 6 Service “Travel to Rome”. Reference information in the context of the situation.

Suggestor

<p>Want to Jazz[x] Coffee[x]</p> <p>Location Antico Forno Roscioli Via dei Chiavari Roma Italy</p>  <p>Schedule Today: 20:00 - excursion Tomorrow: a trip to the Natural History Museum</p>	<p>Antico Forno Roscioli</p>  <p>Via dei Chiavari, 34, 00186 Roma RM Italy +39066864045 http://www.anticofornoroscioli.it/</p> <p>Monday, 11:30AM–2AM Tuesday, 11:30AM–2AM Wednesday, 11:30AM–2AM Thursday, 11:30AM–2AM Friday, 11:30AM–2AM Saturday, 11:30AM–2AM Sunday, Closed</p>
---	---

Figure 7 Service “Travel to Rome”. Detailing of reference information.

Suggestor

Want to
Jazz[x]
Coffee[x]

Location
Antico Forno Roscioli
Via dei Chiavari
Roma
Italy



Schedule
Today:
20:00 - excursion
Tomorrow: a trip to the Natural History Museum

Antico Forno Roscioli



Via dei Chiavari, 34, 00186 Roma RM
Italy +39066864045
<http://www.anticofornoroscioli.it/>

Monday, 11:30AM–2AM
Tuesday, 11:30AM–2AM
Wednesday, 11:30AM–2AM
Thursday, 11:30AM–2AM
Friday, 11:30AM–2AM
Saturday, 11:30AM–2AM
Sunday, Closed

New task

16:00
Taverna Bavarese Franz



Figure 8 Service “Travel to Rome”. Scheduling a new task.

The body of the model has subsections of the signature of operation and the specification of actions. There are three conditions in the signature subsection. The first condition determines the fact that the tourist is near one of the objects that are schedule to visit. The condition uses the predicate *NearDistance*, which takes the value true if the two placements coincide within a given error. If a condition is met for an object, then its placement is remembered because of the condition check. The second condition checks whether a visit to a certain object is actually schedule for the current time. This uses the predicate *NearTime*, which takes the value true if the two times coincide within a given error. If such a visit is scheduled, its ID is also stored because of the condition check. Finally, the third condition combines the results obtained in the two previous conditions and checks whether it is really currently schedule to visit the object near which the tourist is. The action specification section specifies the type of action – retrieving content according to a specific URL and linking to this URL.

7. THE USE OF SITUATIONAL MODELS IN THE INTELLIGENT TOURIST INFORMATION SUPPORT SERVICE

As an example for the implementation and practical testing of the process of using situational models, a model of the tourist service “Journey to Rome” was created (Fig. 6-8). The travel service fills the page with information that is determined depending on the location and schedules of the tourist. You can always get more detailed content about the object, which is schedule to visit, including reviews of other visitors and weather forecast. The service supports the entry of new items on the daily schedule, and in case if nothing is currently schedule, it offers to visit interesting objects, located nearby.

8. CONCLUSION

The proposed approach of modeling and identification of the current situation is illustrated by the example of e-tourism, is advisable to expand and apply in other areas. The implementation of this approach will create intelligent systems and services that respond quickly to changes in the environment.

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