After dark, all CATs are leopards

Casting Light on the Use of CPCAT (Closure Principle Computational Approach Test) in Non-Target Soil Organism Assessments

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Background

Recently, the 'Closure Principle Computational Approach Test' (**CPCAT**) was developed as a method that should overcome the shortcomings of NOEC/LOEC application in ecotoxicological pesticide risk assessments[1]. CPCAT is supposed to handle abundance data characterized by low abundances, Poisson distributed, and overdispersion without restrictions. Assuming that abundance data is Poisson distributed, the method is therefore recommended as a valuable tool e.g. for non-target arthropod and soil organism assessments under field conditions in the draft soil guidance document. In this context, a common approach for guidance conform earthworm and mesofauna data collection is to **transform low-resolution sampling data to a square meter scale** before performing the statistical analysis[2,3].

Aim

Investigating the sensitivity of CPCAT to data transformation and its implications for the reliability of results exemplified for abundance data of non-target soil organisms under field conditions.

Methods

1. **Simulate dataset**

Create datasets to mimic a situation with no differences between control and treatments from which **no statistical significances can be expected** and **false positives** can easily be identified.

- Simulate a dataset with control + two treatment levels (to be suitable for multiple comparisons)
- Draw random samples (n=5) for control and treatment levels from the same Poisson distribution with λ=6. => **no differences between control and treatment !**
- Multiply nominal dataset with factor 10 to 200 in steps of 10 to simulate upscaling from a sample scale to an arbitrary analysis scale
- Simulate 100 replicates to cover random variation

2. **Calculate p-values with CPCAT**

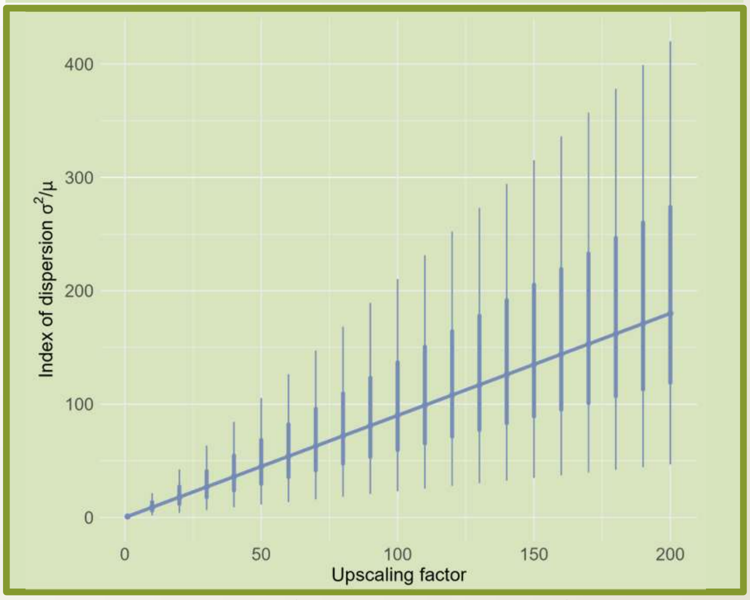

Figure 1: Index of dispersion (ratio of variance over mean) of the simulated data. An index of 1 represent equality of variance and mean, which is expected from a Poisson distribution; index values > 1 represent over-dispersed data. Here the upscaling leads to a linear increase of the ratio since the variance increases quadratically and the mean linearly.

Results

- High sensitivity of CPCAT to upscaled Poisson sampling data, leading to decreased p-values and consequently an **inflation in the false-positive rate** which is correlated with the extent of the transformation applied.
- Upscaling particularly magnified the dispersion of the data in **violation of CPCAT's assumption** regarding Poisson-distributed data.
- The CPCAT algorithm uses Poisson-distributed data to evaluate the observed data and **lacks a variance stabilizing mechanism** to deal with over-dispersed data.

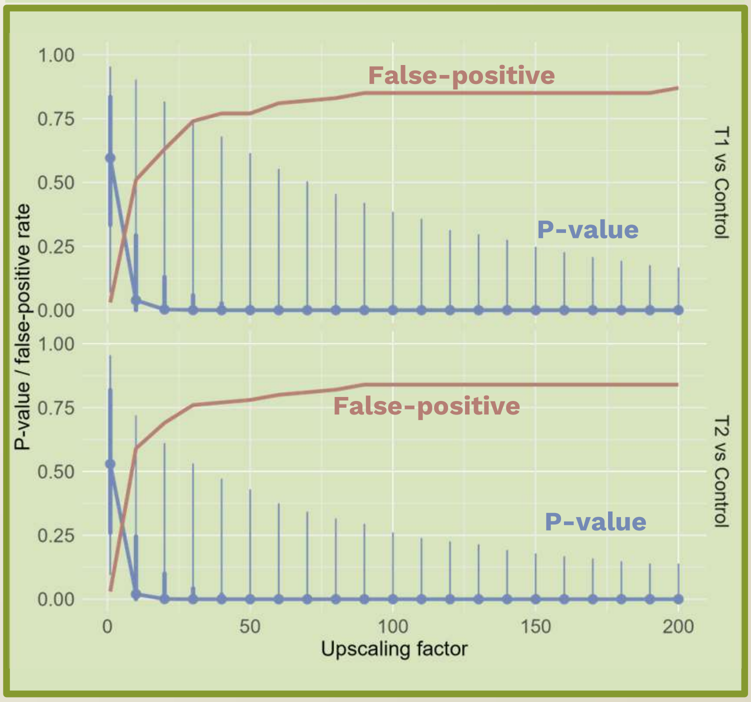

Figure 2: CPCAT p-values for a range of simulated datasets comparing two treatments (T1 and T2) to a control with no differences in their means along a gradient of different multiplication factors upscaling the Poisson data. The blue line denotes the resulting p-values with 50% quantile, 50% and 90% interquartile ranges (25%-75% and 5%-95% quantiles, respectively). The red line indicated the false-positive rate.

Conclusion

- Robustness and reliability of CPCAT results under the current recommendations cannot be guaranteed
- Careful application of CPCAT to (scaled) abundance data (validation of method's suitability is required)
- CPCAT should be extended to be able to handle over-dispersed abundance data
- **Guidelines should consider the current limitations of CPCAT in their suggested procedures**

[1]**Lehmann**, René, et al. (2016) "A new approach to overcome shortcomings with multiple testing of reproduction data in ecotoxicology." Stochastic environmental research and risk assessment 30, 871-882. | [2]**ISO 11268-3:2014(E)** - Soil quality - Effects of pollutants on earthworms - Part 3: Guidance on the determination of effects in field situations | [3]**ISO/FDIS 23611-2:2005(E)** - Soil quality - Sampling of soil invertebrates - Part 2: Sampling and extraction of micro-arthropods (Collembola and Acarina)