The Role of Culture in Early Expansions of Humans (ROCEEH)

Aviation pioneer Amelia Earhart and her Lockheed Vega 5B mark one of the two flight modes of the TimeFlies app, which can be selected on the entry page. Different time periods can also be explored.

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THE ROLE
OF CULTURE
IN EARLY
EXPANSIONS
OF HUMANS

Editorial

The 21st newsletter presents the latest study on Big Data Visualization. Next we take you on a flight to the beginning of human history with the TimeFlies app. We report on the Modes – Forms – Structures-Conference in Karlsruhe and the annual meeting of the European Society for the Study of Human Evolution in Tübingen. Finally we present our new publication on the use of plants by humans in the Paleolithic of Armenia.

Mapping a macroscale image of prehistoric cultural networks

The exploration of Big Data has led to scientific discoveries in many fields. There are many reasons, that make ROAD a suitable source for data analysis of the prehistoric world: over 2,200 sites, more than 20,000 assemblages, increasing spatial coverage and a high degree of structuring. We therefore examined the database from the perspective of Big Data Visualization and applied cartographic methods of social network analysis to prehistoric cultures. This gave us new insights into past cultural connections – and into the discipline of archaeology.

Big Data cartography
Our study relies on a cartographic style termed 'flow mapping' that allows the visualization of networks with millions of connections. Such a network can represent anything from the service area of an airline, to the spread of social media, to the cooperation of international academic researchers (Butler 2010, Beauchesne 2011). A network consists of nodes connected through edges that are weighted through a quantifiable measure. For example, the cultural similarity (weighted edge) between individuals (nodes) in a social network may be quantified based
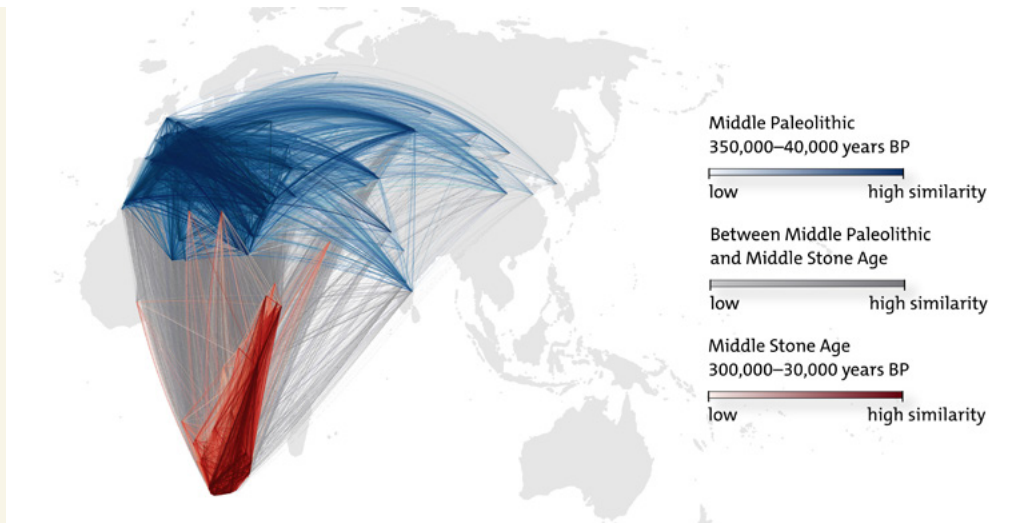
on their shared preferences, such as taste of music, diet or recreational activities. Big Data Visualization employs methods to show a bigger picture emerging from an overwhelming amount of detail by applying cartographic refinement. Consequently, the method allows us to describe the spatial structure of a network, distinguish centers from periphery, and estimate the (dis-) connectedness of places. Often these are associated with political, cultural or natural boundaries. Clearly, we were curious to see what prehistoric cultural networks would tell us.

Constructing a cultural network
Unlike a modern-day social network, the nodes in our study are not made of individuals, but represent the 15,719 archaeological assemblages situated in 1,374 localities queried from the ROAD database. The strength of the cultural relationship is not measured in Likes, but in the similarity of material culture, as documented

▶ Figure 1. We queried 34 artifact categories including lithic and organic tool groups, symbolic artifacts, artifacts with miscellaneous use (mineral pigments, shells, ostrich eggshell), combustion features and burial indicators. Word size is scaled to the category's frequency in the dataset.

Middle Paleolithic
350,000–40,000 years BP

low　　high similarity

Between Middle Paleolithic
and Middle Stone Age

low　　high similarity

Middle Stone Age
300,000–30,000 years BP

low　　high similarity

▲ Figure 2. A cultural network of two periods, the Middle Paleolithic and the Middle Stone Age, and the connections in between. The similarity between assemblages was calculated with the Jaccard index based on the categories shown in Fig. 1. The magnitude of similarity is indicated through color intensity. Graphic: C. Sommer.

in the archaeological record. We queried the presence (or absence) of 32 artifact categories (Fig. 1) for all assemblages and used an index to estimate the likelihood between them. So, the more categories they share, the more similar they are. Furthermore, we had to consider the temporal dimension, so we only constructed edges between assemblages that have at least a minimum overlap in their age ranges. As a result, we created a network with more than three and a half million edges, weighted by cultural similarity, that can be subdivided into eleven cultural periods and more than 100 cultures.

A Middle Paleolithic – Middle Stone Age network

In Figure 2, we present our results for the Middle Paleolithic (MP, blue) and the Middle Stone Age (MSA, red), two periods with a roughly contemporaneous time span, and a geographical division rooted in research traditions. At first glance, you recognize the internal structure within the periods, as well as the culture-shed of Central Africa separating the periods. Looking closer, you discover a few red connections in northern Africa and the Arabian Peninsula, because some scholars break with research tradition by using different cultural taxonomies. Furthermore, we decided to visualize the ties that bind: The cultural similarities between these periods (in gray) set a counterpoint to this distinction.

You also notice how some regions like Europe and the Levant, South and East Africa are densely connected, while others are clearly underrepresented. This indicates that our picture of prehistory is shaped by several layers of bias: taphonomy, research bias and the completeness of ROAD, just to name a few. Finally, you may ask what these lines of similarity might even mean. In social networks, undirected connections suggest some form of exchange, even if it is not direct. Yet do the connections in our example reflect long-range cultural transmission? Can we interpret our past as an intercontinental network of cumulative culture? And how is this picture obscured by the independent

innovation of technology? We hope that our macroscale picture of the prehistoric world, as seen through ROAD, stimulates further discussions about the archaeological record and the interpretations of prehistoric life. Background information about how we produced this map, and things that need to be considered to interpret it, are presented in an article by Sommer, Kandel & Hochschild (2022).

References

Beauchesne, O.H. (2011): Map of scientific collaboration between researchers. https://olihb.com/2011/01/23/map-of-scientific-collaboration-between-researchers/

Butler, P. (2010): Visualizing Friendships. https://paulbutler.org/2010/visualizing-facebook-friends/

Sommer, C., Kandel, A.W. & Hochschild, V. (2022): The use of prehistoric 'Big Data' for mapping early human cultural networks. Journal of Maps. https://doi.org/10.1080/17445647.2022.2118628

Christian Sommer, Andrew Kandel, Volker Hochschild

Early Human History at Coding da Vinci 2022

Coding da Vinci, the first German hackathon for open cultural data, has been connecting culture and technology minded designers and programmers with cultural institutions and their digital data treasures since 2014. Creative applications are designed to open up cultural data to new audiences, to discover it in new contexts, and to make it playful to experience. The project, which is supported by the German Federal Cultural Foundation, the German Digital Library and Wikimedia e.V., among others, aims to "promote structural change in cultural heritage institutions, develop open data as an issue for politics and raise awareness of the accessibility of digital cultural

▲ Figure 3. In his Cessna, aerial archaeologist Otto Braasch flies over the Ethiopian Highlands to find numerous sites from the "Expanding Worlds" time period between 1.8-0.8 million
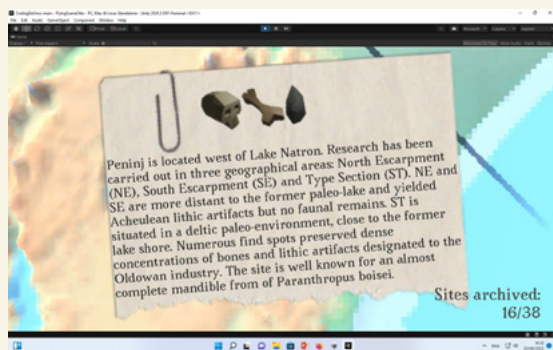
▲ Figure 4. In the Otto flight mode, the sites of different periods can be archived. If you click X while flying over a site, a short description opens, which also shows the categories of finds discovered there (for example, human fossils, animal bones, and stone tools).

heritage in society" (www.codingdavinci.de). After eight successful years, the culture hackathon took place in Baden-Württemberg in 2022. This was a welcome invitation for the Heidelberg Academy of Sciences and Humanities.

Together with more than 30 cultural institutions, the research center "The Role of Culture in Early Expansions of Humans" (ROCEEH) made datasets available under open license. Already in the preparatory phase, the data-providing institutions were often challenged to think in new ways and bring their data to a broad audience in a different form than usual. They had to select editable parts of their holdings, prepare them in various file formats and present them in short films they had developed themselves. At the kickoff at the Zentrum für Kunst und Medien (Center for Art and Media) in Karlsruhe on May 7 and 8, the datasets were presented in one-minute pitches; interested parties were then able to find out more detailed information about the data offered.

The dataset "Kulturausbruch – Von Afrika in die ganze Welt" (Cultural Outbreak - From Africa into the World) provided by ROCEEH is a selection from the ROAD database and offers georeferenced data on nearly 900 archaeological sites in Africa and Eurasia dated between 3.3 million and 20,000

years ago. In addition to site names, geodata, and dating, the dataset includes information on the respective find categories and brief descriptions of the sites. However, the lack of image sources presented a challenge for the creative data takers in this regard. Nevertheless, two projects were enthusiastic about the "Kulturausbruch" dataset and implemented its data in new applications during the following seven-week sprint leading to the final presentation on June 24 at the Württembergisches Landesmuseum in Stuttgart.

The first project, "HistoryMap", (https://historymapmannheim. theetfinder.repl.co/) was developed by Etienne, Michel, Arthur, and Jan, a group of four students from "Hack to the Future". This youth hackathon of the initiative Kindermedienland Baden-Württemberg was held together with Coding da Vinci. The students used "Kulturausbruch" as well as two other datasets from Baden-Württemberg in historical times that can be located in time and space. The goal of their application is to display the data points on a map, where a temporal selection can be made by entering a year or using a time slider. In an overview, several find points are first presented as regional clusters; by clicking on them, one gets to the individual sites and their short descriptions.

The second project, "TimeFlies", (https://www.roceeh. uni-tuebingen.de/cdv/TimeFlies), was developed by Florian Diller from the University of Worms in collaboration with sound designer Ada Schmidt. The flight app makes it possible to experience a large number of archaeological sites from vast time periods and across entire continents. Data from sites are linked to the function of flight gyroscopes from the collection of the University of Stuttgart, another data provider. The "Kulturausbruch" dataset was divided into different time periods for the game: in the prototype, two periods are selectable (African beginnings: 3.3-1.8 million years ago; Expanding worlds: 1.8-0.8 million years ago), for which sites are displayed on a map (currently only Africa). The characters of aviation pioneer Amelia Earhart and aerial archaeologist Otto Braasch, borrowed from the real world, describe two game modes. With Amelia, you can explore the landscape and discover sites. Flying over the hidden sites reveals their names and the finds discovered there. Amelia uses a compass for navigation: a red marker shows the location of the nearest site. With Otto, you archive the sites: clicking X while flying over a site provides background information. Otto navigates with a map oriented to the north.

The app was created with Unity; it can be downloaded or played as a WebGL version in the web browser. A version for mobile devices is planned. Different sounds support the visual impression. "TimeFlies" is to be expanded: to include further time periods up to 20,000 years before present, sites in Europe and Asia, and archiving tasks for Otto. The app will be attached to the internet access to the ROAD database and become part of the Virtual Atlas in the future. There is the possibility to use spatially and temporally tailored versions on special topics, e.g. for exhibitions.

In addition to the two apps that can make the contents of the ROAD database more visible and playful to explore, we at the ROCEEH research center gained a variety of newfound experiences from our participation in Coding da Vinci. From the creation of short videos and shortest-form presentations to new programming environments and the discovery of new uses for the resulting products, our involvement in the culture hackathon spurred our own engagement with the ROAD database on a very different level. Hopefully, such engagements will not only continue to enrich our work, but also inspire new audiences to explore it:

Book a flight to the beginnings of human history between 3.3 million and 20,000 years ago! Choose a time period and one of our pilots, and then take off!

Miriam N. Haidle

"Modes – Forms – Structures" – International conference at KIT, Karlsruhe, Germany, hosted by Mathias Gutmann (KIT, Karlsruhe) and organized in collaboration with Christine Hertler (ROCEEH) and Marco Tamborini (TU Darmstadt), 14-16 September 2022.

After being postponed several times due to Covid restrictions, the conference exploring theoretical and historical foundations of concepts for modes, forms, and structures in an evolutionary context finally took place at the Kalrsruhe Institute of Technology (KIT). The meeting featured three days of elaborate presentations and intense discussions from a variety of disciplines, namely philosophy, theory and history of biological sciences, as well as empirical perspectives ranging from taxonomy and morphology to approaches in behavioral sciences. The participants appreciated the constructive and inspiring atmosphere of the meeting. ROCEEH was represented by two presentations. The first by Christine Hertler discussed modeling procedures in the context of human dispersal and suggested a novel approach using agent based modeling as an alternative. The second by Miriam Haidle introduced determinants and concepts for the impact of behavioral approaches to human evolution and expansion.

The significance of this comprehensive approach to human expansion open to the ROCEEH research center became evident. Morphological and taxonomic approaches benefit from the ROCEEH perspective by including behavioral determinants acting as constraints on the evolution of morphological structure and taxonomically relevant forms. Methodological and historical approaches receive new perspectives on evolutionary processes. ROCEEH on the other hand benefits from such theoretical approaches by exploring in particular historical developments in methodology. The participants appreciated a possible reiteration of such meetings.

Christine Hertler

Report on the 12th ESHE annual meeting in Tübingen from 21-25 September 2022

ROCEEH helped organize the 12th annual meeting of the European Society for the Study of Human Evolution (ESHE). The conference was held from 21–25 September 2022 in Tübingen in a hybrid format, both in person and with virtual participation. In addition to organizing and sponsoring the excursion to the UNESCO World Heritage Sites of the Ice Age in the Swabian Jura, ROCEEH also conducted an introductory workshop on how to use the ROCEEH Out of Africa Database (ROAD).

The 4-hour workshop was aimed at people who never used ROAD before and organized by Andrew Kandel, Zara Kanaeva and Christian Sommer of the ROCEEH team. The workshop covered the basic structure of the database with sections on entering and querying data and visualizing information on maps. In addition, the instructors demonstrated different ways to use data in various aspects of scientific analysis and public outreach.

Andrew Kandel led the first section, introducing the 12 participants to the research center and describing the basic elements of ROAD and its user interface called ROADWeb. Since all of the participants were issued a login, they could follow along with their laptops and maximize their experience using the database. He demonstrated the functionalities of the table views including the application of filters and syntax. He showed how the descriptions of the tables and attributes can be accessed at many levels to help a user better understand the specifications and requirements of data entry. After giving examples of how to access maps, profiles and summaries of sites, he illustrated how to visualize data using ROAD's Map Module.

◄ Figure 5. Participants of the "Modes – Forms – Structures-Conference at KIT. From left to right: Marco Tamborini, Mathias Gutmann, Christine Hertler, Miriam Haidle, Miguel Brun-Usan, Joachim Scholz, Alan Love, Dino Frey, Peter McLaughlin, Peter Nick and Hans-Jörg Rheinberger. Photo: J. Scholz.

Zara Kanaeva taught the second section which focused on querying data using SQL and SPARQL languages. She began by showing how to create a query with one table, and then expanded on this to include two or more tables, a skill which is necessary to retrieve desired information from the ROAD database. She outlined how the query builder works and discussed the function that allows a user to build age queries easily. She also talked about different formats in which ROAD data can be exported, for example, in JSON, XML or CSV. Finally, she introduced RDF querying, which allows a user to extract data with the SPARQL protocol and RDF Query Language (SPARQL). RDF and SPARQL are standards for web data and enable the use of information as Linked Open Data, an essential part of making data accessible and interoperable.

Christian Sommer introduced the participants to some of the ways in which ROAD data can be applied in computational analyses. In addition to datasets exported from ROADWeb, APIs allow a user to access ROAD directly from scientific scripting languages like R and Python. He showed how a variety of extensions of these programming environments can help to provide new insights into ROAD data through various methods of data mining, species distribution modeling or network analysis. But also a broader public can be reached, for example, through creative engagement with the educational game Times Flies or the integration of ROAD data about cultures and artifacts into Wikipedia.

If your institution is interested in hosting a workshop for students and researchers, please contact us to discuss scheduling possibilities (info@roceeh.net). We can arrange a half-day introductory course or a week-long seminar tailored to your needs.

Andrew Kandel, Zara Kanaeva, Christian Sommer

The Thread to the Needle: How our Ancestors Used the Native Flora

DNA from sediments offers insights into the use of plants by Paleolithic humans

An international research team led by the National Academy of Sciences of Armenia and ROCEEH extracted and analyzed plant DNA from the sediments of Aghitu-3 Cave in Armenia. Humans of the Upper Paleolithic used this cave as a shelter between about 39,000 and 24,000 years ago. A detailed analysis of DNA in the sediments shows us that the cave's inhabitants likely used numerous plant species for a variety of purposes, including for medicine, dye, or yarn (ter Schure et al. 2022).

At first glance, nothing sets Aghitu-3 cave apart from the numerous other basalt caves in the highlands of southern Armenia. However, this cave does hold something special: it is one of a handful of sites containing finds from the Upper Paleolithic in the Republic of Armenia. The cave sediments reveal information about human settlement during the period from about 39,000 to 24,000 years before present. "Stone artifacts, animal remains, bones, tools, shell beads, and charcoal from campfires have already been found in the cave," explains Andrew Kandel. "Although we know that plants played a fundamental role in the lives of prehistoric people beyond serving as food, plant parts such as seeds, leaves, fruits, and roots are rarely preserved, since they are organic and usually decay quickly, which makes them difficult for us to study."

In order to provide information about plant use in the Paleolithic, the research team extracted plant DNA from the cave sediments. The results of the DNA analyses indicate that the sediments contained a larger amount of genetic material from plants during periods of increased human use of the cave. During periods when people visited the cave infrequently, less DNA from the plants was recorded. "We therefore attribute most of the plants found to human involvement. People collected the plants during their daily activities. Once used, the remains of the plants were left in the cave where, to our delight, the DNA was preserved in the sediments. By analyzing the DNA and comparing it with previously identified pollen types, we gain a more complete picture of the plants that were available to people and how people might have used them," explains Angela Bruch.

The researchers identified a total of 43 plant orders – all but five of which are suitable for human use, according to the study. Some of the plants have medicinal properties, while others can be used as food, as flavoring, or as a mosquito repellent. The discovery of DNA from plants that provide dyes or fibers suggests that people in this region used plants to make sewing thread or twine and to string up shell beads. "This find fits into the overall picture of Aghitu-3 like a missing puzzle piece – needles made from animal bones were also found in the cave during the excavations. We now know with a high degree of probability that our ancestors sewed in the cave, and how they did it," said Kandel.

According to the researchers, the analysis of plant DNA from sediments is an exciting new tool for studying human behavior in prehistoric times. "In the future, we will use this method at other sites to learn even more about our ancestors," concludes Bruch.

References:
ter Schure, A.T.M., Bruch, A.A., Kandel, A.W., Gasparyan, B., Bussmann, R.W., Brysting, A.K., de Boer, H.J. & Boessenkool, S. (2022): Sedimentary ancient DNA metabarcoding as a tool for assessing prehistoric plant use at the Upper Paleolithic cave site Aghitu-3, Armenia, Journal of Human Evolution 172, 103258. https://doi.org/10.1016/j.jhevol.2022.103258

Andrew Kandel, Angela Bruch

Forthcoming

- 22nd Congress of the Indo-Pacific Prehistory Association

6-12 November 2022, Chiang Mai, Thailand

Session S 16 "Exploring Distant Shores: Simulating Dispersal Across Archipelagos" organized by M. R. Puspaningrum and C. Hertler.

ROCEEH arranges for an introductory ROAD workshop to expand the ROAD community in Southeast Asia.

https://www.ippasecretariat.org/22nd-ippa-congress

- NECLIME Annual Conference

21-25 November 2022, online

organized by Angela Bruch, T. Utescher, M. Kováčová, and M. Stebich.

The conference is planned to focus on two topics – past biodiversity and extreme environments.

For more details see:
https://www.neclime.de/news.html

- CAA 2023 Congress

3-6 April 2023, Amsterdam, Netherlands

Session 33 "Bayesian Inference in Archaeology: new applications and challenges" organized by S. Carrignon, A. Cortell-Nicolau, E. Crema, and C. Sommer.

For more details see:
https://2023.caaconference.org/

- INQUA 2023

14-20 July 2023, Rome, Italy

Session 45 "Plants as Resources for Early Humans – Availability and potential exploitation of useful wild plants through Pleistocene human history" organized by A. Bruch and K. Hahn.

Session 109 "´Quaternary environments and human evolution: fossil record, phylogeny, palaeobiology, palaeoecology and cultural models" organized by P. Sukumaran, C. Hertler and P. R. Chauhan.

Session 131 "A global view on Early Pleistocene climate and vegetation dynamics" organized by K. Sniderman and A. Bruch.

For more details see: https://inquaroma2023.org/

Who's who?
This issue: Florian Diller

Florian Diller is passionate about everything visual, from painting to video games to data visualization. If it involves mobile, interactive or harmonious visuals, it sparks his interest! Coming from an engineering background, he now teaches and researches visualization in the context of his position as a Ph.D. student at the University of Applied Sciences in Worms, Germany. As Florian was always interested in culture, Coding da Vinci was the perfect match and a great opportunity to apply principles from theory. The data of the ROCEEH Out of Africa Database were especially fascinating to him, since they are based in research and every dataset tells a unique story.

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