

Multimodal Knowledge Graphs for Semantic Analysis of Cultural Heritage Data

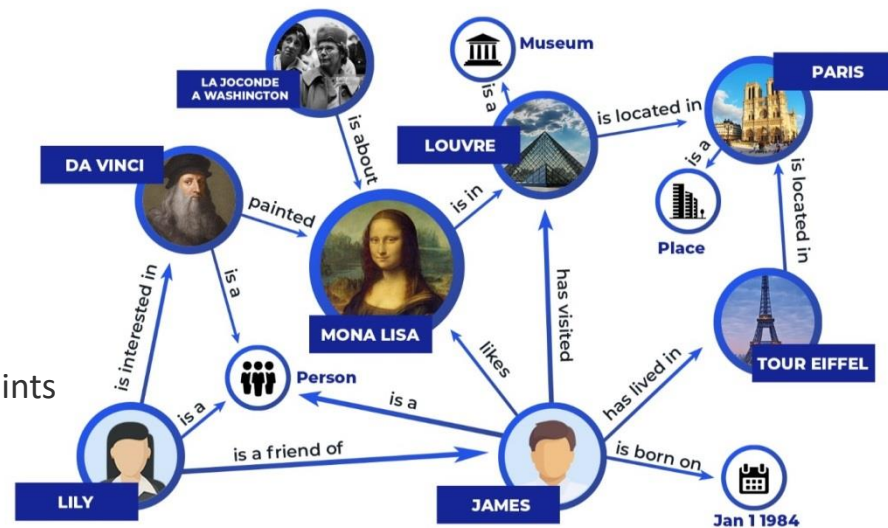
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25.06.2020

Cultural Heritage : Representation and Reasoning

- Cultural Heritage data being digitized at fast pace
- Need for automated analysis
- Knowledge Graph -> structured data representation
- Ontology -> defining the underlying schema and constraints
- Enable semantic analysis for deriving useful insights
- Goal – Automated Construction of a Multimodal Knowledge Graph for Cultural Heritage



Cultural Heritage Data

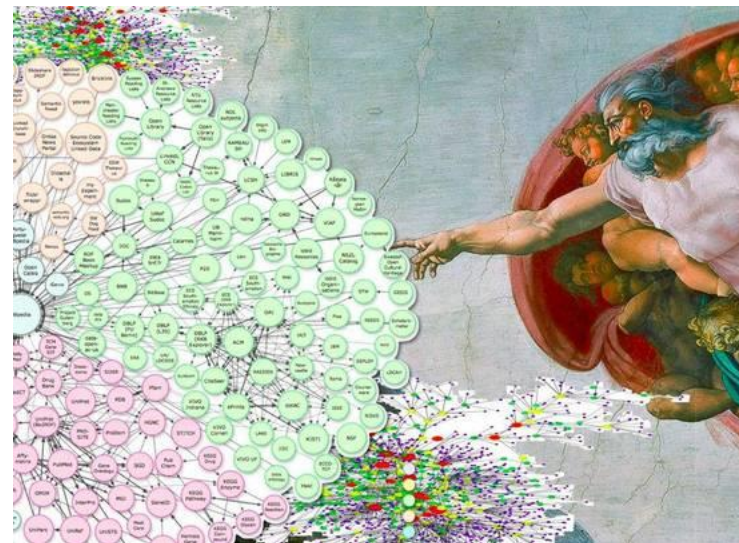
The collage displays various cultural heritage data sources:

- Sotheby's Japanese and Korean Art:** Two auction catalogues showing traditional East Asian art.
- Christie's The William Sandby Collection of Drawings:** A book cover featuring a circular seal and the text "The William Sandby Collection of Drawings by Paul Sandby, R.A. SECOND PORTION ON TUESDAY, MAY 26, 1959 Illustrated Catalogue".
- Art Exhibition Catalogue (The Brig at Sunset):** A page with three small images of ships at sunset, numbered 86, 87, and 88. Each image has a caption and a detailed description of the artwork, including the artist, medium, and provenance.
- Art Exhibition Catalogue (Hyde Park):** A page titled "Hyde Park" with a large illustration of a park scene and a smaller illustration of a carriage. It includes text describing the exhibition and the artist's intent.

- Heterogeneous data sources - Art Books, Exhibition Catalogues, Auction Manuals
- Modalities – Text, Images, Videos
- Challenges
 - Old archival data
 - Multilingual texts
 - No formatting cues available
 - Noisy data due to OCR errors

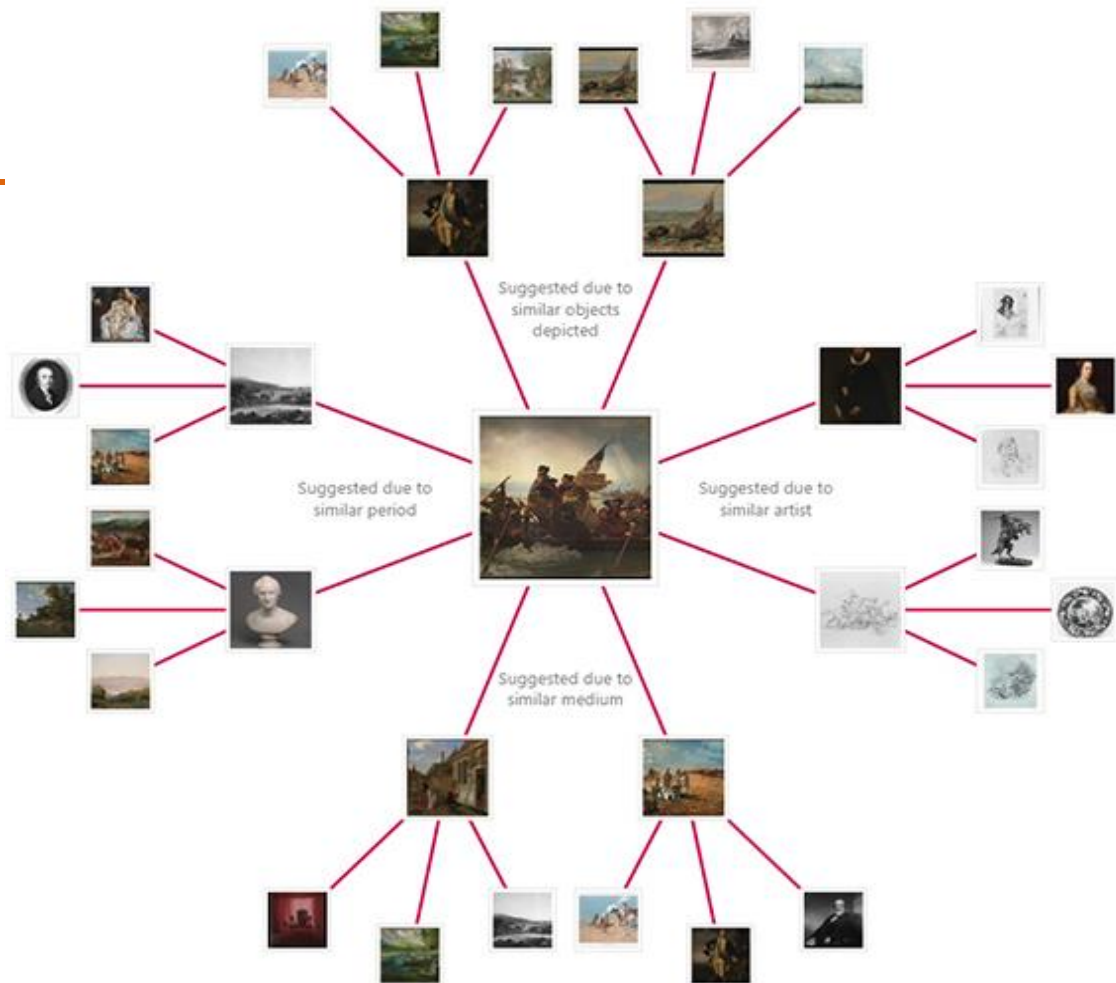
Knowledge Graph for Cultural Heritage

- Represent named entities (text and images) as nodes – Paintings, Sculptures, Artists, Art Styles, Museums, Exhibitions
- Relations between them with qualitative edges – createdBy, exhibitedAt, inspiredBy, livedIn
- Add attributes for the entities – Medium, Depiction, Style, Period
- Perform semantic analysis - Represent correlations between the entities (similarity, entailment..)



Applications

- Recommendations - similarity of paintings based on
 - Time period
 - Art style
 - Artist
 - Medium of painting
 - Objects depicted
- Multimodal question answering
- Multimodal search and browsing



Named Entity Recognition for Artwork Titles

- Titles of artworks are important named entities in cultural heritage domain
- Difficult to identify –
 - Generality – ‘untitled’, ‘Girl before a Mirror’, ‘A Pair of Shoes’
 - Ambiguity – ‘Mona Lisa’, ‘Jacqueline’
- Existing NER tools do not cover such domain-specific entity types
- Fine-grained NER caters to many more entities – but not adapted to cultural heritage domain
- Published at TPDL 2019 (Jain, Nitisha, and Ralf Krestel. “Who Is Mona L.? Identifying Mentions Of Artworks In Historical Archives”)



Girl before a Mirror
Pablo Picasso

Named Entity Linking and Disambiguation

Head of a Woman



Artwork

Artist: [Pablo Picasso](#)

Dimensions: 1.33 m x 65 cm x 71 cm

Created: 1909

Period: [Cubism](#)

Medium: Plaster

Subject: [Head](#)

Head of woman



Artwork

Artist: [Pablo Picasso](#)

Created: 1921

Period: [Neoclassicism](#)

Genre: Portrait

Head of a Woman 1909. This is Picasso's first Cubist sculpture and one of more than sixty Cubist paintings, sculptures, and drawings the artist made of his lover **Fernande Olivier** in 1909. Picasso modeled the bust in Paris after the couple returned from a summer trip to Spain.

Artist: Pablo Picasso (Spanish, Malaga 1881--...

Medium: Bronze



Head of a Woman

Pablo Picasso

1924

Matching Images with Textual Descriptions

Hyde Park
1902, watercolour, 60.8 × 55 cm, London Transport Museum

Designed to advertise the delights of Hyde Park, this illustration for a London Underground poster is full of colour and life. Beneath trees coloured by season to suggest the fresh growth of spring, horses canter, creating a pattern of horseshoe prints, and children whizz about on scooters. As with other Bawden designs, we may look once and take in the general mood, but look again and all kinds of details emerge. An old man feeds the birds, while a motherly young chap chats with a pair of young ladies. Elsewhere a rider tips a hat to a fellow in exuberant plus fours, and lovers kiss on a bench. It's all there, a world in miniature: the stage of London life.

Life Guards
1921-2, colour auto-lithograph, 23.5 × 30.8 cm, The Higgins Collection

Made for the Royal College of Art to commemorate the Coronation, this auto-lithograph was rather an experiment for Bawden. In the early 1920s he was exploring the possibilities for editorial prints, partly no doubt to make up for the waning interest in his watercolours. He has begun illustrating books with lithographs, following the example of Ravilison and their friend Barnett Freedman, and made a couple of prints before turning to linocut. His life guards are a jolly crew.

46 EDWARD BAWDEN

78 III. CRANACHS BILDNIS, SEINE MALERFREUNDE

25 L. Cranach d. Ä., um 1520 (Stl. 27)

26 Dürer, 1524 (Ann. 90)

die Büste des sächsischen Kurfürsten beachte er nach dem Typus antik-römischer Porträtbüsten eine Inschrifttafel an mit dem Wortlaut (hier aus dem Lateinischen übersetzt): «Christus geweiht, er liebt das Wort Gottes in grosser Frömmigkeit, würdig, verehrt zu werden in alle Zukunft. Dem Herrn Friedrich, Herzog von Sachsen, des Heiligen Römischen Reiches Erzmarschall, schuf es Albrecht Dürer aus Nürnberg. Dem Hochverdienten schuf er als Lebender dem Lebenden 1524⁹⁴.» Pathetischer und deutlicher auf Luther bezogen geht es nicht, und man spürt dahinter nicht nur die Ansichten des Kurfürsten, sondern auch den Mitteilungsdrang Dürers.

25 **Lukas Cranach d. Ä.**
Selbstbildnis Abb. 25

um 1520, Holz, Kuppelkammer, 4,7 × 3,9 cm

Schloss Stolzenfels bei Koblenz (verwaltet vom Landesamt für Denkmalpflege Rheinland-Pfalz, Staatliche Schlösser, Mäuz).

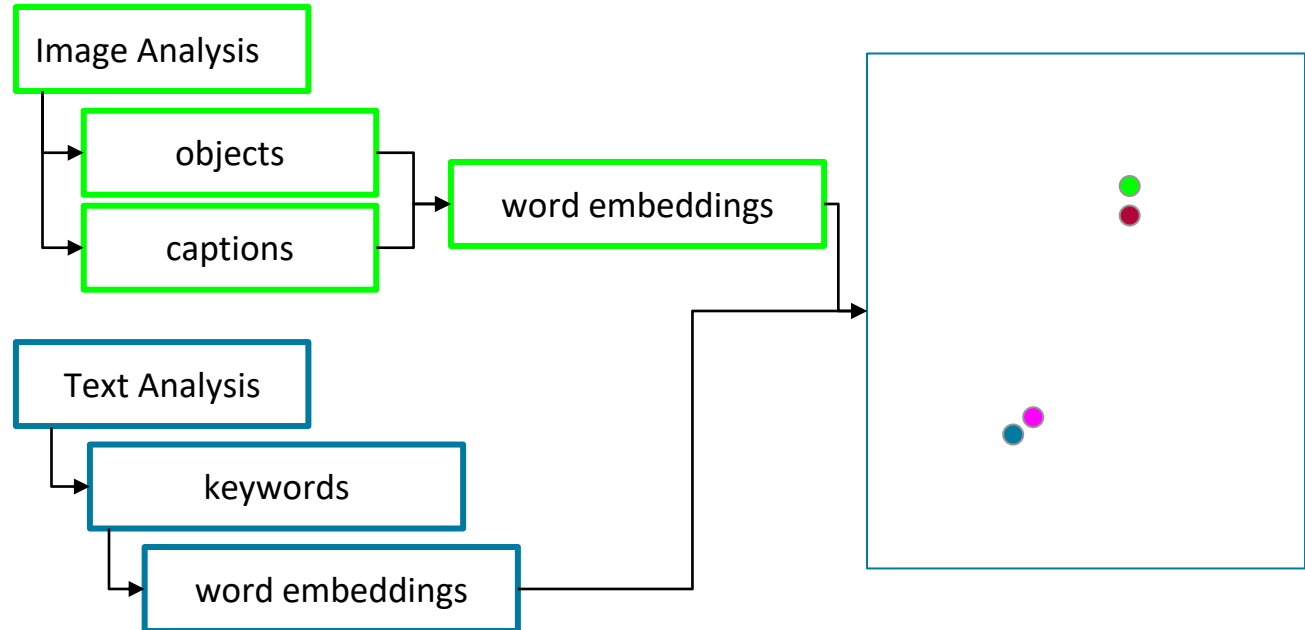
Werner Schade: Das unbekanntere Selbstbildnis Cranachs, in: Dezenarium 2, Zwanzig Jahre VEB Verlag der Kunst, Dresden 1972, S. 368–375, mit Farbstafel.

Schade, dem die Bestimmung des sehr schlecht erhaltenen Bildes nach einer Photographie gelang, behandelt es als ein autonomes Selbstbildnis, was zweifelhaft ist (vgl. W. Schödig, in: Cranach-F., 1913, S. 128 ff.), Schwarzer Grund (über Braun?, Blau durch Hitzeeinwirkung?). Dunkelbraunes Pelzgewand (übermalt?). Braune Hüfte, grauer Bart, braune Augen. Vgl. Nr. 478.

- Semantic matching with captions of a painting for the linking of painting with text
- Pipeline:
 - Locate pictures and analyse content
 - Extract textual content with OCR
 - Identify important phrases to match image content with textual description

Bringing Image Analysis and Text Analysis together

- Embed results of text and image analysis in common semantic space



Matching Images with Textual Descriptions - Full Pipeline

Input Scan



Localized Texts and Images



Text Analysis

NER for Titles

Keyphrase Extraction

Text Segmentation

Image Analysis

Classification

Captioning

Object Recognition

Semantic Alignment

Matched Texts and Images



Summary

- Goal – Multimodal Knowledge Graph for Semantic Analysis of Cultural Heritage Data
- Several domain-specific and research challenges
- (First attempt) Named Entity Recognition for Artwork titles
- (Ongoing work) Automatic matching of images with descriptions
- Questions and feedback welcome!
- More information - <https://hpi.de/naumann/people/nitisha-jain.html>



Mona Lisa

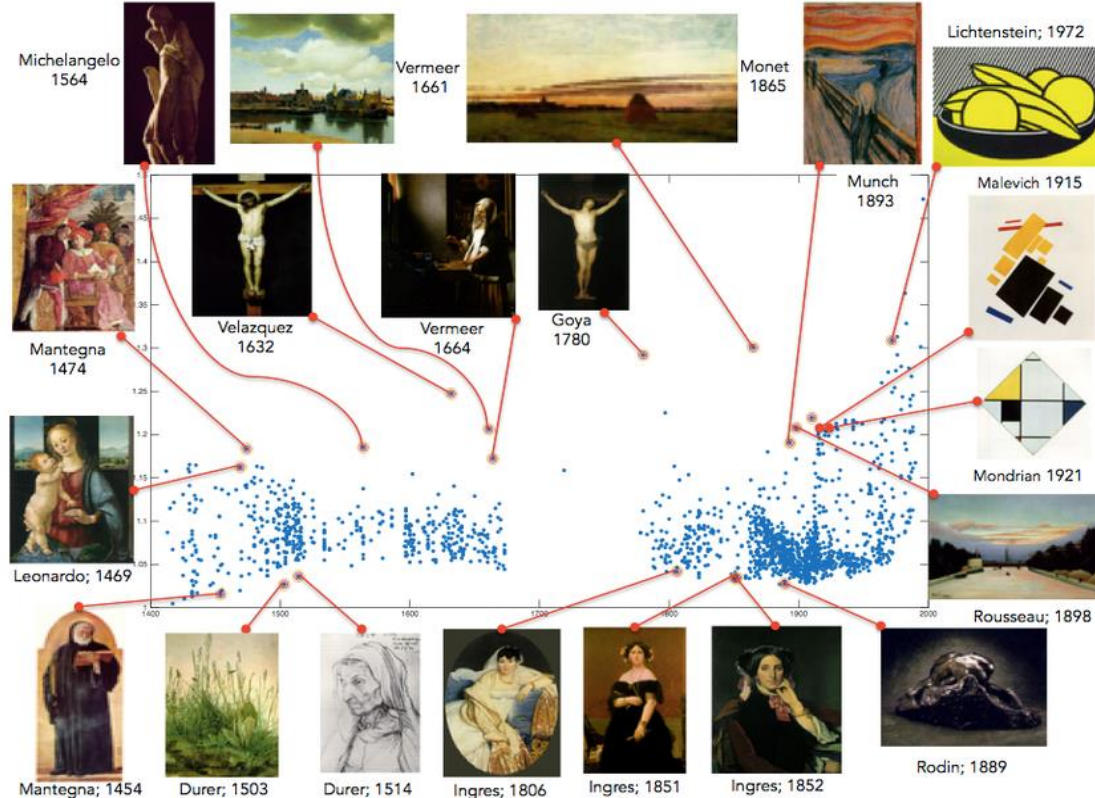
Da Vinci

Date of birth: April 15, 1452
Date of death: May 2, 1519
(age 67 years)

Michelangelo

Thank You for your attention.

Applications



Generate Training Data with Neural Style Transfer

Input Image



Style Image



Output Image



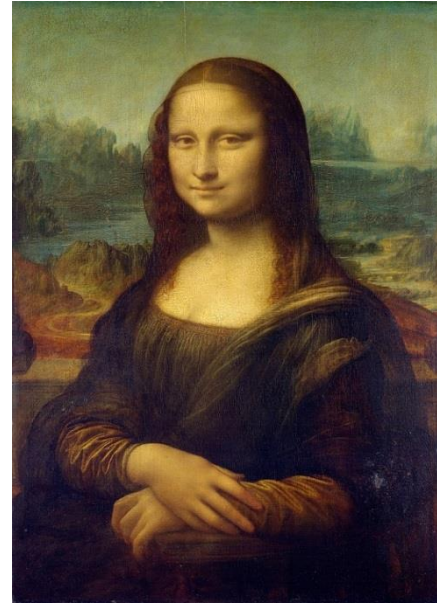
Incorrect Named Entity Type Tagging



Jacqueline
(Pablo Picasso)



King George III
(Allan Ramsay)



Mona Lisa
(Da Vinci)

Person
or
Artwork ?

Named Entity Boundary Detection Errors



Head of a Peasant Woman

Vincent van Gogh
Date: 1884; Nunen
Netherlands



Head of a Peasant Woman with Brownish Cap

Vincent van Gogh
Date: 1885; Nunen
Netherlands



Head of a Peasant Woman with Dark Cap

Vincent van Gogh
Date: 1885; Nunen
Netherlands



Head of a Peasant Woman in a Green Shawl

Vincent van Gogh
Date: 1885; Nunen
Netherlands

Domain-specific KG construction

25/06/2020