The Use of Network Cartography for Visualizing Large Prehistoric Relationships

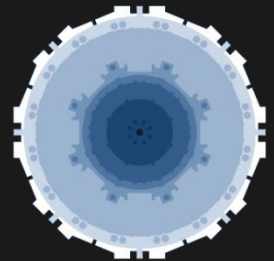
Christian Sommer, Andrew W. Kandel & Volker Hochschild

THE ROLE OF CULTURE IN EARLY EXPANSIONS OF HUMANS

CAA 2022, Oxford

2022-08-09

S08: Are you my type? Network analysis and the study of material culture



CAA2022 OXFORD

INSIDE FORMATION

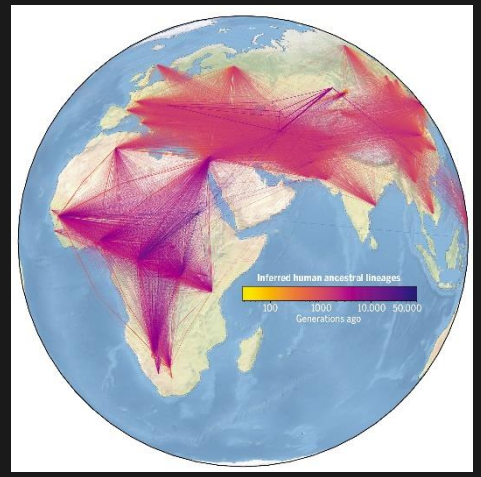
8:11 AUGUST 2022

Paul Butler (2010): Visualizing Facbook Friendships

“Big data” network cartography – a data dump?

- Origin-Destination map
- Flow map
- Goal: showing an overall picture emerging from an overwhelming amount of detail.
- Communicating weighs through colour (saturation, brightness, etc.) and line thickness.
- Cartographic refinement through layer ordering and opacity.

Brockmann & Helbing (2013): The Hidden Geometry of Complex, Network-Driven Contagion Phenomena. Science.



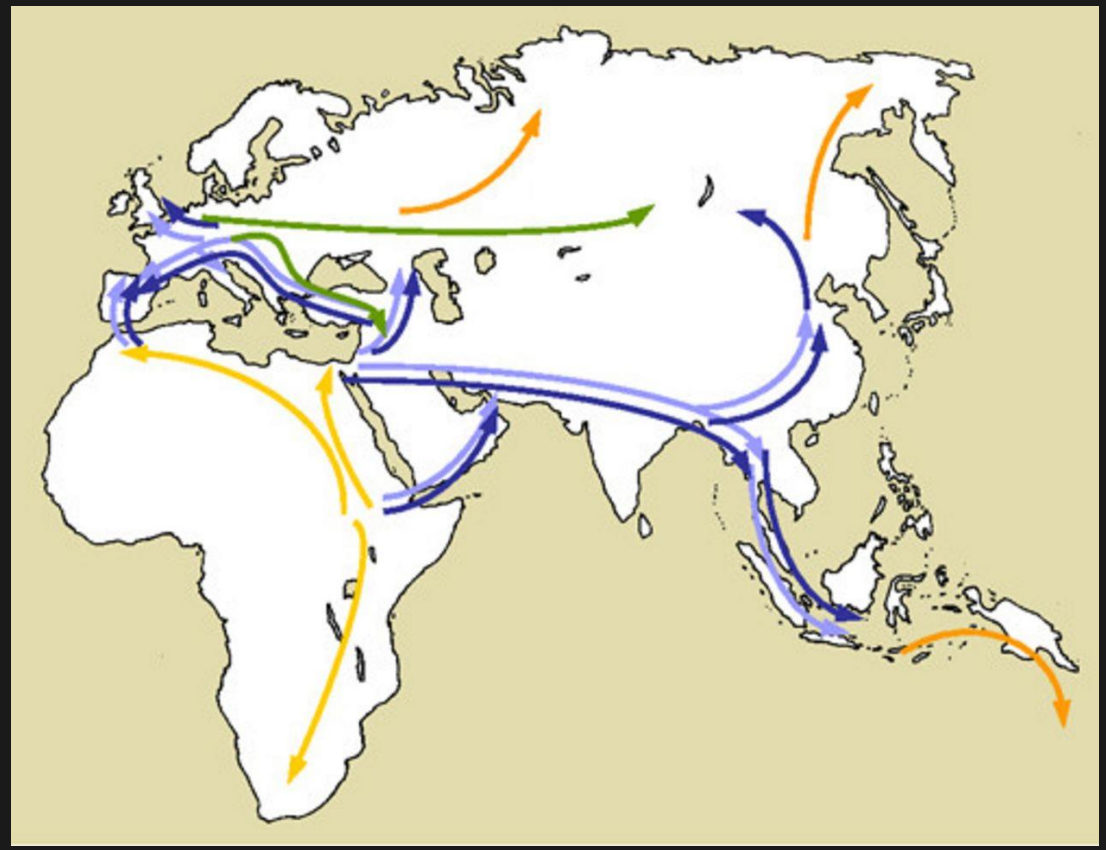
Wohns et al. (2022): A unified genealogy of modern and ancient genomes. Science.

What would a prehistoric cultural network look like?

ROCEEH research center

THE ROLE OF CULTURE IN EARLY EXPANSIONS OF HUMANS

- Long-term grant
  - 2008-2027
- Study expansion of humans in Africa & Eurasia between 3 million & 20,000 years ago
  - Culture
  - Habitat
  - Distribution
- Interdisciplinary perspective with researchers from
  - Archaeology
  - Anthropology
  - Paleobotany
  - Geography…



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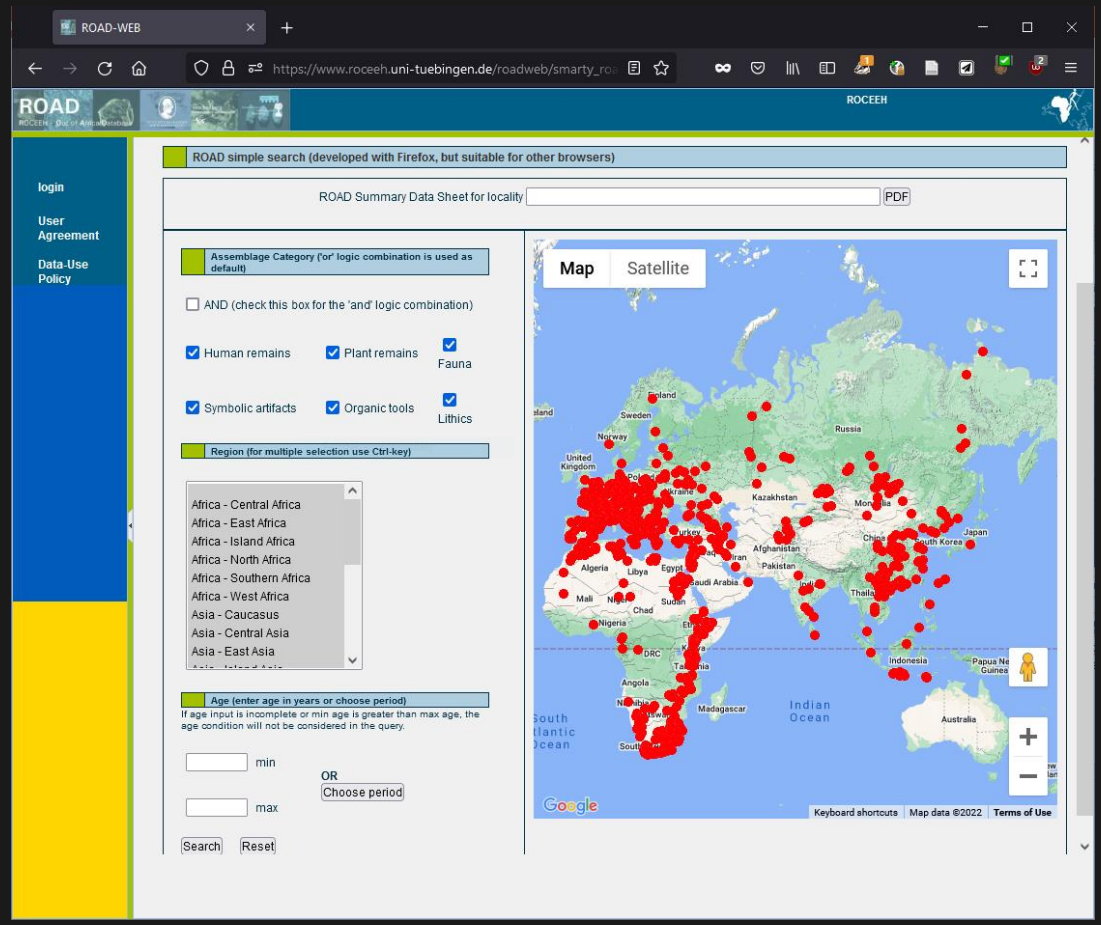
EBERHARD KARLS UNIVERSITÄT TÜBINGEN

SENCKENBERG
world of biodiversity

ROAD database

- >2,200 Paleolithic sites *
- >20,000 assemblages *
- Culture, humans, fauna, plants
- Georelational database
- Uniform taxonomies



* as of July 2022

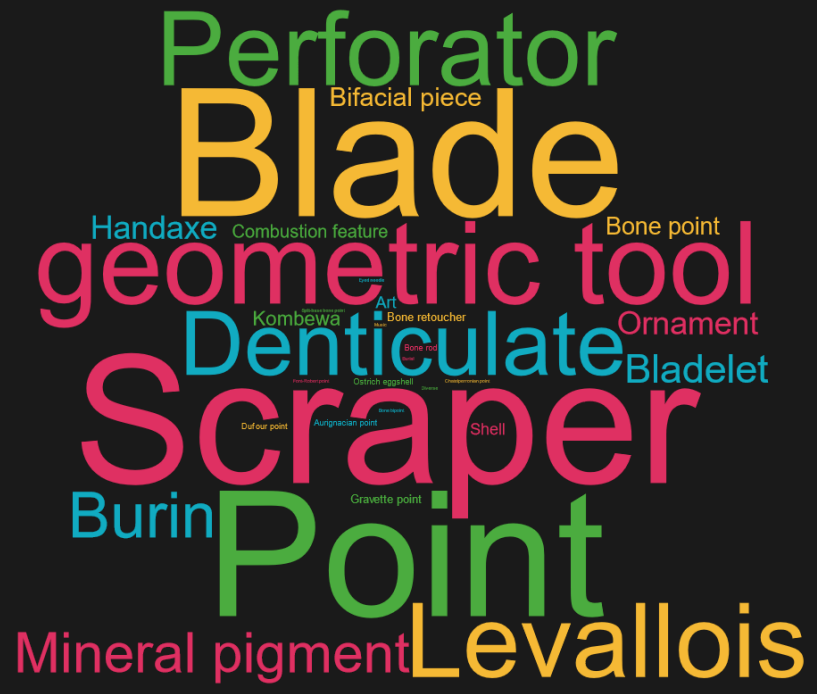
ROAD database

- >4,600 sources* in >10 languages
  - Articles
  - Books
  - Theses
  - Excavation reports
  - Own research
- Digitalization by paid research assistants and guests using data entry masks
- Georeferencing
- Standardization & Thesauri
  - Raw materials, tools, etc.
  - Tool groups
  - Cultures & cultural periods

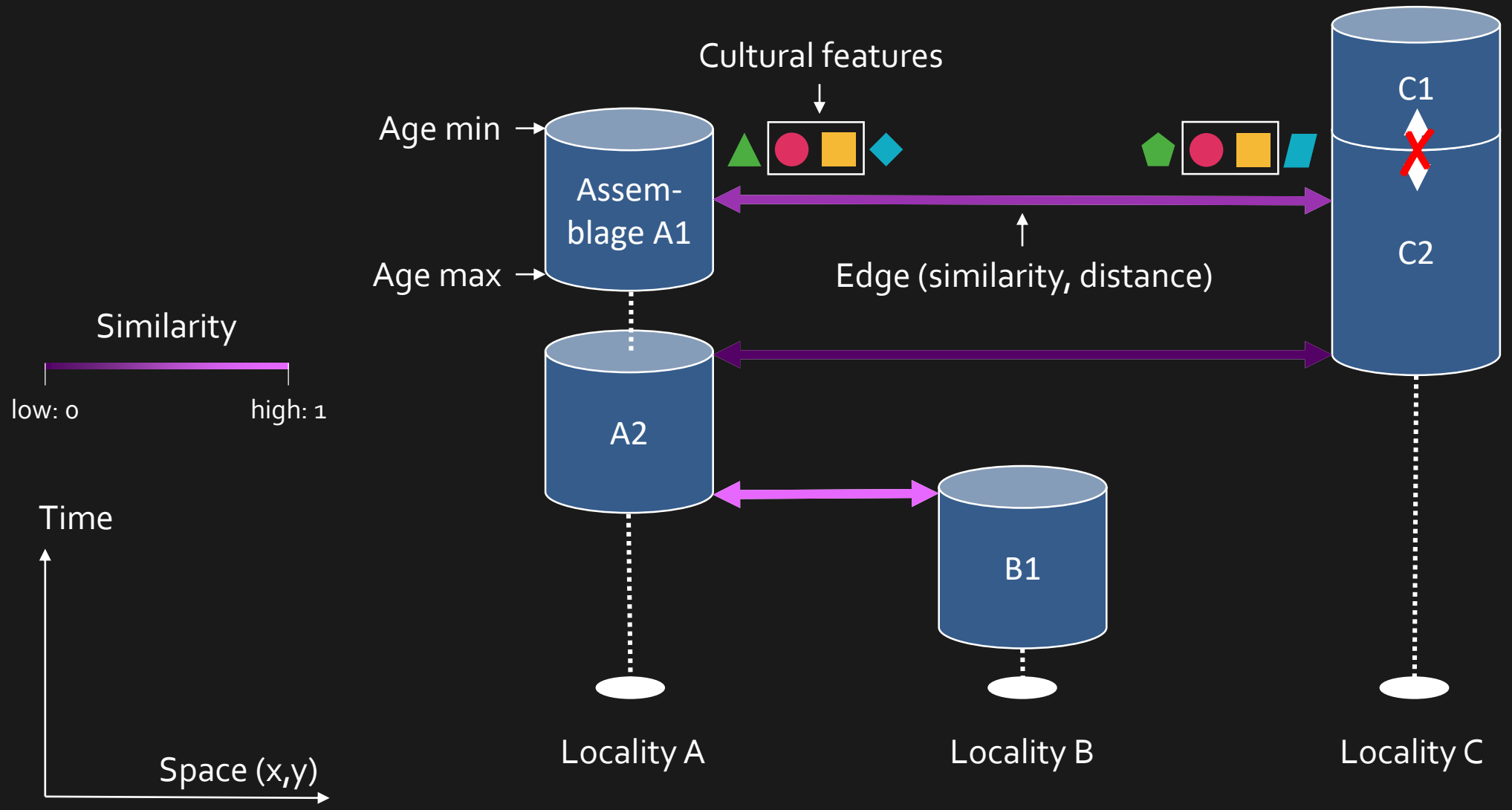
* as of July 2022

Cultural data query for the network

- 15,719 assemblages from 1,374 localities with geocoordinates, age min & max, 100+ cultures, 11 cultural periods
- Presence/absence data of 32 artifact categories including
  - 18 lithic tool groups
  - 6 organic tool groups
  - 3 symbolic artifacts
  - 3 Misc: Mineral pigment, shell, ostrich eggshell
  - combustion features
  - burial

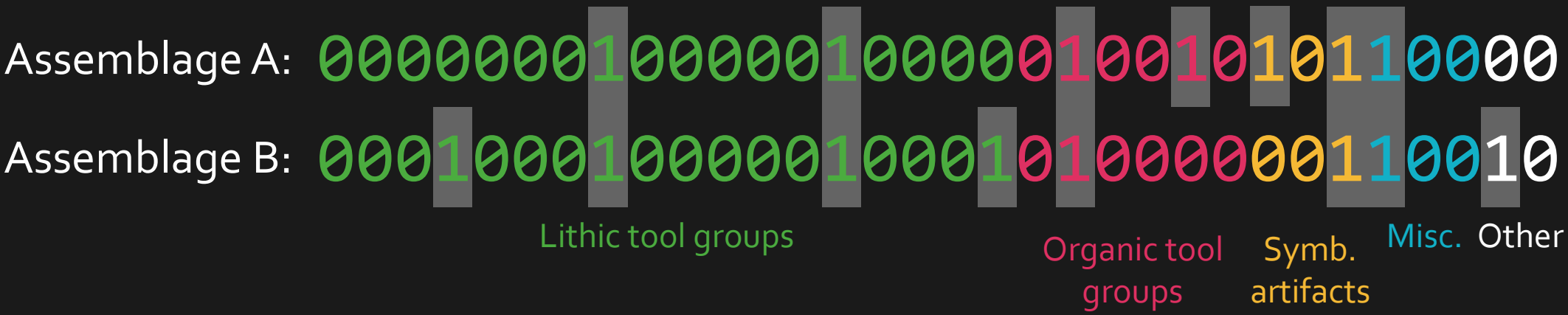


Network construction

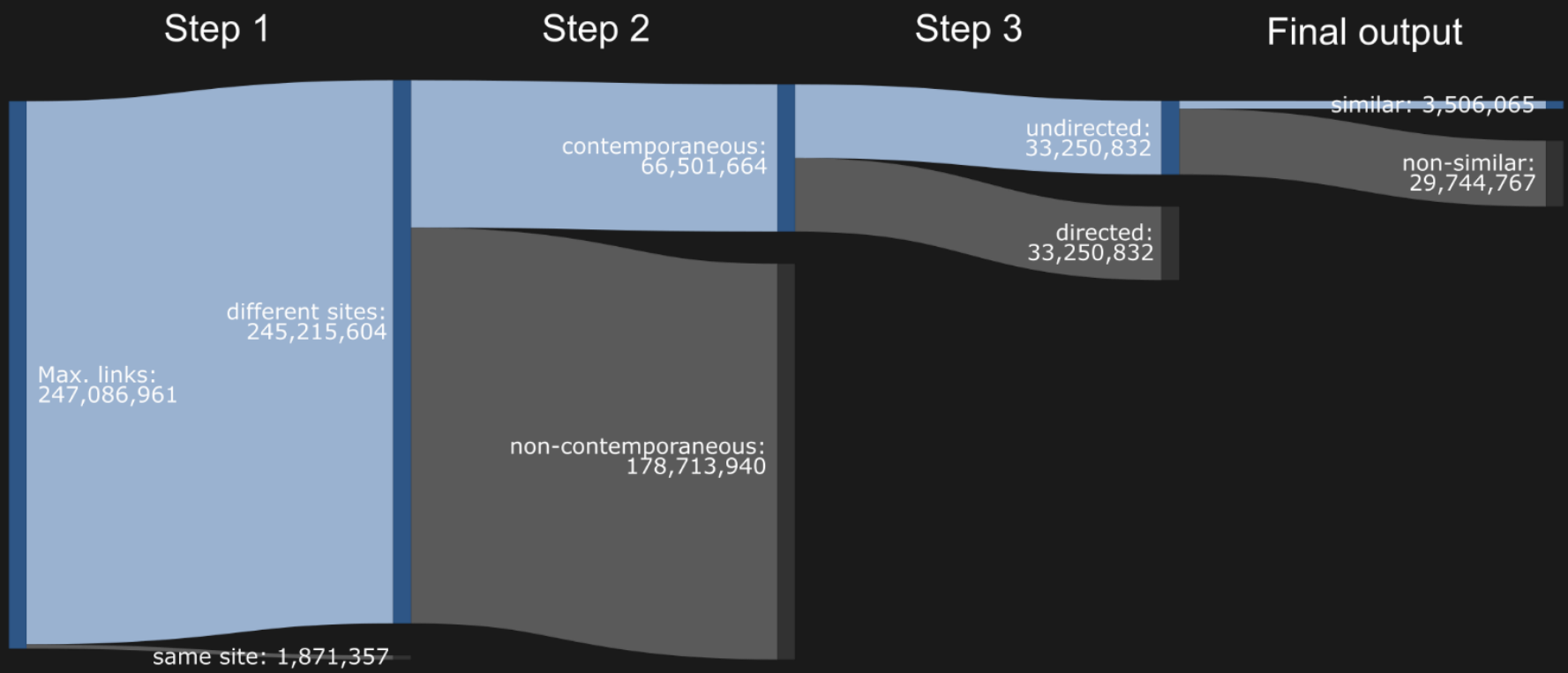


Jaccard Index

$$J_{Sim}(A,B) = 1 - J_{Dist}(A,B) = \frac{|A \cap B|}{|A \cup B|} = \frac{5}{10} = 0.5$$

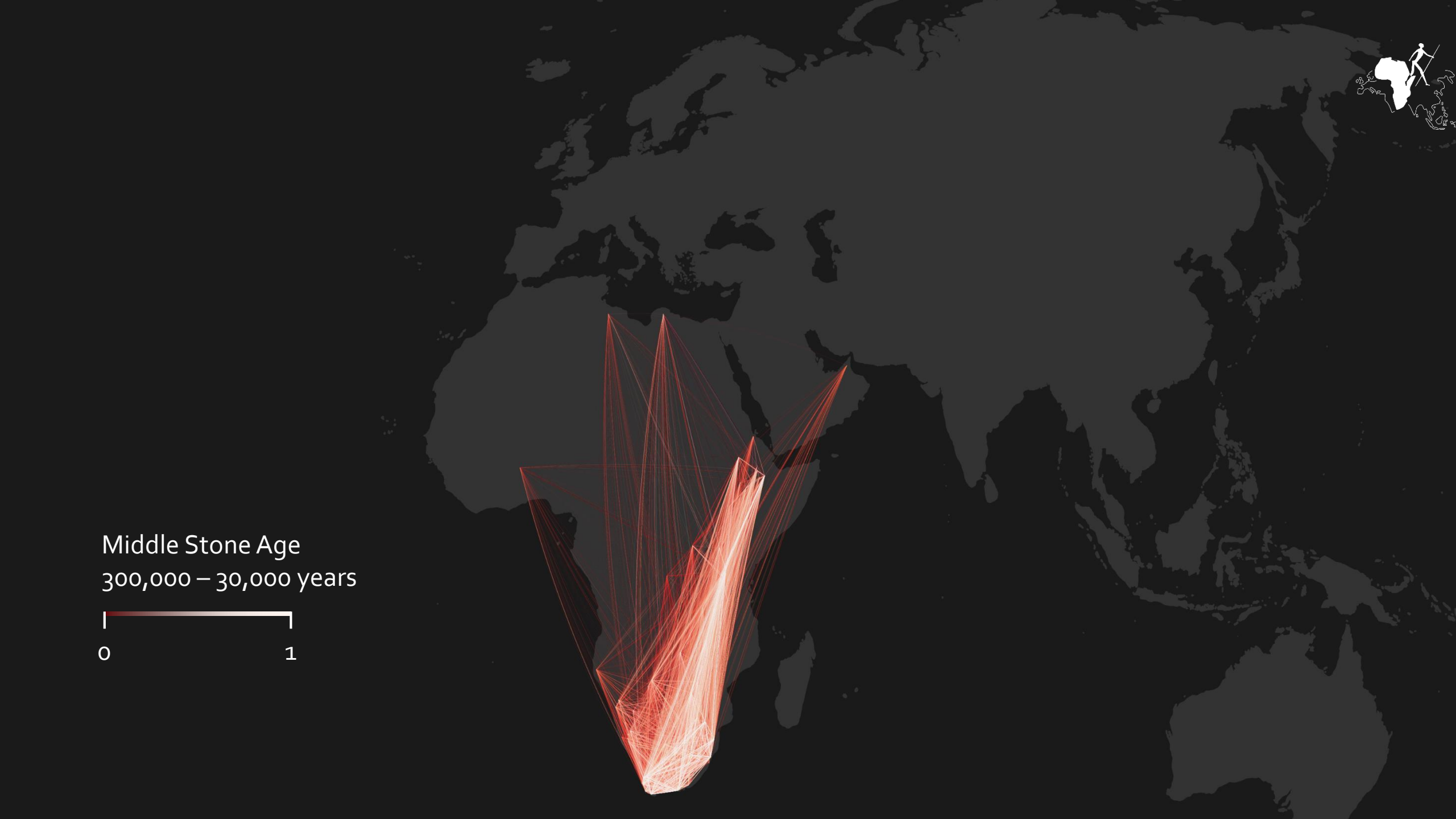


Processing



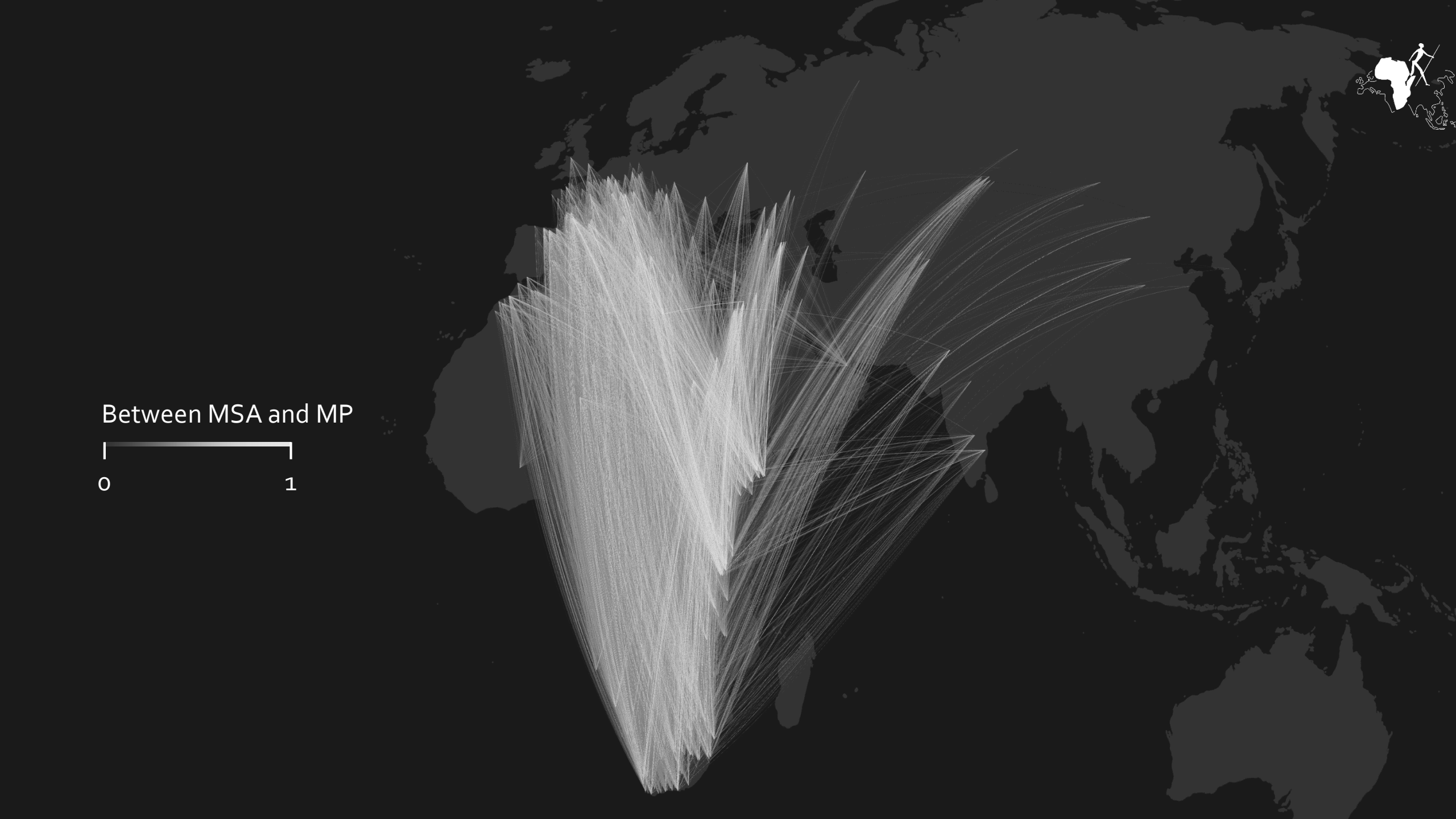
github.com/sommergeo/paleo_cultural_networks

zenodo.org/record/6873723

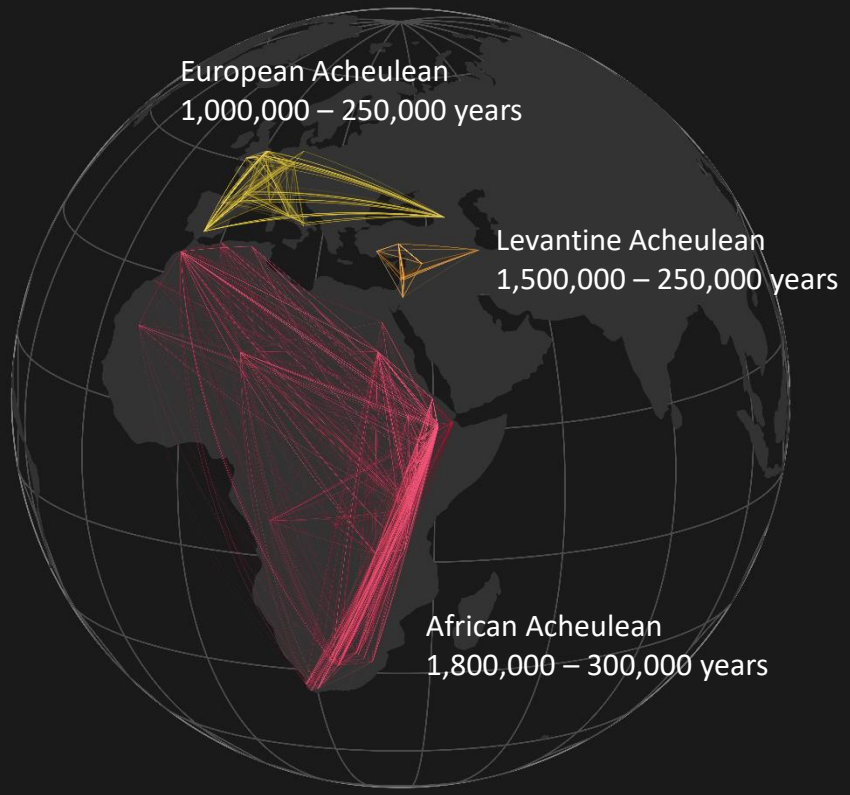

Middle Stone Age
300,000 – 30,000 years
0
1


Middle Paleolithic
350,000 – 40,000 years
0
1
Middle Stone Age
300,000 – 30,000 years
0
1


Middle Paleolithic
350,000 – 40,000 years
0
1
Between MSA and MP
0
1
Middle Stone Age
300,000 – 30,000 years
0
1


Between MSA and MP
0
1

Lower Paleolithic – Early Stone Age

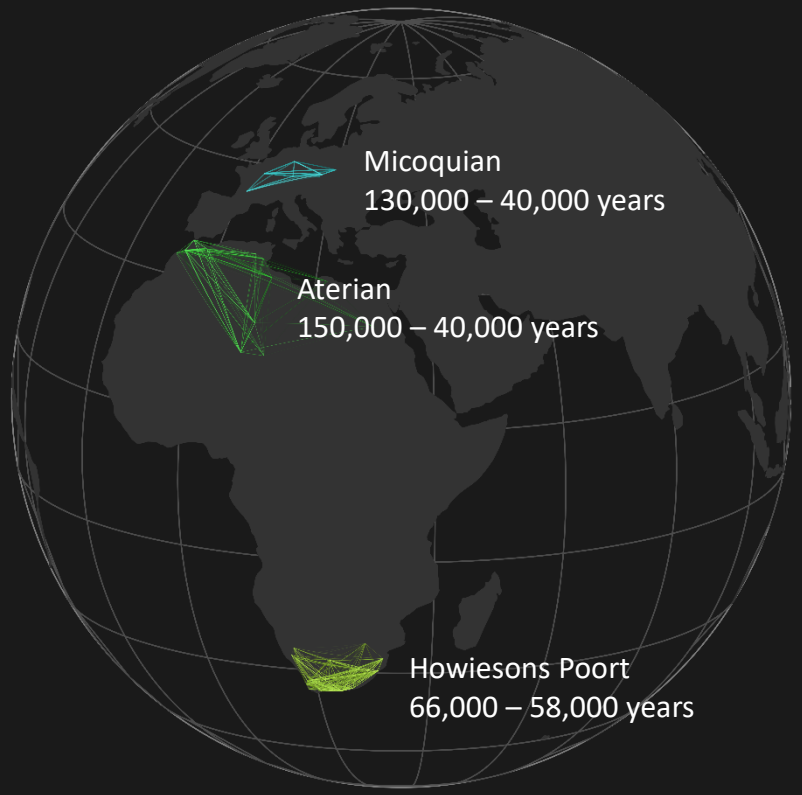


African Acheulean

European Acheulean

Levantine Acheulean

Middle Paleolithic – Middle Stone Age

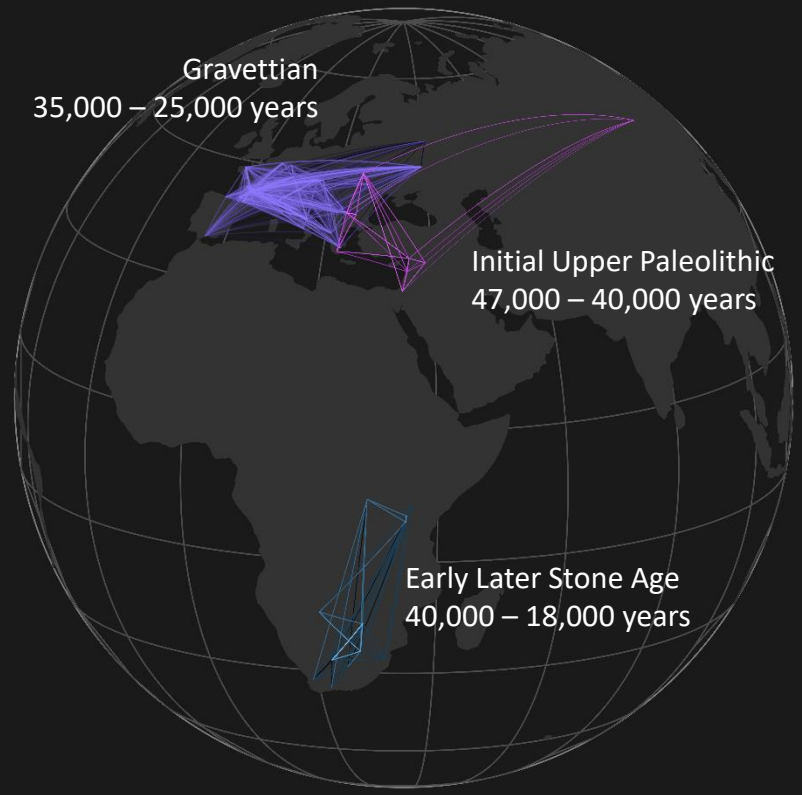


Howiesons Poort

Micoquian

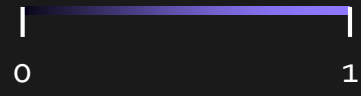
Aterian

Upper Paleolithic – Later Stone Age

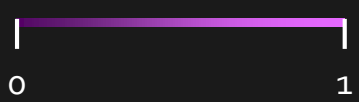


Early Later Stone Age

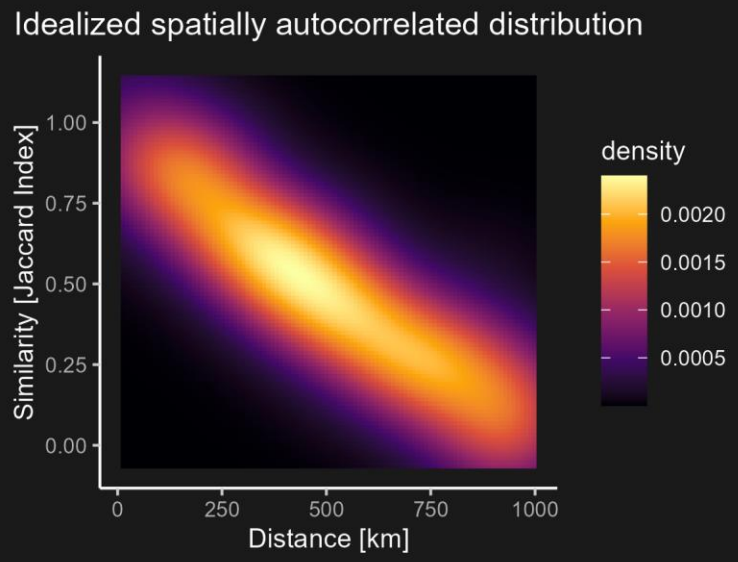
Gravettian

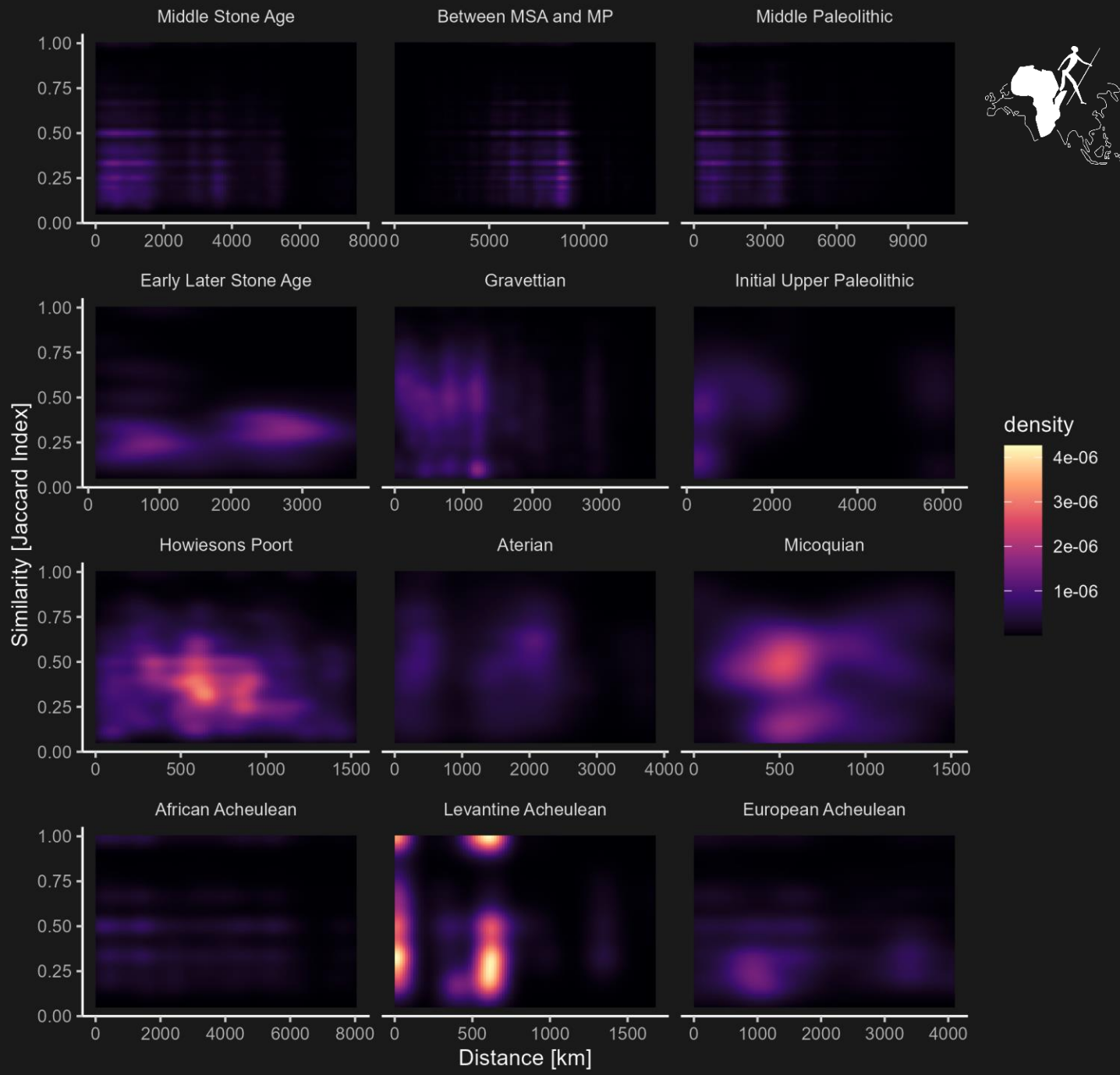


Initial Upper Paleolithic



Absence of spatial autocorrelation?

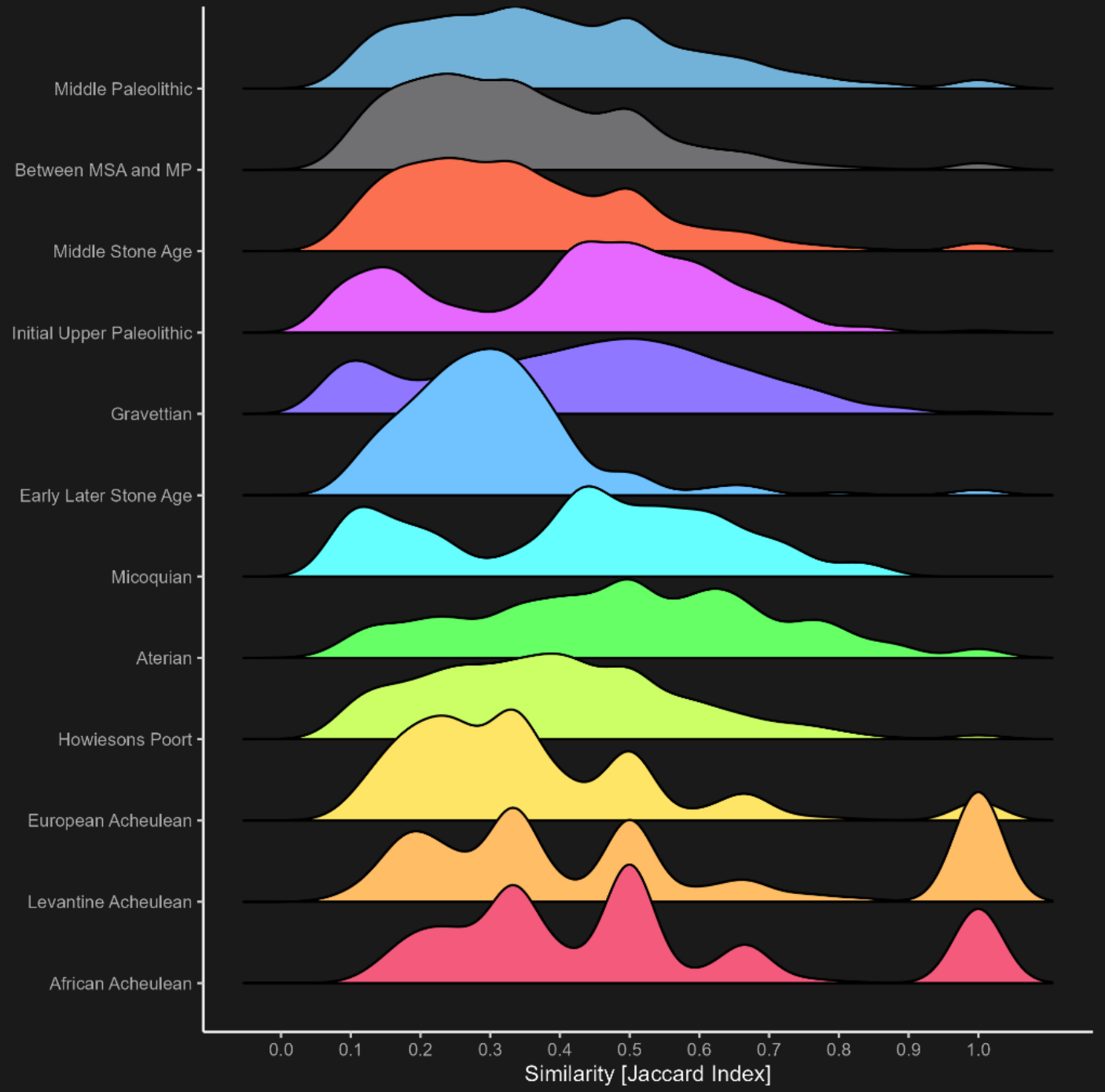




Complex patterns of spatial clustering and cultural similarity

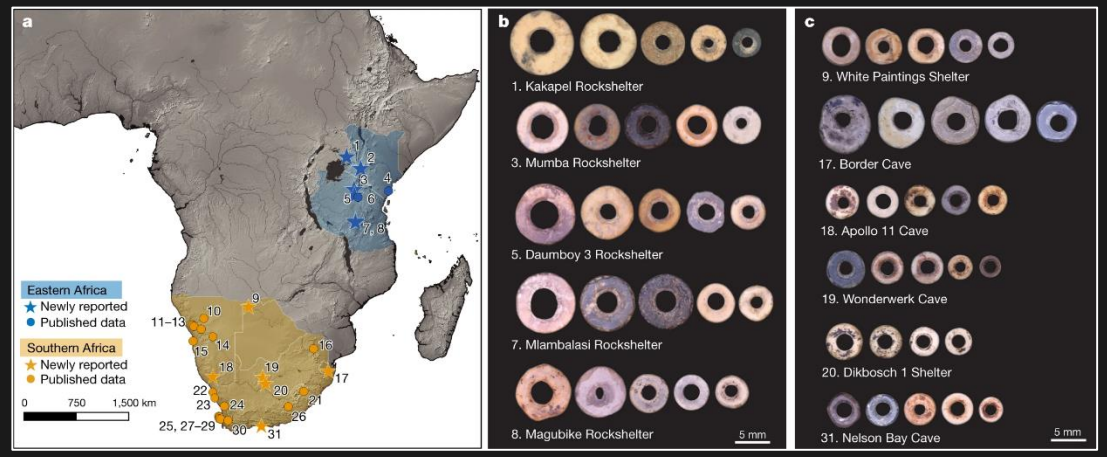
- Average Nearest Neighbour Analysis (Clark & Evans 1954):
  - ANN 0.34, z=-28.66
  - D_{obs}=42.25 km
  - D_{exp}=124.46 km

- Diversification of the hominin toolbox over time
- Multi-purpose vs. specialized tools
- Settlement patterns



Similarity = Relationship?

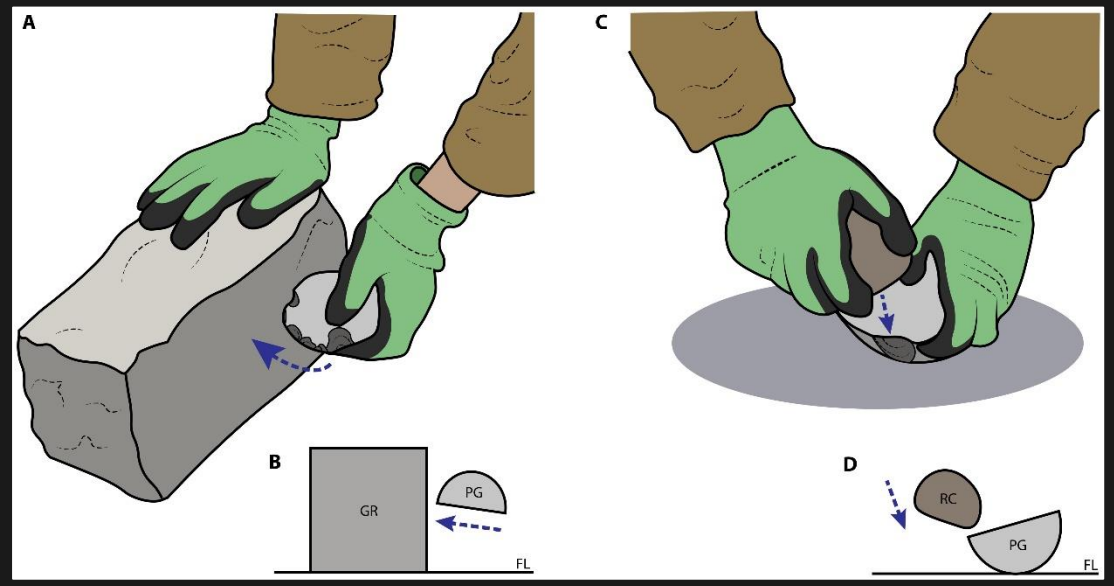
Yes,



Miller & Wang (2022): Ostrich network eggshell beads reveal 50,000-year-old social network in Africa. Nature.

Way, de la Peña, de la Peña & Wadley (2022): Howiesons Poort backed artifacts provide evidence for social connectivity across southern Africa during the Final Pleistocene. Sci. Rep.

but…



Snyder, Reeves & Tennie (2022): Early knapping techniques do not necessitate cultural transmission. Sci. Adv.

Dominguez-Solera et al. (2021): Equids can also make stone artefacts. J. Archaeol. Sci.: Rep.

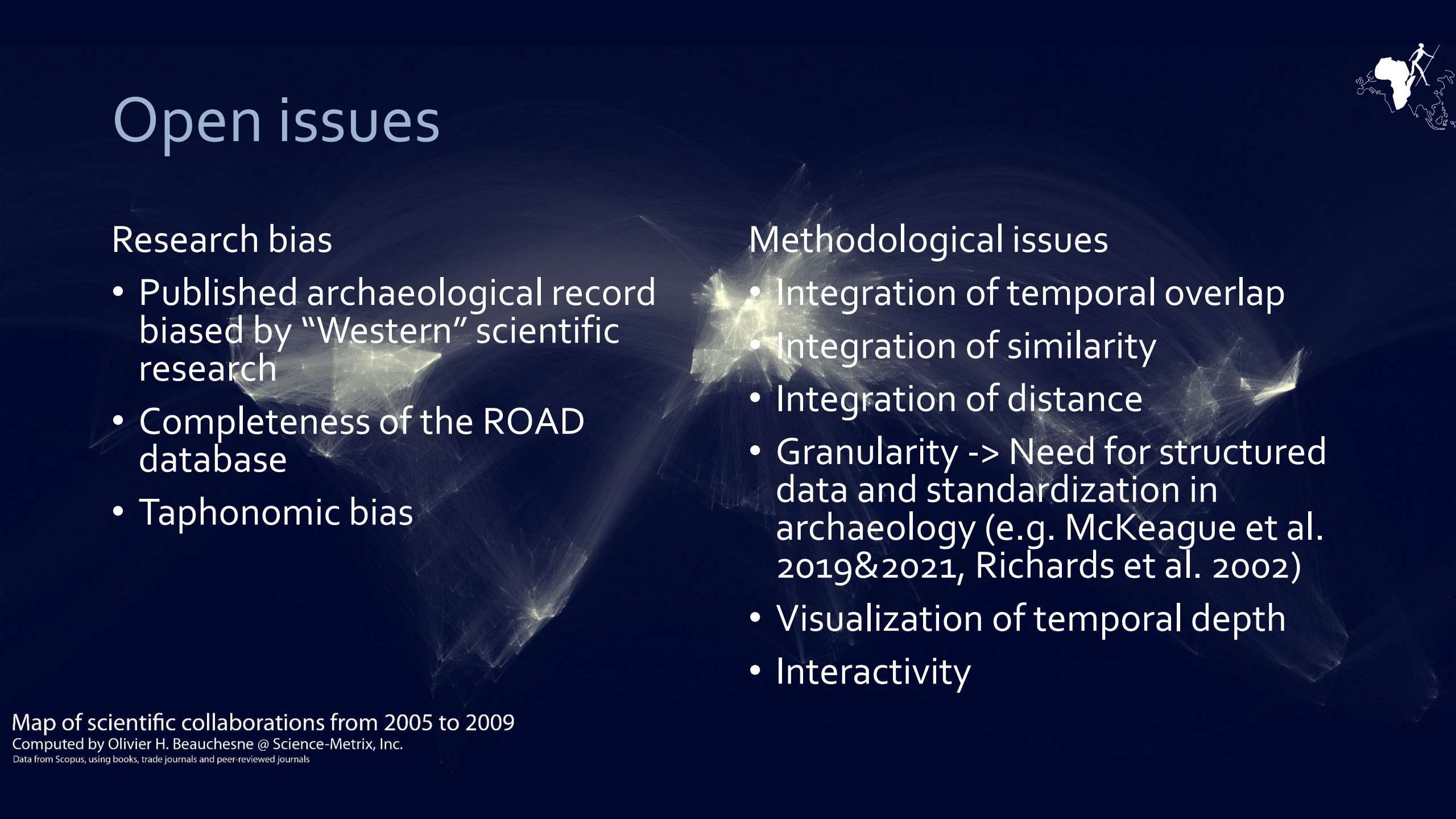
Open issues

Research bias

- Published archaeological record biased by "Western" scientific research
- Completeness of the ROAD database
- Taphonomic bias

Methodological issues

- Integration of temporal overlap
- Integration of similarity
- Integration of distance
- Granularity -> Need for structured data and standardization in archaeology (e.g. McKeague et al. 2019&2021, Richards et al. 2002)
- Visualization of temporal depth
- Interactivity



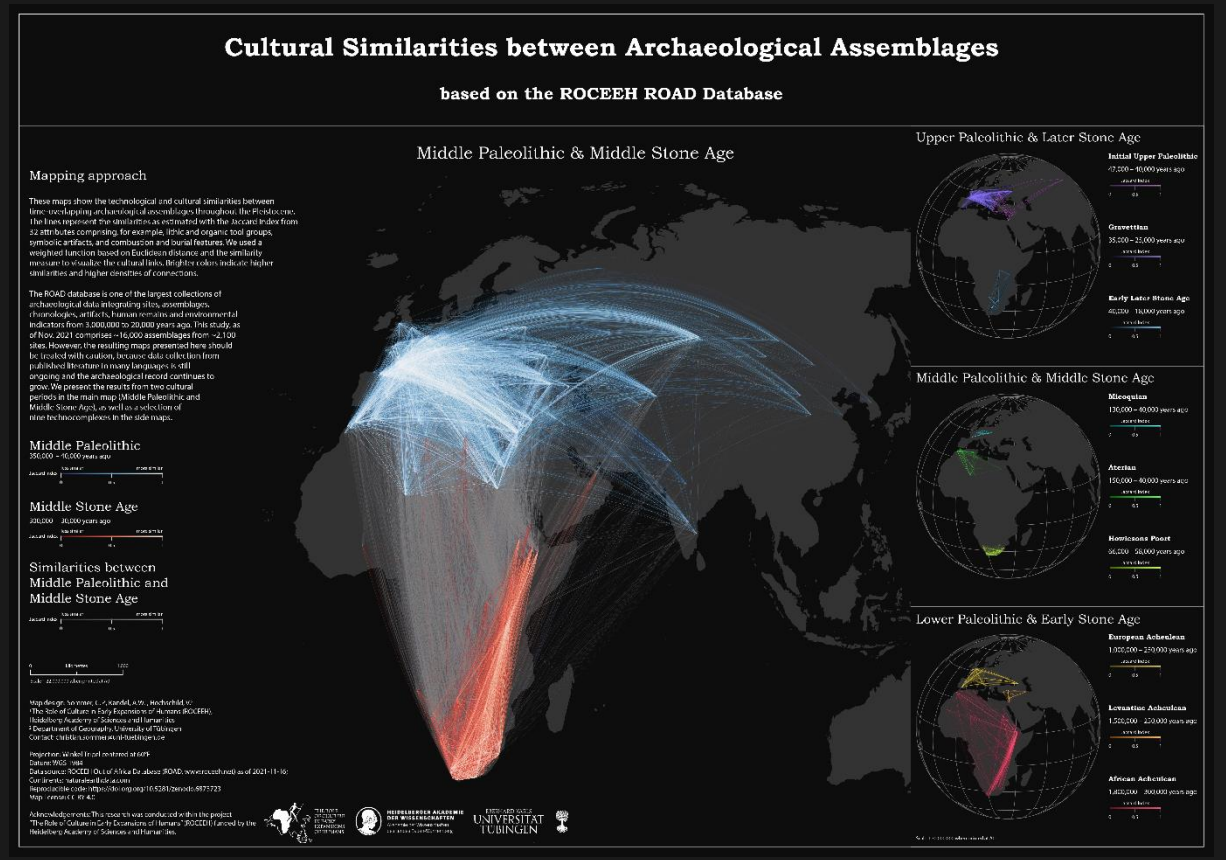
Thank you!

www.roceeh.net

@sommer_geo, @roceeh_news

github.com/sommergeo/

Sommer, C., Kandel, A. W., & Hochschild, V. (2022). The use of prehistoric 'big data' for mapping early human cultural networks. *Journal of Maps*, 1–12. https://doi.org/10.1080/17445647.2022.2118628



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