An Individual-Based Predator-Prey Ecosystem for Image Segmentation: Effect of Explorers

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Abstract

We present an individual-based predator-prey ecosystem for image segmentation. The ecosystem is modeled from bottom-up and consists of three components - environment in which the predators and prey live. The image to be segmented is mapped as the environment's landcover in which the predators and prey live. The prey species have certain "color genes" which endow their coat/skin with certain color. A prey whose coat color matches that of the environment is camouflaged from predators and is said to have adapted to the local environment. The predators have visual acuity and attempt to kill prey that they can distinguish against the environment. A density-dependent growth scheme is used to stabilize the prey population. The reproduction operator of the prey along with the mutation operator help introduce new genotypes into the population. We take inspiration from nature in assuming that overtime only those genotypes which provide camouflage to the prey, offering a better chance of survival in the environment, would survive.

Although this scheme is able to populate large areas of continuous color, areas which are not of sufficient size to allow local adaptation of the prey are not populated. To populate these smaller areas (called "niches") using the larger populated areas as feeders, we investigate the effect of exploration in the prey species. The prey species are modeled with an "explorer gene" which determines whether a prey individual is a settler or an explorer. Settlers have a sense of boundary and do not venture out beyond a certain distance from their birth place. Explorers on the other hand, have no sense of boundary and freely move about in the environment. We present results from experiments with and without explorers (for various degrees of exploration), to demonstrate that it is mainly due to the explorers that the unpopulated areas can be populated.