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API mashups: How well do they support the travellers' information needs?

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Abstract

This paper investigates the adequacy of API mashups for supporting the information requirements of travelers, prior, during and after the journey. We analyse the information requirements of travelers at the various stages of a multimodal journey, and perform a gap analysis against the actual information supplied by travel APIs. We base the approach on the analysis of three publicly available travel related APIs. Finally, we propose how semantically annotating APIs can support intelligent travel assistants that address the information requirements of travelers.

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Keywords: API, API composition (mashup), cognitive travel process, semantic annotation, travel API

1. Introduction

Travelling is an activity that has greatly transformed by the Internet and the digitisation of the travel industry. Travel information search and travel planning on the Internet however, is a complex, dynamic and information intensive process[1]. Application programming interfaces (APIs) have been proposed as a solution towards streamlining and aggregating the online travel information. Information about flight timetables, hotel, room availability, price, etc., is provided via APIs by suppliers (the hotels, airlines, car rental companies) or third parties such as General Distribution Systems (GDS) and Online Travel Agents (OTAs).

However, there is a diversity of such APIs, leading to a confusing consumer experience, as different pieces of relevant information are scattered around the Web on different sites. It has been reported that travellers are visiting

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as many as 38 sites before making a decision. Through the technique of API mashups[2] this problem has been alleviated to some extent, as now users can access multiple APIs from a single location (i.e. Web page), organised and linked together in a way that aligns with the context of the user's travel process.

Nevertheless, we argue that in their current state, travel related APIs and mashups still do not meet the information needs of travellers, in particular for complex, intermodal journeys. Reis et al[3] argue that there are three types of friction between travel modes that hamper intermodality:
--friction due to inefficiencies during transport, including the transfer between transport modes such as: delay in one segment resulting in losing the next one, lost baggage, etc.
--friction that prevents the detection and recovery of a problem, for example: the impossibility of a fast transfer connection for delayed passengers
--friction that prevents the customers to be compensated for any problems that occurred during the transport service, caused for example, by lack of agreement between the involved transport providers about the assignment of liability.

We argue that well designed travel APIs that address the above issues would allow a better travel planning and booking experience. That, in turn, will benefit all industry participants, such as suppliers, agents, and aggregators due to access to more accurate information and complete data flows.

The rest of the paper is structured as follows. In the next section, we first discuss information requirements of travellers during the different phases of the travel process. Then, we survey and classify travel related APIs. In Section 3, we perform a systematic classification of traveller information needs and then map them against the information of three popular APIs for flights, rail, and bus transit. In Section 4, we propose how the semantic annotation of existing APIs using travel ontologies, could make them more useful in supporting the traveller information requirements. We conclude the paper with a proposal as to how the proposed enhancement of travel APIs can lead to a new generation of more useful travel planner and assistant tools.

2. Travel process information needs and travel APIs

2. 1 Traveller information needs

Travel is a dynamic process in which the user has to carry out different information driven tasks. The travel process sequence consists of three time-based contexts: *pre-trip*[4] (prior to the beginning of the trip), *on-trip*[4] (during the trip), and *post trip* (Figure 1).

Travel information can be provided to individuals both pre-trip and en-route. It can be either public, or personal (customised) and *descriptive* or *prescriptive*[5]. *Descriptive* information gives more and updated information about the state of the network, e.g. real travel time of a particular route. *Prescriptive* information on the other hand, does not give quantitative information and may introduce new choice alternatives to the individual.

Information needs of travellers vary, depending on which stage of the trip they are in. During the trip, real time information is needed. This information concerns vehicle schedule (arrival, departure, delays), waiting time, connection between vehicles, travel time, etc. Also, information about network disruptions like traffic jams or roadworks is required. Such real time, information must be provided to the traveller at strategic points of the trip where the user has an alternative between two or more routes[4].

Thus, APIs need to support not only the planning stage but also the travel performance phase. Typically, single APIs do not cater for all these types of information. For example, location information sufficient to calculate transit/connection times might not be provided by the main travel information API and needs to be obtained using third party APIs.

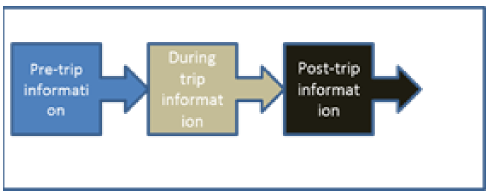

Fig. 1: Steps of the travel process.

Multimodal trips place a higher demand on the traveller's cognitive functions[6] and thus have more demanding information requirements. In a multimodal journey, connections, i.e. points where the mode of traffic changes, can be a source of stress for the traveller. In order to decrease this stress, travellers need to obtain precise information, such as stops name, terminus name, number of stops, estimated time for the route, estimated time for the connection, and so on. Tables 1 to 3 summarise the key information requirements of travellers for the three journey phases.

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Table 1. traveler information requirements (Pre-trip)

Info.Requirement id	Travel Information need
PT1	Information about each network (e.g.: pricing data, time data and location).
PT2	Information about connection between networks (e.g.: time and area).
PT3	Connection between vehicles (e.g.: time and area).
PT4	Cost (tariff zones, reductions/discounts, payment methods, ticket validity, methods to buy ticket).
PT5	Special travel requirements (e.g. travel with baby carriage / bike / dog) and accessibility requirements (e.g. elevators for disabled, low platform buses, etc,).

Table2 . traveler information requirements (On-trip)

Info. Requirement id	Travel Information need
DT1	Wayfinding (locating the station or stop; locate oneself on the station or airport level and platform).
DT2	Real time network service updates (remaining length of the journey, stops left, stop to get off, disembarking platform or gate)
DT3	Network service exceptions (disruptions: traffic jam, roadwork, strike, demonstration, etc.); delays in service, cancelled stops, revised timetables, revised boarding on or off locations (e.g. airport gates or rail station platform).
DT4	Real time updates for connections or transfers (e.g. because of delays or alterations in previous legs of journey).

Table 3. classification of traveler information requirements (Post-trip)

Info. requirement id	Travel Information need
PT1	Obtain information about compensation due to delays, cancellations etc.
PT2	Obtain information about lost or delayed luggage
PT3	Provide feedback, recommendations etc to the service providers and/or other travellers

2. 2Travel APIs

For our research, we used the Programmable Web (http://www.programmableweb.com) that claims to be the world's largest repository (registry) for APIs, containing in excess of 14,000 API entries as of 2015. To retrieve travel related APIs the category 'travel' was used to retrieve relevant APIs from the Programmable Web repository. The number of results (in excess of 300) indicates the proliferation of travel related APIs.

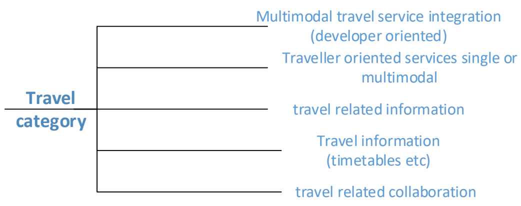

Fig. 2. classification of travel related APIs

As shown in Figure 2, travel APIs fall into the following categories:

- APIs oriented towards developers that want to integrated/aggregate existing travel services (e.g. for travel aggregators to create portals and mashups). These also cover multiple travel modes (sea, land, air) and facilities (e.g. car and hotel hire). Some of these APIs have transactional capability (e.g. create bookings).
- APIs oriented towards one type of service/travel mode (e.g. air travel) and/or one provider (e.g. one particular airline only). These APIs also may have transactional capability.
- APIs that provide travel related but static information (e.g. about locations such as places to visit or airports) but they do not (normally) support itinerary planning as timetabling and dynamic travel information is not included
- APIs that provide timetable information such as bus or flight arrival information, flight tracking, for single or multi-mode, often with real time status updates.
- APIs that allow the sharing of information or resources between travellers, such as recommendations about visiting places, travel routes and trails etc.

3. API Travel Information support gap analysis

From the set of APIs discussed in section 2, we selected three representative ones that cover main travel modes and trip phases. We did not find APIs catering for the post travel service, hence this area is not considered in the following section. The following APIs were selected for evaluation and information gap analysis:

- U.K.'s National Rail Enquiries API that includes also the (NRE) Darwin database which analyses raw data from numerous rail industry sources to predict the arrival times of trains.
- Google's transit APIs (GTFS and GTFS real time)
- Flighstat's (flightstat.com) Alerts API.

Tables 5,6 and 7 map functions of the above APIs to information requirements identified in the previous section.

Table 5. UK Rail API (pre and during trip support)

API function	Reference to Info Requirement
Timetable & Schedule Feeds	PT1, PT2, PT3
Fares Feed	PT4
(through Darwin Push Port:)	
Schedule data	PT2
Association data	PT2
Actual and Forecast data	PT2
Station Messages	PT 5

Train Alerts	PT 5

Table 6. Google Transit (pre and during trip support)

API function	Info Requirement Ref
Arrival stop and departure stop information	PT1
coordinates of the transit station/stop	PT1
arrival time and departure time for a leg of the journey	PT1
headsign (the direction in which to travel on a line)	DT1
headway (the expected time between departures from a stop)	DT1
the number of stops in this journey leg,	DT1

Table 7. Flight Stat Alert API (during trip support)

API function	Info Requirement Ref
Flight status codes (i.e. Scheduled, Active, Unknown, cancelled Redirected)	DT3
Arrival Gate, Departure Gate	DT3, DT4
Arrival Delay, Departure Delay	DT1
Baggage Pickup Location	

4 Semantic annotation of APIs

Towards enhancing the utility of APIs in delivering travel information in mashups, we have created an API annotation engine that uses the semantic descriptions of established open Ontologies such as WordNet (http://wordnet.princeton.edu) and ConceptNet (http://conceptnet5.media.mit.edu/). The annotation engine parses API descriptions in XSD, JSON, and other hierarchical formats, and subsequently uses the linguistic constructs (nouns, verbs etc.), that describe API data and operations), to map them to concepts of the ontology hierarchy.

This method has been implemented as a semi-automatic data mapping engine. We have created a unified graph data model for travel that holds travel related concepts from different ontologies. Namespaces have been defined for different ontologies. This way, APIs can be annotated in a consistent and uniform way. Each API data item or operation are annotated with the ontology concept that most closely describes it (i.e. the one located at the lowest possible level of the hierarchy). Ambiguities such as multiple inconsistent mappings and non-mappings are flagged and assigned for resolution to a human API expert.

```
<Route
    xmlns:cn=" http://conceptnet5.media.mit.edu/">
    xmlns:eu=" http://eutravelproject.eu/unifiedtravelmodel/">
    <Supplier>airberlin</Supplier>
        <cn:flight flightnumber=AB349>
            <eu:Origin>
                <cn:airport>
                    <Code>STN</Code>
                </cn:airport>
            </eu:Origin>
```

```
                        <eu:Destination>
                                <cn:airport>
                                        <Code>MAD</Code>
                                </cn:airport >
                        </eu:Destination>
                </cn:flight>

</Route>
```

Fig. 3: Example annotation of a flight route

Figure 3 shows an example of annotating an API that returns information about a flight itinerary. The annotations are shown in bold, while the rest of the description is the original output of the API call. It can be noticed that multiple ontologies/schemas can be used for the annotation. In the above example, the use of the 'cn' namespace indicates that the concept is borrowed from the ConceptNet ontology, while 'eu' indicates the universal travel model we have created. It is expected that intelligent travel assistants can process these annotations and use it to guide the user at the appropriate stages of the journey.

5 Discussion and conclusions

Our survey of travel APIs indicates that such APIs provide mainly descriptive information. This needs to be converted to prescriptive information (guidance, advice) by tools such as travel and route planners that implement a "door-to-door" routing logic and accompany the travellers during their trips.

Light weight service compositions, also known as mashups, are popular ways of creating new composite services. Intelligent travel planners compose (mashup) APIs in order to combine information from different travel services and to determine suitable travel plans. For dynamic plans that take into account real time service status, it is important to connect to service updates via appropriate APIs. Thus, a route planner or travel assistant needs to know the name, location and usage characteristics of such APIs. This will require semantic information about the API's capabilities. A *smart* mashup is a mashup with enough flexibility to provide the end user with a choice for certain services. Several approaches to smart mashups based on annotations have been proposed[7,8.] As proposed in this paper, annotation based on a single ontology schema will probably not be sufficient to meet all information requirements identified in this paper.

The paper therefore argues that a combination of travel ontologies, each addressing a different facet or phase of the travel process, is required. Our approach to create a Common Information Model for travel is ongoing. We hope that its outcome will be a uniform approach for annotating the plethora of travel APIs that are currently in existence.

In summary, the contribution made by this paper is to identify the current gaps in information provision by travel related APIs, propose a semantic API annotation approach, and define directions for future research towards bridging such gaps.

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References

1 Jeng, Jiann-Min Exploring the Travel Planning Hierarchy: An Interactive Web Experiment. PhD Thesis University of Illinois at Urbana Champaign. http://hdl.handle.net/2142/86039

2 Caragea, Doina Tanveer Syeda-Mahmood. Semantic API Matching for Automatic Service Composition. Proceeding WWW Alt. '04 Proceedings of the 13th international World Wide Web conference on Alternate track papers & posters.

3 Reis, V., et al., Rail and multi-modal transport. Research in Transportation Economics (2012), http://dx.doi.org/10.1016/j.retrec.2012.10.005

4 Infopolis Consortium Needs of Travellers an Analysis Based on the Study of their Tasks and Activities Infopolis2 Deliverable 3 DEL/ULB/Del.3/V1.0/09-07-99

5 Parvaneh, Zahra , Theo Arentze, Harry Timmermans. Travelers' Behavior in Provision of Travel Information: A Bayesian Belief Approach EWGT 2012, 15th meeting of the EURO Working Group on Transportation.

6 Csiszar Csaba Dávid Földes Advanced Information Services for Cognitive Behaviour of Travellers Conference Paper · October 2015 DOI: 10.1109/CogInfoCom.2015.7390578

7 Gomadam, Karthik Ajith Ranabahu, Amit Sheth, (SA-REST: Semantic Annotation of Web Resources Member Submission 05 April 2010 http://www.w3.org/Submission/2010/SUBM-SA-REST-20100405/

8 Lee Yong-Ju. Semantic-Based Data Mashups Using Hierarchical Clustering and Pattern Analysis Methods, JOURNAL OF INFORMATION SCIENCE AND ENGINEERING 30, 1601-1618 (2014)

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