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A Social Platform to support Citizens Reuse of Open 3D Visualisations: a Citizen Science approach

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Abstract

There is a growing interest in the world of Open Data, with many initiatives in the Cultural Heritage field. Platforms like Europeana, archive.org, Open Heritage by Google are only few examples of on-line catalogues full of open artefacts published with various formats. It is a new and promising way to engage public, such as, students, citizens, non-profit organisations.
This paper faces the question of how to help audience in reusing Open 3D models and other artefacts available on Open Cultural Heritage repositories. The idea is to provide a Social Platform named SPOD where citizens can visualise artefacts, share and comment with others in a social way to increase understanding, awareness and engagement in cultural heritage. The foundation is the Datalet-Ecosystem Provider (DEEP), an open source, extensible, scalable, and Edge-centric visualisation architecture to support reuse of visualisations of Open Data in Cultural Heritage. It consists of reusable, dynamic and interactive visualizations named datalets. It includes a variety of visualisations, charts, geographical maps and 3D visualisations. Datalets can be generated and embedded in any web-page as well. SPOD exploits the DEEP architecture to support users within the platform in generating visualisations of Open artefacts, reuse and share them within discussions.

CCS Concepts

•Human-centered computing → Visualization systems and tools; •Information systems → Collaborative and social computing systems and tools;

1. Introduction

Among the areas in which it is possible to define the experience of enhancing Cultural Heritage (CH), new opportunities for social and economic development is offered by Open Data (OD) [Int17, Por18]. OD culture is widespread all over the world with a growing interest in the open data initiatives for CH. Open Data and Cultural Heritage can be linked in several ways. Just to give an example, actually a potential risk is that the heritage of tangible and intangible material, which include oral traditions, performing arts, social practices, rituals, festive events, knowledge and practices concerning nature and the universe or the knowledge and skills to produce traditional crafts [UNE18] is denied to new generations. The collection, digitalisation and visualisation of OD in CH is a way to fill this gap. In this context, the possibility to create and reuse visualisations of datatasets (e.g. charts), geographical maps, 3D models and other artefacts available on OD portals allows to increase also the value of data from the user's point of view. Today many projects provide repositories of OD for CH with a variety of content. Among them there are Europeana [Eur18], archive.org, Open Heritage [Goo18], Archivio di Stato in Italy [MiB18], and others. They can be used [KFH09, SCC*11] for cataloguing and documentation, historical studies, experimental architectural and urban history, and public outreach and education.

The objective of this paper is to address exactly the outreach point by allowing citizens to create visualisations of OD named datalets and share them within a Social Platform during discussions. The visualisation architecture is named DatalEt-Ecosystem Provider (DEEP) and is based on the Edge-centric Computing (EcC) paradigm [GLME*15]. It enables to gather (dynamic data), query and visualize data in classical HTML pages. The architecture supports a variety of visualisations, including several types of charts, geographical maps, media content for pictures, 3D models and audio. The most important design feature concerns data manipulation that is made on the client side, and not on the server side, as in other architectures. This ensures the scalability in terms of number of concurrent visualizations, and dependability of the data and provenance (because the data are dynamically loaded client side, without any server interactions). In our architecture we exploit the advantages of OD, that are typically available in machine readable format and are accessible through RESTful Web API, establishing an automated way to gather data.

The paper describes the DEEP visualisation architecture to create visualisations named datalets from CH data, sharing and reusing them in any web site. A relevant community of citizens named HETOR is presented as example of collaborative creation of OD in CH and their reuse through visualisations.

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2. Related Work

A "*visualization is worth then thousands of words*". They are used to convey information in a pleasant, understandable and intuitive way as well as they are a powerful tool to visually understand, get insight and interpret data. Instead to have tables, data can be represented though visualisations such as charts, maps, time lines and many others. "Data displayed in a chart rather than a table are easier to understand and trends or patterns are easier to identify" [Szo82]. Journalists use infographics and charts along with their articles to support argumentations. Economist's Graphic Detail (GD) is a blog where journalists publish articles with charts, maps and other visualizations. According to [HDMA15] these visualizations proved to engage users, indeed 42.2% of comments below the articles referenced to the content of visualization, data, and content. This study can be exploited in the CH field, sparking the idea to support users in creating their own alternative visualizations to support argumentations [Ack89]. Moreover, technologies for creating digital artefacts can help in preserving and restoring CH [SCC*11], that is another motivation in favour of OD culture [McD10, BJG10]. It is demonstrated that 3D models are useful for the study of artworks and as archive of knowledge [ACF*17, ACF*16]. According to Scopigno et al. [SCC*11] there is a wide market of didactic resources for electronic learning. In addition, we think that there is even wider market of citizens that can consume 3D models for personal use or even more, as we envision in this paper, as collaborative understanding. Typical usages of digital representations are [KFH09]: cataloguing and documentation, public outreach and education, historical studies, and experimental architectural and urban history. The publication and reuse of OD generate the so-called Public Value [Moo94, AH08, CHN10, JB07, Moo95a, RW09, SAT04, WH09, MOR09, Alf08] that is the creation of value through the collective deliberation by involving citizens, public agencies, and stakeholders [Moo95b].

There is a cost in re-using data, which is the effort that a user needs to make in order to use the data. The European Data Portal [Por16] mentions as a cost the effort needed to transform OD in a standard format (e.g. remove typos within the numerical values) that requires proper data skills. The low quality of datasets is one of the main barriers to the exploitation of OD. For this reason, it is important for Public Agencies to publish qualitative datasets in order to lower the such cost and engage citizens [DDFM*18].

This paper is based on the novel Distributed Computing paradigm named Edge-centric Computing (EcC) [GLME*15]. In computing, as in in many aspects of human activity, there has been a continuous struggle between the forces of centralization and decentralization. The EcC architecture is composed of a core and several edge devices. The core are small web servers and content distribution networks, while the edge devices consist of standard PCs or mobile devices. Unlike the Cloud Computing paradigm, in EcC the most of the computation is moved edge side. The core is responsible for a minimum part of the total computation and information sharing, while the edge devices actively contribute to their computation, without the interference of the core, ensuring data trustiness (data cannot be manipulate from the core), privacy (sensitive data are not shared with the core) and scalability (each edge provides computational capability).

3. DatalEt-Ecosystem Provider

The DatalEt-Ecosystem Provider (DEEP) is an open source, extensible and pluggable architecture providing visualizations of OD in a distributed web computing fashion.

3.1. Datalets as Visualisation components

Datalets are off-the-shelf, reusable, real-time, dynamic, and interactive visualisations that can can be embedded in any web page [MMP*16], for instance, a Wordpress blog. In the HETOR project, described along this paper, datalets are used for discussions and published along articles to engage readers. Of course, multiple different datalets can be embedded in the same web-page. The objective is to reuse existing visualisation libraries (i.e. Highcharts, Leaflet), providing the needed scaffolding to be used for OD (e.g. data retrieving, filtering, preparation, quality checking [PS18]) as an innovative transparent way to use them, reducing the cost. Datalets are *real-time*, they fetch data directly from the data source (e.g. OD portal) to ensure *data provenance*. All datalets show the link to the original dataset used to create the visualization. In this way, any user can determine whether information is trusted or not (e.g. whether data have been manipulated). The user can track back the data source to check who is the data creator and evaluate the authoritativeness of source as well. Below any datalet there is the link to the source, so any user can download and check data.

The catalogue[†] of datalets provides a variety of visualisations, among them there are charts, geographical maps, and other such as treemaps and heatmaps, plus the 3D model visualisation. If the dateset is related to artefacts or archaeological findings may be especially useful to have the ability to view the 3D object; so the user can manipulate virtually the object and can appreciate every aspect of it. The possibility of having such a degree of detail for this type of artifacts on a social open data platform can be useful not only to the experts of the domain, but also to anyone who wants to make known and enhance this type of cultural objects. To achieve this aim, HETOR through the visualization tools integrated in the SPOD platform allows to incorporate 3D models external resources on ckan or in general of some open data management system.

A datalet is reusable web widgets. DEEP exploits web components standard compliant with W3C specification. According to this standard, datalets are built by using Polymer [Pol18], a library developed by Google engineers that supports the major number of requirements as template, web components, material components, data binding, filters, events handling, touch and gestures, and AJAX/RESTful support. In terms of performance, datalets are executed directly by the clients when they load the web-page. It means that instead to generate any content on the server side, all the computation is performed by clients them self, including the fetch and filtering of datasets. The filtering is made on client side as well, by fetching the whole dataset and running in-memory filters. Datalets ensure the scalability in terms of visualizations. The computation is made client side, and does not experience bottlenecks due to overloading of the core. The core may provide other

[†] The catalogue of visualisations is available at `http://deep.routetopa.eu`.

services to the edges; for instance: reports, statistics, forecasting for certain data exploiting the Datalets usage.

3.2. DEEP architecture

A datalet takes in input: a dataset URL, a query to be performed on the data, and (optionally) a filter and/or some additional configuration parameters. Datalets have been designed to process any dataset as input. The Data Provider must have APIs to retrieve the dataset in a machine readable format (e.g. JSON, CSV). Actually datalets can fetch data from CKAN, OpenDataSoft, and Europeana.

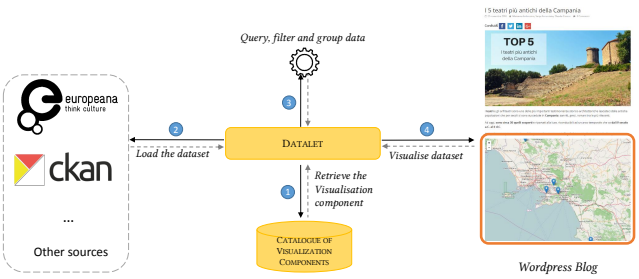

Figure 1: *Steps to visualise a dataset.*

Fig. 1 depicts the process that DEEP follows to execute a datalet embedded in a web page. The first step is to retrieve the source code (i.e. javascript files) that contains the logic of the datalet component. This file is retrieved from the DEEP datalet repository. The second step is to retrieve the dataset from its original source. Fig. 1 depicts Europeana repository, but any other can be integrated in the architecture. Fig. 3 shows a 3D model fetched from the Europeana data portal and visualised by a datalet. The choice to retrieve the dataset directly from the original third part data repository is a specific design choice that has its own advantages and disadvantages. Retrieving, querying and filtering are performed directly by the web client according to the EoC paradigm for scalability and data provenance. The disadvantage could be the non-availability of data source at some point or it could be slow, reducing the performance of the visualisation. In this case a caching module can be integrated in the architecture to use the cached dataset when the original source is not reachable. An explicit icon can be placed on the datalet to show that the dataset is the cached one. This is especially relevant for 3D model that can be very large in size. The third step is to query, filter and group data defined by the user during the creation of the datalet. The last step is the running of the interactive visualisation by giving the resulting data in input.

The datalet design follows Object-Oriented Paradigm. A datalet consist of four hierarchical layers: the Architectural layer provides common behaviours for all datalets; the Library layer includes all behaviours referred to a particular visualization library (e.g., Highcharts); the Visualization-depended layer encloses the behaviour refereed to a specific visualization (e.g. Bar chart, table chart, etc.); the Datalet layer is the real implementation of the web component datalet, and is developed on top of this hierarchy of behaviours. This means that the DEEP is designed to support the integration of any third part visualisation library, reusing in this case the other modules of the architecture, that are the real-time fetching of the data, the grouping and filtering as well as the overall scaffolding.

3.3. Media Slider Datalet

The datalet Media Slider is a slider to showcase multimedia content. It supports several media types, including pictures, charts, visualisations, audio, and 3D models. The user can interact, for instance, with the 3D model (e.g., rotating and translating it) as well as move to the next media in the sequence (Fig. 3).

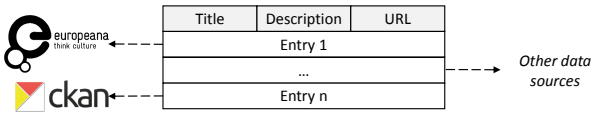

Figure 2: *The data structure provided in input to the Media Slider that displays a sequence of interactive 3D objects.*

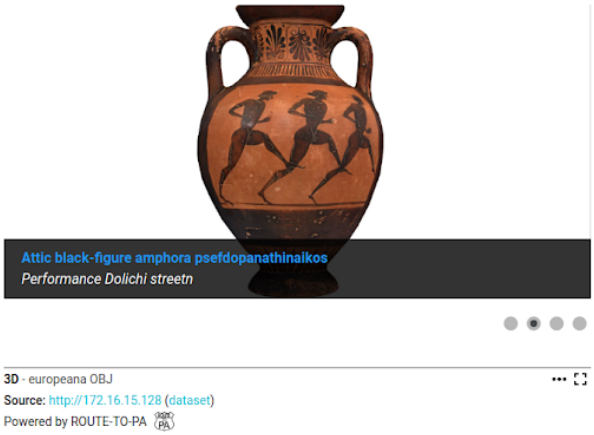

Figure 3: *Example of Media Slider datalet.*

In order to visualise multiple objects the Media Slider takes in input a data structure, where each entry contains the title and description to display, and a link to dataset (e.g. CSV, JSON file or a 3D model). Actually this data structure in input is in JSON format but the library can be extended to accommodate any kind of data structure of course providing the same data. The 3D formats supported are OBJ, JSON models, STL models.

4. Social Platform for OD in CH

SPOD is a virtual place named Agora where citizens can meet and discuss together, forming communities of interests. It enables Data-Driven discussions for creation of value form open data [ZJ-vdKP16]. Discussions evolve around data and datalets that are shared and used to support argumentations (Fig. 4).

SPOD provides in its stack a WP installation with a plugin to include datalets along articles. It is a showcase of the community content to opening up the knowledge, increase visibility, and reach a wider audience by engaging other citizens. In this way, some of

the knowledge produced in SPOD within rooms become transparent, living outside SPOD and this is what we mean as sharing of knowledge gained during discussions. The process to generate information from OD to answer to a question of interest, as well as the reasoning about the content and the effort to write them in an understandable article is part of the knowledge acquisition. It is named learning as participation. Effective transparency is assessed in terms of accessibility, understandability and usefulness of information and knowledge.

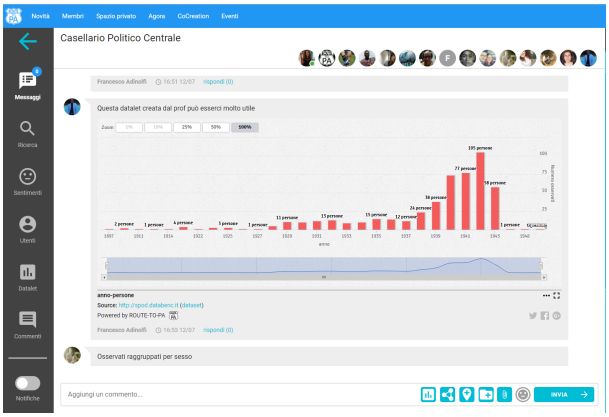

Figure 4: *Example of a datalet in the agora: the bar chart shows the people listed in the Central Political Registry dataset per year.*

SPOD provides co-creation rooms where small groups of users can collaboratively collect data and create new datasets. There is a collaborative spreadsheet with version control where users can manipulate tabular datasets. The co-creation is fully and seamlessly integrated with a quality checking tool [DDFM*18,PS16], datalets, OD portals, Agora and showcase. There is also an Android mobile app, where users can take photo and populate the dataset as well.

5. HETOR in CH

HETOR is devoted to the stimulation of local communities in the Campania Region in Italy (citizens, associations and institutions) to co-create OD for CH, to improve the quality and quantity of the OD available about the protection and preservation of CH and enhancement of local cultural and environmental resources. It is an opportunity to spread the knowledge of OD through the recovery of the collective local historical memory, enhancing the tangible and intangible cultural heritage.

In order to support discussions, SPOD provides ready-to-use data from official sources (ISTAT, ANCITEL, MIBACT, UNESCO, etc.), hierarchically partitioned by Towns (Municipality), Provinces (Province) and Regions (DISAGGREGATION) as well as data about cultural resources, enlarged with demographic data about the town/sub-town district they are located in, allowing further cross-dataset comparisons, within a single dataset (ENRICHMENT).

HETOR has involved students, ordinary citizens and members of associations. The platform has been used for the Alternanza Scuola Lavoro programme (school to work transition program) and through several OD challenges. We involved 255 users who co-created 55 datasets for 9867 records, and 284 datalets. In our experience, the aspect that engages the audience is the topic to be discussed, then, datalets and other tools can support and further stimulate discussions. Actually in our experience CH thematic is relevant for local communities especially when they touch local thematic and issues. This Section reports two experiences of datalets' uses:

Trademarks in the city of Nocerca Students of the "I.I.S.S.G. B. Vico di Nocera Inferiore" organized the research focusing on the contemporary era with the aim of enhancing the industrial archaeology. The study started from a collection of trademarks made available in open format by the Central State Archives. Students reconstruct the presence of existing factories on the territory by cataloguing the trademarks registered at the Italian chambers of commerce from the 19th century until the 80s of the 20th century. The table on disused factories has 94 rows and 16 columns. It is interesting to reconstruct the transformation of the city territory, in particular from the point of view of the new generations. Timeline shows a collection of brands placed in a diachronic way, the citizen can see the evolution of the brands over the years and compare images created by different companies.

Castles in Campania region Students collected information on castles, towers and noble palaces in Campania region. They were extracted from various verified sources and inserted within an open dataset formed by 523 lines and 29 columns. Students created a map datalet of the geographic spread of the fortifications. This is obviously a synchronic vision, but it is possible to create thematic maps (according to the century, the typology, the province). So, using visualisation of DEEP one can create images that show how a territory was fortified through the centuries; or it is possible to observe the distribution of a particular type of fortification in the region. This type of datalet can be very useful for planning and presenting thematic itineraries to develop tourist activities in the different districts.

6. Conclusions

This paper described an Edge-centric visualisation architecture designed to enable the reuse of visualisations. SPOD the social platform, exploits it by supporting the display, sharing and comment of visualisations, including 3D objects models. The main barriers we faced in the project especially running the HETOR pilot, are the limited availability of 3D models as open data that allows the reusing with an open license. Moreover, another barrier when there is the direct access to the on-line resources is that some platforms do not enable cross-site requests for the resource files (i.e., obj files). As future work we will perform an User Evaluation Study to evaluate the usability of the system [FGM*16] and its impact on the user engagement.

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