Metadata Matters

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Keeping Current
November 18, 2020

College of Engineering
Department of Computer Science

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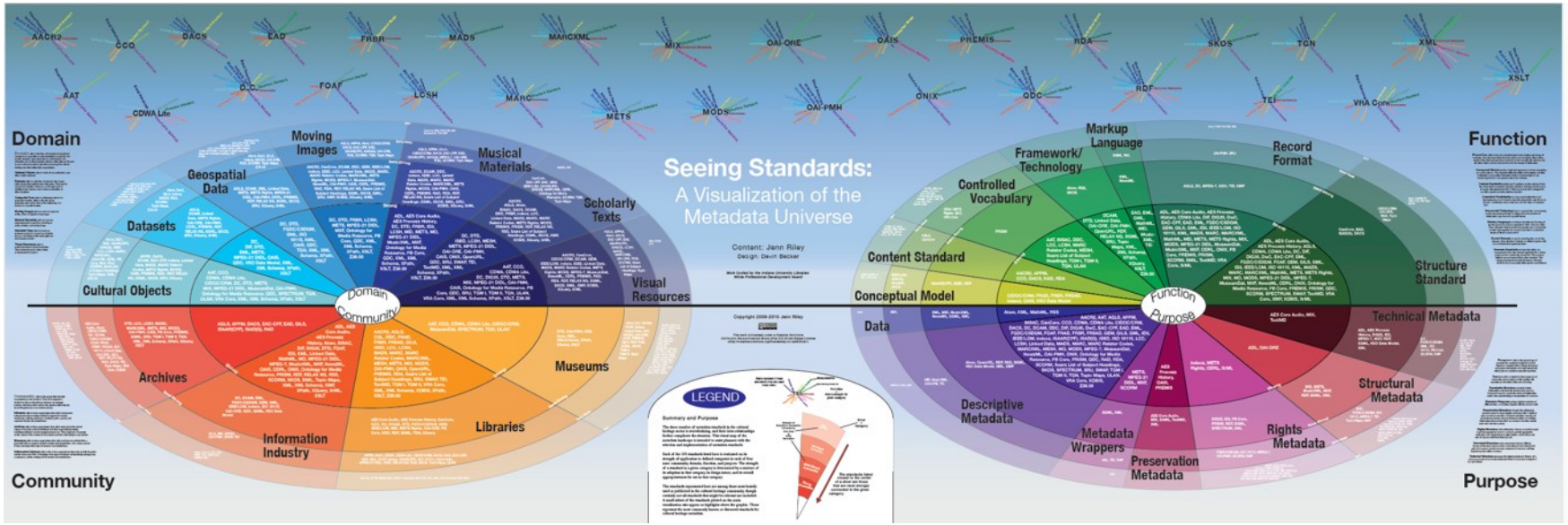
The Metadata Universe http://jennriley.com/metadatamap/seeingstandards.pdf (2010)

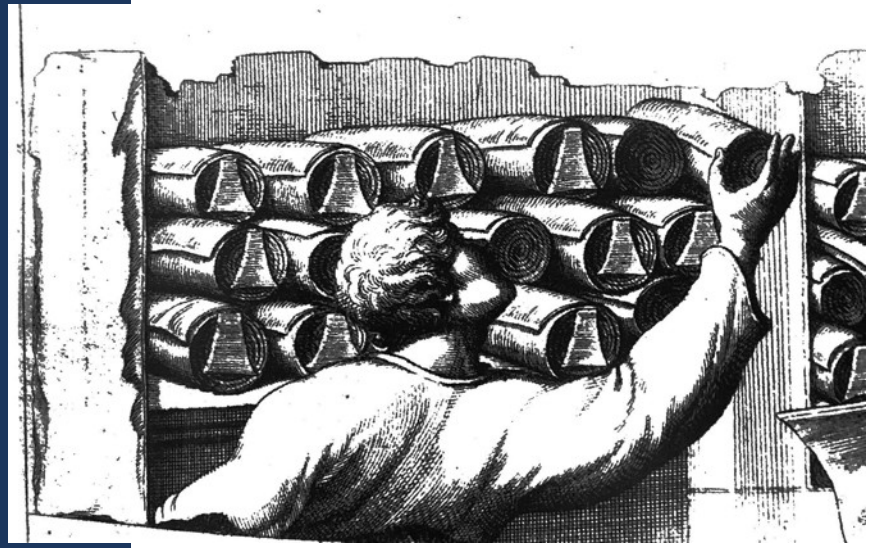


What is metadata?

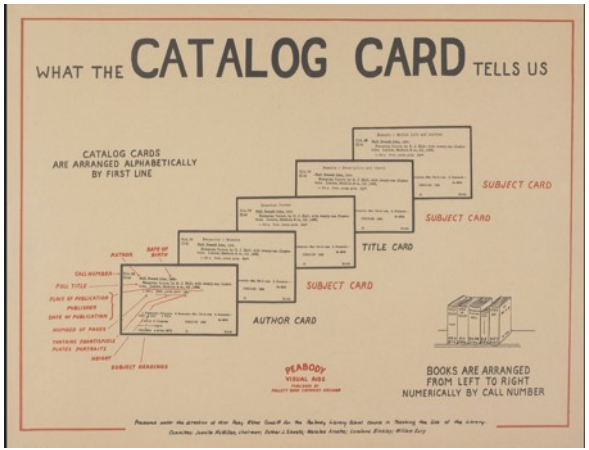
”Data about data” is too simplistic a definition.

Metadata comprises the tidbits of information that provide contextual understanding about an object, whether that object be digital or analog; text, image or audio; conceptual or concrete, etc.

Early Forms of Metadata



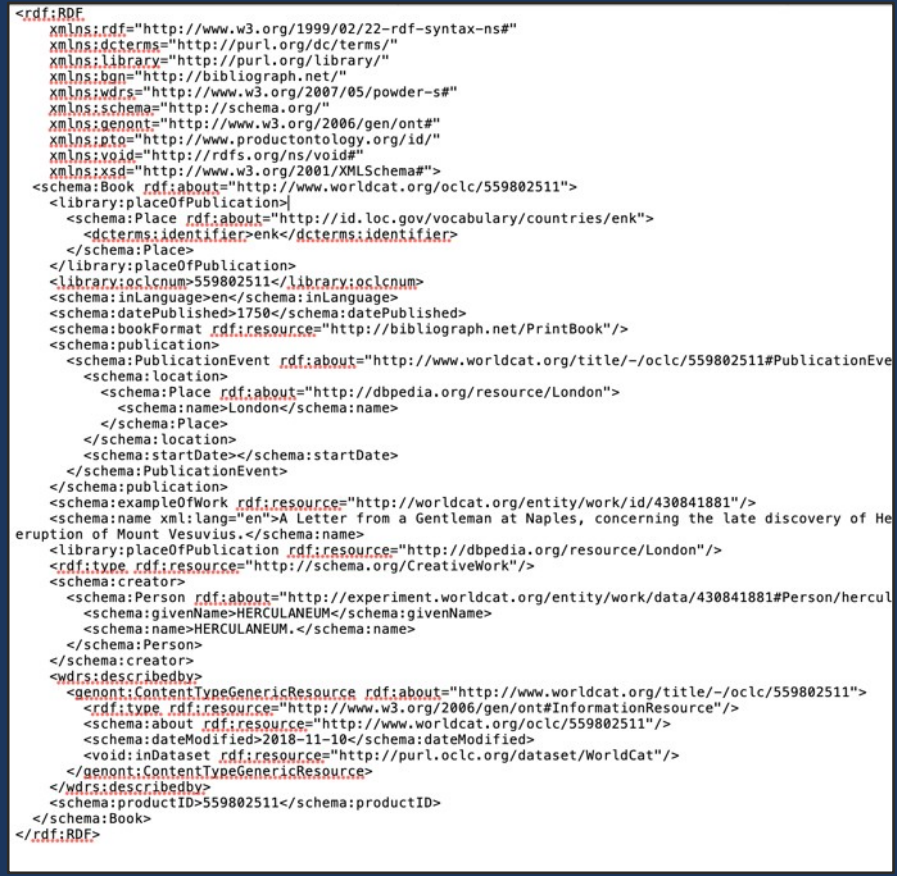
From Wilhelm von Massow, *Die Grabmäler von Neumagen* (Berlin, 1932), fig. 141, p. 243.



Metadata Today

- Machine readable mark-up makes the metadata searchable by computer systems so that the associated information objects can be found and retrieved by users.

- File types include JSON, HTML, and, XML, which is increasingly the de facto standard.



```
<rdf:RDF
    xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
    xmlns:dcterms="http://purl.org/dc/terms/"
    xmlns:library="http://purl.org/library/"
    xmlns:bgn="http://bibliograph.net/"
    xmlns:wdrs="http://www.w3.org/2007/05/powder-s#"
    xmlns:schema="http://schema.org/"
    xmlns:genont="http://www.w3.org/2006/gen/ont#"
    xmlns:pto="http://www.productontology.org/id/"
    xmlns:void="http://rdfs.org/ns/void#"
    xmlns:xsd="http://www.w3.org/2001/XMLSchema#">
  <schema:Book rdf:about="http://www.worldcat.org/oclc/559802511">
    <library:placeOfPublication>
      <schema:Place rdf:about="http://id.loc.gov/vocabulary/countries/enk">
        <dcterms:identifier>enk</dcterms:identifier>
      </schema:Place>
    </library:placeOfPublication>
    <library:oclcnum>559802511</library:oclcnum>
    <schema:inLanguage>en</schema:inLanguage>
    <schema:datePublished>1750</schema:datePublished>
    <schema:bookFormat rdf:resource="http://bibliograph.net/PrintBook"/>
    <schema:publication>
      <schema:PublicationEvent rdf:about="http://www.worldcat.org/title/-/oclc/559802511#PublicationEve
        <schema:location>
          <schema:Place rdf:about="http://dbpedia.org/resource/London">
            <schema:name>London</schema:name>
          </schema:Place>
        </schema:location>
        <schema:startDate></schema:startDate>
      </schema:PublicationEvent>
    </schema:publication>
    <schema:exampleOfWork rdf:resource="http://worldcat.org/entity/work/id/430841881"/>
    <schema:name xml:lang="en">A Letter from a Gentleman at Naples, concerning the late discovery of He
eruption of Mount Vesuvius.</schema:name>
    <library:placeOfPublication rdf:resource="http://dbpedia.org/resource/London"/>
    <rdf:type rdf:resource="http://schema.org/CreativeWork"/>
    <schema:creator>
      <schema:Person rdf:about="http://experiment.worldcat.org/entity/work/data/430841881#Person/hercul
        <schema:givenName>HERCULANEUM</schema:givenName>
        <schema:name>HERCULANEUM.</schema:name>
      </schema:Person>
    </schema:creator>
    <wdrs:describedby>
      <genont:ContentTypeGenericResource rdf:about="http://www.worldcat.org/title/-/oclc/559802511">
        <rdf:type rdf:resource="http://www.w3.org/2006/gen/ont#InformationResource"/>
        <schema:about rdf:resource="http://www.worldcat.org/oclc/559802511"/>
        <schema:dateModified>2018-11-10</schema:dateModified>
        <void:inDataset rdf:resource="http://purl.oclc.org/dataset/WorldCat"/>
      </genont:ContentTypeGenericResource>
    </wdrs:describedby>
    <schema:productID>559802511</schema:productID>
  </schema:Book>
</rdf:RDF>
```

Mijoux, Rhône-Alpes, France
January 15, 2018 at 1:57:50 PM · 824 of 4,264

HDR PORTRAIT

Info

Add a Title
IMG_0673.JPG
January 15, 2018 1:57:50 PM

Apple iPhone X
iPhone X back dual camera 6mm f/2.4
4032 × 3024 2.5 MB JPEG

ISO 16 6mm 0 ev ƒ/2.4 1/187s

Add a Description

Add a Keyword

Mijoux, Rhône-Alpes, France

Why Metadata Matters

Metadata makes good science.

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Scientific data must be FAIR

- In 2016, the “ **FAIR Guiding Principles for scientific data management and stewardship** ” were published in *Scientific Data*. The principles emphasize machine-actionability (i.e., the capacity of computational systems to find, access, interoperate, and reuse data with none or minimal human intervention) because humans increasingly rely on computational support to deal with data as a result of the increase in volume, complexity, and creation speed of data.

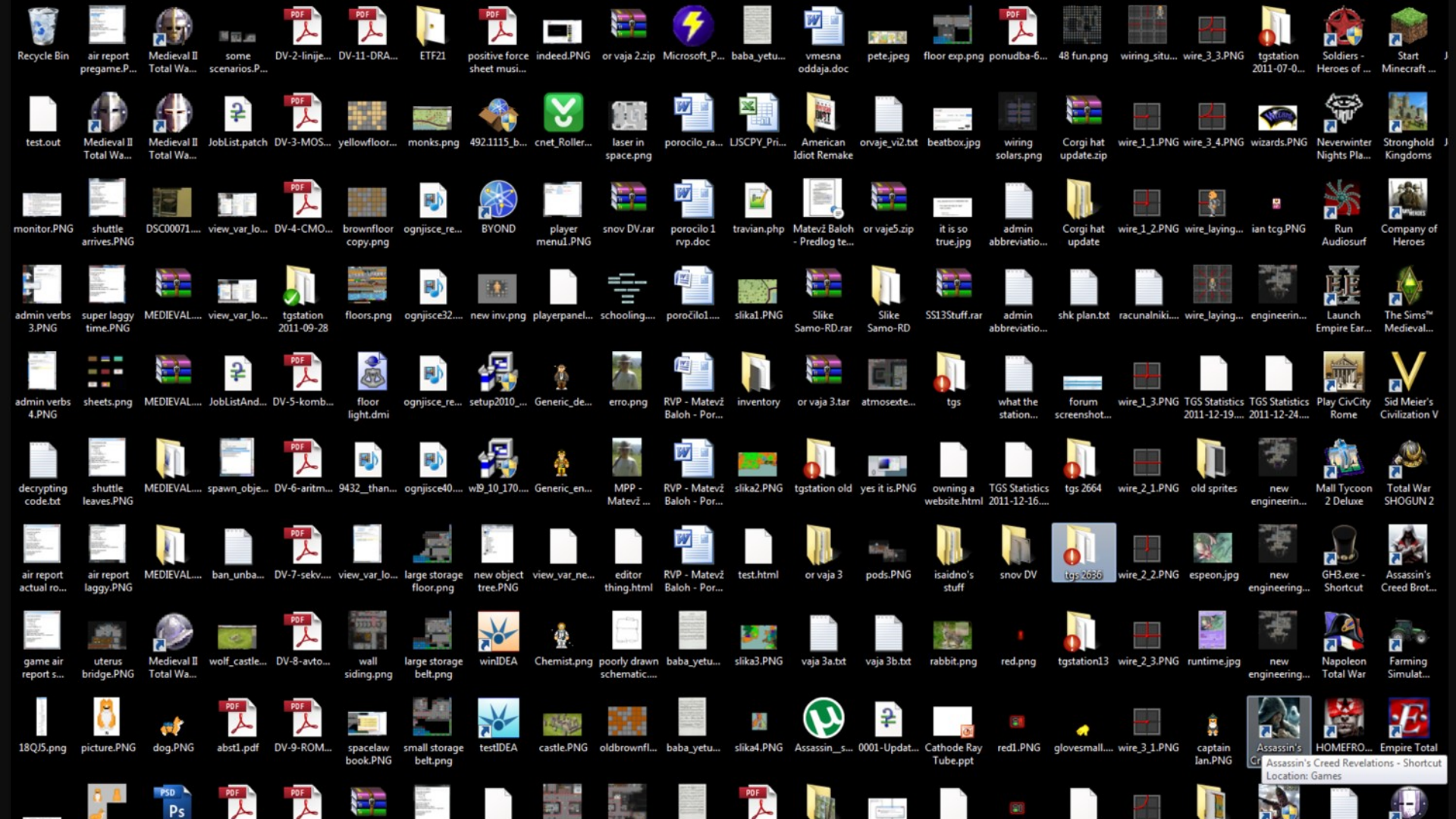
https://www.go-fair.org/

FAIR Data

Why Metadata Matters

If you tag it, they will find it.

If you don’t tag it, it doesn’t exist.


Recycle Bin
air report pregame.P...
Medieval II Total Wa...
some scenarios.P...
DV-2-linije...
DV-11-DRA...
ETF21
positive force sheet musi...
indeed.PNG
or vaja 2.zip
Microsoft_P...
baba_yetu...
vmesna oddaja.doc
pete.jpeg
floor exp.png
ponudba-6...
48 fun.png
wiring_situ...
wire_3_3.PNG
tgstation 2011-07-0...
Soldiers - Heroes of ...
Start Minecraft ...
test.out
Medieval II Total Wa...
Medieval II Total Wa...
JobList.patch
DV-3-MOS...
yellowfloor...
monks.png
492.1115_b...
cnet_Roller...
laser in space.png
porocilo_ra...
LJSCPY_Pri...
American Idiot Remake
orvaje_vi2.txt
beatbox.jpg
wiring solars.png
Corgi hat update.zip
wire_1_1.PNG
wire_3_4.PNG
wizards.PNG
Neverwinter Nights Pla...
Stronghold Kingdoms
monitor.PNG
shuttle arrives.PNG
DSC00071....
view_var_lo...
DV-4-CMO...
brownfloor copy.png
ognjisce_re...
BYOND
player menu1.PNG
snov DV.rar
porocilo 1 rvp.doc
travian.php
Matevž Baloh - Predlog te...
or vaje5.zip
it is so true.jpg
admin abbreviatio...
Corgi hat update
wire_1_2.PNG
wire_laying...
ian tcg.PNG
Run Audiosurf
Company of Heroes
admin verbs 3.PNG
super laggy time.PNG
MEDIEVAL....
view_var_lo...
tgstation 2011-09-28
floors.png
ognjisce32....
new inv.png
playerpanel...
schooling....
poročilo1....
slika1.PNG
Slike Samo-RD.rar
Slike Samo-RD
SS13Stuff.rar
admin abbreviatio...
shk plan.txt
racunalniki....
wire_laying...
engineerin...
Launch Empire Ear...
The Sims™ Medieval...
admin verbs 4.PNG
sheets.png
MEDIEVAL....
JobListAnd...
DV-5-komb...
floor light.dmi
ognjisce_re...
setup2010_...
Generic_de...
erro.png
RVP - Matevž Baloh - Por...
inventory
or vaja 3.tar
atmosexte...
tgs
what the station...
forum screenshot...
wire_1_3.PNG
TGS Statistics 2011-12-19....
TGS Statistics 2011-12-24....
Play CivCity Rome
Sid Meier's Civilization V
decrypting code.txt
shuttle leaves.PNG
MEDIEVAL....
spawn_obje...
DV-6-aritm...
9432__than...
ognjisce40....
wl9_10_170....
Generic_en...
MPP - Matevž ...
RVP - Matevž Baloh - Por...
slika2.PNG
tgstation old
yes it is.PNG
owning a website.html
TGS Statistics 2011-12-16....
tgs 2664
wire_2_1.PNG
old sprites
new engineerin...
Mall Tycoon 2 Deluxe
Total War SHOGUN 2
air report actual ro...
air report laggy.PNG
MEDIEVAL....
ban_unba...
DV-7-sekv....
view_var_lo...
large storage floor.png
new object tree.PNG
view_var_ne...
editor thing.html
RVP - Matevž Baloh - Por...
test.html
or vaja 3
pods.PNG
isaidno's stuff
snov DV
tgs 2636
wire_2_2.PNG
espeon.jpg
new engineering...
GH3.exe - Shortcut
Assassin's Creed Brot...
game air report s...
uterus bridge.PNG
Medieval II Total Wa...
wolf_castle...
DV-8-avto...
wall siding.png
large storage belt.png
winIDEA
Chemist.png
poorly drawn schematic....
baba_yetu...
slika3.PNG
vaja 3a.txt
vaja 3b.txt
rabbit.png
red.png
tgstation13
wire_2_3.PNG
runtime.jpg
new engineering...
Napoleon Total War
Farming Simulat...
18QJ5.png
picture.PNG
dog.PNG
abst1.pdf
DV-9-ROM...
spacelaw book.PNG
small storage belt.png
testIDEA
castle.PNG
oldbrownfl...
baba_yetu...
slika4.PNG
Assassin__s...
0001-Updat...
Cathode Ray Tube.ppt
red1.PNG
glovesmall....
wire_3_1.PNG
captain Ian.PNG
Assassin's Cr...
HOMEFRO...
Empire Total
Assassin's Creed Revelations - Shortcut
Location: Games

April 2, 2019 NOVA

https://www.youtube.com/watch?v=T76bK2t2r8g

Is it real, or is it IT black box magic?

Can I believe that what I see
is truly authentic?

The medical profession has an ethic: First, do no harm

Silicon Valley has an ethos: Build it first and ask for forgiveness later

https://www.nytimes.com/2018/02/12/business/computer-science-ethics-courses.html

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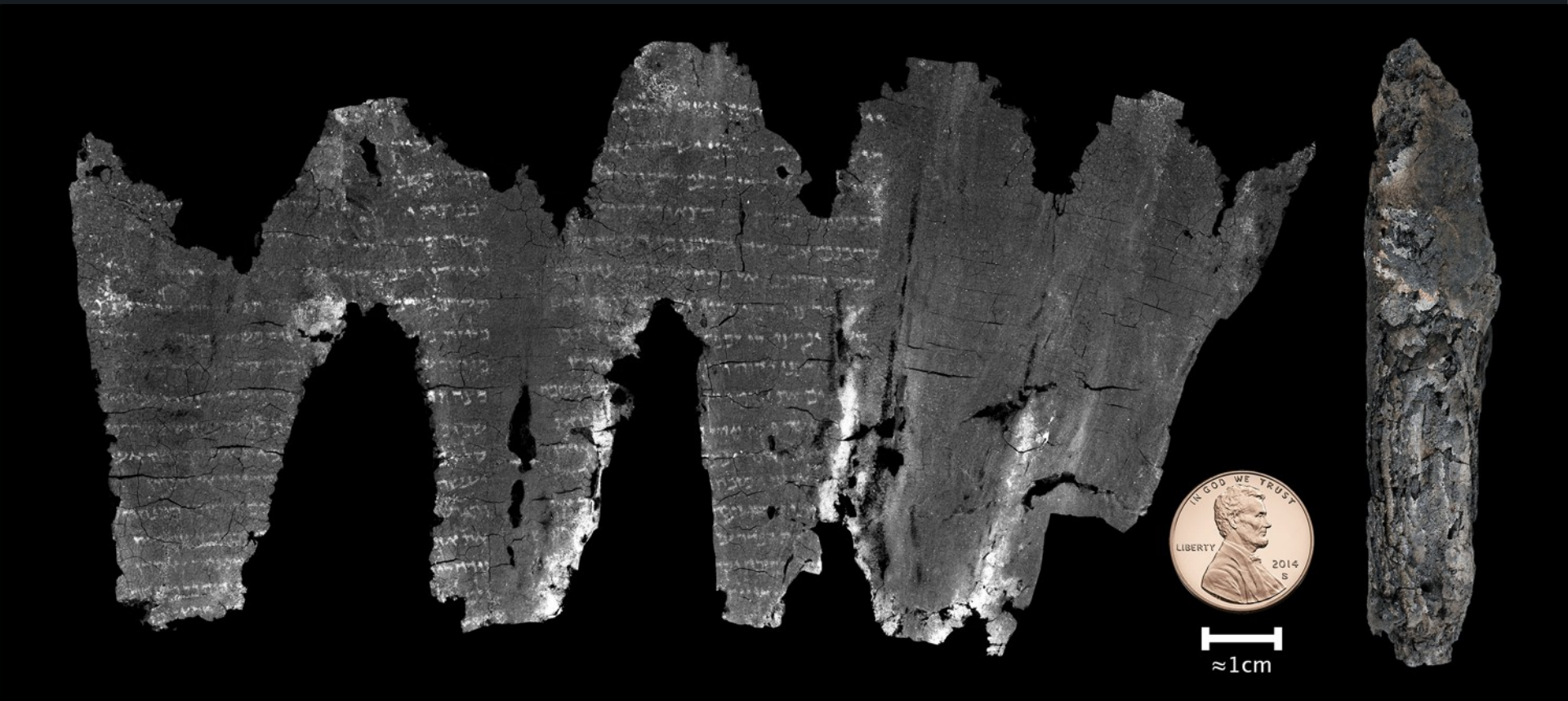
[Breaking News | Radiolab
http://www.wnycstudios.org/story/breaking-news/](http://www.wnycstudios.org/story/breaking-news/)

IRA KEMELMACHER-SHLIZERMAN, a professor in the computer science department at the University of Washington and also works at Facebook.

What does this have to do with me?



Computer Science > Computer Vision and Pattern Recognition

[Submitted on 26 Aug 2015 (v1), last revised 2 Sep 2015 (this version, v2)]

A Neural Algorithm of Artistic Style

Leon A. Gatys, Alexander S. Ecker, Matthias Bethge

In fine art, especially painting, humans have mastered the skill to create unique visual experiences through composing a complex interplay between the content and style of an image. Thus far the algorithmic basis of this process is unknown and there exists no artificial system with similar capabilities. However, in other key areas of visual perception such as object and face recognition near-human performance was recently demonstrated by a class of biologically inspired vision models called Deep Neural Networks. Here we introduce an artificial system based on a Deep Neural Network that creates artistic images of high perceptual quality. The system uses neural representations to separate and recombine content and style of arbitrary images, providing a neural algorithm for the creation of artistic images. Moreover, in light of the striking similarities between performance-optimised artificial neural networks and biological vision, our work offers a path forward to an algorithmic understanding of how humans create and perceive artistic imagery.

Subjects: **Computer Vision and Pattern Recognition (cs.CV)**; Neural and Evolutionary Computing (cs.NE); Neurons and Cognition (q-bio.NC)
Cite as: arXiv:1508.06576 **[cs.CV]**
(or arXiv:1508.06576v2 **[cs.CV]** for this version)

Submission history


A
B
C
D

Is it real, or is it IT black box magic?

Can I believe that what I see is truly authentic?

Ethics of the computer scientist demand they consider how their tools will be used and design protections against nefarious uses in the software.

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The Oath recited by an inductee of The Pledge of the Computer Professional is:

I am a Computing Professional.

My work as a Computing Professional affects people's lives, both now and into the future.

As a result, I bear moral and ethical responsibilities to society.

As a Computing Professional, I pledge to practice my profession with the highest level of integrity and competence.

I shall always use my skills for the public good.

I shall be honest about my limitations, continuously seeking to improve my skills through life-long learning.

I shall engage only in honorable and upstanding endeavors.

By my actions, I pledge to honor my chosen profession.

Students taking the Pledge

http://pledge-of-the-computing-professional.org/home-page/the-oath

The Ten Commandments of Computer Ethics

1. Thou shalt not use a computer to harm other people.
2. Thou shalt not interfere with other people's computer work.
3. Thou shalt not snoop around in other people's computer files.
4. Thou shalt not use a computer to steal.
5. Thou shalt not use a computer to bear false witness.
6. Thou shalt not copy or use proprietary software for which you have not paid.
7. Thou shalt not use other people's computer resources without authorization or proper compensation.
8. Thou shalt not appropriate other people's intellectual output.
9. Thou shalt think about the social consequences of the program you are writing or the system you are designing.
10. Thou shalt always use a computer in ways that ensure consideration and respect for your fellow humans.

http://computerethicsinstitute.org/home.html

ACM Code of Ethics

https://www.acm.org/code-of-ethics

1.1 Contribute to society and to human well-being, acknowledging that all people are stakeholders in computing.

This principle, which concerns the quality of life of all people, affirms an obligation of computing professionals, both individually and collectively, to use their skills for the benefit of society, its members, and the environment surrounding them. This obligation includes promoting fundamental human rights and protecting each individual's right to autonomy. An essential aim of computing professionals is to minimize negative consequences of computing, including threats to health, safety, personal security, and privacy. When the interests of multiple groups conflict, the needs of those less advantaged should be given increased attention and priority.

Computing professionals should consider whether the results of their efforts will respect diversity, will be used in socially responsible ways, will meet social needs, and will be broadly accessible.

ACM Code of Ethics

https://www.acm.org/code-of-ethics

1.2 Avoid harm. **In this document, "harm" means negative consequences, especially when those consequences are significant and unjust. Examples of harm include unjustified physical or mental injury, unjustified destruction or disclosure of information, and unjustified damage to property, reputation, and the environment. This list is not exhaustive. Well-intended actions, including those that accomplish assigned duties, may lead to harm. When that harm is unintended, those responsible are obliged to undo or mitigate the harm as much as possible.**

Avoiding harm begins with careful consideration of potential impacts on all those affected by decisions. When harm is an intentional part of the system, those responsible are obligated to ensure that the harm is ethically justified. In either case, ensure that all harm is minimized. To minimize the possibility of indirectly or unintentionally harming others, computing professionals should follow generally accepted best practices unless there is a compelling ethical reason to do otherwise. Additionally, the consequences of data aggregation and emergent properties of systems should be carefully analyzed. Those involved with pervasive or infrastructure systems should also consider Principle 3.7.\A computing professional has an additional obligation to report any signs of system risks that might result in harm. If leaders do not act to curtail or mitigate such risks, it may be necessary to "blow the whistle" to reduce potential harm. However, capricious

ACM Code of Ethics

https://www.acm.org/code-of-ethics

3.1 Ensure that the public good is the central concern during all professional computing work.

People—including users, customers, colleagues, and others affected directly or indirectly—should always be the central concern in computing. The public good should always be an explicit consideration when evaluating tasks associated with research, requirements analysis, design, implementation, testing, validation, deployment, maintenance, retirement, and disposal. Computing professionals should keep this focus no matter which methodologies or techniques they use in their practice.

Is it real, or is it IT black box magic?

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Metadata helps us determine the answer.

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Why is metadata important?

Digital Provenance

Tags are like a trail of breadcrumbs, any single element alone isn’t too helpful, but together they can lead us to the truth about a digital object.

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UC Merced, Library and Special Collections > Clark Center for Japanese Art and Culture collection > 美人競艶図

Image set / 美人競艶図

Set contains 5 items. Jump to first item Jump to last item

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Summary Information.

Title	美人競艶図
Alternative Title	Set of five bijin-ga
Creator	Yamaguchi, Soken, 1759-1818


```
<mods:mods>
  <mods:titleInfo>
    <mods:title>美人競艶図</mods:title>
  </mods:titleInfo>
  <mods:titleInfo type="alternative" displayLabel="English Title">
    <mods:title>Set of five bijin-ga</mods:title>
  </mods:titleInfo>
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    <mods:namePart type="date">1759-1818</mods:namePart>
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    </mods:role>
  </mods:name>
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  <mods:genre authority="aat">pentaptychs</mods:genre>
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  <mods:genre authority="aat">Ukiyo-e</mods:genre>
  <mods:genre authority="aat">pentaptychs</mods:genre>
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    <mods:place>
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    </mods:place>
    <mods:dateCreated>undated</mods:dateCreated>
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    <mods:dateCreated encoding="iso8601" point="end">1818</mods:dateCreated>
  </mods:originInfo>
  <mods:physicalDescription>
    <mods:extent>5 hanging scrolls, 179 x 93 cm. each</mods:extent>
    <mods:note type="marks">
      No signature, seals, or inscriptions on paintings. Box inscriptions reads "美人六幅__山口素絢画."
    </mods:note>
    <mods:note type="medium">ink and colors on paper</mods:note>
  </mods:physicalDescription>
  <mods:note type="exhibitions">
```

Sample METS Metadata File

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  <mix:BasicDigitalObjectInformation>
    <mix:FormatDesignation>
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    </mix:FormatDesignation>
    <mix:Compression>
      <mix:compressionScheme>Uncompressed</mix:compressionScheme>
    </mix:Compression>
  </mix:BasicDigitalObjectInformation>
  <mix:BasicImageInformation>
    <mix:BasicImageCharacteristics>
      <mix:PhotometricInterpretation>
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      </mix:PhotometricInterpretation>
    </mix:BasicImageCharacteristics>
  </mix:BasicImageInformation>
  <mix:ImageCaptureMetadata>
    <mix:GeneralCaptureInformation>
      <mix:imageProducer>UC Merced Library</mix:imageProducer>
      <mix:captureDevice>transmission scanner</mix:captureDevice>
    </mix:GeneralCaptureInformation>
    <mix:ScannerCapture>
      <mix:scannerManufacturer>Fuji</mix:scannerManufacturer>
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  <mix:ImageAssessmentMetadata>
    <mix:SpatialMetrics>
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      </mix:xSamplingFrequency>
      <mix:ySamplingFrequency>
        <mix:numerator>761</mix:numerator>
      </mix:ySamplingFrequency>
    </mix:SpatialMetrics>
    <mix:ImageColorEncoding>
      <mix:bitsPerSample>
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        <mix:bitsPerSampleUnit>integer</mix:bitsPerSampleUnit>
      </mix:bitsPerSample>
      <mix:samplesPerPixel>3</mix:samplesPerPixel>
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  </mix:ImageAssessmentMetadata>
```

```
<mix:BasicDigitalObjectInformation>
  <mix:FormatDesignation>
    <mix:formatName>image/jpeg</mix:formatName>
  </mix:FormatDesignation>
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    <mix:compressionScheme>JPEG Baseline Sequential</mix:compressionScheme>
  </mix:Compression>
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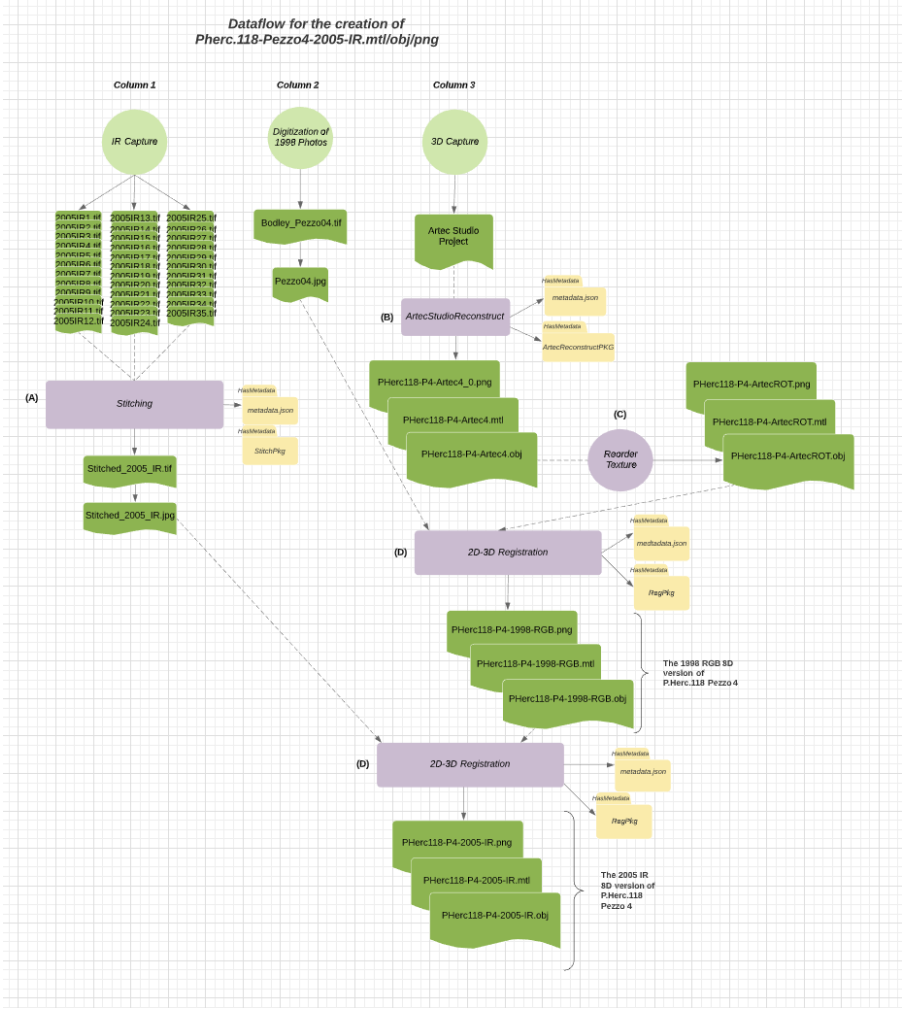
    </mix:ProcessingSoftware>
  </mix:ImageProcessing>
</mix:ChangeHistory>
```


Pezzo 6.
N. 118.
© Bodleian


Dataflow for the creation of
Pherc.118-Pezzo4-2005-IR.mtl/obj/png
Column 1
Column 2
Column 3
IR Capture
Digitization of 1998 Photos
3D Capture
2005IR13.tif
2005IR25.tif
2005IR12.tif
2005IR24.tif
2005IR35.tif
Bodley_Pezzo04.tif
Pezzo04.jpg
Artec Studio Project
(A)
Stitching
HasMetadata
metadata.json
StitchPkg
Stitched_2005_IR.tif
Stitched_2005_IR.jpg
(B)
ArtecStudioReconstruct
ArtecReconstructPKG
PHerc118-P4-Artec4_0.png
PHerc118-P4-Artec4.mtl
PHerc118-P4-Artec4.obj
(C)
Reorder Texture
PHerc118-P4-ArtecROT.png
PHerc118-P4-ArtecROT.mtl
PHerc118-P4-ArtecROT.obj
(D)
2D-3D Registration
RegiPkg
PHerc118-P4-1998-RGB.png
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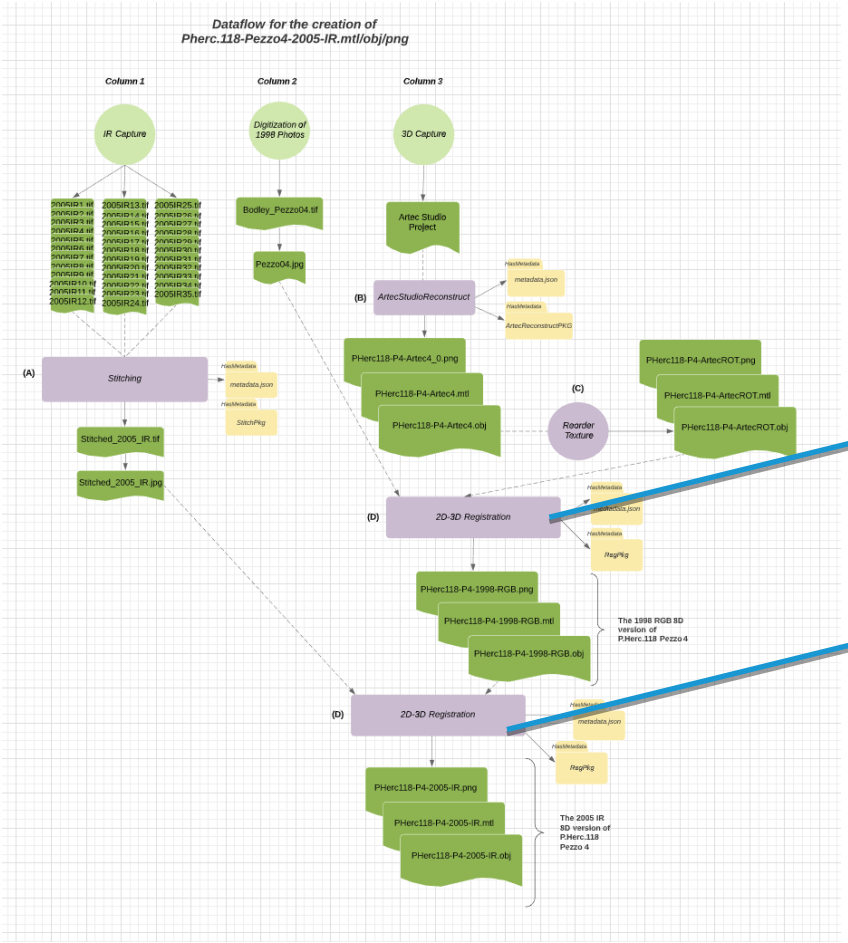
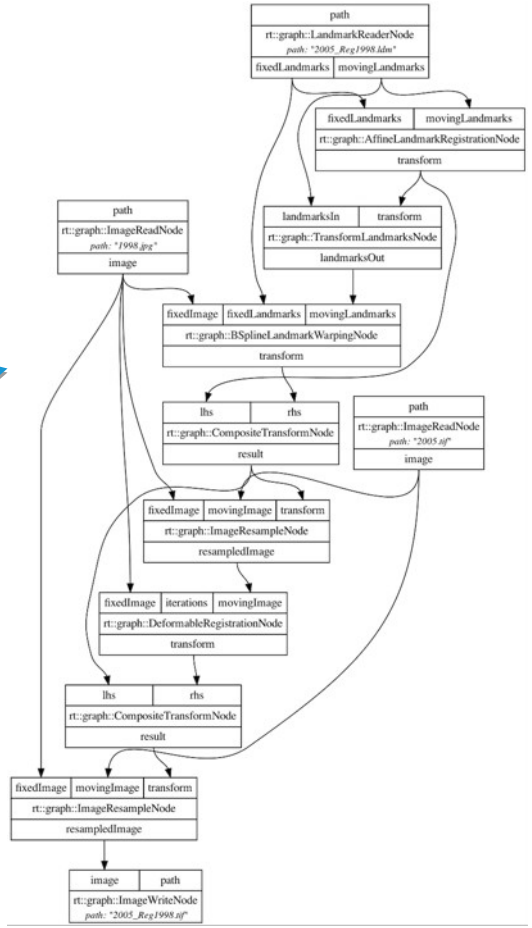
PHerc118-P4-1998-RGB.obj
The 1998 RGB 8D version of P.Herc.118 Pezzo 4
PHerc118-P4-2005-IR.png
PHerc118-P4-2005-IR.mtl
PHerc118-P4-2005-IR.obj
The 2005 IR 8D version of P.Herc.118 Pezzo 4





Metadata for 3D Models

model_repository_id	Model	-	Unique id of the Model Record within the repository, assigned when the Model is entered into the repository. Used to reference the Model Record in other repository records.
model_guid	Model	-	GUID of the model, only appible if the records 'model_purpose' element is 'master'
model_file_name	Model	-	Contains the name of the file as it appears in the file system.
model_file_type	Model		Specifies the file type of the model file
date_of_creation	Model	-	Date model was created
derived_from	Model	-	Contains the repository id's of the datasets and/or models that went into creating a model.
creation_method	Model	-	Method used to create model
model_modality	Model	-	Type of information represented in the model file, either a point cloud data or a surface mesh
units	Model	-	Units that should be used to interpret the models scale
model_purpose	Model	-	Use of model. Either identifies a model as an intermediate processing step informative enough to be saved, a master model, or a derivative of a master model for a specific use or delivery method.
registered to			We need a way to track if models are registered to each other and how their transform files should be used
point_count	Model	Point Cloud Attributes	Number of points in a model
has_normals	Model	Point Cloud Attributes	Boolean for if the model has normals
is_watertight	Model	Mesh Attributes	Boolean for if the model is watertight
face_count	Model	Mesh Attributes	Number of faces in a model
vertices_count	Model	Mesh Attributes	Number of vertices in a model
has_vertex_color	Model	Mesh Attributes	Boolean for if the model has vertex color
has_uv_space	Model	Mesh Attributes	Boolean for if the model has uv space
mesh style			Do we need to track if a model is based on triangles, quads, nerbs...?
model_maps	Model	Mesh Attributes	Contains the value in the 'uv_map_repository_id" element in the parent UV Map Record. Used to identify the UV Maps to used with a given Model

https://dpo.si.edu/blog/smithsonian-3d-metadata-model

Metadata for Machine Learning

Schelter, S., Böse, J., Kirschnick, J., Klein, T., & Seufert, S. (2017). Automatically Tracking Metadata and Provenance of Machine Learning Experiments.

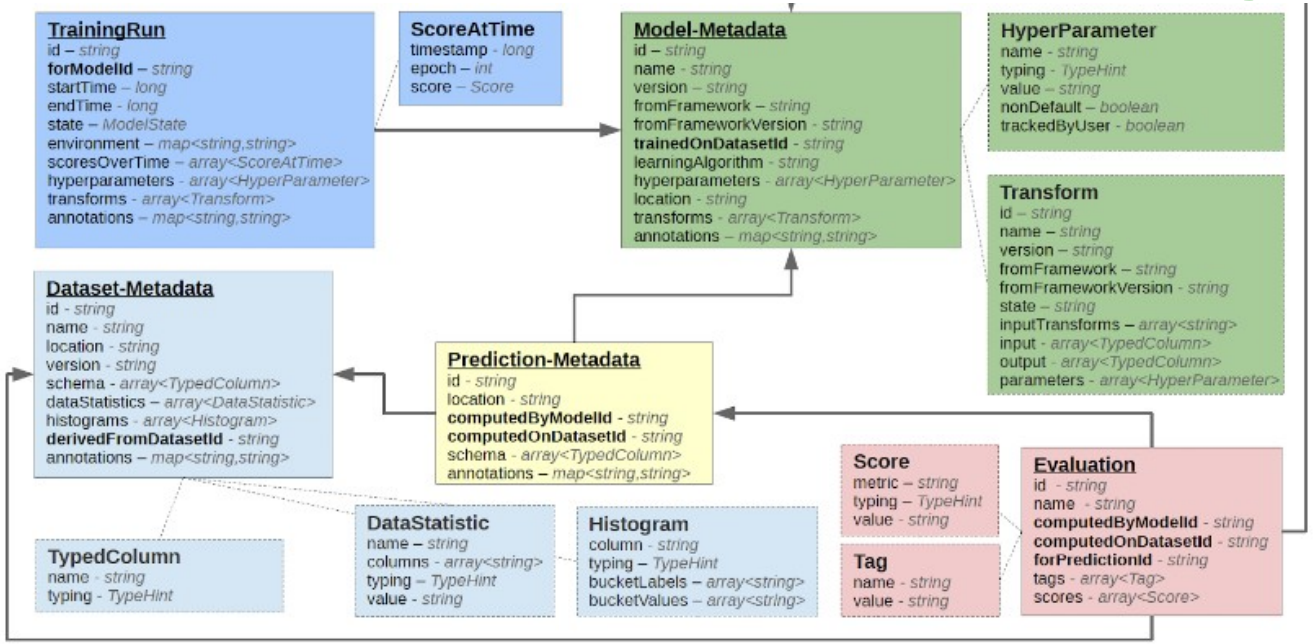


Figure 2: Simplified version of our schema used to store artifact metadata and lineage information. A detailed version available under Apache license can be found at `https://github.com/awslabs/ml-experiments-schema`. Bold attributes indicate lineage relationships and every entity can be extended via arbitrary key-value pairs stored in the annotation attribute.