

Reconstruct fossil mammal communities by recommender systems, and its improvement on paleoenvironmental estimations

Liping Liu^{a,b}, Abigail Parker^c, Miikka Tallavaara^a and Indre Zliobaite^{c,d}

^a Department of Geosciences and Geography, University of Helsinki, Helsinki, Finland

^b The Swedish Museum of Natural History, Stockholm, Sweden

^c Department of Computer Science, University of Helsinki, Helsinki, Finland

^d Finnish Museum of Natural History, LUOMUS, Helsinki, Finland

The fossil record is incomplete due to various natural and human biases. Each fossil assemblage represents only a small fraction of all species that have ever lived, making it challenging to reconstruct the planet's history accurately.

We apply a new machine learning approach to reconstruct fossil community structures at fossil sites. The proposed recommender systems modelling (Zliobaite, 2022) corrects for sampling or preservation biases by building a computational modelling of co-occurrences across a wide range of sites. The main predictive power bases on the assumption that what occurs together (due to affinity to similar environments) is likely to occur together again. Co-occurrences link incomplete data of different sites, and the recommender outputs likely fill in missing taxa at each site based on cooccurrence patterns within database of mammal sites.

We demonstrate the potential of this approach for reconstruct past mammal community on a case study of Pleistocene fossil sites in Nihewan basin, a famous early Pleistocene hominin occupation region in North China. Most Pleistocene fossil assemblages in the Nihewan basin indicate low diversity of faunal communities. Some estimations of paleo-temperature and paleo-precipitation based on dental traits of real fossil occurrence (Liu et al., 2012) give unrealistic estimations of precipitation and temperature. The recommender systems modelling enriches effectively the Nihewan mammal communities by filling in missing taxa, and thereby, smooths the dental trait distributions for fossil sites and improves estimations of paleoenvironments.

References

- Zliobaite I., 2022: Recommender systems for fossil community distribution modelling. *Methods in Ecology and Evolution*, vol. 13, no. 8, pp. 1690-1706. <https://doi.org/10.1111/2041-210X.13916>.
- Liu, L., K. Puolamäki, J.T. Eronen, et al., 2012. Dental Functional Traits of Mammals Resolve Productivity in Terrestrial Ecosystems Past and Present. *Proc. Royal Society B* 279, no. 1739: 2793–99.