

Archaeology 4.0: Archaeology in the Third Era of Computing

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Abstract

We are in the middle of the digital transformation era, which, as a digital revolution, affects society in economic as well as in scientific terms. This digital revolution as a third part of industrial revolution is based on digital technologies that have already become established in individual stages in various areas of life. Terms such as Industry 4.0, Work 4.0 and Web 4.0 are lived reality in our digital society.

Archeology has also undergone a digital transformation from an analogous science to an Archaeology 4.0. Starting with an *analogue era*, in which research data was kept in books, followed by a *digital era* in which digitization progresses and data are published on the WWW, followed by a *semantic era*, in which semantic modelling and publication of Linked Data is reality, we end up in a *knowledge era*, in which the analysis and the creation of new knowledge through machines will be reality.

Key words: Archaeology 4.0; Linked Data; Semantic Reasoning; Artificial Intelligence.

1 Archaeological Evolution

Today, in 2019 we are living in the centre of the Digital Transformation era. The digital transformation affects all kind of 'humanoid' and 'machine' communities: individuals and society, state, companies and science (research/teaching). In archaeology, researcher develop and use new digital technologies. This results in positive effects on science and archaeology itself. The state promotes (e.g. funding by the Federal Ministry of Education and Research - BMBF) and uses these digital technologies and serves as a regulator. Also the society is using more and more digital technologies. Companies are developing and using new digital technologies as well.

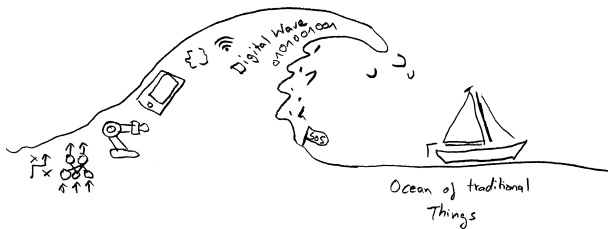


Fig. 1. The Digital and the Ocean of Traditional Things, Florian Thiery [CC BY 4.0]

Thus, science and archaeology should seek collaboration with companies to positively influence the state and society through digital technologies. But does the digital wave overtake us? (Fig. 1) We should surf the wave! On a first wave of digitalisation we have already recorded, saved, transmitted and processed machine-readable data via internet and cloud computing technologies. Furthermore, on the second wave of digitalisation we have to analyse, enhance and use these research data in active ways as machine-interpretable data using artificial intelligence and machine learning.

While surfing the waves, we actively experience the evolution of archaeology from analogue data to Knowledge Graph Computing. That is what I will call Archaeology 4.0 (Fig. 2).



Fig. 2. Archaeology 4.0, Florian Thiery [CC BY 4.0]

Email address: rse@fthiery.de (Florian Thiery).

Archaeological Sciences fulfilled a digital transformation from an 'analogous science' to modern digital science of humanities. Starting from an *analogue era* (Archaeology 1.0), in which research data was kept in books and monographs, across the *digital era* (Archaeology 2.0) in which digitisation progresses and data are published on the WWW, to a *semantic era* (Archaeology 3.0), where semantic modelling and publication of Linked Data prevail, we end up in a *knowledge era* (Archaeology 3.0), in which the analysis and the creation of new knowledge through a machine results.

1.1 Archaeology 1.0



Fig. 3. Archaeology 1.0 Symbol, pixabay [Pixabay License]

I will call the era of non digital things ('analogue') the *analogue era*. Research, and its underlying data, was published in printed books and monographs. Data access was only possible via active visiting libraries or complicated interlibrary loan. Research Data was not 'OPEN' at this time, because it was a privilege of an individual.

1.2 Archaeology 2.0



Fig. 4. Archaeology 2.0 Symbol, pixabay [Pixabay License]

I will call the time using and creating digital things the *digital era*. With the invention of the Internet in ≈ 1969 by Vinton Gray Cerf ('father of the internet') and others and the invention of the World Wide Web in 1989 by computer scientist Sir Tim Berners-Lee and the so born Web 1.0 digital methods in archaeology come into play. (Archaeological) Research Data is from now on not exclusive any more, it is accessible for everyone via searchable online databases or PDF documents. The Web 2.0 including its so called 'Social Media' and the collaborative potential like Wikipedia and Google Docs enlarge the odds of shared archaeological research around the globe. The new possibilities of digitalisation methods of photographs and 3D documentation, using image analysis and 3D techniques, expand the range even more.

1.3 Archaeology 3.0

Web 3.0 Semantic Web, RDF, Triples, Ontologien, CIDOC CRM

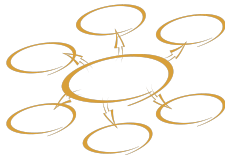


Fig. 5. Archaeology 3.0 Symbol, pixabay [Pixabay License]

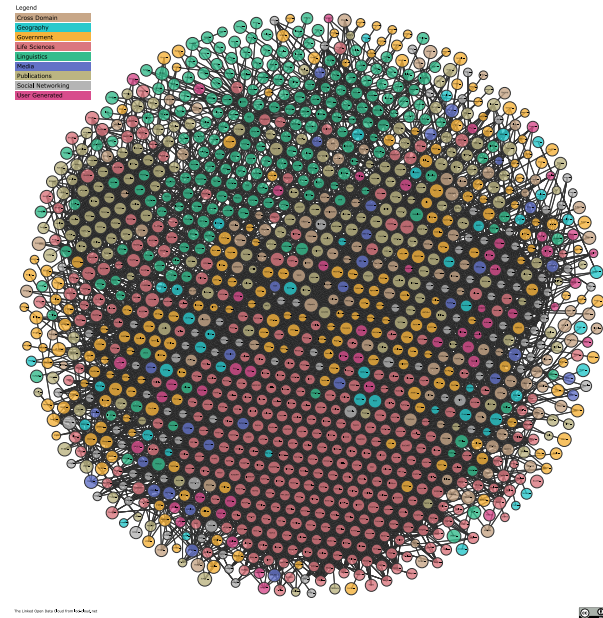


Fig. 6. Linked Open Data Cloud 2019-03-29, lod-cloud.net [CC BY 4.0]

Linked Data Modellierung, 5 Star Open Data

Projekte fr Ressourcen im Netz

GeoNames, Pleaides, Pelagios, Chronontoogy, Getty, Nomisma

Beispiele in PhD von Leif und meiner Ma

- [1]
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- [6]

Ziele eine Linkd Archiaological Data Cloud

Problem

Techniken der Archologie 4.0 bentigen oft groe Mengen an Trainingsdaten, (BigData) die in der Archologie (noch) nicht vorhanden sind.

Daten mittels Archologie 3.0 semantisch u archologisch korrekt mit Metadaten beschreiben UND verlinken, so

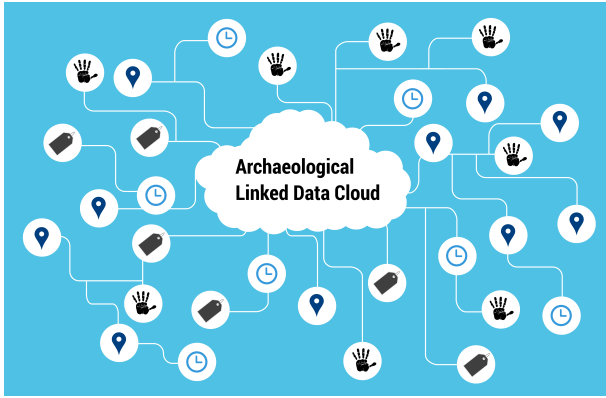


Fig. 7. Archaeological Linked Data Cloud, Florian Thiery [CC BY 4.0]

dass eine verlinkte Archologische Data Cloud als breitere Basis fr Trainingsdaten entsteht.

1.4 Archaeology 4.0



Fig. 8. Archaeology 4.0 Symbol, pixabay [Pixabay License]

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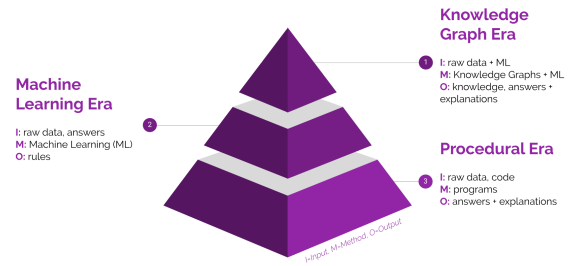


Fig. 9. Era of Computing, Florian Thiery [CC BY 4.0]

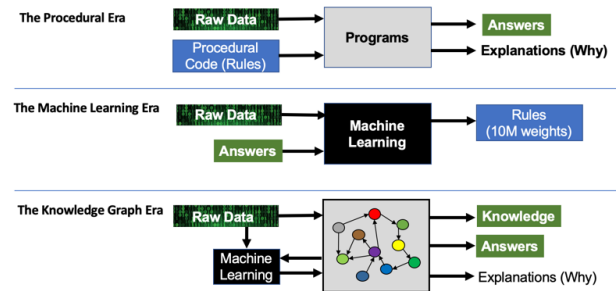


Fig. 10. Era of Computing, Dan McCreary [5]

and Römisch-Germanisches Zentralmuseum. In particular Prod. Dr. Kai-Christian-Bruhn (ORCID: 0000-0001-8322-1260) and Dr. Allard Mees FSA (ORCID: 0000-0002-7634-5342).

References

- [1] Tim Berners-Lee. Linked Data - Design Issues, July 2006.
- [2] Michael Hausenblas and James G. Boram Kim. 5-star Open Data, August 2015.
- [3] Anthony J. G. Hey and Gyuri Ppay. *The computing universe: a journey through a revolution*. Cambridge University Press, New York, NY, USA, 2015.
- [4] Leif Isaksen. *Archaeology and the Semantic Web*. phd, University of Southampton, December 2011.
- [5] Dan McCreary. Knowledge Graphs: The Third Era of Computing, March 2019.
- [6] Florian Thiery. *Semantic Web und Linked Data: Generierung von Interoperabilität in archäologischen Fachdaten am Beispiel römischer Toepferstempel*. master thesis, Fachhochschule Mainz, December 2013.