

Appendix 4: Genetic Algorithm

Algorithm 1 Genetic algorithm used to find good sequences of management actions

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1: for rep = 1 to rep = number_reps do
2:   Randomly generate initial population  $P$  of action sequences  $\mathbf{a}$ .
3:   for gen = 1 to gen = number_gen do
4:     for all  $\mathbf{a} \in P$  do
5:       Initialize population in state  $n_0$ 
6:       for  $t = 1$  to  $t = T$  do
7:         Run the population model under action sequence  $\mathbf{a}$ 
8:         Record  $N''(\mathbf{a}, n_0, t)$  at each step.
9:       end for
10:      Calculate  $R(\mathbf{a}, n_0)$ 
11:    end for
12:    Randomly pair each  $\mathbf{a} \in P$ 
13:    For each pair put the  $\mathbf{a}$  with the highest  $R(\mathbf{a}, n_0)$  into population  $P'$ .
14:    Randomly pair each  $\mathbf{a} \in P'$ 
15:    for all pairs do
16:      Copy each sequence in the pair to  $\mathbf{a}_1^*$  and  $\mathbf{a}_2^*$ 
17:      Randomly select a point  $t^* \in 2 : (T - 1)$ 
18:      Swap section  $\mathbf{a}_1^*[1 : t^*]$  and  $\mathbf{a}_2^*[1 : t^*]$ 
19:       $\forall a^t \in \mathbf{a}_j^*, a^t \leftarrow a^{t^*} \in \mathbf{A}$  with probability  $m$ 
20:      Put  $\mathbf{a}_j^*$  into  $P'$ .
21:    end for
22:     $P \leftarrow P'$ 
23:  end for
24: end for
25: Compare  $\mathbf{a}$  with highest  $R(\mathbf{a}, n_0)$  from each  $P$  in the final generation between reps to
    check they have converged on the same action sequence.
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