

Biological pattern recognition by neural networks

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ABSTRACT: Neural network analysis was proposed and evaluated as a method for image analysis of plankton data derived from automatic counting techniques. It was shown that a neural network with 2 layers of weights was capable of learning a large data set by the backward-error propagation method. Significant results were achieved in separating novel images of 2 co-occurring species of *Ceratium* spp. from the western North Atlantic Ocean.

INTRODUCTION

There is a growing concern amongst the marine scientific community about the diminishing numbers of competent plankton taxonomists remaining in, and being recruited to, research. This has led to a number of initiatives attempting to overcome this problem using automated pattern recognition techniques (Jeffries et al. 1984, Rolke & Lenz 1984, Steidinger et al. 1990). Certainly it is a generally held belief that the majority of plankton samples will eventually be sorted, counted and taxonomically analysed using automatic techniques. No definitive system has yet been built but it is highly likely that pattern recognition and image processing will be the method to achieve the processing of the data. There is also a growing requirement for discrimination and identification of video images collected from cameras mounted on remote vehicles and towed systems. Recognition of biological patterns by neural networks is a new concept and one which we suggest could play a role in achieving these ends.

The majority of previous attempts to use automated pattern recognition for taxonomic identification have utilised explicitly statistical techniques, whereby morphological measurements are made on sample data (either by hand or by some automatic image analysis technique), and the measurements submitted to discriminant analysis (Yarranton 1967, Jeffries et al. 1980, 1984). Typically such techniques involve making a wide range of measurements, and using the statistical analysis to determine which measurements or combi-

nation of measurements allows the best discrimination to be made. Obtaining images clean enough to enable accurate measurement is itself quite problematic. A neural network approach was considered suitable for this type of problem for a number of reasons: (1) neural networks (strictly, artificial neural networks) are able to be taught, i.e. exposed to data and 'told' what the correct response (e.g. category) is for that stimulus, and do not need to be given a rule-base to determine behaviour; (2) they are able to form arbitrary input-output mappings, and so can be used in a wide variety of domains; (3) they have been shown to be largely resistant to noisy or imperfect inputs; (4) their massive operational parallelism means that hardware versions of networks can be made that perform very complex mapping tasks at great speed.

MATERIALS AND METHODS

Samples. To assess the possibilities of artificial neural networks' discriminating images of planktonic species, specimens of the genera *Ceratium* were used. *Ceratium* spp. are generally compressed in one plane and are ideal organisms for drawing or video imaging. They are also morphologically variable and specimens are at times difficult to separate, when there can be up to 20 different and distinct species of the genera occurring in one plankton sample. The 2 species selected were *C. arcticum* (Ehrenberg) Cleve, and *C. longipes* (Bailey) Gran., which have sympatric geographical distributions in the western Atlantic Ocean.

Pattern Recognition In Biological Tech

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Pattern Recognition In Biological Tech:

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