

CP.4.2.6, Sauer3

The bloodstream concentration of a drug, measured hourly after administration, is given in the accompanying table. Fit the model

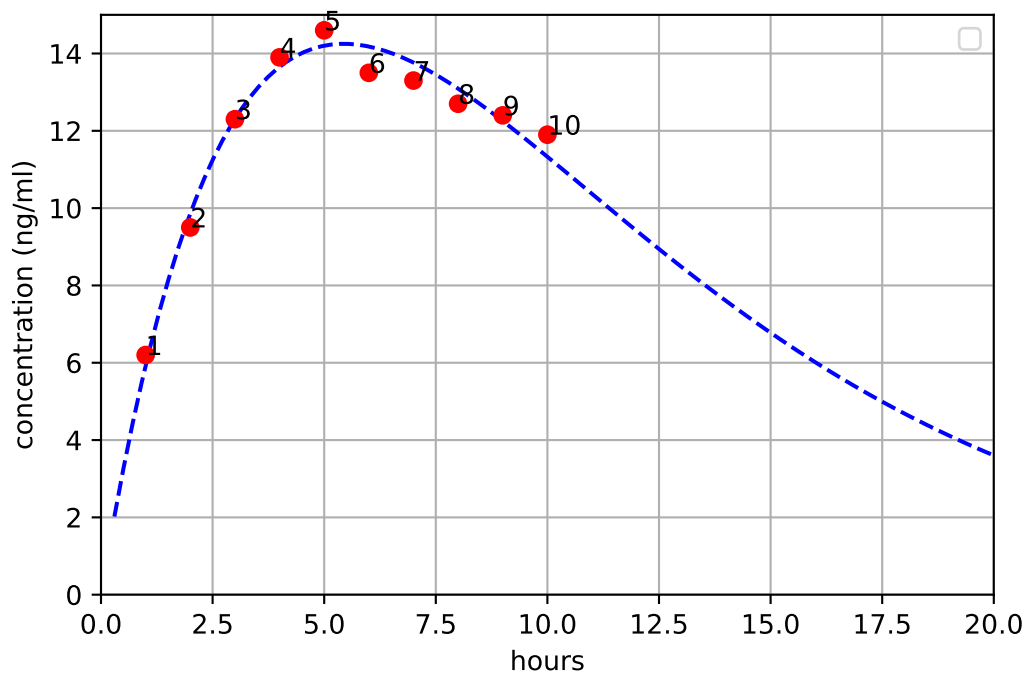
$$y = c_1 t e^{c_2 t} \quad (4.21).$$

Find the estimated maximum and the half-life. Suppose that the therapeutic range for the drug is 4–15 ng/ml. Use the equation solver of your choice to estimate the time the drug concentration stays within therapeutic levels.

Do not worry about the questions of Sauer. This problem is (more or less) solved in the following notebook. You have 9 questions to answer next page.

hours	concentration (ng/ml)
1	6.2
2	9.5
3	12.3
4	13.9
5	14.6
6	13.5
7	13.3
8	12.7
9	12.4
10	11.9

Jupyter Notebook: <https://colab.research.google.com/drive/1KQChAXtFm-tQmeb9GvaHJPkkNDIarVY>



Handwritten questions:

a. In the code what do the array **xx** and the array **yy** represent?

b. Explain what this line do:

```
A = np.array([ np.ones( xx.shape ), xx ]).T
```

Note: Writing “this creates the matrix *A*” is not enough. Something like “this creates the matrix *A* such as the first column is ... and the second column is ..., each row represents ...” is needed

c. Explain what this line do:

```
b = np.array([ np.log(yy) - np.log(xx) ]).T
```

d. Explain what this line do: **x = np.linalg.lstsq(A,b,rcond=None)[0]**

e. Explain what this line do: **yyy[i] = exp(x[0]) * xxx[i] * exp(x[1] * xxx[i])**

f. We find that the model is

$$c(t) = 7.12 \, t \, e^{-0.18t}.$$

What is $c(t)$? What is t ?

g. Do you think we have a good fit? Is this a good model?

h. Describe biologically/physically what is happening? Why is the curve rapidly increasing, and then slowly decreasing with time?

i. Visually, answer the question: “Suppose that the therapeutic range for the drug is 4–15 ng/ml. Estimate the time interval the drug concentration stays within therapeutic levels.” (“Visually” means “look at the graph and guess an interval”.)