

Question 1

The Universal Scalability Law (Gunther, 1993) is given by the following equation:

$$R(N) = C \frac{N}{1 + \alpha(N - 1) + \beta N(N - 1)}$$

- a. In terms of using USL for modelling the performance of swarm systems, could you explain the variables in the model?
- b. Could you describe the performance of the swarm system when best fit of model is given by the parameters $C = 1$ and $\alpha = \beta = 0$? Make a plot of the USL spanning at least $N=200$ processes.
- c. How would that change if best fit is given by $C = 1$, $\alpha = 0.0001$ and $\beta = 0$?
- d. Or $C = 1$, $\alpha = 0.0007$ and $\beta = 0.0003$?
- e. Now, given the parameters $C = 0.25$, $\alpha = -0.0335$ and $\beta = 0.00032$, how would you characterize the performance of this swarm system? What is the optimal performance?
- f. How does this model compare to the linear case?
- g. How does the marginal performance vary as a function of N ? When is the addition of a process at its most valuable?
- h. What would constitute an optimal operation level for this swarm system considering that a loss of processes would have to be replaced with a limited number of robots available?