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Computer Science Applications to Cultural Heritage

Visualization

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Academic year 2018/2019



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Disseminating Cultural heritage content

Recent advances in multimedia technologies can improve the way in which content is exploited and disseminated for future generations.

Museums today face a challenge in keeping a steady stream of visitors

... particularly true for young visitors born in the digital age...

- Used to actively interact with the things they learn
- Needs more than a static painting to be engaged



Disseminating Cultural heritage content

“Museums are much more than repositories of objects; they are meeting places for people and ideas. Their future depends on remaining a dynamic part of the public realm.”

- Robert Hewison

Evolution of modern museums:

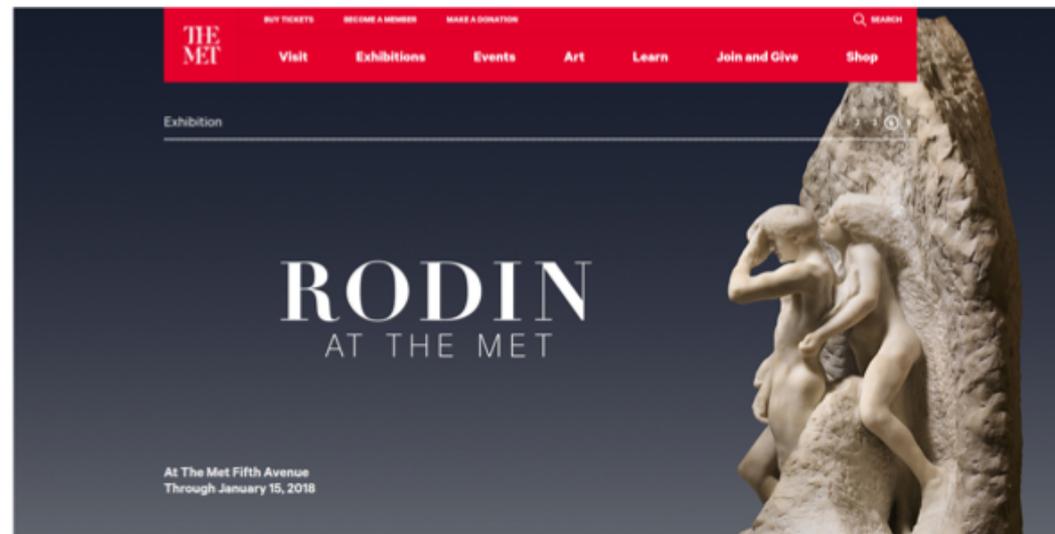
- Web 1.0 Online museums
- Web 2.0 participative museums
- Serious games
- Computer graphics and augmented reality



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Web 1.0 museum

- All contents prepared by museum
- Users can browse or follow pre-defined tours
- In general, users cannot contribute



The Metropolitan
Museum of Art

Buy Tickets



The Met
Fifth Avenue

Over 5,000 years of art from every corner
of the world

Open Today 10AM-5:30PM

The Met
Breuer

Modern and contemporary art through
the lens of history

Next open Tomorrow, at 10AM

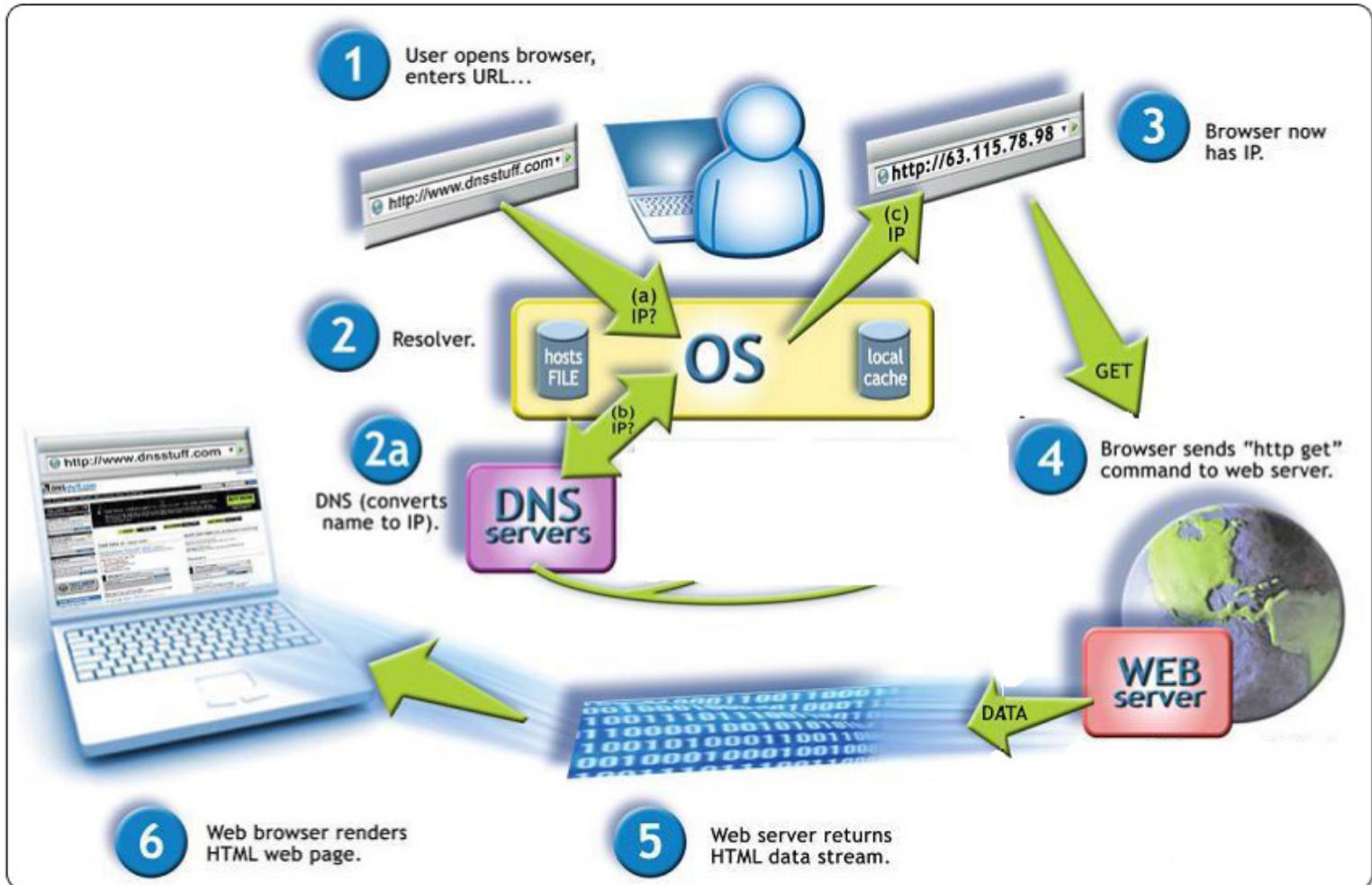
The Met
Cloisters

Wonders of medieval Europe through its
art, architecture, and gardens

Open Today 10AM-6:45PM



Web 1.0 - static pages





XHTML+CSS

Content of web pages is defined by using a markup language called XHTML (or the older HTML)

XHTML is interpreted by a **web browser** and defines the structure of text, images, and other material that is presented into **visual** or audible web pages

Default characteristics (like color, etc) for every item of HTML markup are defined in the browser. These characteristics can be altered by the web page designer's additional use of CSS (Cascading Style Sheets)



XHTML+CSS

XHTML markup consists of several key components:

- Tags with their attributes
- character-based data types
- character references
- entity references

```
<!DOCTYPE html>
<html>
  <head>
    <title>This is a title</title>
  </head>
  <body>
    <p>Hello world!</p>
  </body>
</html>
```



XHTML+CSS

CSS is a style sheet language used to define how each element in the XHTML file should be presented

CSS is designed primarily to enable the separation of presentation and content.

Advantages:

- Provide more flexibility for presentation
- Allow more XHTML pages to share the same style (reduce the repetition of the structural content)
- Improve content accessibility

Separation of formatting and content makes it possible to present the same markup page in different styles for different rendering methods



CMS

Directly creating web pages using XHTML and CSS can be a tedious task that requires some expertise to be mastered

Many times, a Content Management System (CMS) is used to create and modify digital content into web pages.

Most CMSs include Web-based publishing, format management, history editing and version control, indexing, search, and retrieval.



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CMS for cultural heritage

Omeka is an open-source CMS for online digital collections (like wordpress for museums)

<http://omeka.org/>

The screenshot shows the Omeka.org website homepage. At the top, there is a navigation bar with the Omeka logo (a golden spiral) and the word "omeka" in white on a dark red background. To the right of the logo is a search bar with the text "Search Omeka.org" and a "Search" button. Below the navigation bar are four yellow boxes with the following text: "Serious Web Publishing", "Cost-Effective Design", "Flexible and Extensible", and "Free and Open Source".

The main content area is divided into two columns. The left column features a section titled "Serious Web Publishing" with the text: "Create complex narratives and share rich collections, adhering to Dublin Core standards with Omeka on your server, designed for scholars, museums, libraries, archives, and enthusiasts." Below this text is a red button with a white download icon and the text "Download Omeka" and "Linux, Apache, MySQL, PHP5". To the right of this button is a green button with the text "No server? Try Omeka.net!".

The right column features a screenshot of the Omeka user interface, showing a list of items with columns for "Title", "Description", "Date", and "Actions".

Below the main content area, there is a "Tour Omeka" section with a video player showing a screenshot of the Omeka admin interface. The video player has a play button and a progress bar showing "04:01".

To the right of the "Tour Omeka" section is a "News" section with the title "Omeka.net Refreshed and Renewed" and the date "August 28, 2017". The text below the title reads: "Today marks the launch of a new look for Omeka.net, and many new benefits for users. Now is the time to sign up for an account to take advantage of our new pricing structure, enhanced functionality options, and additional storage. We've reduced the prices for our most popular plans: Plus Plan is now \$35 a [...]" Below the text is a link that says "Continue reading...".

At the bottom of the page, there is a "Previous Posts" section with a list of posts, including "Annotating Washington with Exhibit Image Annotation".



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Omeka

A “digital publishing suite for scholars, librarians, archivists, museum professionals, and cultural enthusiasts”

(definition given by the omeka team)

Main functions:

- Store digital objects (photos, pdf, videos, etc)
- Store metadata associated to those objects
- Create digital exhibitions around those objects

Operations can be performed by non-experts with a menu-driven interface



Web 2.0 museums

- Contents prepared by museum and/or users
- Users can contribute with comments, tags, ratings, experiences, etc
- Visitors can leave traces:
 - Stories, comments, ratings, tags
 - Selective visualization of the content to improve the experience
- Usage of new technologies to put **storytelling** at the centre of the experience
- Interactive, digital narratives can be achieved through virtual/augmented reality, image recognition, etc.



Web 2.0 museums

Example of a museum with user generated content:

1. Your smartphone exchange a vague idea of your interests (eg. by using browsing history) to the museum system
2. Museum present some tour selections: most popular vs. recommended by your interest
3. Device tracks your movement while you walk in the museum
 - a. Automatically tell stories about artifact
 - b. Allows you to leave comment, feedback or record stories
 - c. Feedback is used to adapt the tour
4. Some screens near each artifact summarize the reactions of the majority of users standing in front

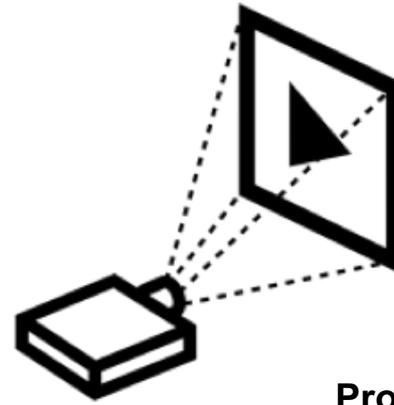


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New technologies for museums



Smartphones



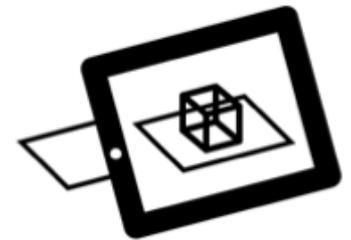
Projectors



Tags/RFID



Virtual reality



Augmented
reality



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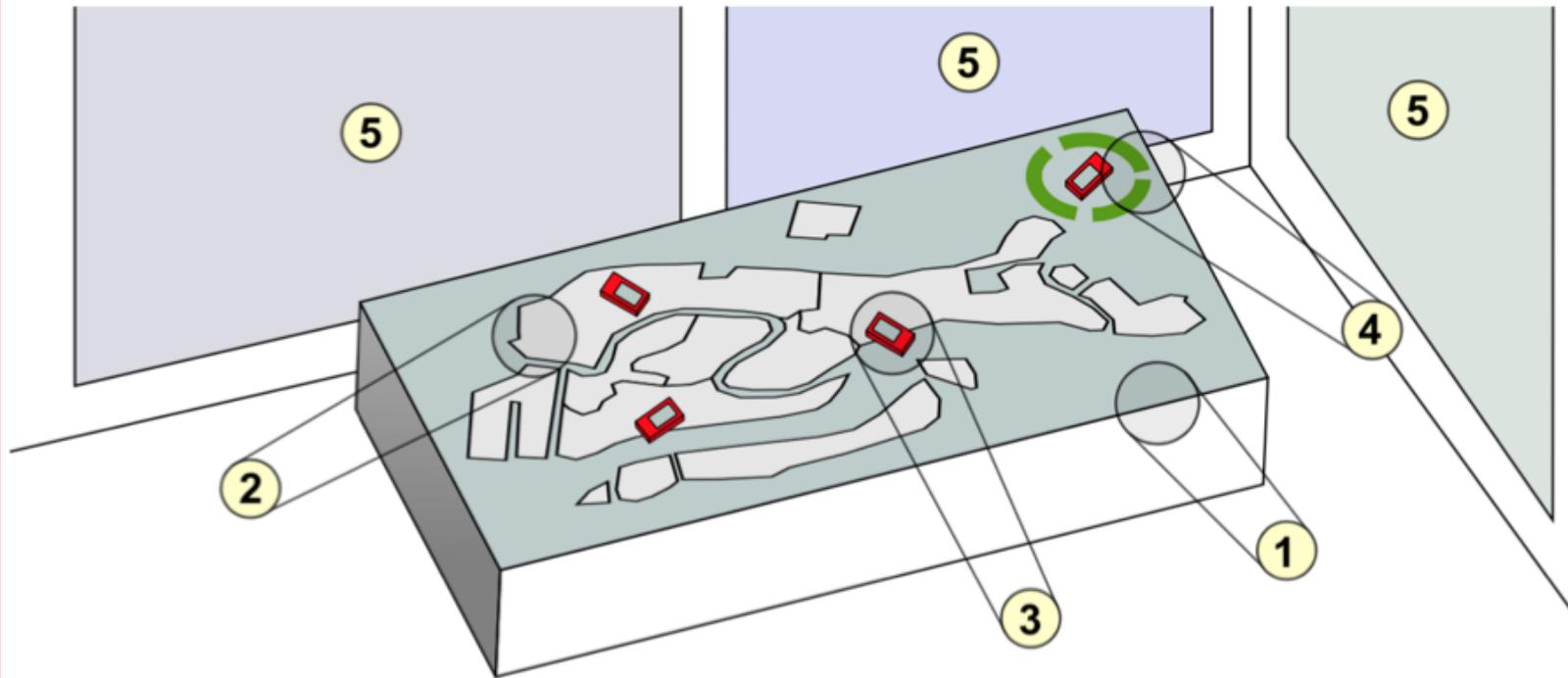
Our local case-study

Interactive tables developed by the computer vision group for the Ca' Foscari exhibition “William Congdon in Venice (1948-1960): An American Look”



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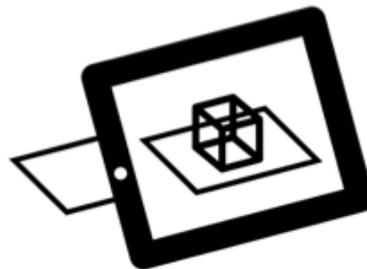


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From 2D to 3D views

Most conventional images offer a two-dimensional projection of a three-dimensional scene

In the recent past we assisted a huge increase of technologies to support stereo vision or to give the perception of 3D scenes on dedicated devices



**Mom: Don't sit too close to the TV.
It's bad for your eyes.**



20 years later...



From 2D to 3D views

Stereo viewers were very popular in the first half of the last century.

Based on the idea of simultaneously showing different images of a scene to each eye, which reflects how each of our eyes will see the same scene from slightly different point of view.

Fig. 11.2
Stereographic camera:
Le Rêve, France, 1904
(photo by Jean-Jacques
Milan)





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Visualizing a stereo pair

1891: Louis Arthur Ducos invented a technique called “Anaglyph”

merge the stereo pairs into the same image by using two different colours (e.g. red and blue) to represent the left and right images

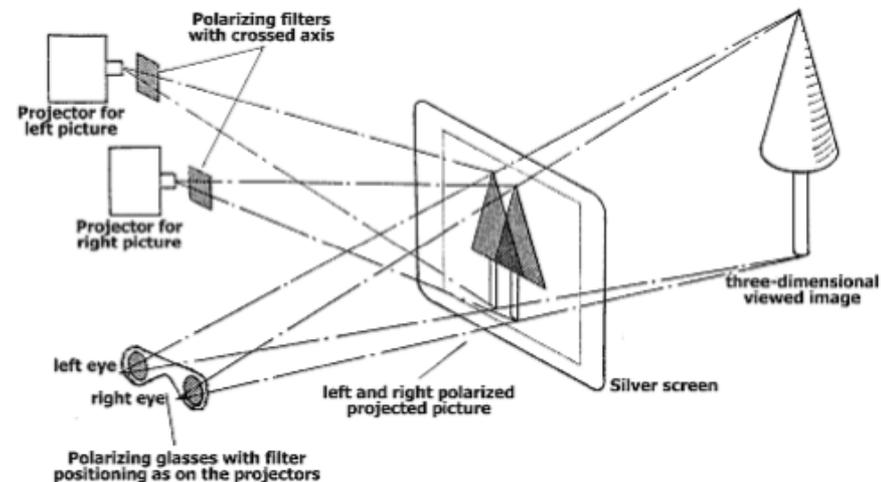
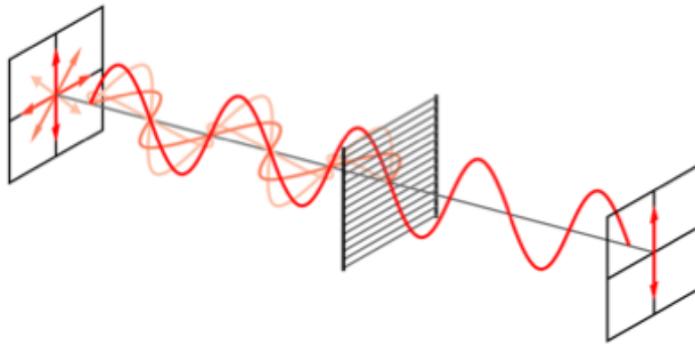
Works only for black & white images because colors are used to encode the stereo information



Visualizing a stereo pair

Using a similar technique, the stereo pairs can be merged not into the same print but on the same projection screen using cross-polarised light

Glasses fitted with cross-polarization filters just let the right image be visible to right eye and left image to the left eye





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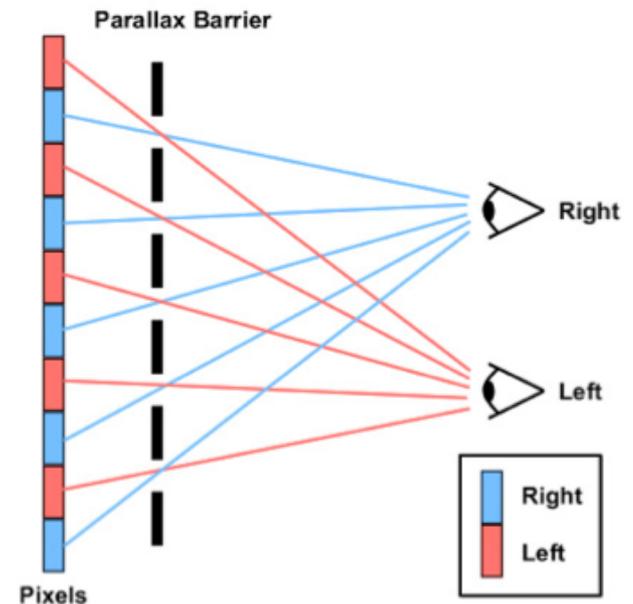
Visualizing a stereo pair

Two images can be multiplexed in time if the projector/screen supports a high frame rate. Using active shutter glasses left and right images are displayed at even and odd frames



Visualizing a stereo pair

Stereo pairs can also be visualized without dedicated glasses by placing a properly crafted opaque grid on top of the screen. Technique known as “**parallax barrier**”





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From 3D movies to virtual reality

Visualization of 3D content is even more immersive if the scene is generated on-the-fly with computer graphics techniques.

Allows the dynamic change of the point-of-view of the observer to truly give the sensation of being inside the scene.

Requires dedicated hardware and high computing power

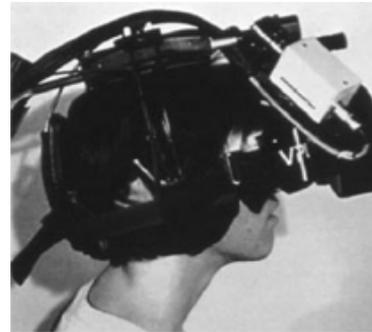


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From 3D movies to virtual reality

The term “virtual reality” mainly refers to three-dimensional worlds that are typically experienced through the use of special VR appliances such as data gloves and head-mounted displays

In 1969, at the University of Utah, **Ivan Sutherland**, the father of computer graphics, created what he called the “ultimate display”, a head-mounted display that was able to generate and manage two stereoscopic images and thus generate a three-dimensional scene in real time.





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From 3D movies to virtual reality

Modern virtual reality appliances





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Augmented reality

“Augmented reality (AR) is a live direct or indirect view of a physical, real-world environment whose elements are “augmented” by computer-generated or extracted real-world sensory input such as sound, video, graphics, haptics or GPS data.”

[Source: Wikipedia]





Serious games

Recently, serious games are attracting growing interests from educations since they proven to be particularly effective to enhance a museum experience

Simple definition:

Serious games are a class of games (usually videogames) whose primary goal is not entertainment. Objectives: train, educate, communicate, etc.

Idea:

contextualize the player's experience in a stimulating and realistic environment



Serious games

DALE , E. 1969. “Audiovisual Methods in Teaching”,
Dryden Press, New York:

- Students only remember 10% of what they read
- But.. almost 90% when they perform a “task”

Why Serious Games are effective:

- heighten players sensations in immersive situations
- CH artifacts can represent an interesting context for adventure and exploration. A serious game can embed a lot of additional information related to an artifact
- People is more and more familiar with playing games



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Ancient serious games

The **knucklebones** (astragaloi) introduced in ancient Greek times are believed to have had Asiatic origins and to have been connected to dice, while a Greek sculpture from 330 BCE shows two girls playing with knucklebones



The oldest known **dice** were excavated as part of a backgammon-like game set at the Burnt City, an archeological site in south-eastern Iran, estimated to be from between 2800–2500 BC.





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Ancient serious games

The **Senet** is a board game from ancient Egypt and one of the oldest known board games

- Grid of 30 squares, arranged in three rows of ten
- Original game rules are not completely known
- Rules are based on snippets of texts that span over a thousand years, over which time gameplay is likely to have changed
- **Religious mysticism:** The space you end at forecast good or bad fortune





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Ancient serious games

Mancala is a generic name for a family of 2-player turn-based strategy board games

- Played with small stones, beans, seeds etc
- Earliest evidence of the game are fragments of a pottery board and several rock cuts found in Aksumite areas in Matara (in Eritrea) and Yeha (in Ethiopia) dated between the 6th and 7th century AD
- Began as an accounting tool for trading goods and evolved in a form of entertainment
 - **Gambling** sheep, goods, etc





Ancient serious games

Ancient games but with serious purposes

- Fortune telling
- Religious divinations
- Gambling / Accounting

From the perspective of the ancient society “divination” is equivalent to the use of mathematics and science in modern days

> Games used to make intelligent decisions and understand the universe

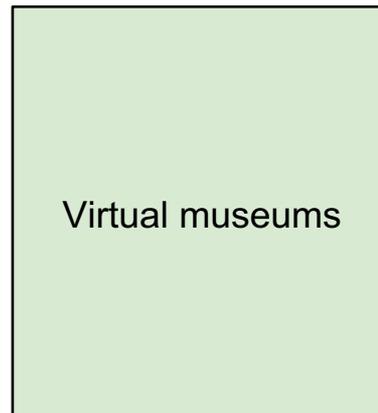
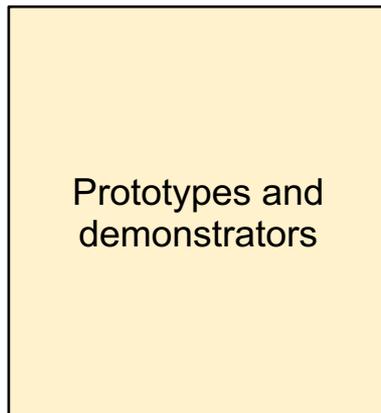


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Serious games

FALK ANDERSON , E., MCLOUGHLIN , L., LIAROKAPIS , F.,
PETERS , C., PETRIDIS , P., AND DE FREITAS , S. 2010.
“Developing serious games for CH: A state-of-the-art review.”
Virtual Real. 14, 4, 255–275

Domain divided in 3 areas:





Prototypes and demonstrators

Roma Nova

Born to investigate the efficacy of the Rome Reborn Project for learning, exploration, re-enactment and research of cultural and architectural aspects of ancient Rome

- The Rome Reborn project is the world's largest digitisation project to produce a high resolution version of Rome at 320 AD
<https://vimeo.com/32038695>
- Cutting-edge technologies
 - Quest3D visualization engine
 - Instinct artificial life engine
 - ATOM spoken dialogue system



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Prototypes and demonstrators

Ancient Pompeii

Shows a model of ancient Pompeii constructed using mathematical procedural methods and then populated with avatars in order to simulate life in Pompeii in real-time

GOAL: Simulate a crowd of virtual Romans exhibiting realistic behaviours





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Virtual museums

Virtual Egyptian temple

Shows an hypothetical Virtual Egyptian Temple, which has no real-world equivalent. Temple is divided into four major areas. Each area of this virtual environment represents a different feature from the architecture of that era.

The objective of the game 'Gates of Horus' is to explore the model and gather enough information to answer the questions asked by the priest

http://publicvr.org/html/pro_gates.html



Virtual museums

The ancient olympic games

Contains multiple mini-games associated with the Olympic Games in ancient Greece

- “Olympic Pottery Puzzle”: user must re-assemble a number of ancient vases putting together pot shards
- “Feidias Workshop” which is a highly interactive virtual experience taking place at the construction site of the 15-meter-tall golden ivory statue of Zeus
- “Walk through Ancient Olympia” where the user, learns about the ancient games themselves by interacting with athletes in the ancient game of pentathlon





Commercial games

These are games that were primarily created for entertainment, but their historical accuracy allows them to be used in educational settings as well.

Total War

provide a gameplay combination of turn-based strategy (for global events) and real-time tactics (for battles)

games also include several independent battle-scenarios with historical background information that depict real events and allow players to partake in moments of historical significance

games from the Total War series have been used to great effect in the visualisation of armed conflicts in historical programmes produced for TV



Sandbox Serious games

One common class of serious games is called “sandbox” and consists of:

- A spatial organization the knowledge distributed in a so called “virtual world”
- Tasks that are spread in the virtual world.
 - Simple activities
 - Can be discovered and played by the user
 - **Goal:** construct meaning, build lasting memories and/or deepen understanding [BELLOTTI , F., BERTA , R., D E GLORIA , A., AND PRIMAVERA , L. 2010. “Supporting authors in the development of task-based learning in serious virtual worlds.” British J. Edu. Technol. 41, 1, 86–107]