German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig
Deutscher Platz 5e, 04103 Leipzig, Germany

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sDiv working group meeting summary

" sPRED - synthesizing Predictability Research of Ecological Dynamics"

Summary:

Ecology has a tradition of using predictions to test hypotheses and theories, however, anticipating how global environmental change will affect natural ecosystems requires a new set of tools and thinking to help safeguard biodiversity for future generations. Currently, quantitative statements of how well community ecology does in prediction are hampered by a lack of quantitative data. However, even with the few syntheses that are available, it is hard to judge whether predictive skill (i.e. realized predictability) in ecology is good or bad, because we do not know how much predictive structure (i.e. intrinsic predictability) ecological data contains and hence how difficult it is to make ecological predictions. We aim to develop a theory of intrinsic predictability and thus provide ecologists with a tool to address when and why their forecasting strategies succeed or fail. We will synthesize methods developed in fields such as computer science and complex systems to infer intrinsic predictability on simulated ecological datasets and then apply these metrics to empirical datasets from Lake Constance and experimental mesocosms. By issuing a data request to practitioners, we will collect datasets with existing realized predictions, with which we can apply the metrics of intrinsic predictability broadly across ecosystem types. With this analysis, we aim to establish the baseline of intrinsic and realized predictability in community ecology, and start a dialogue about the data needed for improving predictive models. Our workshop is timely, because we not only critically need to quantify, but anticipate the effects of global change on global biodiversity to implement successful conservation and management.

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Working group participants:

Georgina Brennan (Bangor University); Ulrich Brose (iDiv); Björn Rall (iDiv); Ursula Gaedke (Potsdam University); Joshua Garland (Santa Fe Institute); Alison Iles (iDiv); Ute Jacob (University of Hamburg); Pavel Kratina (Queen Mary University of London); Blake Matthews (Eawag); Stephan Munch (UC Santa Cruz); Mark Novak (Oregon State University); Frank Pennekamp (University of Zurich); Owen Petchey (University of Zurich); Benjamin Rosenbaum (iDiv); Andrea Tabi (University of Zurich); Colette Ward (University of Zürich); Richard Williams (Slice Intelligence); Gian Marco Palamara (University of Zurich)

Presentations

We started with short introductions by all workshop participants, covering their area of expertise, expectations from workshop, and degree of optimism about ecological predictability.

Introduction by Frank and Alison to the theme of the workshop:
We summarized some of the problems that hamper a synthesis of ecological predictability: the absence of truly anticipatory predictions, the difficulty of comparing predictability across systems, processes and scales, and finally the uncertainty about how data deficiency may limit predictive proficiency of forecasting models. All these issues limit the synthesis of the baseline predictive skill in ecology, in contrast to other fields, such as weather forecasting, where such baselines exist (see Baur et al. 2015).

We then introduced a potential solution: the quantification of predictability by means of the forecast horizon and evaluation of intrinsic predictability as a reference measure. The first workshop was centered on permutation entropy as a measure of time series complexity and intrinsic predictability. Joshua Garland from the Santa Fe Institute introduced the metric, showed its application and limits based on examples from his PhD and current Postdoc research.

The working group then split into two major breakout groups to discuss two main topics:

- What is intrinsic predictability, how can it be measured and how can it advance ecological predictability research?
- Can permutation entropy guide the practice of prediction in ecology by informing about misspecification of forecasting models and information-poor time series?

Working group organization:

Presentations had a minor role in the workshop (20%), whereas group discussions (20%) and breakout groups (60%) were emphasized. The group generally worked in two to three small breakout groups, reporting back to the plenary once or twice per day to share findings/insights with all participants. Breakout groups either tried to clarify conceptual issues (what is permutation entropy? what is the scope and limits to inform about ecological predictability?), worked on the application of permutation entropy to real data using a recent synthesis for time series predictability (based on data provided by workshop participants, and a study of Ward et al. 2014, Oikos), or tested PE on simulated data.

Outputs:

The workshop produced a series of outputs:

- A Github repository with code to calculate overall permutation entropy (PE) and a sliding window version of PE
- Simulations to understand the behaviour of PE according to observation and process noise, in different systems (Ricker map, logistic and tent map, tri-trophic food chain)
- Manuscript draft for a synthesis paper on the use of permutation entropy to inform realized predictions (using particular forecasting models)
- Drafting a database of ecological time series: collection of time series from different systems (field + experimental) to assess time series information content via permutation entropy

Future directions:

- Writing of conceptual paper about intrinsic predictability, scope and application to ecological time series (planned for January 2017)
- Meta-analysis of PE on the database of ecological time series (expected by July 2017)
- Application of permutation entropy to complex communities and food webs (goal for second workshop meeting in October 2017)