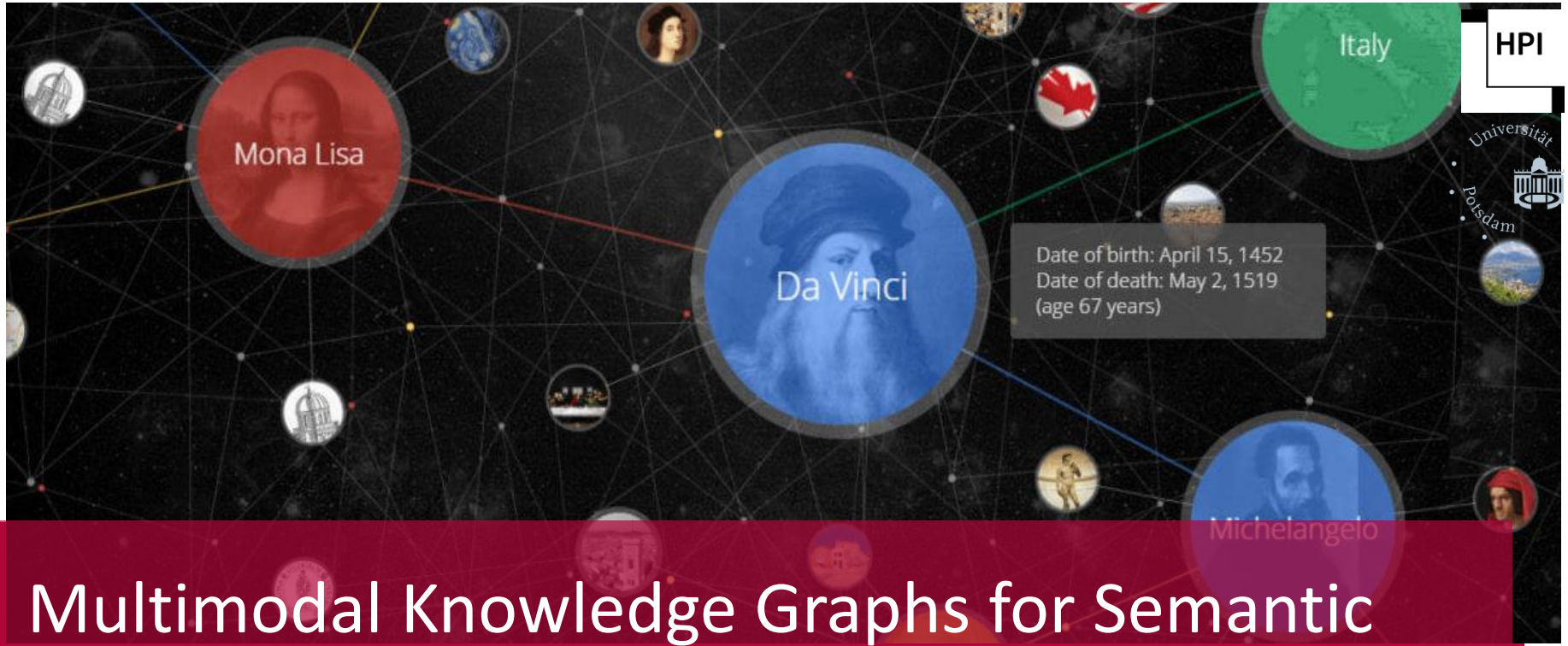

Multimodal Knowledge Graphs for Semantic Analysis of Cultural Heritage Data

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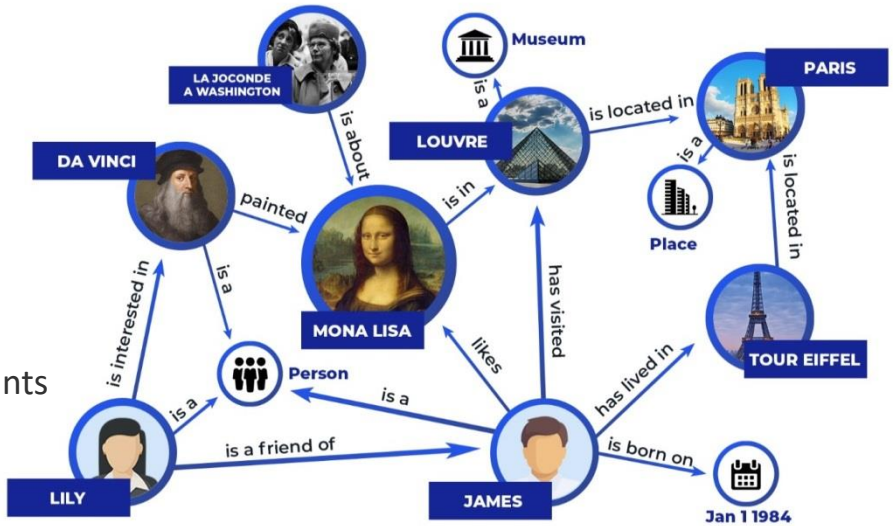
Hasso Plattner Institute

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**

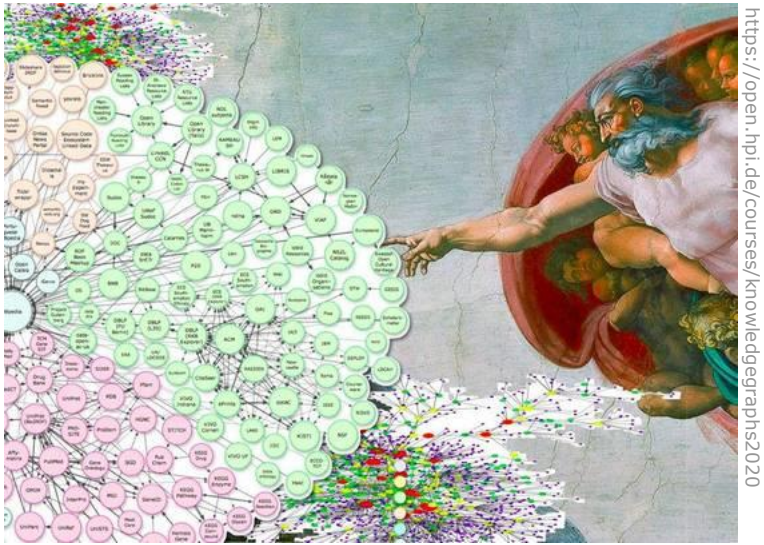
Cultural Heritage Data

- 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

Project Partner – Wildenstein Plattner Institute (https://wpi.art/)

Knowledge Graph for Cultural Heritage

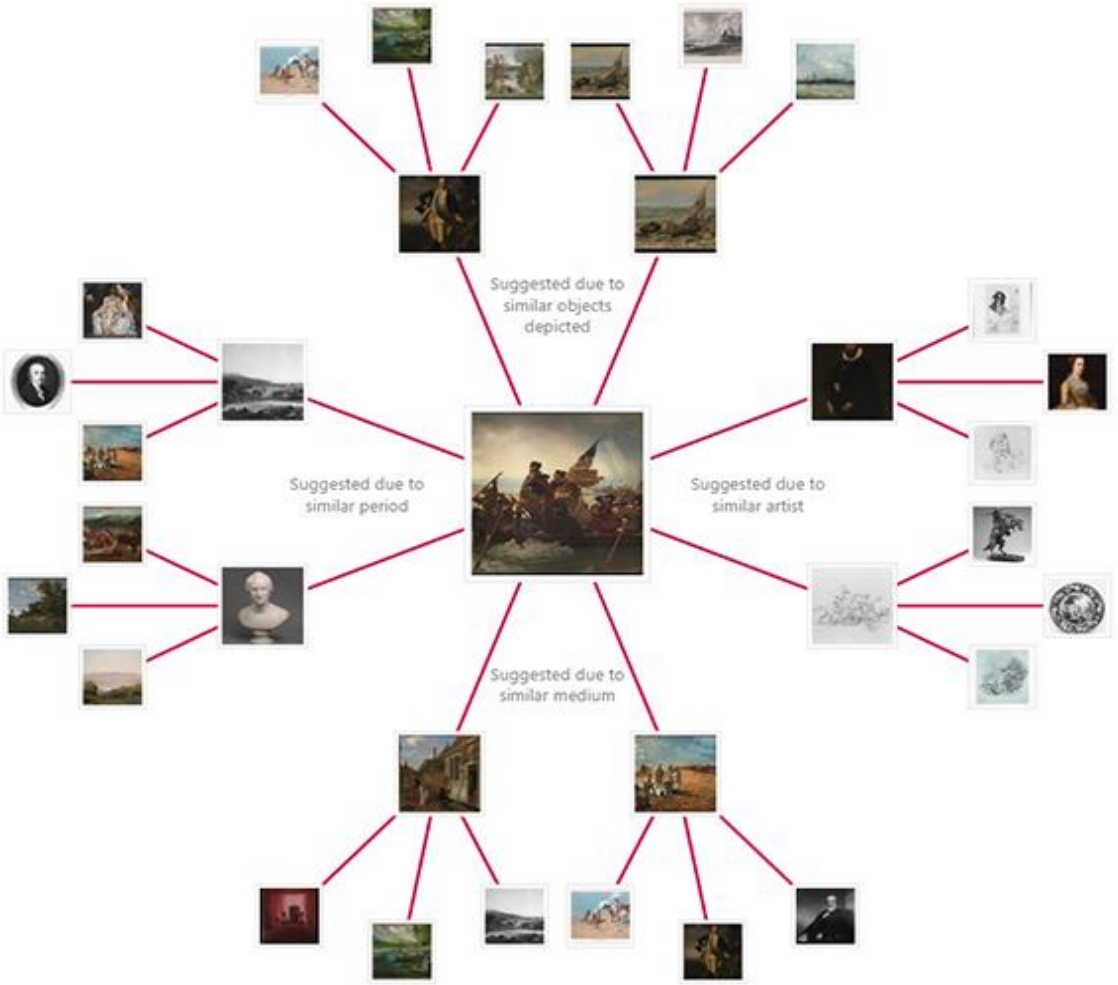
- Represent named entities (text and images) as nodes – Paintings, Sculptures, Artists, Art Styles, Museums, Exhibitions
- Relations between them with qualitative edges – createdBy, exhibitedAt, inspiredBy, livedIn
- Add attributes for the entities – Medium, Depiction, Style, Period
- Perform semantic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



https://open.hpi.de/courses/knowledgegraphs2020

Applications

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



https://www.metmuseum.org/blogs/now-at-the-met/2019/met-microsoft-mit-exploring-art-open-access-ai-whats-next

AKBC for Cultural Heritage – Challenges

- Extraction of cultural heritage entities from digitized data (NER)
- Entity linking and disambiguation
- Matching of images with textual descriptions

Painting on Light Ground, 1916 **Red Oval, 1920**

Named Entity Recognition for Artwork Titles

Girl before a Mirror
Pablo Picasso

- 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")

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

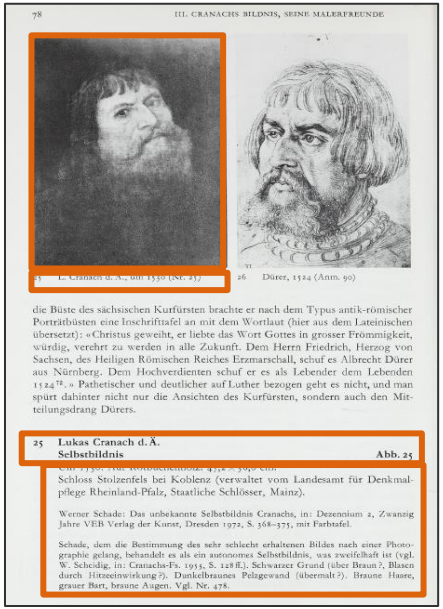
Head of a Woman 1909. This is Picasso's first Cubist sculpture and one of more than sixty Cubist paintings, sculptures, and drawings the artist made of his lover **Fernande Olivier** in 1909. Picasso modeled the bust in Paris after the couple returned from a summer trip to Spain.

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

Medium: Bronze

Head of a Woman
Pablo Picasso
1924

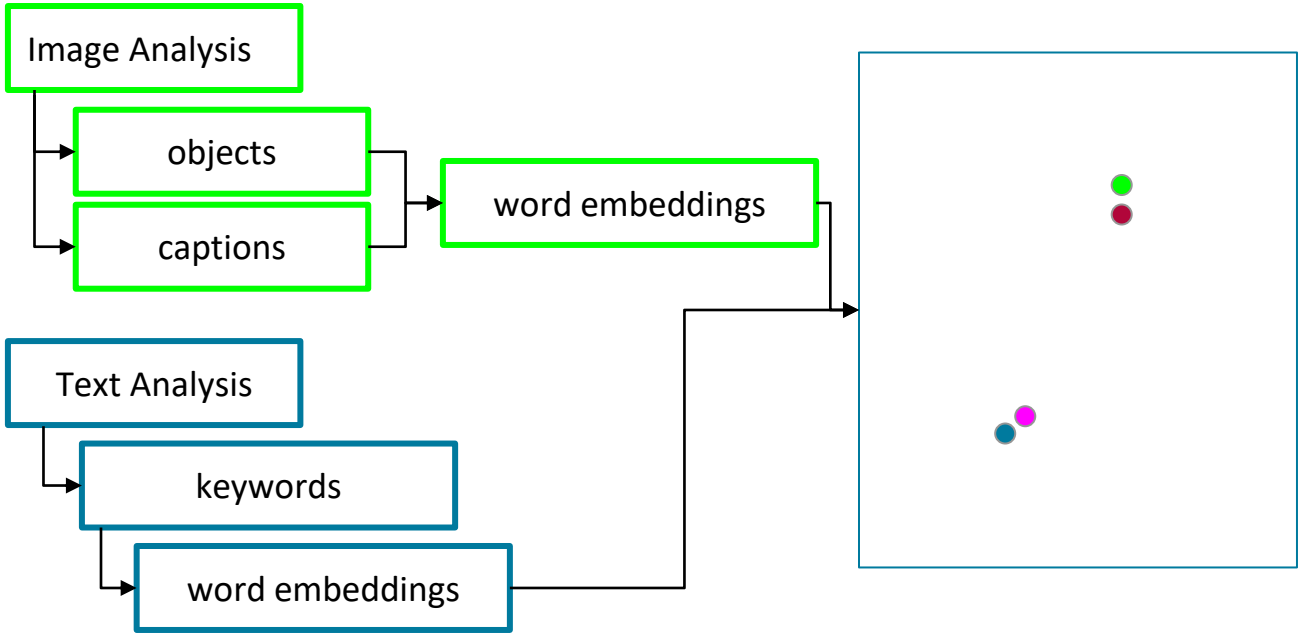
Matching Images with Textual Descriptions



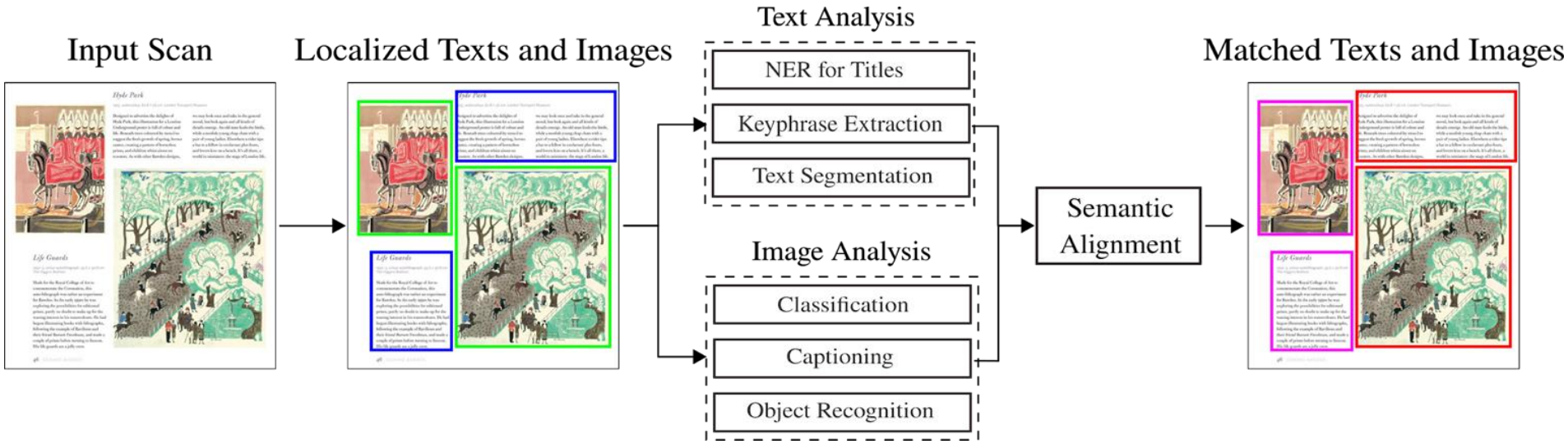
- Semantic matching with captions of a painting for the linking of painting with text
- Pipeline:
  - Locate pictures and analyse content
  - Extract textual content with OCR
  - Identify important phrases to match image content with textual description

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

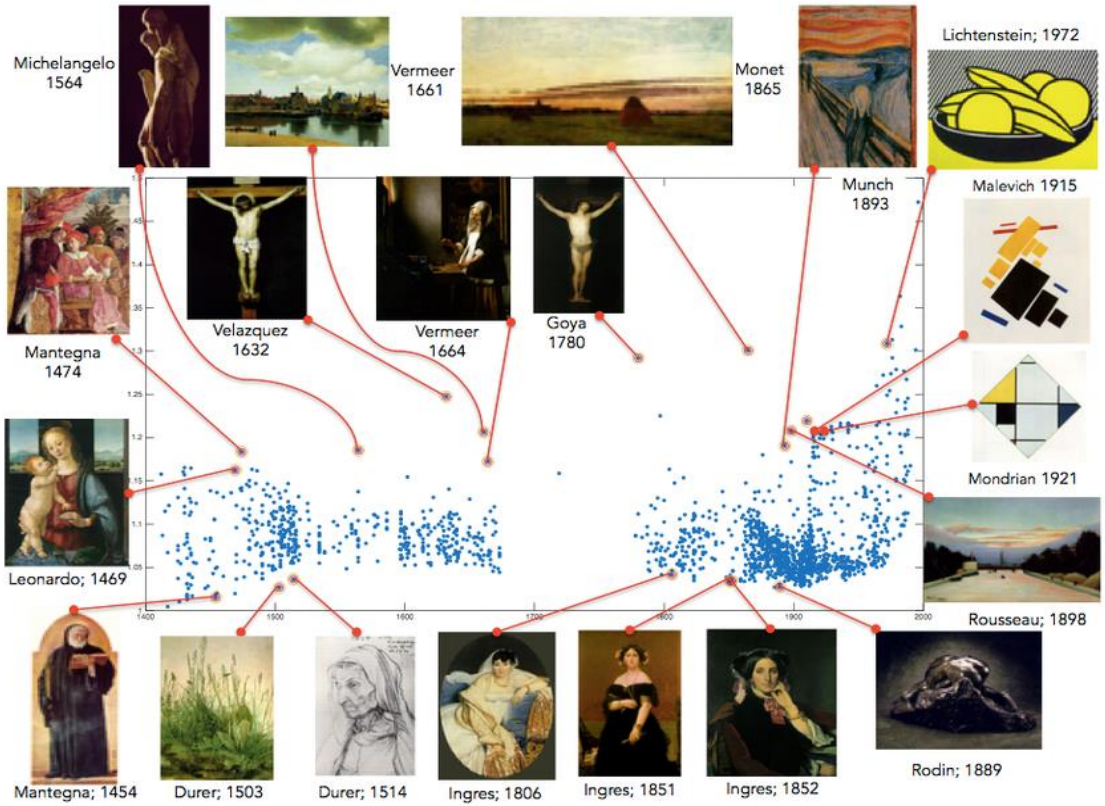


Summary

- 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

Thank You for your attention.

Applications



https://theconversation.com/which-paintings-were-the-most-creative-of-their-time-an-algorithm-may-hold-the-answers-43157

Generate Training Data with Neural Style Transfer

Input Image

Style Image

Output Image

generated with Attention-aware Multi-stroke Style Transfer

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