**VENICE TIME MACHINE**

**Modelling a 1000 years of European Circulations**

**The Venice Time Machine** **Project** is a pioneer international Digital Humanities scientific programme launched by the EPFL and the University Ca’Foscari of Venice in 2012 ([http://vtm.epfl.ch](http://vtm.epfl.ch/)). It includes major Venetian patrimonial institutions: the State Archive in Venice, The Marciana Library, The Instituto Veneto and the Cini Foundation. The project is currently supported by the READ (Recognition and Enrichment of Archival Documents) European eInfrastructure project (official number:674943, grade 15/15), the SNF project Linked Books and ANR-SNF Project GAWS. It involves more than 15 academic teams. EPFL and Ca’ Foscari are expanding their existing partnership to the Italian Institute of Technology, with an antenna in Venice. This new partnership is currently being developed and is expected to be launched in Venice in Fall 2016.

The **international board** of the project includes scholars from Princeton, Stanford, Columbia and London Universities. Three hundred researchers and students from different disciplines (Basic Sciences, Engineering, Computer Science, Architecture, History and History of arts) have already collaborated to this international programme. A doctoral school is organized every year in Venice and several bachelor and master courses already use the data produced in the context of the project.

**The Venice Time Machine Flagship** will be based on an extended European consortium beyond the founding Italian and Swiss partners, regrouping researchers from University of Oxford, the University of Amsterdam, the University Paris-I-Pantheon-Sorbonne, the Ecole Normale Supérieure de Lyon, the IRCAM-Centre Pompidou and the University of Warsaw. Our vision for this new phase is to progressively extend the Venetian case study to create a European Time Machine.

**What is the challenge and the vision?**

Research in the Humanities is about to undergo an evolution similar to what happened to life sciences 30 years ago. This evolution is characterized by projects at a new scale**,** beyond what any single research team can do and the use of advanced computational approaches. This constitutes a paradigm shift in which computer scientists and humanists need to join forces.

Already considered a pioneer scientific programme in the field of Big Data Humanities, The Venice Time Machine project aims at building a multidimensional model of Venice and its evolution covering a period of more than 1000 years. Kilometers of archives are currently being digitized, transcribed and indexed setting the base of the largest database ever created on Venetian documents. Millions of photos are processed using machine vision algorithms and stored in a format adapted to high performance computing approaches. In addition to these primary sources, the content of thousands of monographs are indexed and made searchable. The information extracted from these diverse sources is organized in a semantic graph of linked data and unfolded in space and time as part of an historical geographical information system, based on high-resolution scanning of the city itself.

The diversity, amount and accuracy of the Venetian documents are unique in Western history. The Venice Time Machine puts in operation a technical pipeline to transform this heritage in *Big Data of the Past*. Fast document scanners produce a stream of digital images that are analyzed using deep learning networks. These algorithms find reoccurring patterns in hand-written documentation, maps but also paintings and musical scores extracting information about people, places and art works, creating a giant network of linked data. The information items extracted from the documents are intricately interweaved. By combining this mass of information, it is possible to reconstruct large segments of the city’s past. At a larger scale, the Venetian archives reveal a 1000 years of European circulations, offering new tools to study population and economical dynamics, linguistic evolution, disease spreading, and pattern migrations in the domains of visual arts, architecture and music.

Moreover, one of the major conceptual and technological challenges of this project is to provide intellectual accountability for all these various reconstitutions. The Venice Time Machine does not only aim at creating vivid representations of the past, but organizes transparent processes linking historical records and computer-based visualizations. Ambiguity and lack of precision in historical records and associated uncertainties in reconstructed maps and networks are systematically qualified and quantified. By maintaining a rigorous and constructive approach, the findings obtained through the Venice Time Machine are open to peer review and can be included in the scholarly debates of the humanities.

The Venice Time Machine is organized around several core technological components

* New scanning technologies: including low-cost open-hardware scanners, high resolution photogrammetric environment scanning systems, Tomographic X-ray approaches, distributed smartphone based campaigns, acoustic active measurements for the virtual reconstruction of soundscapes.
* High quality distributed storage system for long-term preservation of Big Cultural Data.
* High performance architectures for deep learning approaches adapted to image analysis and supporting hand-written recognition, painting analysis, music analysis, etc.
* Large scale semantic graphs with metahistorical coding and inference engines for simulating data and testing coherence
* 4D multiscale geohistoric simulator and procedural methods for reconstructing possible pasts compatibles with digitized sources.
* Immersive and augmented reality interfaces playing the role of time capsules to navigate in reconstructed virtual representations including architectural and acoustic dimensions.
* Search engines for searching the past as easily as we search the data of the present.

Research and deployment of these components can be envisioned as a collective European effort, creating a distributed infrastructure that could support the creation of “Big Data of the Past” beyond the Venetian example. An early version of the Venice Time Machine’s vision was featured in 2013 on a TED Talk viewed more than 1 Million times (Frederic Kaplan, How to build a Time Machine) [http://www.ted.com/talks/frederic\_kaplan\_how\_i\_built\_an\_information\_time...](http://www.ted.com/talks/frederic_kaplan_how_i_built_an_information_time_machine)

**Why is it good for Europe?**

European universities are now in a unique position to transform the way we experience cultural heritage, history of arts and societies using digital technologies. Europe’s cultural heritage is one of its most precious assets. Transformed by digital technologies, it can become the basis of an extremely dynamic economical market, impacting society at large. Venice is the perfect case study to demonstrate this innovation potential.

Venice was Europe's economic hub for centuries. In order to comprehend the complex interactions between Venice's art, architecture and commerce, the Venice Time Machine project model both the terrestrial and Mediterranean Venetian networks and their evolution over time. Circulation of news, money, commercial goods and migration of artistic patterns along the roads to the Netherlands and Germany or down to ports of the Black sea tell a united story of the construction of Europe.

All technological development of the Venice Time Machine are open source, helping to create a share technological patrimony, lowering the cost for other institutions to follow the same methodologies and encouraging the creation of start-up and services following similar approaches and standards. This can lead to numerous local initiatives for fostering tourism, cultural entertainment services and new urban planning approaches. The global modeling methodologies developed for Venice could in turn be used of any other big European urban nodes. Cities like Amsterdam, Paris, Geneva have already expressed the desire to benefit form the innovation developed with the Venetian case study.

A **business incubator** will be created in Venice to strengthen the development of *cultural entrepreneurship* based on Big Data of the Past. This effort will reinforce the existing initiatives and dynamics already in place in the Veneto region (H-Farm and others).  List of possible ICT ventures include among others: Augmented reality applications for tourism and digital museography, architectural and acoustic virtual reconstructions, spatio-temporal search engines, crowdsourced and crowdfounded digitization campaign, restoration and replicas of cultural heritage, deep learning technology for new expertise of art works, long-term urban planning for future cities, computational epidemiology based on big data of the past, genealogical platforms, multiplayer historical role playing games.

To advance skills sets that are relevant to new research approaches and new businesses, the Venice Time Machine will also experiment the creation of an **educational hub** around the resources of the project including in-situ labs and courses but also Massive Open Online Courses reaching much larger audiences. Students will participate directly in on-going research projects, explore the virtual archives autonomously and perform collective enquiries and reconstructions. The core idea is to connect the mass of digitized documents with a large number of students from all over the world. These educational approaches, supported by open technology, will be easily applicable to other European case studies, putting Europe as an undisputed leader in the field of digital cultural heritage.

**What would it take to do it?**

The efforts are organized in several consecutive phases of increasing scale:

**Phase I (2012-2016):** Prototype of the Venice Time Machine system, development of the methodologies on one neighborhood of Venice (Rialto) and small time period (1700 – 1800). Core team of researchers and definition of the working methodologies. Prototyping of the main technologies (deep learning networks, semantic graphs, etc.) This phase is about to be completed

**Phase 2 (2016-2020):** Creation of a large network of European Universities participating to the project. Support of several industrial partners for high performances storage and computing. Development of the early service demonstrators. Extension at the level of the entire city, and study of the terrestrial and maritime circulation. Development of the educational hub and business incubator.

**Phase 3 (2020-2024):** Extension to other European cities and networks (Amsterdam, Antwerp, Paris, London, Berlin, the ports of the Mediterranean and more). New services to develop financial autonomy of the digitization centers and ensure long-term sustainability of the project. Replication of models of the education hub and business incubator to other centers in Europe.

European researchers in the field of humanities and computing are in a unique position to match these challenges. The project already benefits from the experience gathered during Phase I supported by one European H2020 project and two national projects. Development in Phase 2 will be done in synergy with DARIAH’s activities, the H2020 eInfrastructure development and other European initiative for cultural heritage (Europeana programme, the International Center for Archival Research (ICARUS) regrouping more than 160 European archives)

Thanks to its rich heritage and its technological assets, Europe can invent a new sustainable cultural model for the future and form the next-generation of actors leading this transformation. The past is the next frontier and Europe can be the leader of this scientific and technological journey.

Frederic Kaplan 29 April 2016 - updated 2 years ago

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