

Computer Aided Archaeology

01 - Introduction

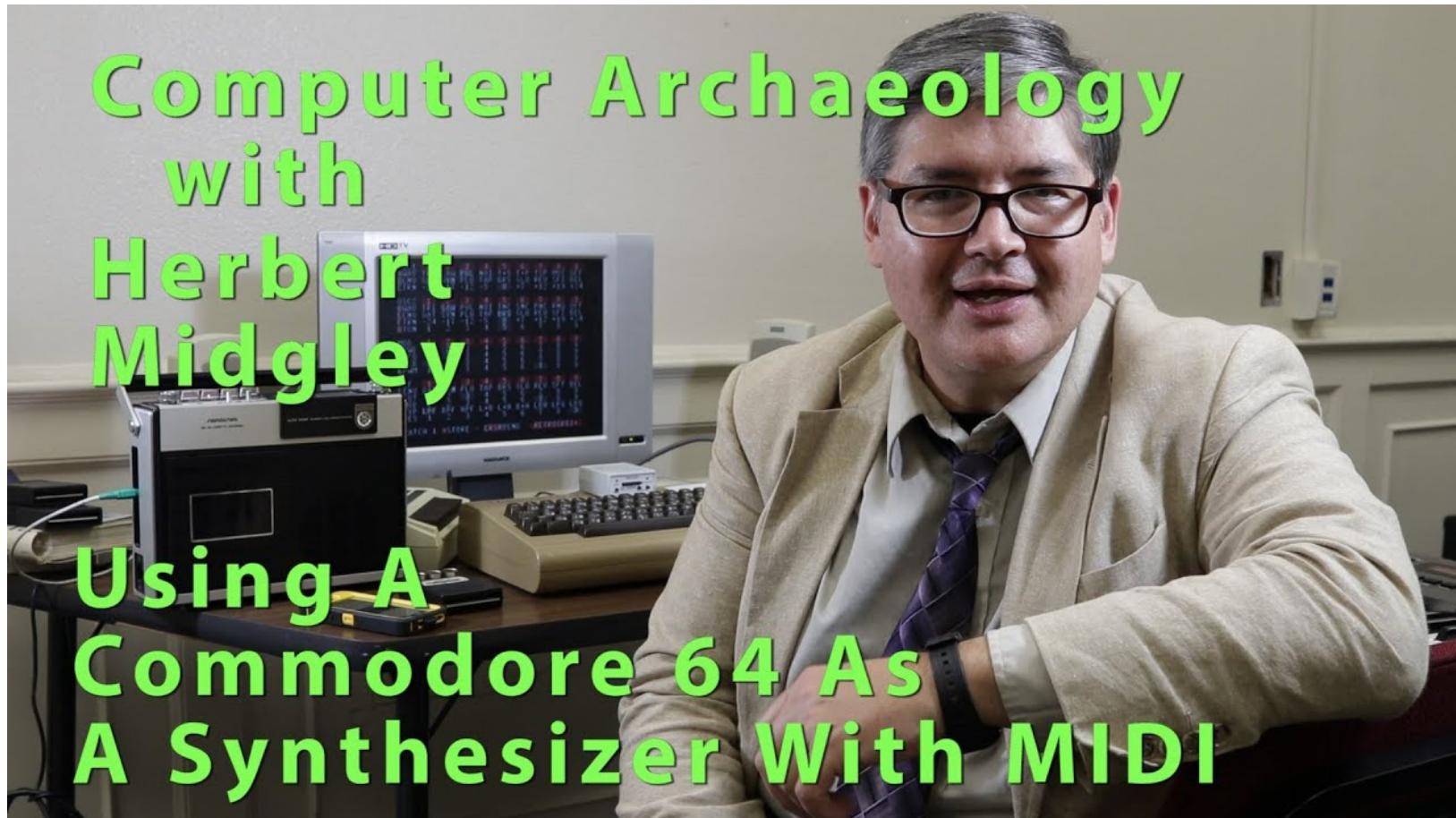
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Institut für Archäologische Wissenschaften, Universität Bern

20/09/23

What is not computer aided archaeology

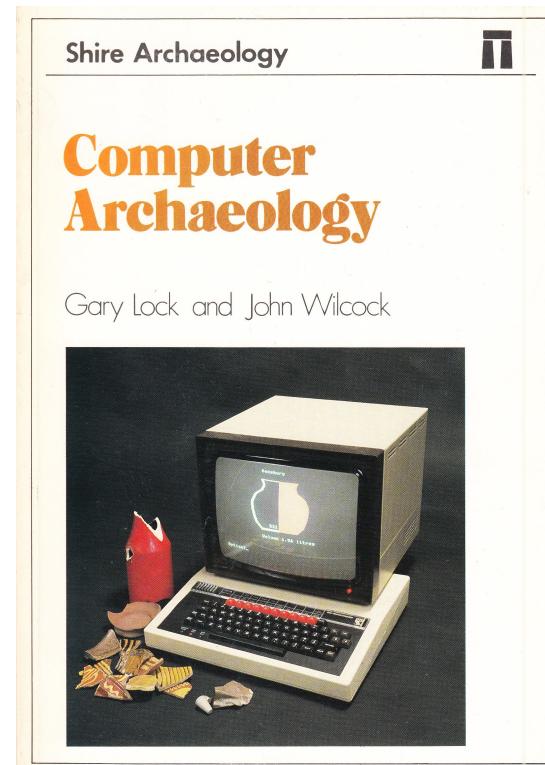
in relation to our course



What is computer aided archaeology

Topics^{*}

1. The use of **digital data** in archaeological research.
2. The general **use of computers** in archaeological research.
3. The use of **computational algorithms to fill gaps in archaeological data** in ways that can't be done with traditional techniques.
4. **Data mining and multidimensional analyses** of archaeological data.
5. The use of **simulation models and artificial intelligence** to understand the processes and dynamics of past societies.
6. The use of **computer visualizations** to create immersive **virtual** experiences of archaeological sites and materials



[*] from <http://isaacullah.github.io/What-is-Computational-Archaeology/>

What is computer aided archaeology

Fields^{*}

1. **GIS and geospatial data analysis.**
2. **Digital imagery and photogrammetry.**
3. **Statistical computing and quantitative analysis.**
4. **Data visualization.**
5. Agent Based Modeling and simulation.
6. 3D modeling, virtual reality, and augmented reality.
7. Video gaming and digital animation.



Sorry, no fancy 3D Modelling (this time)

We will touch the **highlighted** subjects.

[*] from <http://isaacullah.github.io/What-is-Computational-Archaeology/>

Other terms

- Computational Archaeology
 - Cyber Archaeology
 - Digital Archaeology
 - Archaeoinformatics
 - Digital Humanities



IT BUZZWORD

| B | I | N | G | O |
|--------------------|---------------------------------------|--------------------------------|----------------------|-----------------------------------|
| As a service | Cyber | Cloud | NextGen | "Hack", improperly used |
| Machine learning | Future-proof | Blockchain | Single pane of glass | Synergy |
| Internet of Things | crypto-anything" | Hyper-converged infrastructure | leveraged | Artificial intelligence (or A.I.) |
| Turnkey | Big data | Digital transformation | Outside the Box | Cloud, again |
| Thought leader | Drone, used instead of RC Quad-copter | Seamless integration | game changer | App(s) |

Schedule

| date | title | topics |
|----------|--------------------------------|---|
| 20.09.23 | Introduction | Overview;Organisation;Software to be used |
| 27.09.23 | Your Computer as research tool | Basic Scientific Software;Online Ressources;Digital Data;Spreadsheets and Databases;Reference management tools (Zotero) |
| 04.10.23 | Data Bases I | What is a Database;ER-Model;Normalisation |
| 11.10.23 | Data Bases II | Example Archaeological Database;Tables;Relationships;Forms;Data Entry;Queries |
| 18.10.23 | Visualisation I | General Charts;Pie Charts;Bar Charts;Scatterplots;Box Plots;Histogram;Kernel Plots |
| 25.10.23 | Visualisation II | Seriation;Correspondence Analysis |
| 01.11.23 | Basic Statistics | Overview;Sample & Population;Scales of Measurement;Hypothesis testing; χ^2 -test |
| 08.11.23 | GIS I | Overview;Coordinate Systems and Projection;Georeferencing;Digitising |
| 15.11.23 | GIS II | Simple Mapping;Heatmap;Thematic map;Exporting maps |
| 22.11.23 | 14C Calibration I | 14C Basics;Calibration Background;OxCal;Simple Calibration |
| 29.11.23 | 14C Calibration II | OxCal Combine;Sequential Calibration |
| 06.12.23 | No Meeting | |
| 13.12.23 | Project Presentations | Presentation of the Students Projects |
| 20.12.23 | Digital Documentation/Survey | |

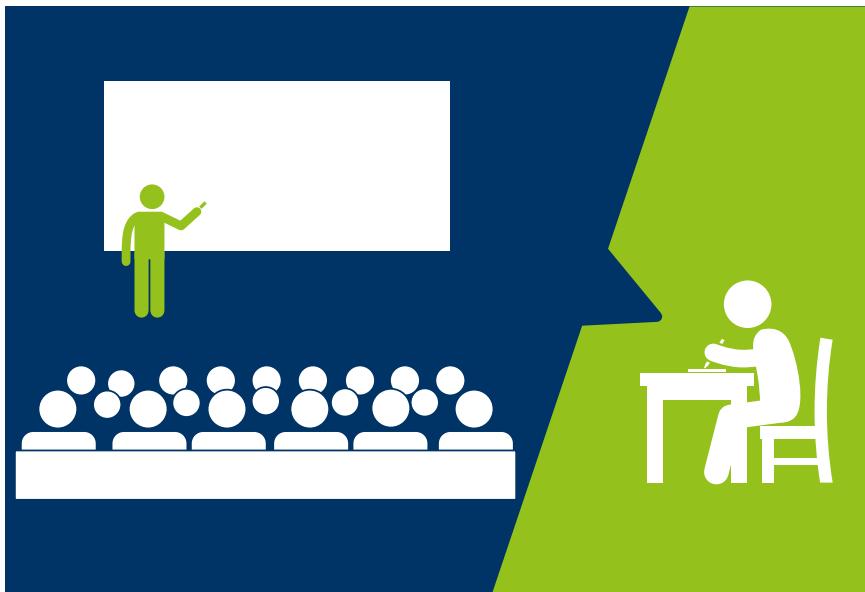
Learning Content

In presence as frontal lecture

Applying Content

On your own as homework

Konventionelle Lehre



Learning Content

On your own at home

Applying Content

Supervised in presence

Inverted Classroom



source: <https://dbs-lin.ruhr-uni-bochum.de/lehreladen/e-learning-technik-in-der-lehre/inverted-classroom/was-ist-inverted-classroom>

Website

<https://berncodalab.github.io/caa>

Computers as research tools

What is it

- review literature
- collect data
- structure information
- process images
- write a paper



vs.



Computers as research tools

only session

- Types of Digital Data
 - Working with Digital Data
 - Software suggestions
 - Using citation software

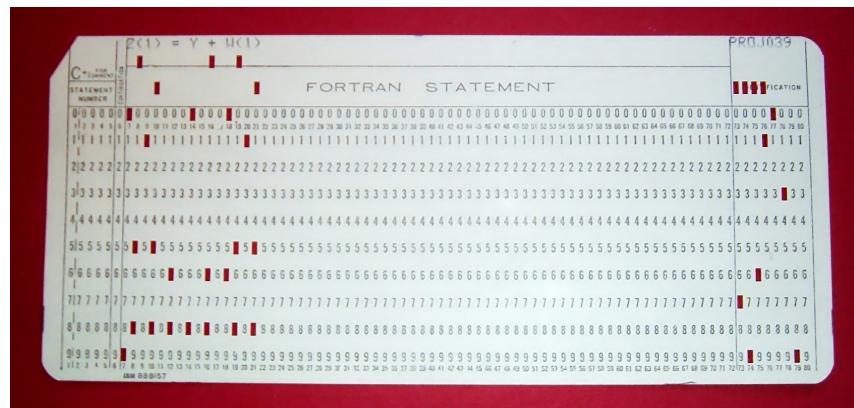


This one sparks joy.



This one does not spark joy.

- structuring your research environment
 - working with open and sustainable formats
 - glimpse on
 - markdown
 - latex
 - version control



Databases

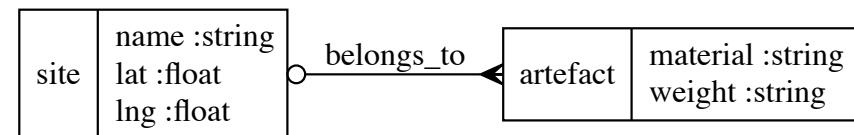
What is it

A database is an organized collection of data, generally stored and accessed electronically from a computer system. - Wikipedia

- on one computer -> for personal data organisation
 - Libre Office, MS Access, Sqlite
 - single file
- server - client, often web based
 - PostgreSQL, MySQL
 - data exchange and collaborative data management

Relates different information on different abstraction levels eg.:

1 site <-> multiple artefacts

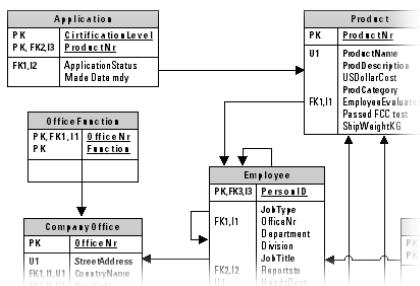


Databases

First section

Create a simple data base

- site information
- artefact information
- lookup tables



Topics

- data normalisation
- table design
- variable types
- form creation

Students

| FirstName | LastName | Knowledge |
|-----------|----------|----------------|
| Thomas | Mueller | Java, C++, PHP |
| Ursula | Meier | PHP, Java |
| Igor | Mueller | C++, Java |

Startsituation

Result after Normalisation

Students

| FirstName | LastName | Knowledge |
|-----------|----------|-----------|
| Thomas | Mueller | C++ |
| Thomas | Mueller | PHP |
| Thomas | Mueller | Java |
| Ursula | Meier | Java |
| Ursula | Meier | PHP |
| Igor | Mueller | Java |
| Igor | Mueller | C++ |

Databases

Second section

Retrieve informations from the data base

- queries
- joining tables
- exporting data



Topics

- query logic
- sql
- csv

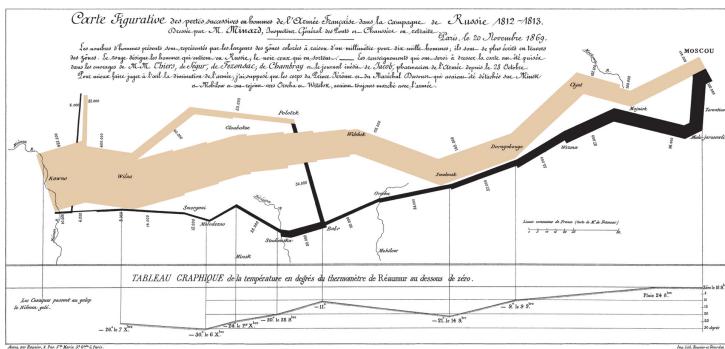


Visualisation

What is it

Data visualization is the graphic representation of data. It involves producing images that communicate relationships among the represented data to viewers of the images. - wikipedia

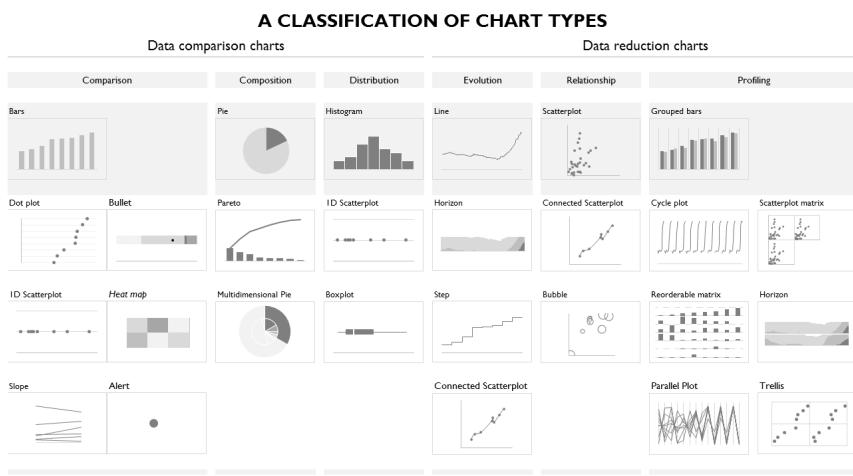
- 'statistical' charts like barcharts, pie charts, scatterplots...
- humans are visual animals
- explore data / find structures
- visualise multidimensional relationships



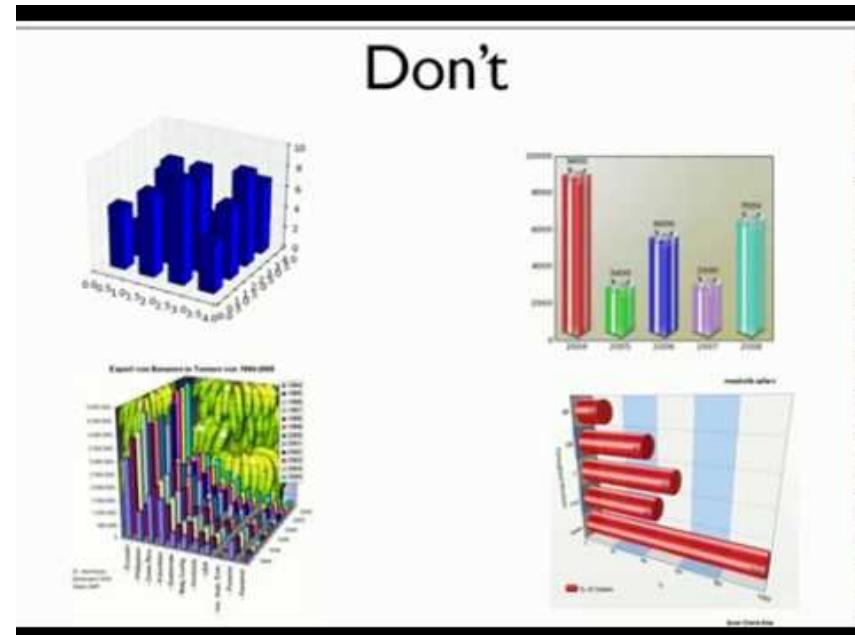
Visualisation

First section

- prepare your data for visualisation
- Basic visualisation using spreadsheet software (LibreOffice Calc)
- export for later (re)use



- handling spreadsheet software
- scatterplots, bar charts, histograms
- visualisation best practises

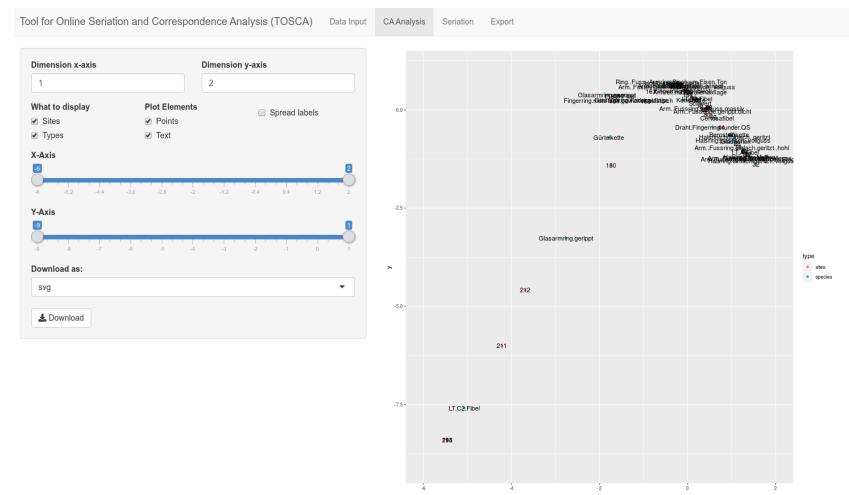
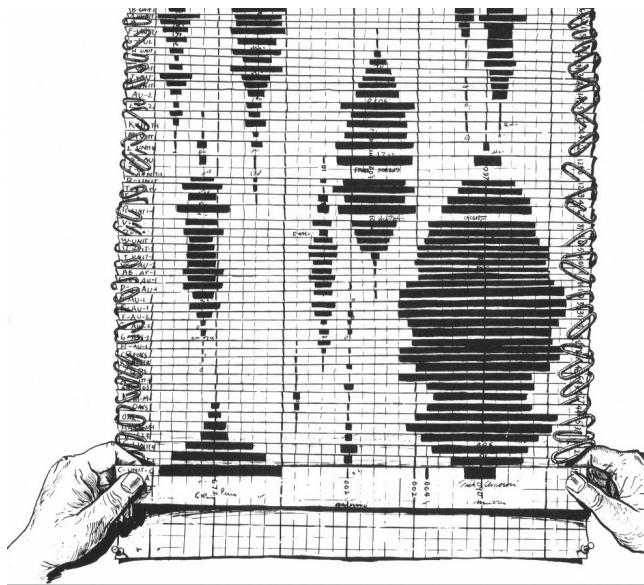


Visualisation

Second section

- Visualisation of highdimensional data
 - Correspondence Analysis
 - Seriation

- preparing your data
 - conduct correspondence analysis
 - interpret the result

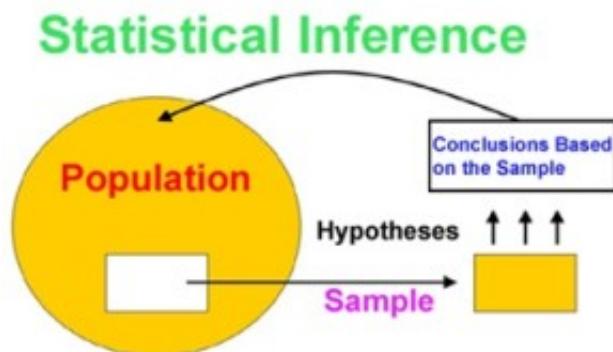


Basic Statistics / Hypothesis testing

What is it

A statistical hypothesis, sometimes called confirmatory data analysis, is a hypothesis that is testable on the basis of observing a process that is modeled via a set of random variables.[1] A statistical hypothesis test is a method of statistical inference. - wikipedia

- decide between hypotheses using standardised (mathematical) tools
- probability theory
- scientific method



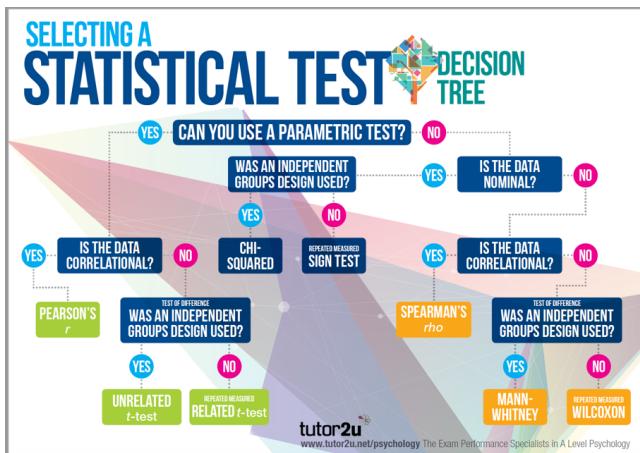
| Decision is: | The Null Hypothesis is | |
|--------------|----------------------------------|----------------------------------|
| | True | False |
| Accept H_0 | $(1-\alpha)$ Confidence Level | β |
| Reject H_0 | α | $(1-\beta)$ Power of the test |

Basic Statistics

Only section

- Basics of hypothesis testing
- H_0 and H_1
- statistical significance

- data preparation
- Chi-Square Test
- Interpretation

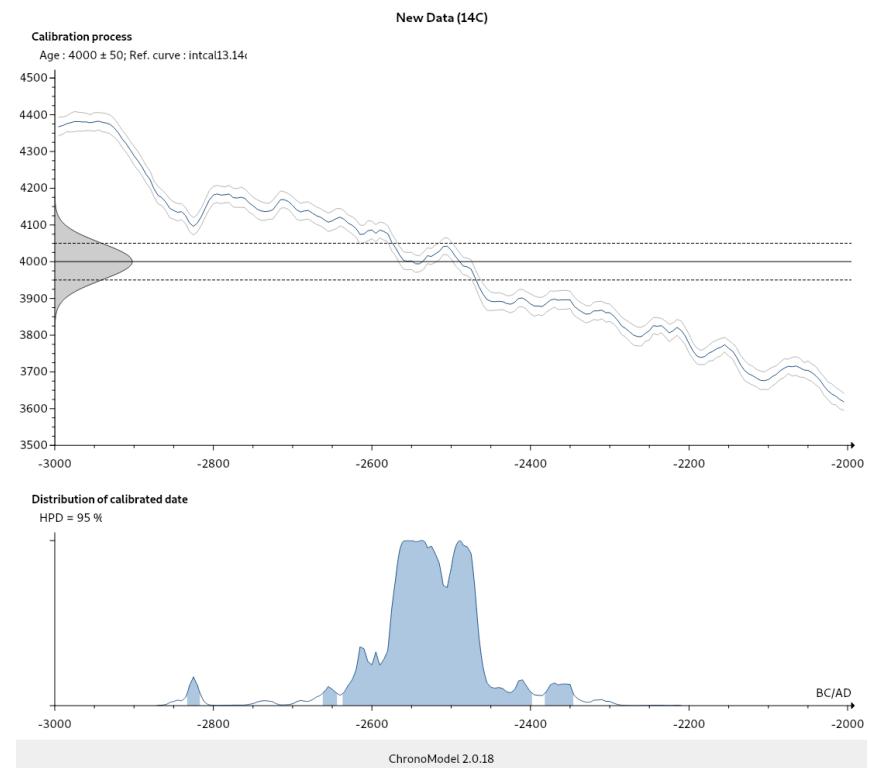
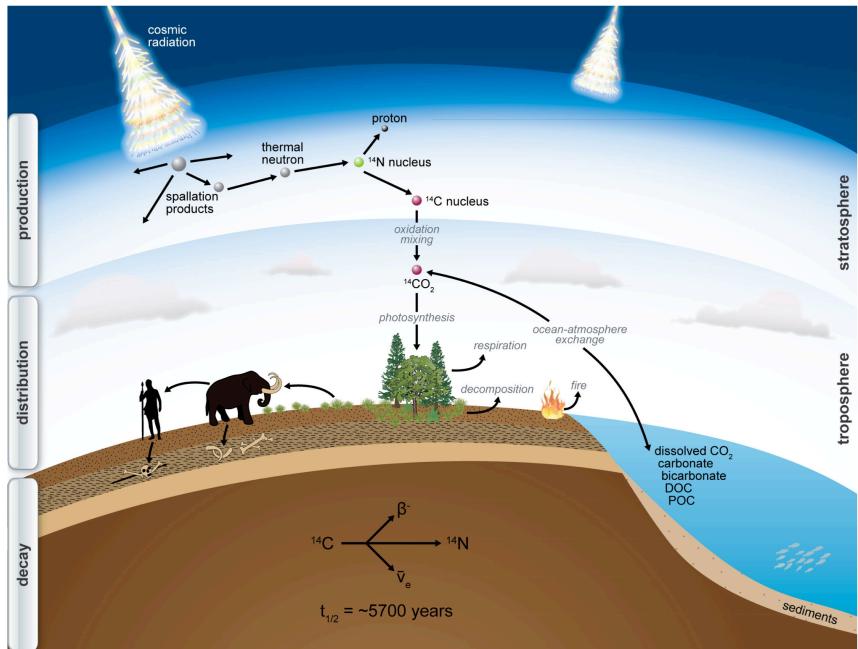


$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

χ^2 = the test statistic \sum = the sum of
 O = Observed frequencies E = Expected frequencies

14C Calibration

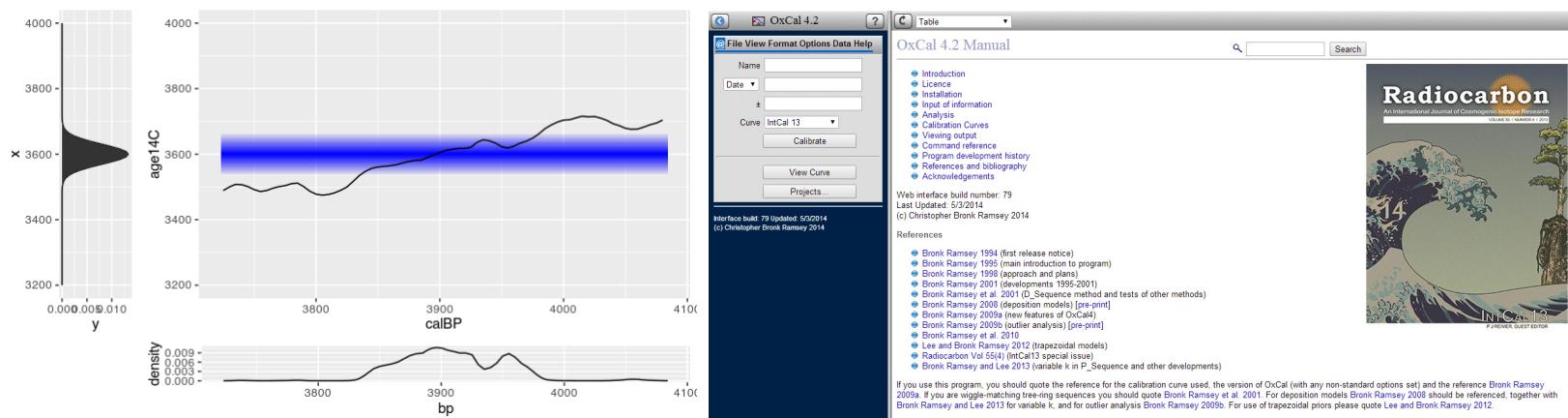
What is it



14C Calibration

First section

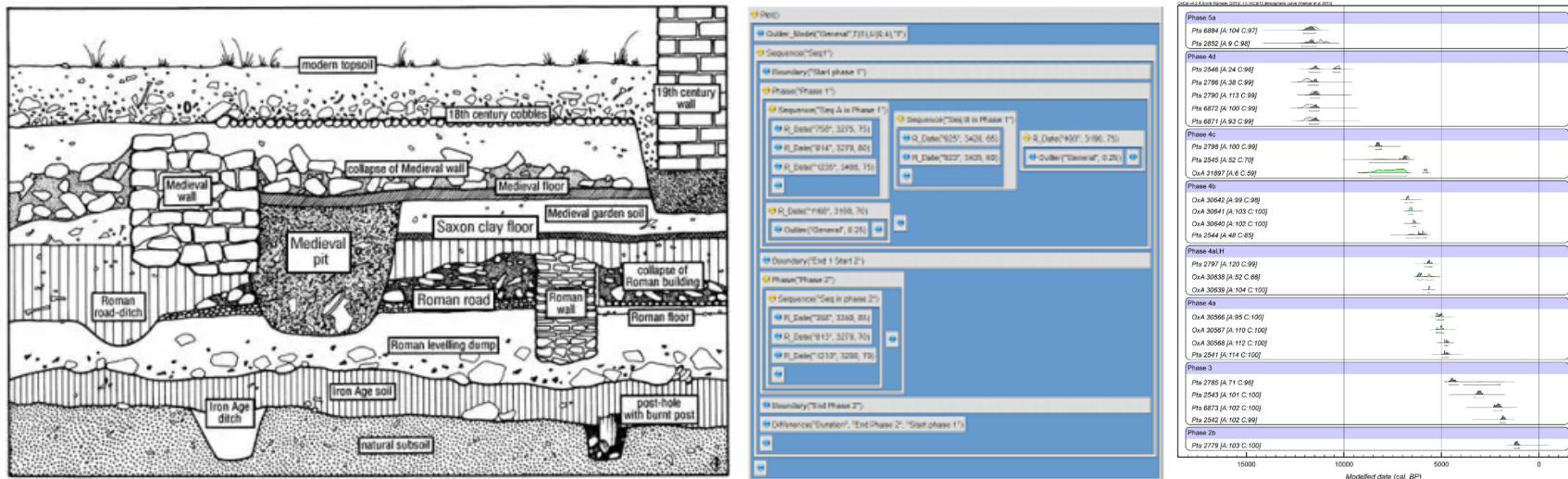
- understand the calibration process
- being able to calibrate individual dates



14C Calibration

Second section

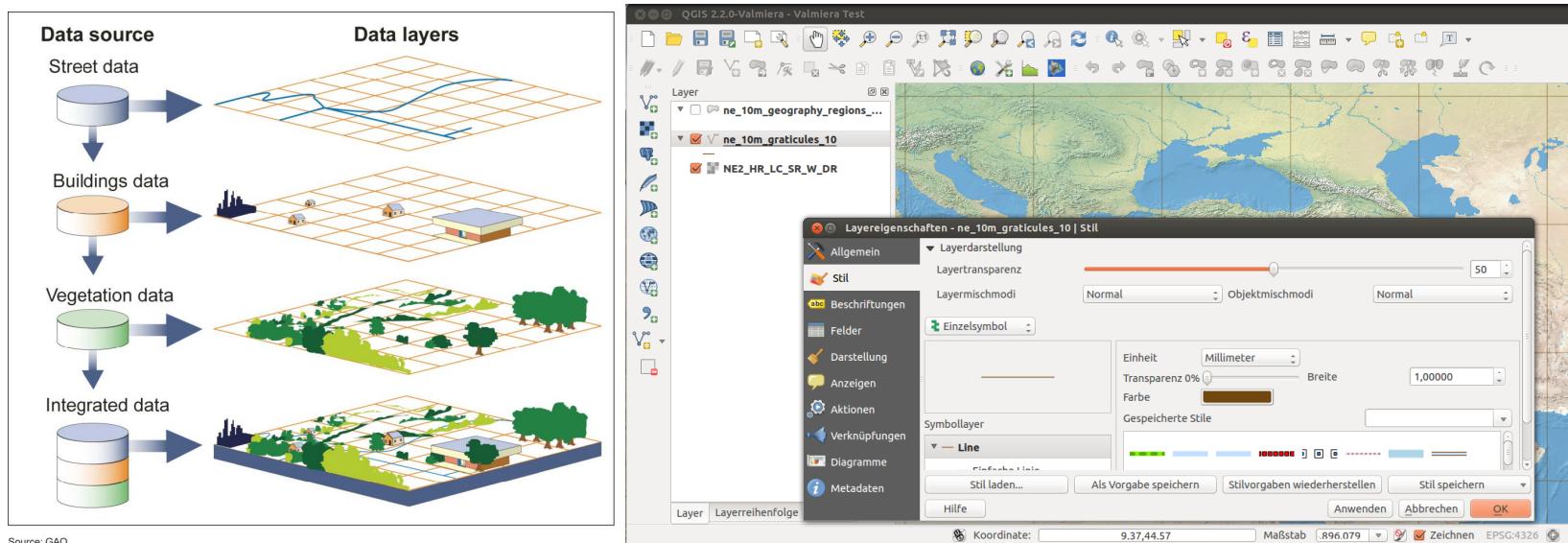
- translate stratigraphical sequences into OxCal models
- doing sequential calibration



GIS

What is it

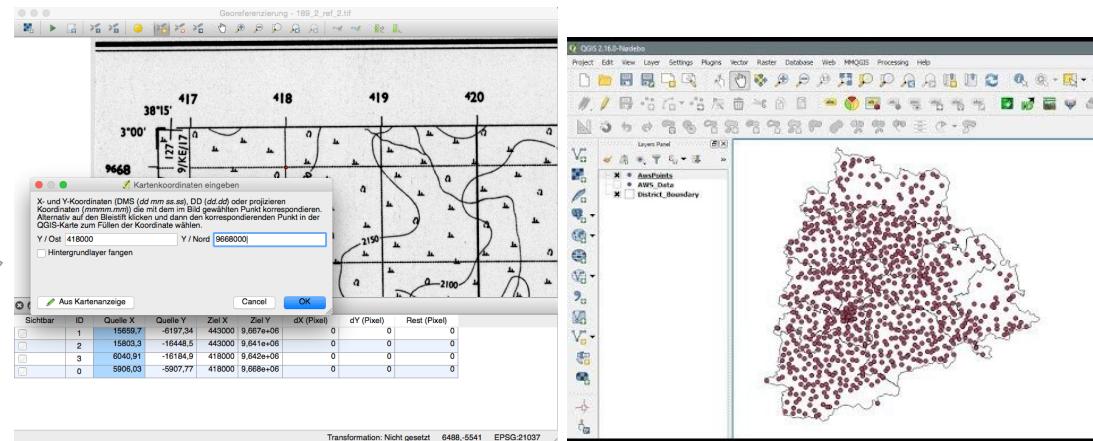
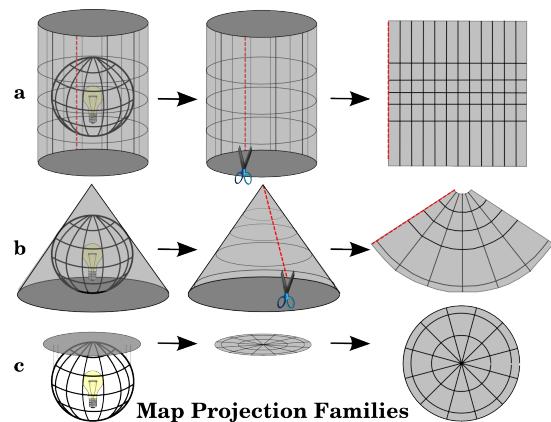
A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present spatial or geographic data. - Wikipedia



GIS

First section

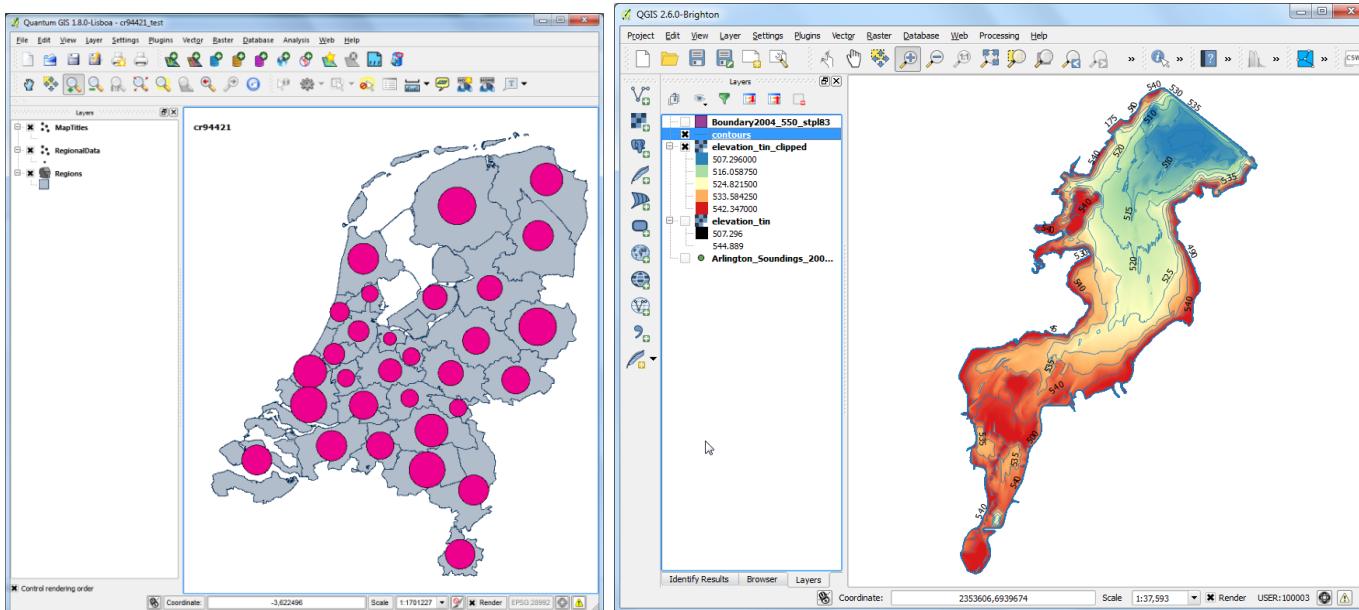
- basically understand projection systems
- being able to map geographical locations with background maps
- digitizing/georeferencing maps



GIS

Second section

- thematic mapping
- interpolation



Software in this course

- free (and most of the time) open source software
- most basic software

Zotero

- free and open source (FOSS) citation manager
- integrates well in browser and Office Software

Libre Office

- FOSS office package
- most commands and procedures similar to 'the other' office package

OxCAL

- free, but not open source
- quasi standard in archaeology

QGIS

- FOSS GIS package
- General ideas and concepts are transferable to 'the other' GIS software

Prerequisite for successful participation

- a laptop (if you do not own one, we can provide you)
- endurance
- curiosity
- installing some software

And in the end a test, consisting of a theoretical and a practical part

Test will be written after the semester.

ToDo till next meeting

- Install Libre Office (<https://de.libreoffice.org/>)
- Install Zotero (<https://www.zotero.org/>)
- (optional) install Zotero Connector (<https://www.zotero.org/download/connectors>)

Any questions?

You might find the course material (including the presentations) at

<https://berncodalab.github.io/caa>

You can contact me at

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