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:

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

a) Given the following measured data set from a swarm system:

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

what numerical parameter values would be a reasonable assumption for "manually" fitting a USL curve to the data? You can assume that $C=1$ but α and β are unknown.

We also have data from a second swarm system:

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

what would be the corresponding parameter values in this case?

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

c) 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

d) 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