Technichal University of Munich
Department of Mathematics

MA4401 Applied Regression, Homework problem 6

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Problem H.6

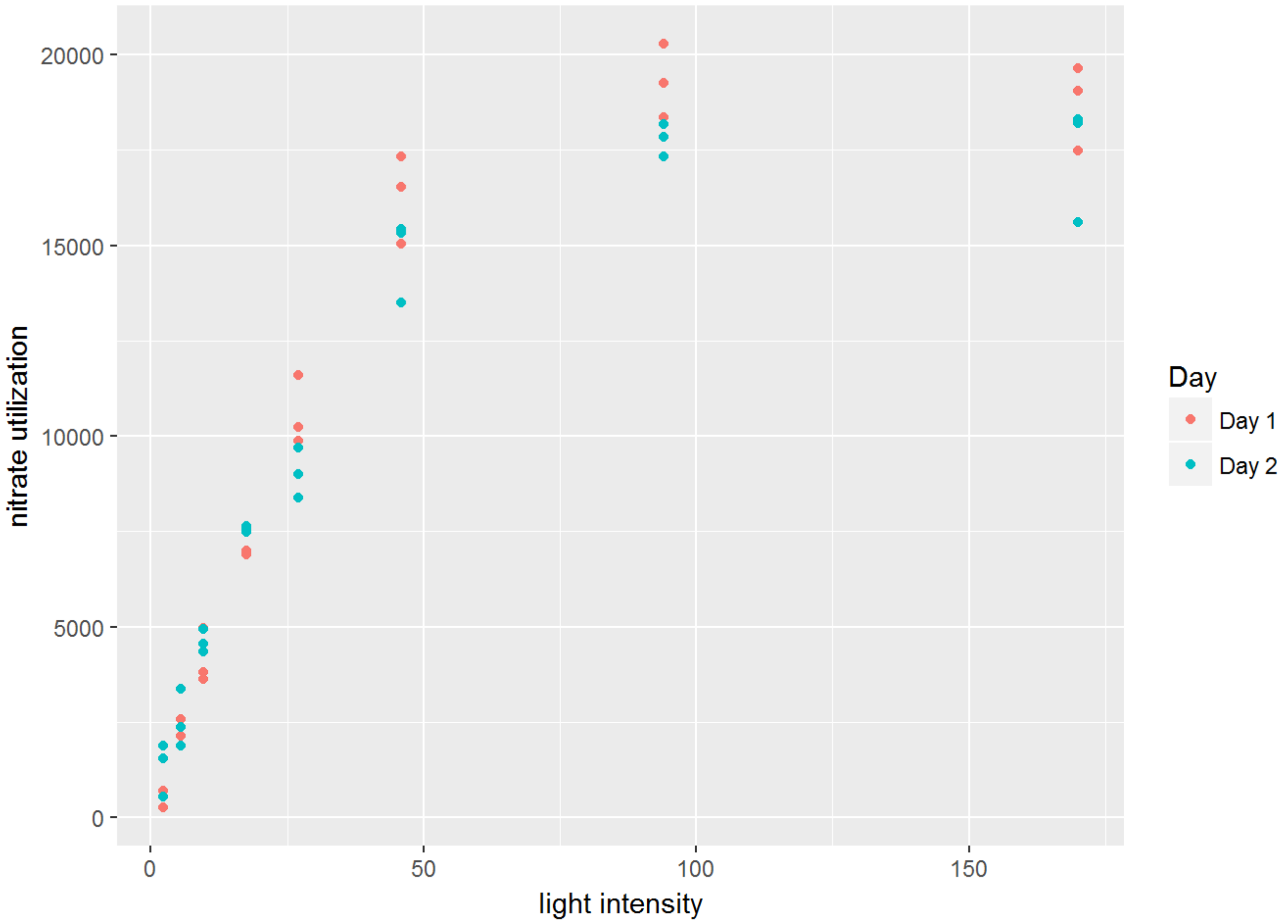
Load the `nitrate` dataset, which is available on moodle. Data on the utilization of nitrate in bush beans as a function of light intensity were obtained by J.R. Elliott and D.R. Perison (https://doi.org/10.1016/S0176-1617(88)80030-0) of Wilfrid Laurier University (Canada). Portions of leaves from three 16-day-old-plants were subjected to eight levels of light intensity (in microeinsteins per square meter per second) and the nitrate utilization (in nanomoles per gram per hour) was measured.

Nitrate utilization should be zero at zero light intensity and should approach an asymptote as the light intensity increases.

Consider the following plot of nitrate utilization versus light intensity.

```
library(tidyverse)
nitrate <- read_csv("nitrate.csv")
```

```
ggplot(nitrate, aes(x = Light, y = Nitrate, colour = Day)) + geom_point() +
  xlab("light intensity") + ylab("nitrate utilization")
```



Note that the experiment was carried out on two different days.

a) Consider the Michaelis-Menten model $y_i = \frac{\beta_1 x_i}{\beta_2 + x_i} + \varepsilon_i$ with $\varepsilon_i \overset{iid}{\sim} N(0, \sigma^2)$. Choose suitable initial values for β_1 and β_2 and fit the model to the data (pool day 1 and day 2 observations) using the function `nls()`. Use `stat_function()` to add the fitted model to the scatterplot of the data. Discuss the adequacy of the fitted model. *(4 points)*

b) Investigate whether the parameters in the Michaelis-Menten model change with the day. Therefore, consider the following model

$$y_i = \frac{(\beta_1 + \alpha_1 z_i) x_i}{(\beta_2 + \alpha_2 z_i) + x_i} + \varepsilon_i,$$

where $\varepsilon_i \overset{iid}{\sim} N(0, \sigma^2)$ and z is an indicator variable that is 1 if day 2 observations are involved and 0 otherwise. Choose suitable initial values for α_1 and α_2 and fit this model to the data by using the function `nls()` and the same initial values for β_1 and β_2, which have been used in part a). and add the fitted model for each of the two days by using again `stat_function()`. *(4 points)*

c) Decide if the modifications in part b) are needed. Therefore test the null hypothesis, that $\alpha_1 = \alpha_2 = 0$. *(2 points)*