Time-lapse imagery is cheap and timely in the fight against colonial species' decline

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Abstract

Many of the species in decline around the world are subject to different environmental stressors across their range, so replicated large-scale monitoring programmes, are necessary to disentangle the relative impacts of these threats. At the same time as funding for long-term monitoring is being cut, studies are increasingly being criticised for lacking statistical power. For those taxa or environments where a single vantage point can observe individuals or ecological processes, time-lapse cameras can provide a cost-effective way of collecting time series data replicated at large spatial scales that would otherwise be impossible. However, networks of time-lapse cameras needed to cover the range of species or processes create a problem in that the scale of data collection easily exceeds our ability to process the raw imagery manually. Citizen science and machine learning provide solutions to scaling up data extraction (such as locating all animals in an image). Crucially, citizen science, machine learning-derived classifiers, and the intersection between them, are key to understanding how to establish monitoring systems that are sensitive to – and sufficiently powerful to detect –changes in the study system. Citizen science works relatively 'out of the box', and we regard it as a first step for many systems until machine learning algorithms are sufficiently trained to automate the process. Using Penguin Watch (www.penguinwatch.org) data as a case study, we discuss a complete workflow from images to parameter estimation and interpretation: the use of citizen science and computer vision for image processing, and parameter estimation and individual recognition for investigating biological questions. We discuss which techniques are easily generalizable to a range of questions, and where more work is needed to supplement 'out of the box' tools. We conclude with a horizon scan of the advances in camera technology, such as on-board computer vision and decision making.

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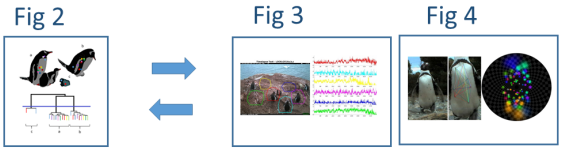
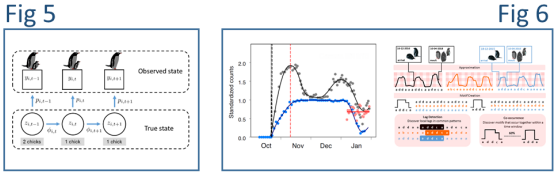
Data collection

Processing



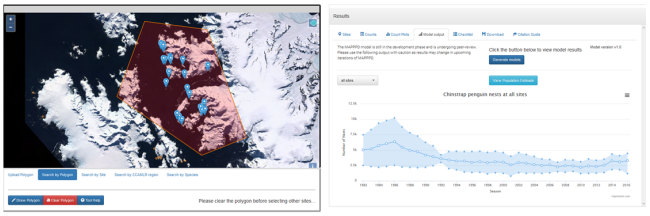
citizen science computer vision

Analysis



parameter estimation survival analysis

Interpretation and policy



data portal visualisation indicators and models