MACHINE LEARNING CLASSIFICATION OF BEACH STATE FROM ARGUS IMAGERY

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INTRODUCTION

Nearshore beach morphology is of interest to coastal managers due to the strong influence it exerts on subaerial beach erosion, pollutant dispersal, and recreational safety. In particular, wave breaking conditions and nearshore hydrodynamics are highly dependent on sandbar configuration. The term 'beach state' describes specific planform configurations of nearshore morphology that are in dynamic equilibrium with the time-varying forcing conditions. Beach state categories were first introduced by Wright and Short (1984), who observed sandbar systems in Narrabeen-Collaroy, Australia and extended by Lippman and Holman (1990), based on observations of time-exposure Argus imagery of sandbar systems in at Duck, NC, USA.

In this study, we use machine learning algorithms to identify beach states from Argus imagery at two distinct sites: Narrabeen-Collaroy (hereafter Narrabeen), SE Australia, and Duck, NC. We assess the ability of the algorithm to classify beach states at each site and its transferability from one beach to another. Additionally, we investigate the extent to which the spatial and temporal evolution of beach states influences the ability of the algorithm to classify images into discrete beach states.

METHODS

BEACH STATE CLASSIFICATION SCHEMES

Two beach state classification systems are considered in this study: Wright and Short (1984) and Lippman and Holman (1990). While existing beach state classifications systems are extremely useful as qualitative descriptors, in practice beaches evolve both spatially and temporally continually between the discrete states. This makes it difficult to quantitatively assign a given beach into a single category over a given region of interest at a given instant in time. As such, in this study the beach state of a single image has been classified using as a weighted combination of discrete states, in a representation known as a probability simplex. In this way, a beach can exhibit the characteristics of more than one state.

DATASET AND LABELS

The two datasets of Argus imagery from Narrabeen and Duck encompass the years 2004-2015 and 1984-2015, respectively. Discrete beach state labels for both Duck and Narrabeen were obtained by individuals assigning labels while consistently looking at one location within the image. Additionally, a probability simplex dataset for Duck was obtained through human voting.

MACHINE LEARNING

A Convolutional Neural Network (CNN) was used to categorize images. The performance of this algorithm was optimized and assessed for different operating conditions and input data including: RGB vs greyscale images; oblique vs rectified angles; base architectures; dataset sizes; and additional auxiliary information.

PRELIMINARY RESULTS

Preliminary results of the CNN classifications of the Duck dataset show an average accuracy 74%, with per-class accuracies ranging from 57% to 87%. The CNN could clearly distinguish between beach states of different trough configurations (i.e., discontinuous or continuous troughs), but was more likely to confuse beach states of different longshore variability (i.e., linear versus crescentic bar). Similarly, probability simplices were more likely to have a broad distribution for beach configurations associated with discontinuous troughs, and have a narrower distribution for beach configurations associated with continuous troughs.

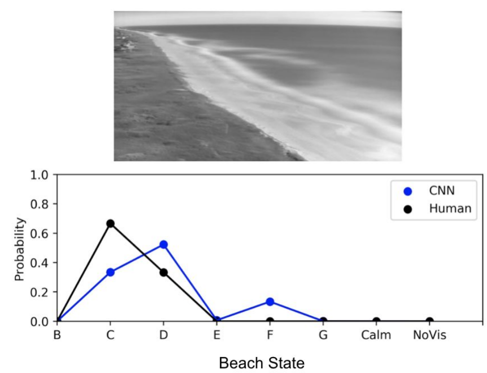

Figure 1: Example of a beach state encompassing two categories, and categorized as a probability simplex by humans (black) and the CNN (blue).

REFERENCES

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Wright, Lynn D., and Andrew D. Short. "Morphodynamic variability of surf zones and beaches: a synthesis." *Marine geology* 56, no. 1-4 (1984): 93-118.