

The Navigation of Multi-itineraries for the Cultural Heritage Context

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Abstract. Itinerary planning is a challenging knowledge acquisition activity. An itinerary is an ordered list of points of interest (POIs) obtained after the analysis of several dimensions (e.g., current context, user preferences, etc.) that are jointly considered for a context-aware recommendation of customized paths. When the system returns many itineraries, it is difficult for a user to understand which of them is optimal. This is particularly true if they are returned by a single query, they present large overlaps, and the points of interest are new to the user.

This paper presents the *SearchPath* service which is a vertical application dedicated to the retrieval of indexed itineraries according to the geographic context and user's interests. The innovation underlying this service is the navigation of multi-itineraries where a path is considered according to several conceptual interconnected views. Moreover, a collection of cards for additional knowledge and multimedia information can be expanded for each of the POI. The *SearchPath* service has been integrated in the Pollicina project where cultural heritage itineraries have been defined by users during their learning activities.

Keywords: Cultural itineraries · Navigation maps · Metro map

1 Introduction

Nowadays the number of services dedicated to the promotion of tourism is growing. There is, in fact, an increasing demand for web-market applications which could help the users to plan their own personalized itineraries. The result of a query of one of these travel applications is often a collection of itineraries. Deciding which of them is more interesting is not a simple task, especially when the knowledge of the points of interest (POIs) is limited. Indeed, the definition of an itinerary should take into account several user preferences such as: available time, topics of interest, means of transport, etc.

An itinerary is in fact defined as a set of POIs linked with each other typically according to the geographical coordinates encoded as latitude/longitude

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pairs. In the literature, several works [1–3,6–10] address the task of identifying the optimal path from a pool of POIs, according to different features (the nearest POIs to the user, the means of transportation, the time available for the visit, etc.). In our case, the itineraries are built with a social suite called Educational Social Network (EduSN) defined in the Pollicina Project (POR FESR 2014–2020) [4,5]. The main goal of this project is to provide a collaborative tool which allows the students to create cultural paths connecting artworks belonging to different cultural institutions distributed in the territory following a theme provided by the teacher. This paper presents the *SearchPath* service, a vertical application dedicated to the retrieval of the relevant itineraries stored in the Pollicina's repository. A query defines the context which is used by the search engine to return the relevant itineraries by exploiting the BM25 similarity function. The result of a query is a set of cards of the itineraries with snippets including: title, a list of concepts, a list of cultural entities, etc. When a user selects a group of itineraries of interest from the results, it can be difficult to establish the relevant differences among the paths, especially in case when there are many overlapping POIs. The related problematic of the visualization of multi-itineraries is addressed with the help of different conceptual views in the form of metro maps. Each *view* captures a different knowledge aspect for the itinerary, according to a specific topic. Since the views are in the form of (partially) overlapping metro lines a user can immediately grasp the relevant conceptual differences among the itineraries. In this early phase of our work we focused on the user experience. At variance in respect to [7,9,10], the faceted search, the query results, and the itinerary preview are all shown in the same page, in order to facilitate query insertion and path selection. The *SearchPath* service is the only tourist application that supports a multi-path preview that enables the users to easily compare and select different paths. Other works present multi-path visualization services [1,2] but the paths cannot be selected incrementally by the user. The *SearchPath* service has also an educational aspect, since its collaborative topological view of the paths can be used to create conceptual maps showing links between topics. This helps to visually connect multiple information and topics. Such a tool is very useful within the flipped learning paradigm where the students collaborate for the construction of the itinerary among cultural objects by sharing ideas, material, and feedback under the supervision of a coach (the teacher). These itineraries are stored in the platform and they are available for all the scholastic institutions involved in the Pollicina project.

The *SearchPath* service is used by students and teachers to plan their cultural visits within Regione Lombardia (Italy) as the Pollicina project has been developed under the Regional Operational Program. The idea is to include cultural materials from the ICCD repository (http://www.iccd.beniculturali.it/) in order to define itineraries having POIs in the Italian territory, and later to externalize and personalize the use of the *SearchPath* service for tourism companies.

This paper is organized as follows. Section 2 presents the *SearchPath* service dedicated to the retrieval and navigation of multi-itineraries, Sect. 3 proposes a

use case of the *SearchPath* service in the Pollicina project. Finally, in Sect. 4 the conclusions are stated.

2 The *SearchPath* Service

This section introduces the *SearchPath* service designed to support the users during their activity of searching cultural paths. As described in Sect. 1, it is possible to find in the literature several algorithms which establish optimal paths, according to multi-featured distances within a set of POIs. In our research instead, we focus on the management of sets of pre-made itineraries (see Sect. 3). The *SearchPath* service is a vertical application comprising offline and online phases. The offline phase is used for indexing the itineraries according to the standard approach presented in the information retrieval research context, whereas the online one is dedicated to the search, selection, and navigation of multi-itineraries. This means that, given a query, the vertical search engine is able to retrieve a set of relevant itineraries based on the BM25 similarity. The intuitive environment presented in this paper allows the users to access to several views of the selected itineraries by the adoption of an innovative mode of knowledge navigation. We present here an overview of the online phase:

Search: The user can express the information needs in a query facet form which contains three kinds of features that explicitly represent the request: (1) the identification of a specific POI (a user can directly write the name of the cultural institute of interest), (2) the address of interest, and (3) the concepts of interest. For sake of usability, the features (1) and (2) are collapsed in a unique field named *place* within the query facet form. If one inserts the name of the POI, this attribute is searched into its corresponding address via Google Places API. A user is supported during the insertion of the query with the adoption of a query suggestion methodology developed according to the vocabulary of the indexed itineraries. A query q is defined as $q := p \cup C$, where p is the *place* and $C = \{c_1, c_2, ..., c_n\}$ is the set containing all the concepts inserted by the user.

Selection: The result of the query is a ordered collection of itineraries, and the user can select one or more of them. Each itinerary is represented as a card with the following attributes: a title, a list of POIs with related preview images, and a list of concepts.

Navigation: there are two visualization modes for the selected itineraries:

1. *The Geographic Mode* is the default view of the service where the selected itineraries appear in the geographic map. Since a multi-itinerary selection is allowed, it is important to provide a clear visualization system in the map. For each itinerary, the service takes the latitude/longitude pairs of all POIs and sorts them at first by latitude and then by longitude. Finally, each pair of adjacent coordinates is connected by a unique edge. The color of each itinerary is generated with a pseudo-random procedure. A user can display the paths according to the selected means of transport: the order of the POIs

is fixed, but the trajectory between adjacent POIs can change according to the mean of transport (the default selection is "walking mode"). The user is geo-localized in order to facilitate the choice of the means of transport.

2. *The Topological Mode* returns a conceptual multi-view in the form of metro maps. A metro map is a form of visualization where collections of objects are arranged as lines where the order of the stops follows specific features of the objects. This visualization method is used to better understand information in many areas, including news, stories, research, legal cases and literature, because it summarizes different connections between the objects [11]. We implemented two possible topological itineraries, one based on the authors and the other on the cultural objects. The lines are identified with the same color used in the *Geographic Mode*. The stops (stations) are arranged in chronological order, following the birth date (for the author view) or the creation date (for the cultural object view). In addition, a list of cards is visualized when a user selects a stop. The cards correspond to all of the authors (or objects) of the itinerary associated with the specific station. The cards contain knowledge in the form of textual descriptions, multimedia content, technical information regarding the object, etc.

3 The Use Case: The Pollicina Project

Pollicina is a cultural navigator developed under the Regional Operational Program of the European Fund for Regional Development 2014–2020 (POR FESR 2014–2020) of the Regione Lombardia in Italy. The core idea of the project is to provide tools for creating customized cultural paths among different cultural institutions. Visits to cultural institutions are very popular, but they are usually confined within the institutions themselves, or their close surroundings. A person, however, might be interested in following specific ideas and interests which go beyond the collections of a single institution. Pollicina is an initial answer to these needs since it allows a user to browse through collections belonging to many sources and to produce trans-institutional cultural paths. Pollicina's most natural target includes scholastic institutions ranging from primary to high school. The classes are in fact one of the main sources of visitors for cultural institutions, and the problem of integrating specific study lines with the collections of the museums needed to be addressed. This project follows the Flipped Learning pedagogical approach. The idea is that a teacher should not impart information with a top-bottom approach, but rather provide the students with sufficient information and let them build collaboratively their own solutions. Within Pollicina, a coach (the teacher) defines a generic theme (for example, waterways in Lombardy) and associates more specific sub-themes for better filtering the research, providing a basic conceptual map. At the beginning the students enrich the conceptual map with their own ideas. Later, with the help of a search engine they are able to retrieve the cards related to the objects linked with the concepts. A user friendly interface allows them to drag and drop the cards on a table and complete the conceptual map. This phase is done collaboratively by the students,

with an integrated peer-review process meant to define a minimum standard for the quality of the choices. A further collaborative step includes a pruning of the conceptual map, where the students decide the more relevant objects. At this point one can publish the cultural itinerary in order to use it as a guideline for a real visit of the objects, beyond the single institution. In large collaborative environments like schools it is possible to produce many cultural paths, even related to the same main theme. Once the repository starts to contain many of these paths, it becomes necessary to produce a navigator helping to understand the similarities and differences among them. In particular, such a system should provide quick and intuitive views of the structures of each path. This is at the basis of the present research where we introduce a service dedicated to the search, navigation and visualization for collections of paths.

3.1 The *SearchPath* Service for the Cultural Heritage Context

The *SearchPath* service has been developed according to the microservice architecture where the development of a single application is seen as a set of small services, each of which is run by its own process and it communicates via http API, allowing for a simple and agile integration with the Pollicina platform. The *SearchPath* user interface is a ReactJS hybrid app, that contains a navigation service based on the Google Maps APIs and a metro map interactive visualization developed with D3.js, a JavaScript library for producing dynamic, interactive data visualizations. The service works cross-browsers and cross-devices. In the following, we contextualize with an example the usage of the *SearchPath* service within the Pollicina project according to the steps described in Sect. 2.

Phase 1 - Search: John Doe, an architect, is visiting Milan for the first time, and he decides to have a walk in the city downtown. For this reason, he accesses the *SearchPath* service in order to visit some POIs near him. At start, a locator returns his position on the map. He inserts "Gallerie d'Italia" in the *place* field of the query, since the concierge of his hotel recommended it to him. He also inserts "architecture" as a topic of interest in the *concepts* input field. Since he enjoys urban sightseeing, he selects *walking* as a travel mode, and he starts the query by clicking the magnifying glass icon.

Phase 2 - Selection: As soon as the platform updates the screen, the locator for "Gallerie d'Italia" appears on the geographic map. At the same time the itineraries that match the criteria appear under the map as summary cards. Each summary card of an itinerary contains information such as title, associated concepts, associated POIs, etc. It also contains a *Show Itinerary* button. John clicks on the button of the itinerary entitled "Fashion Houses of Milan". As a result, a magenta border highlights the summary card. The sorted POIs of the itinerary are displayed on the map and they are connected with a magenta line. At this point, John clicks on another itinerary button. A green border appears around the card and a green path is added to the geographic map (see Fig. 1).

Phase 3 - Navigation: At the top right corner of the geographic map, there is a toggle button allowing to pass from the geographic to the metro map

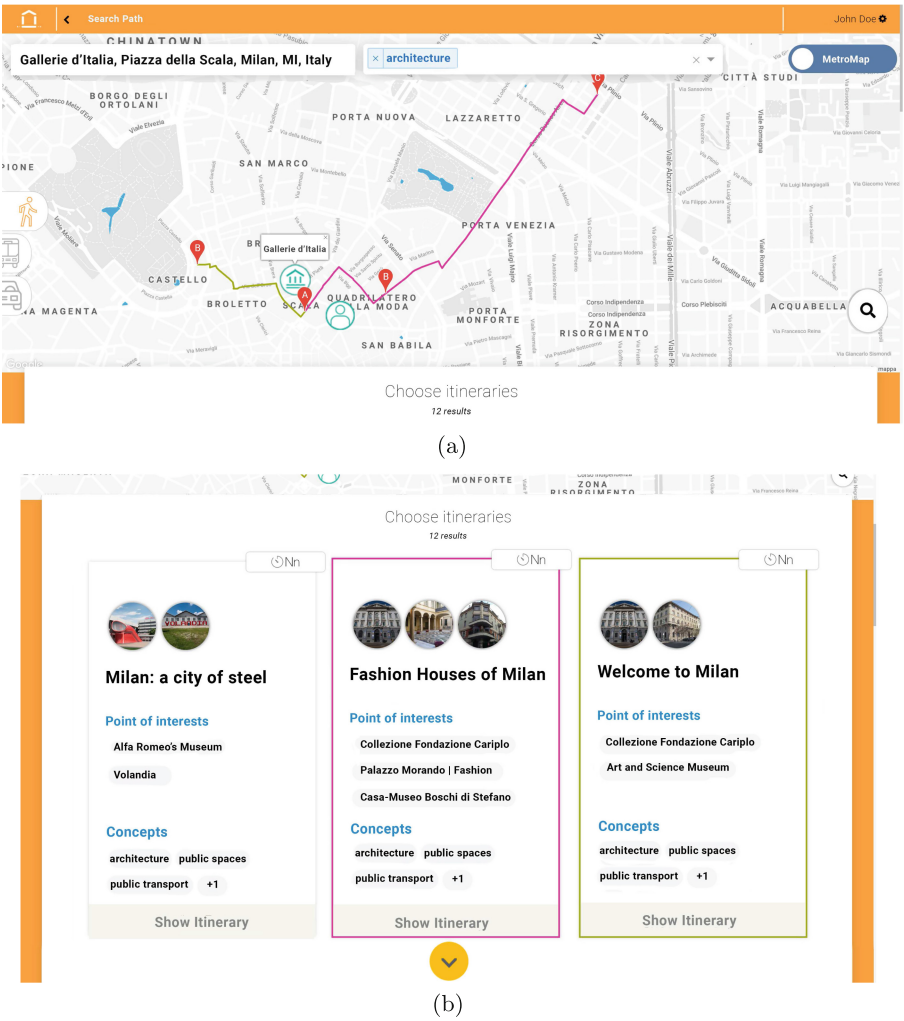


Fig. 1. (a) The query regarding "Gallerie d'Italia" (*place* field) and "architecture" (*concept* field). (b)Two of the returned itineraries have been selected and are shown on the *Geographic Mode*.

visualization. John clicks on it and the system shows the two selected itineraries as metro lines where the stations are the cultural objects sorted by the creation date. When a cultural object is present in two or more metro lines, that cultural object becomes an interchange station between the lines. The label of each station is composed by the title of the cultural object and the creation date year. If more cultural objects are associated with a single date, all of them are aggregated in a unique station/stop. In this case, the label indicates the number of objects (denoted with the term "badges"), and their creation date (Fig. 2).

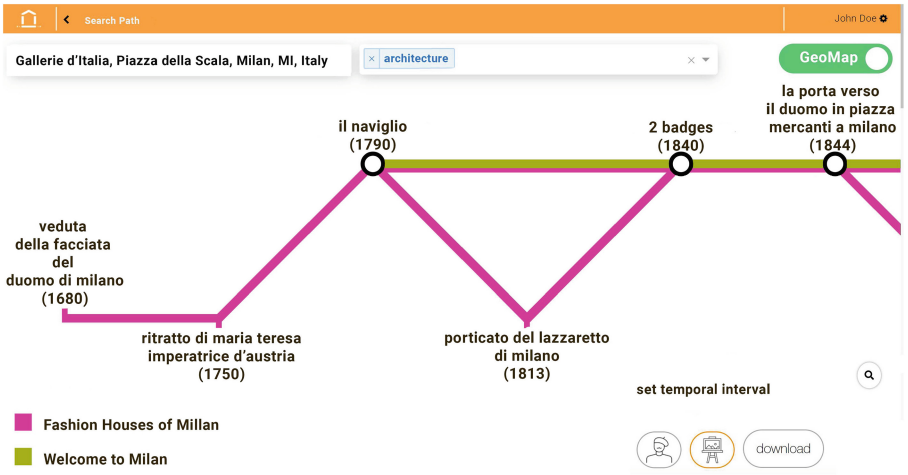


Fig. 2. Metro line visualization of two paths in the cultural object mode. Each stop represents the creation date of a cultural object of the itinerary. The station associated with 1840 contains two objects.

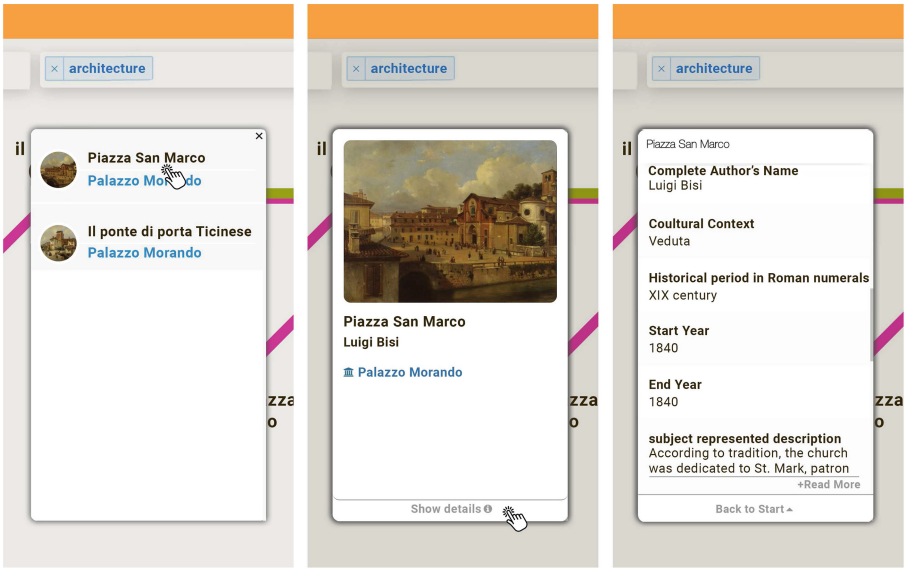


Fig. 3. (Left) The two possible badges related to the stop 1840 are shown in a modal. (Center) After clicking on "Piazza San Marco" one obtains a new modal with a summary of the card of the object. (Right) By expanding the card in the center, one can access to more detailed information regarding the selected badge.

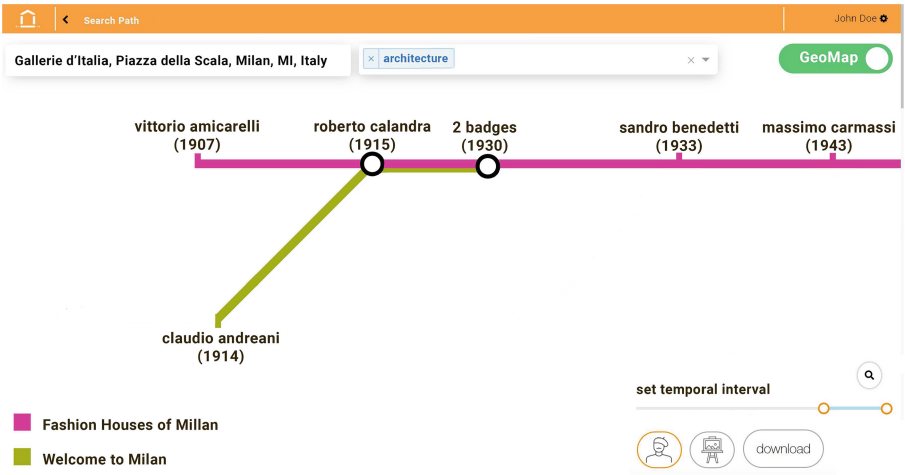


Fig. 4. The complementary metro map based on the author's birthdate.

John clicks on the interchange station among the lines corresponding to the year 1840. As a result, he obtains the two cultural badges of the stop. By clicking on one of them, John accesses to the knowledge of the cultural object: a painting named "Piazza San Marco" (Fig. 3). In addition, John has the possibility to switch to the metro visualization mode based on the authors or select an interval of time. With this second option, only those elements matching the time interval are used to form the metro map. He selects the author view and the time interval from 1900 to present since he is specialized on buildings of the 20th century. This new metro line mode (Fig. 4) shows that the itinerary "Fashion houses of Milan" is better suited to his interests.

4 Conclusions and Future Work

This paper presented the *SearchPath* service included in the Pollicina project. This service helps the users to navigate cultural heritage itineraries. At variance in respect with those articles devoted at finding an optimal path connecting POIs, we provide here a tool to search itineraries and to help the navigation when those itineraries are already existing. The problem at the time of choosing among multi-paths is exactly the fact that they share many features, and it is difficult for a user to understand which of them is more interesting. The *SearchPath* service provides two interacting systems for visualization: the *Geographic Mode*, and the *Topological Mode*. The *Geographic Mode* is the natural view showing the itineraries as routes among the POIs on the map; whereas the *Topological Mode* produces conceptual views in the form of metro maps, where the order of the POIs follows specific information. Having more views helps to disentangle the differences among the itineraries and supplements them with non trivial connections among POIs, like for example the periods of time.

As future works we are going to validate the *SearchPath* service following the guidelines of the User Centered Designed approach. We are also developing a hybrid recommender system according to the preferences of the users.

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