TEK5010 Multiagent systems

Lecture 4: Swarm robotics 1

Exercise: Curve fitting USL to data

Question 1

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

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

The measured performance of a swarm system (data set 1) is given by:

N	0	15	30	60	100	125	150
$R_1(N)$	0	7	24	22	25	29	26

We also have performance data from a second swarm system (data set 2):

N	0	15	30	60	100	125	150
$R_2(N)$	0	20	50	65	30	26	15

a) What numerical parameter values would be a reasonable assumption for "manually" fitting a USL curve to data set 1? You can assume that C=1 but α and $\beta$are unknown.

b) What would be the corresponding parameter values for "manually" curve fitting data set 2?

c) Why must we use non-linear regression methods for curve fitting the USL? And why does this complicate the analysis?

d) Could you use the Python library SciPy to curve fit the USL to the given data?

   Hint, you could base your answer on tweaking the examples given in https://hernandis.me/2020/04/05/three-examples-of-nonlinear-least-squares-fitting-in-python-with-scipy.html

e) Optional: Could you explain the underlaying mathematics for curve fitting the USL using non-linear least squares?

   Hint, a good explanation on non-linear regression for curve fitting is given in the following link http://www.incertitudes.fr/book.pdf