Estimating density from presence/absence data in clustered populations

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ABSTRACT:

1. Inventories of plant populations are fundamental in ecological research and monitoring, but such surveys are often prone to field assessment errors. Presence/ absence (P/A) sampling may have advantages over plant cover assessments for reducing such errors. However, the linking between P/A data and plant density depends on model assumptions for plant spatial distributions. Previous studies have shown, for example, how that plant density can be estimated under Poisson model assumptions on the plant locations. In this study, new methods are developed and evaluated for linking P/A data with plant density assuming that plants occur in clustered spatial patterns.

2. New theory was derived for estimating plant density under Neyman–Scott-type cluster models such as the Matérn and Thomas cluster processes. Suggested estimators, corresponding confidence intervals and a proposed goodness-of-fit test were evaluated in a Monte Carlo simulation study assuming a Matérn cluster process. Furthermore, the estimators were applied to plant data from environmental monitoring in Sweden to demonstrate their empirical application.

3. The simulation study showed that our methods work well for large enough sample sizes. The judgment of what is 'large enough' is often difficult, but simulations indicate that a sample size is large enough when the sampling distributions of the parameter estimators are symmetric or mildly skewed. Bootstrap may be used to check whether this is true. The empirical results suggest that the derived methodology may be useful for estimating density of plants such as *Leucanthemum vulgare* and *Scorzonera humilis*.

4. By developing estimators of plant density from P/A data under realistic model assumptions about plants' spatial distributions, P/A sampling will become a more useful tool for inventories of plant populations. Our new theory is an important step in this direction.

A modeling framework for integrating Citizen Science data and professional surveys in ecology: A case study on risk of dead of birds caused by powerlines

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The variety of data sources in biodiversity related to the spatial distribution of species and events related to them is wide. Unfortunately, not all the sources of information we have access to are collected in standard ways. Hence, proposing models that make use of them simultaneously becomes a challenge that needs to be addressed carefully.
The goal of our case study is to find hotspots of dead of birds caused by powerlines in Trøndelag, Norway. There are two types of information available: professional surveys collected by expert scientists and opportunistic records of Citizen Scientists across the region. We propose a modeling framework that integrates both sources of information considering their different properties. This framework assumes that the different types of information available have a common underlying process, represented as a Gaussian Random Field. The framework also accounts for the spatial and systematic biases characteristic of Citizen Science data by modeling the observed point pattern as a thinned version of the true point pattern. Our modeling framework lies within the group of Latent Gaussian Models. Hence it can be easily fitted using the INLA-SPDE approach. We test the models we propose through simulations and comparison criteria against simpler models.

Population synchrony of gray-sided voles in northern Norway

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The climate and day-length patterns of the globe's northern regions create unique ecological patterns. For the sub-Arctic forests and tundra, this is reflected in very marked seasonal differences and multi-annual cycles for several animal populations. Small rodents are a keystone group of these ecosystems, with close food web interactions with most arctic species, and are important predictors and bio-indicators of the full system [1]. Among rodents, the gray-sided vole constitutes one of the most abundant species which has attracted a lot of attention over past decades. This species shows cyclic fluctuations which are often well described by second-order autoregressive processes (AR(2)) and shows spatial population synchrony [2]. Animal population synchrony is a consequence of how the environment interacts with a given species, whether it be through the weather, inter-species interactions such as predation, or intra-species dynamics such as dispersal. Studying the spatial synchrony can thus be fundamental to understand what forces drive population change and, in the case of the voles, what could be the key drivers/predictors of the ecosystem. We present a case study using a time series of 21 years from gray-sided vole capture-recapture data from northern Norway, collected in both spring and fall. We investigate different sources of synchrony by fitting yearly and seasonal models, reflecting the local variations in the species dynamics, as well as estimating the strength and scale of population synchrony. We further correlate synchrony with available environmental variables to identify some of the main drivers behind it. In addition to the case-study conclusions, we further assess the importance of addressing seasonality in related synchrony studies.

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Classification of cod stocks by image analysis of otoliths – a comparison of Fisher discriminant analysis of contour features with a Deep Learning approach

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Fisher's linear discriminant based on elliptical Fourier coefficients (EFDs) of closed cod otolith contours has proven to be an efficient tool to discriminate between the vulnerable Norwegian Coastal Cod (CC) and the much more abundant North-East Arctic cod (NEAC), with about 90% classification score for each stock [1]. The published results were based on segmentation of the otolith contour from original grey tone images with a dark otolith on a bright background, with the contour characterized by an oval gross shape superimposed by many high-frequent ripples. An alternative parameter-sparse approach is examined with good results based on 1D Fourier coefficients of lasso (smallest convex) contours ([2], [3]). To compensate for the removal of ripple information, the ratio of the contour perimeter including the ripples divided by the convex perimeter was added as an additional feature to the Fourier coefficients, as this ratio was shown to be significantly different for the two stocks. The same image material (367 CC and 243 NEAC otolith images) has also been analyzed by deep learning. Deep learning and Convolutional Neural Networks are known to produce good results in image classification tasks by producing probabilistic estimates of class belongings. An experiment on both unprocessed and standardized otolith images resulted in good accuracy scores. The test scores for the model were validated using $k * l$-fold cross-validation with the data being split in different training, validation and test sets by proportionate allocation stratification. A semi-supervised model using self-training with predicted labels were also compared with the supervised model. Interpretability is an important aspect of Deep Learning algorithms, and heatmaps are generated on images, to determine the features which are emphasized by the model. A deeper insight into differences and similiarities between which shape features are drivers behind the stock decision made by the deep learning and Fourier coefficient approach can be obtained by comparing average heatmaps for the two stocks with the corresponding average contours based on the Fourier coefficients. Further details of the methodology and the final results will be presented at the conference.

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