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ecodive: Fast Implementations of Ecological Diversity Metrics in R

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Figure 1: Ecodive package logo

Summary

In the context of ecology, diversity measures the distribution of different species within in a community. This calculation may include the number of species present, relative abundances, evolutionary relationships, or a combination thereof. Alpha diversity metrics consider a single community in isolation, whereas beta diversity metrics compute the dissimilarity between two communities.

Applying diversity metrics to large collections of communities, for instance thousands of gut microbiome samples, can offer insights into how specific disease states may be predicted or diagnosed based on ecological "fingerprints".

Statement of Need

Some diversity metrics, such as Faith's PD (Faith, 1992) and UniFrac (Lozupone & Knight, 2005), require complex integration species counts with evolutionary distances. Furthermore, processing thousands of communities is computationally intensive and best implemented with parallel processing and compiled libraries. For these reasons, the ecodive R package was developed to handle these challenges so that R users don't have to.

Related Works

There are currently five other R packages that can calculate alpha and beta diversity metrics: abdiv (Bittinger, 2020), ampvis2 (Andersen et al., 2018), GUniFrac (Chen et al., 2023),

phyloseq (McMurdie & Holmes, 2013), and vegan (Oksanen et al., 2025). However, ecodive provides an implementation which is both faster and more memory efficient.

The bench R package (Hester & Vaughan, 2025) was used to compare abdiv, ampvis2, ecodive, GUniFrac, phyloseq, and vegan. The benchmarking runs are detailed in the benchmark vignette, which is available from within R with `vignette('benchmark')` and online at https://cmmr.github.io/ecodive/articles/benchmark.html.

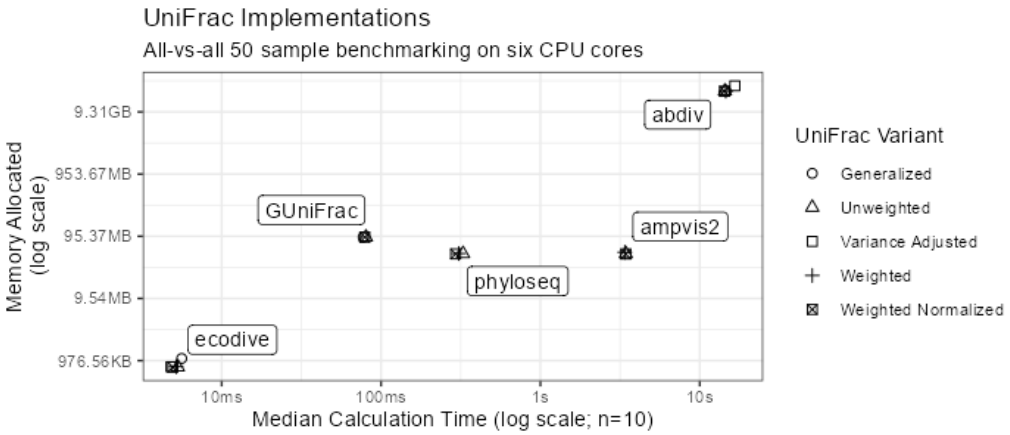

Figure 2: UniFrac benchmarks. Ecodive is 15 to 2800x faster and uses 60 - 25000x less memory.

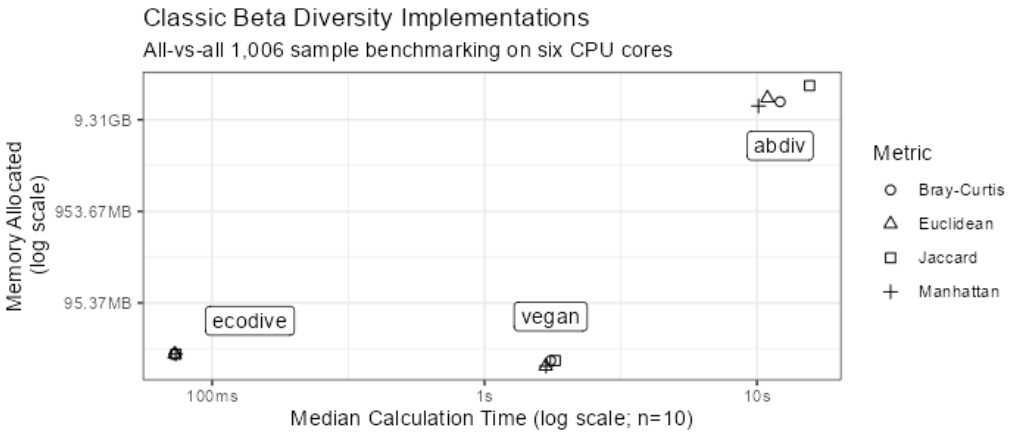

Figure 3: Classic beta diversity benchmarks. Ecodive is 23 to 160x faster and uses 0.8 to 640x less memory.

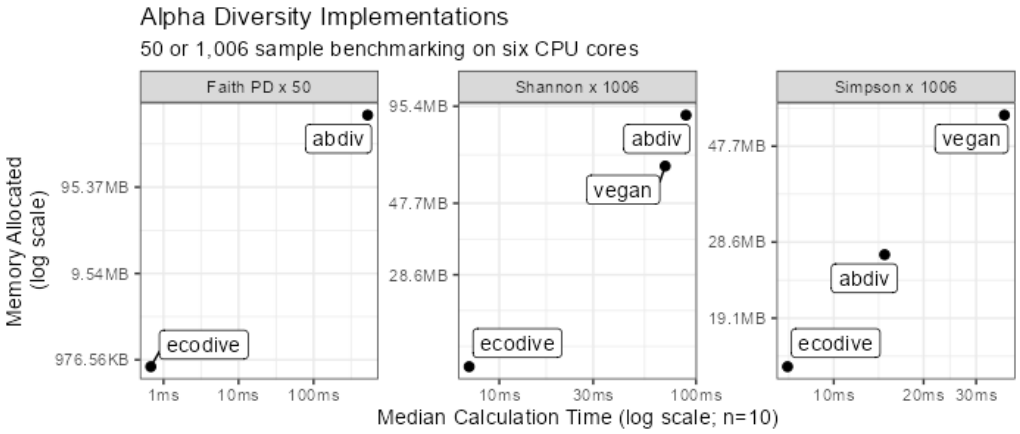

Figure 4: Alpha diversity benchmarks. Ecodive is 10 to 40x faster and uses 5 to 25x less memory.

Acknowledgements

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