SkinCell\_Analysis

## Introduction

Skincells dataset has 3 variables, day of observation, amount of time colony was exposed to solar simulator, number of live cells in the colony. Experiment was performed on 4 days, and collected 118 observations.

Sample data can be seen in Table1.

head(data)

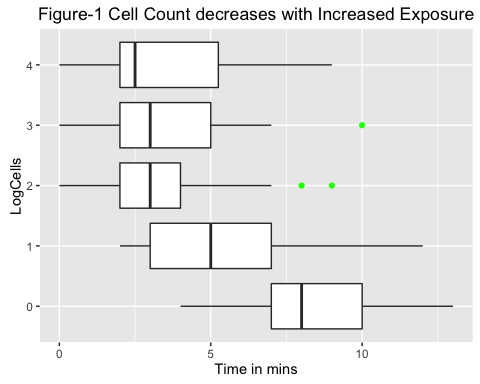
## day time logcells  
## 1 1 0 7  
## 2 1 0 10  
## 3 1 0 10  
## 4 1 0 12  
## 5 1 0 9  
## 6 1 1 5

## Descriptive Analysis

Descriptive analysis is performed on the data and below are the observations 1. Number of observations collected on Day1 to Day3 are 29, and Day4 is 31. 2. Time exposed in mins, ranges from 0 to 4 minutes 3. logcells values range from 0 to 12 in count. At first glance, it is evident that the longer time the cells are exposed, the shorter their life span is.

Refer Figure-1 below

g + geom\_boxplot(outlier.colour = "green") + coord\_flip()



A linear regression model was fitted to these data with logcells as a continuous response variable, time is a continous predictor, day is a categorical predictor. To allow maximum flexibility in the initial model, an interaction of day and time was included.

## Model - 1

data$day <- as.factor(data$day)  
reg.model<-lm(logcells~(time+day+day\*time),data=data)  
summary(reg.model)

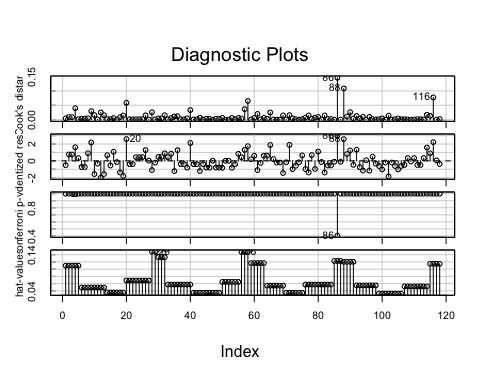
##   
## Call:  
## lm(formula = logcells ~ (time + day + day \* time), data = data)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -4.7879 -1.7144 -0.4493 1.4934 6.7416   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 8.2161 0.8248 9.961 < 2e-16 \*\*\*  
## time -1.4282 0.3809 -3.750 0.000284 \*\*\*  
## day2 -2.2981 1.2268 -1.873 0.063694 .   
## day3 -1.6523 1.1851 -1.394 0.166065   
## day4 -1.1056 1.1941 -0.926 0.356547   
## time:day2 0.4528 0.5558 0.815 0.416983   
## time:day3 0.3519 0.5264 0.668 0.505283   
## time:day4 0.1198 0.5264 0.228 0.820335   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 2.491 on 110 degrees of freedom  
## Multiple R-squared: 0.3059, Adjusted R-squared: 0.2618   
## F-statistic: 6.926 on 7 and 110 DF, p-value: 7.924e-07

anova(reg.model)

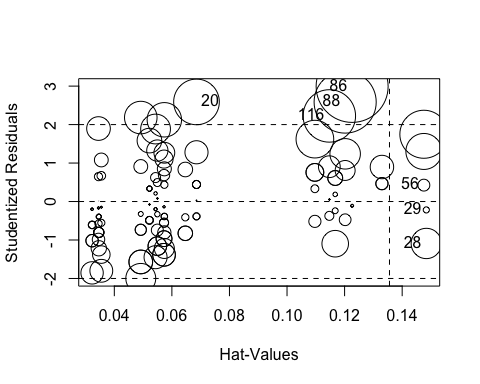
## Analysis of Variance Table  
##   
## Response: logcells  
## Df Sum Sq Mean Sq F value Pr(>F)   
## time 1 263.08 263.080 42.4130 2.285e-09 \*\*\*  
## day 3 32.26 10.752 1.7334 0.1643   
## time:day 3 5.40 1.802 0.2905 0.8322   
## Residuals 110 682.31 6.203   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

p-value is statistically significant for time, indicating that cells count is predominantly dependent on exposure time. Every unit of increased exposure time, cells count decreases by 1.4 units Prediction accuracy of the model is 26%, which is very low. Outlier detection analysis is performed to check, if there were incorrect observations captured due to contamination or any other factors.

## Influence measures of  
## lm(formula = logcells ~ (time + day + day \* time), data = data) :  
##   
## dfb.1\_ dfb.time dfb.day2 dfb.day3 dfb.day4 dfb.tm.2 dfb.tm.3  
## 1 -1.81e-01 1.50e-01 1.22e-01 1.26e-01 1.25e-01 -1.03e-01 -1.08e-01  
## 2 2.66e-01 -2.20e-01 -1.79e-01 -1.85e-01 -1.84e-01 1.51e-01 1.59e-01  
## 3 2.66e-01 -2.20e-01 -1.79e-01 -1.85e-01 -1.84e-01 1.51e-01 1.59e-01  
## 4 5.69e-01 -4.71e-01 -3.83e-01 -3.96e-01 -3.93e-01 3.23e-01 3.41e-01  
## 5 1.17e-01 -9.65e-02 -7.84e-02 -8.12e-02 -8.05e-02 6.62e-02 6.99e-02  
## 6 -1.54e-01 9.14e-02 1.04e-01 1.07e-01 1.06e-01 -6.26e-02 -6.61e-02  
## 7 -1.54e-01 9.14e-02 1.04e-01 1.07e-01 1.06e-01 -6.26e-02 -6.61e-02  
## 8 1.91e-01 -1.13e-01 -1.28e-01 -1.33e-01 -1.32e-01 7.76e-02 8.19e-02  
## 9 4.58e-01 -2.71e-01 -3.08e-01 -3.19e-01 -3.16e-01 1.86e-01 1.96e-01  
## 10 -3.29e-01 1.95e-01 2.21e-01 2.29e-01 2.28e-01 -1.34e-01 -1.41e-01  
## 11 -6.78e-02 4.02e-02 4.56e-02 4.72e-02 4.68e-02 -2.75e-02 -2.91e-02  
## 12 -4.19e-01 2.49e-01 2.82e-01 2.92e-01 2.90e-01 -1.70e-01 -1.80e-01  
## 13 -3.29e-01 1.95e-01 2.21e-01 2.29e-01 2.28e-01 -1.34e-01 -1.41e-01  
## 14 5.31e-02 2.16e-02 -3.57e-02 -3.69e-02 -3.67e-02 -1.48e-02 -1.56e-02  
## 15 -4.40e-02 -1.79e-02 2.96e-02 3.06e-02 3.04e-02 1.22e-02 1.29e-02  
## 16 8.57e-02 3.48e-02 -5.76e-02 -5.97e-02 -5.92e-02 -2.39e-02 -2.52e-02  
## 17 -1.16e-02 -4.72e-03 7.81e-03 8.08e-03 8.02e-03 3.23e-03 3.41e-03  
## 18 -1.09e-01 -4.44e-02 7.36e-02 7.62e-02 7.56e-02 3.05e-02 3.21e-02  
## 19 -1.43e-01 -5.80e-02 9.60e-02 9.94e-02 9.87e-02 3.98e-02 4.20e-02  
## 20 -1.31e-01 4.95e-01 8.78e-02 9.09e-02 9.03e-02 -3.39e-01 -3.58e-01  
## 21 1.95e-02 -7.38e-02 -1.31e-02 -1.36e-02 -1.35e-02 5.06e-02 5.34e-02  
## 22 1.95e-02 -7.38e-02 -1.31e-02 -1.36e-02 -1.35e-02 5.06e-02 5.34e-02  
## 23 -2.24e-02 8.47e-02 1.50e-02 1.56e-02 1.54e-02 -5.80e-02 -6.13e-02  
## 24 -2.24e-02 8.47e-02 1.50e-02 1.56e-02 1.54e-02 -5.80e-02 -6.13e-02  
## 25 -2.24e-02 8.47e-02 1.50e-02 1.56e-02 1.54e-02 -5.80e-02 -6.13e-02  
## 26 -6.46e-02 2.45e-01 4.34e-02 4.50e-02 4.46e-02 -1.68e-01 -1.77e-01  
## 27 -1.43e-03 5.43e-03 9.63e-04 9.97e-04 9.90e-04 -3.72e-03 -3.93e-03  
## 28 2.07e-01 -3.99e-01 -1.39e-01 -1.44e-01 -1.43e-01 2.73e-01 2.88e-01  
## 29 4.14e-02 -7.97e-02 -2.78e-02 -2.88e-02 -2.86e-02 5.46e-02 5.77e-02  
## 30 4.74e-17 -1.85e-17 1.35e-01 -2.07e-17 -2.47e-17 -1.14e-01 2.29e-17  
## 31 3.64e-17 -1.31e-17 1.35e-01 -2.05e-17 -2.32e-17 -1.14e-01 2.20e-17  
## 32 6.40e-17 8.09e-17 2.60e-01 -8.20e-17 -6.69e-17 -2.20e-01 5.24e-17  
## 33 2.96e-17 -1.94e-17 7.47e-02 -6.65e-18 -1.03e-17 -4.94e-02 1.06e-17  
## 34 7.96e-17 9.44e-19 1.46e-01 -4.34e-17 -4.51e-17 -9.64e-02 4.13e-17  
## 35 1.30e-17 -1.12e-16 -2.09e-01 4.49e-17 4.86e-17 1.38e-01 -4.18e-17  
## 36 -3.30e-17 9.18e-18 2.17e-01 7.35e-18 1.89e-17 -1.44e-01 -9.29e-18  
## 37 -2.86e-17 1.47e-17 -6.66e-02 9.83e-18 1.18e-17 4.41e-02 -1.20e-17  
## 38 -4.01e-17 1.73e-17 -6.66e-02 1.35e-17 1.41e-17 4.41e-02 -1.41e-17  
## 39 1.45e-17 -3.02e-17 -1.37e-01 7.50e-18 3.76e-18 9.10e-02 -6.50e-18  
## 40 3.70e-20 1.13e-16 3.64e-01 -4.54e-17 -6.57e-17 -2.41e-01 4.66e-17  
## 41 -4.96e-18 3.75e-19 -2.52e-02 2.82e-18 1.32e-18 -3.27e-03 -3.69e-18  
## 42 -3.38e-18 3.26e-19 -2.52e-02 3.33e-18 2.01e-18 -3.27e-03 -3.84e-18  
## 43 2.90e-17 -3.94e-17 -7.77e-02 -7.58e-18 -1.31e-17 -1.01e-02 3.34e-18  
## 44 -4.01e-18 -6.90e-19 -2.52e-02 3.19e-18 1.90e-18 -3.27e-03 -3.76e-18  
## 45 5.49e-17 -4.76e-17 -5.13e-02 -1.73e-17 -2.11e-17 -6.67e-03 1.43e-17  
## 46 5.49e-17 -4.76e-17 -5.13e-02 -1.75e-17 -2.12e-17 -6.67e-03 1.46e-17  
## 47 -8.20e-19 6.49e-19 8.53e-04 3.22e-19 3.72e-19 1.11e-04 -2.79e-19  
## 48 4.20e-17 -4.37e-17 -5.13e-02 -1.15e-17 -1.40e-17 -6.67e-03 1.00e-17  
## 49 4.20e-17 -4.37e-17 -5.13e-02 -1.15e-17 -1.40e-17 -6.67e-03 1.00e-17  
## 50 -1.41e-16 1.41e-16 3.47e-02 4.45e-17 4.21e-17 -1.08e-01 -3.79e-17  
## 51 -1.87e-19 1.16e-19 -1.42e-04 1.28e-19 1.02e-19 4.43e-04 -8.07e-20  
## 52 -1.87e-19 1.16e-19 -1.42e-04 1.28e-19 1.02e-19 4.43e-04 -8.07e-20  
## 53 -1.40e-16 1.47e-16 3.47e-02 4.34e-17 4.17e-17 -1.08e-01 -3.61e-17  
## 54 -4.67e-18 1.47e-17 1.73e-02 1.12e-18 1.12e-18 -5.37e-02 -2.64e-18  
## 55 -5.38e-17 -2.47e-17 -3.50e-02 4.35e-17 4.43e-17 1.09e-01 -3.62e-17  
## 56 -1.11e-17 -3.60e-17 -6.66e-02 3.34e-17 2.70e-17 1.13e-01 -2.58e-17  
## 57 -1.17e-16 5.35e-18 -2.03e-01 1.02e-16 6.94e-17 3.45e-01 -9.06e-17  
## 58 -2.07e-16 -6.23e-17 -2.73e-01 1.56e-16 1.82e-16 4.64e-01 -1.66e-16  
## 59 -6.11e-17 3.49e-17 4.82e-17 4.84e-02 2.52e-17 -1.83e-17 -3.91e-02  
## 60 -3.02e-16 2.79e-16 2.80e-16 1.60e-01 6.88e-17 -2.29e-16 -1.29e-01  
## 61 6.95e-16 -6.86e-16 -4.65e-16 -2.86e-01 -1.30e-16 3.67e-16 2.31e-01  
## 62 1.31e-16 -1.14e-16 -8.91e-17 -6.26e-02 -4.07e-17 5.25e-17 5.05e-02  
## 63 -3.07e-16 2.77e-16 2.99e-16 1.60e-01 6.70e-17 -2.38e-16 -1.29e-01  
## 64 -1.03e-16 7.93e-17 1.06e-16 1.01e-01 2.30e-17 -5.94e-17 -6.23e-02  
## 65 -9.54e-17 -3.75e-17 7.83e-17 3.05e-01 9.48e-17 1.11e-16 -1.88e-01  
## 66 -1.56e-17 1.45e-17 1.57e-17 3.41e-02 4.64e-18 -5.71e-18 -2.11e-02  
## 67 3.87e-17 -2.43e-17 -3.37e-17 -3.24e-02 -1.47e-17 1.37e-17 2.00e-02  
## 68 4.06e-17 -2.42e-17 -3.49e-17 -3.24e-02 -1.47e-17 1.37e-17 2.00e-02  
## 69 2.69e-16 -2.25e-16 -1.85e-16 -2.34e-01 -5.50e-17 1.01e-16 1.45e-01  
## 70 2.54e-17 -1.64e-17 -2.53e-17 -1.18e-02 -1.19e-17 1.22e-17 -5.91e-04  
## 71 -2.08e-16 1.26e-16 1.42e-16 1.34e-01 1.00e-16 -5.68e-17 6.71e-03  
## 72 1.87e-17 -4.18e-17 -3.39e-17 -6.96e-02 -9.24e-18 1.89e-17 -3.48e-03  
## 73 3.81e-17 -2.05e-17 -2.89e-17 -4.06e-02 -2.22e-17 8.29e-18 -2.03e-03  
## 74 2.34e-17 -1.55e-17 -2.41e-17 -1.18e-02 -1.16e-17 1.18e-17 -5.91e-04  
## 75 4.23e-18 1.20e-18 2.41e-18 4.58e-02 3.11e-18 -6.15e-18 2.29e-03  
## 76 3.29e-17 2.48e-17 -6.17e-17 1.84e-02 -1.24e-17 3.21e-17 -1.04e-01  
## 77 -1.31e-16 1.67e-16 4.37e-17 2.64e-02 4.92e-17 -2.76e-17 -1.49e-01  
## 78 8.45e-17 -9.44e-17 -4.95e-17 -1.31e-02 -2.81e-17 3.20e-17 7.37e-02  
## 79 1.60e-17 3.86e-17 -3.63e-17 1.84e-02 -6.28e-18 4.58e-18 -1.04e-01  
## 80 5.74e-17 -5.98e-17 -7.02e-17 -2.10e-02 -3.41e-17 2.30e-17 1.18e-01  
## 81 -3.23e-18 6.74e-18 -3.91e-18 2.63e-03 8.04e-19 2.28e-18 -1.48e-02  
## 82 -1.16e-16 1.53e-16 1.58e-17 2.64e-02 3.43e-17 -1.84e-17 -1.49e-01  
## 83 -1.20e-16 1.14e-16 1.24e-16 1.05e-02 3.41e-17 -1.01e-16 -5.91e-02  
## 84 -1.20e-16 1.14e-16 1.24e-16 1.05e-02 3.41e-17 -1.01e-16 -5.91e-02  
## 85 -2.30e-17 1.43e-17 1.32e-17 1.25e-02 8.01e-18 2.28e-18 -2.41e-02  
## 86 3.70e-16 -3.41e-16 -1.80e-16 -3.40e-01 -6.20e-17 -1.14e-16 6.55e-01  
## 87 -1.98e-17 1.22e-17 9.63e-18 1.25e-02 7.23e-18 4.57e-18 -2.41e-02  
## 88 2.34e-16 -3.14e-16 -6.70e-17 -8.69e-17 6.91e-01 7.65e-17 3.51e-16  
## 89 -3.51e-17 -6.77e-17 2.36e-17 1.06e-16 2.16e-01 2.15e-17 3.79e-17  
## 90 2.95e-16 -5.05e-16 -9.23e-17 -1.70e-16 3.31e-01 2.28e-16 4.19e-16  
## 91 -1.41e-16 1.74e-16 3.14e-17 8.45e-17 -1.27e-01 -6.30e-17 -1.51e-16  
## 92 9.53e-17 -7.97e-17 2.24e-17 -2.13e-17 2.19e-01 -9.00e-18 5.72e-17  
## 93 2.55e-17 -2.13e-17 -6.16e-17 -4.23e-17 -1.23e-01 6.26e-17 2.37e-17  
## 94 -4.33e-17 1.42e-16 -2.97e-17 -6.37e-17 -1.91e-01 -4.15e-17 -5.71e-17  
## 95 -5.82e-20 -4.60e-18 1.24e-18 3.96e-18 1.34e-02 3.91e-19 2.95e-18  
## 96 -2.74e-17 1.24e-16 -2.97e-17 -6.37e-17 -1.91e-01 -3.53e-17 -3.80e-17  
## 97 4.79e-17 -3.95e-17 -1.94e-17 -1.58e-17 8.14e-02 1.38e-17 2.84e-17  
## 98 -3.14e-17 3.96e-17 1.30e-17 1.06e-17 -5.45e-02 -1.30e-17 -2.60e-17  
## 99 5.39e-17 -3.02e-17 -2.69e-17 -3.96e-17 -4.34e-02 1.77e-17 2.37e-17  
## 100 3.69e-17 -1.70e-17 -1.67e-17 -5.30e-17 -7.26e-02 2.34e-17 3.71e-17  
## 101 5.41e-18 -3.24e-18 -9.12e-19 -1.05e-17 -1.43e-02 -3.61e-19 2.07e-18  
## 102 6.86e-17 -7.12e-17 -2.02e-17 -6.43e-17 -1.32e-01 3.91e-17 5.70e-17  
## 103 8.89e-18 -6.43e-18 -5.17e-18 -1.45e-17 -1.43e-02 3.81e-18 4.58e-18  
## 104 4.87e-17 -3.33e-17 -2.21e-17 -3.96e-17 -4.34e-02 2.00e-17 3.06e-17  
## 105 8.10e-17 -3.17e-17 -5.89e-17 -7.95e-17 -7.26e-02 3.74e-17 4.63e-17  
## 106 2.81e-17 -2.60e-17 -7.48e-18 -2.38e-17 -4.34e-02 1.49e-17 2.22e-17  
## 107 5.83e-17 -6.87e-17 -2.18e-17 -5.21e-17 1.00e-02 2.53e-17 5.68e-17  
## 108 1.90e-17 -2.51e-17 -2.08e-17 -1.25e-17 -6.89e-03 2.37e-17 1.66e-17  
## 109 2.64e-18 -5.38e-18 2.44e-18 -1.32e-18 1.57e-03 -2.08e-18 4.14e-18  
## 110 1.50e-17 -2.22e-17 -1.56e-17 -1.52e-17 -6.89e-03 1.99e-17 1.89e-17  
## 111 3.90e-17 -5.38e-17 -2.20e-18 -3.76e-17 1.00e-02 8.54e-18 4.73e-17  
## 112 3.05e-17 -4.53e-17 4.08e-18 -3.30e-17 1.00e-02 2.43e-18 4.26e-17  
## 113 -5.77e-18 -8.17e-18 -1.36e-18 -5.28e-18 -6.89e-03 1.15e-17 1.42e-17  
## 114 8.48e-17 -1.23e-16 -5.84e-17 -7.73e-17 -3.26e-02 1.08e-16 7.65e-17  
## 115 -2.59e-16 2.97e-16 1.06e-16 1.69e-16 -1.06e-01 -1.08e-16 -2.47e-16  
## 116 -1.83e-16 2.11e-16 -1.53e-17 1.08e-16 -2.61e-01 6.13e-17 -2.71e-16  
## 117 -1.15e-17 1.10e-17 5.82e-18 9.89e-18 -6.12e-03 -4.80e-18 -1.30e-17  
## 118 1.03e-16 -1.06e-16 -5.05e-17 -6.86e-17 4.37e-02 4.29e-17 8.99e-17  
## dfb.tm.4 dffit cov.r cook.d hat inf  
## 1 -1.08e-01 -0.181027 1.185 4.12e-03 0.1097   
## 2 1.59e-01 0.265912 1.159 8.87e-03 0.1097   
## 3 1.59e-01 0.265912 1.159 8.87e-03 0.1097   
## 4 3.41e-01 0.569310 0.998 3.99e-02 0.1097   
## 5 6.99e-02 0.116600 1.199 1.71e-03 0.1097   
## 6 -6.61e-02 -0.167109 1.088 3.51e-03 0.0492   
## 7 -6.61e-02 -0.167109 1.088 3.51e-03 0.0492   
## 8 8.19e-02 0.207030 1.065 5.37e-03 0.0492   
## 9 1.96e-01 0.496462 0.804 2.98e-02 0.0492   
## 10 -1.41e-01 -0.357141 0.946 1.57e-02 0.0492   
## 11 -2.91e-02 -0.073496 1.123 6.81e-04 0.0492   
## 12 -1.80e-01 -0.454508 0.848 2.51e-02 0.0492   
## 13 -1.41e-01 -0.357141 0.946 1.57e-02 0.0492   
## 14 -1.56e-02 0.128306 1.079 2.07e-03 0.0355   
## 15 1.29e-02 -0.106286 1.091 1.42e-03 0.0355   
## 16 -2.52e-02 0.207204 1.024 5.36e-03 0.0355   
## 17 3.41e-03 -0.028079 1.114 9.94e-05 0.0355   
## 18 3.21e-02 -0.264535 0.971 8.68e-03 0.0355   
## 19 4.20e-02 -0.345340 0.882 1.46e-02 0.0355   
## 20 -3.58e-01 0.702438 0.716 5.86e-02 0.0685 \*  
## 21 5.34e-02 -0.104717 1.142 1.38e-03 0.0685   
## 22 5.34e-02 -0.104717 1.142 1.38e-03 0.0685   
## 23 -6.13e-02 0.120156 1.138 1.82e-03 0.0685   
## 24 -6.13e-02 0.120156 1.138 1.82e-03 0.0685   
## 25 -6.13e-02 0.120156 1.138 1.82e-03 0.0685   
## 26 -1.77e-01 0.347324 1.025 1.50e-02 0.0685   
## 27 -3.93e-03 0.007701 1.155 7.48e-06 0.0685   
## 28 2.88e-01 -0.455022 1.158 2.58e-02 0.1484   
## 29 5.77e-02 -0.090999 1.259 1.04e-03 0.1484 \*  
## 30 1.92e-17 0.182057 1.221 4.17e-03 0.1330 \*  
## 31 1.78e-17 0.182057 1.221 4.17e-03 0.1330 \*  
## 32 4.81e-17 0.351264 1.170 1.55e-02 0.1330   
## 33 1.10e-17 0.107488 1.126 1.45e-03 0.0574   
## 34 4.38e-17 0.209653 1.083 5.51e-03 0.0574   
## 35 -4.41e-17 -0.300906 1.024 1.13e-02 0.0574   
## 36 -5.97e-18 0.312811 1.015 1.22e-02 0.0574   
## 37 -1.41e-17 -0.095806 1.129 1.16e-03 0.0574   
## 38 -1.48e-17 -0.095806 1.129 1.16e-03 0.0574   
## 39 -8.97e-18 -0.197888 1.089 4.91e-03 0.0574   
## 40 5.54e-17 0.524192 0.825 3.33e-02 0.0574   
## 41 -2.13e-18 -0.074549 1.102 7.00e-04 0.0346   
## 42 -2.45e-18 -0.074549 1.102 7.00e-04 0.0346   
## 43 1.03e-17 -0.230081 1.001 6.59e-03 0.0346   
## 44 -2.21e-18 -0.074549 1.102 7.00e-04 0.0346   
## 45 1.94e-17 -0.151964 1.063 2.90e-03 0.0346   
## 46 1.95e-17 -0.151964 1.063 2.90e-03 0.0346   
## 47 -3.51e-19 0.002525 1.114 8.04e-07 0.0346   
## 48 1.36e-17 -0.151964 1.063 2.90e-03 0.0346   
## 49 1.36e-17 -0.151964 1.063 2.90e-03 0.0346   
## 50 -3.75e-17 -0.217111 1.094 5.91e-03 0.0647   
## 51 -9.42e-20 0.000891 1.150 1.00e-07 0.0647   
## 52 -9.42e-20 0.000891 1.150 1.00e-07 0.0647   
## 53 -3.59e-17 -0.217111 1.094 5.91e-03 0.0647   
## 54 -2.54e-18 -0.107856 1.136 1.47e-03 0.0647   
## 55 -3.73e-17 0.218910 1.093 6.01e-03 0.0647   
## 56 -2.09e-17 0.177292 1.245 3.96e-03 0.1475 \*  
## 57 -6.06e-17 0.541497 1.116 3.64e-02 0.1475   
## 58 -1.40e-16 0.727425 1.011 6.49e-02 0.1475   
## 59 -2.36e-17 0.067441 1.215 5.74e-04 0.1167   
## 60 -8.00e-17 0.222423 1.185 6.22e-03 0.1167   
## 61 1.53e-16 -0.398586 1.116 1.98e-02 0.1167   
## 62 3.71e-17 -0.087205 1.213 9.59e-04 0.1167   
## 63 -7.54e-17 0.222423 1.185 6.22e-03 0.1167   
## 64 -2.29e-17 0.149270 1.106 2.80e-03 0.0543   
## 65 -5.90e-17 0.451741 0.880 2.49e-02 0.0543   
## 66 -4.44e-18 0.050498 1.134 3.22e-04 0.0543   
## 67 1.41e-17 -0.048038 1.134 2.91e-04 0.0543   
## 68 1.25e-17 -0.048038 1.134 2.91e-04 0.0543   
## 69 5.92e-17 -0.346864 0.977 1.49e-02 0.0543   
## 70 1.09e-17 -0.031623 1.112 1.26e-04 0.0345   
## 71 -9.31e-17 0.358667 0.859 1.57e-02 0.0345   
## 72 1.06e-17 -0.186245 1.038 4.34e-03 0.0345   
## 73 1.91e-17 -0.108685 1.088 1.49e-03 0.0345   
## 74 1.06e-17 -0.031623 1.112 1.26e-04 0.0345   
## 75 -4.36e-18 0.122419 1.081 1.88e-03 0.0345   
## 76 7.85e-19 -0.237898 1.066 7.08e-03 0.0573   
## 77 -6.35e-17 -0.341311 0.993 1.44e-02 0.0573   
## 78 3.47e-17 0.169316 1.102 3.60e-03 0.0573   
## 79 -4.19e-18 -0.237898 1.066 7.08e-03 0.0573   
## 80 4.13e-17 0.271916 1.044 9.22e-03 0.0573   
## 81 -1.75e-18 -0.033972 1.140 1.46e-04 0.0573   
## 82 -4.47e-17 -0.341311 0.993 1.44e-02 0.0573   
## 83 -3.78e-17 -0.135616 1.116 2.31e-03 0.0573   
## 84 -3.78e-17 -0.135616 1.116 2.31e-03 0.0573   
## 85 -5.66e-18 -0.041228 1.225 2.14e-04 0.1226 \*  
## 86 4.21e-17 1.118681 0.652 1.46e-01 0.1226 \*  
## 87 -4.66e-18 -0.041228 1.225 2.14e-04 0.1226 \*  
## 88 -5.64e-01 0.955585 0.760 1.09e-01 0.1202 \*  
## 89 -1.76e-01 0.298468 1.166 1.12e-02 0.1202   
## 90 -2.71e-01 0.458274 1.093 2.61e-02 0.1202   
## 91 1.03e-01 -0.175093 1.203 3.86e-03 0.1202   
## 92 -1.42e-01 0.319560 1.002 1.27e-02 0.0549   
## 93 7.95e-02 -0.179114 1.093 4.03e-03 0.0549   
## 94 1.24e-01 -0.279505 1.032 9.73e-03 0.0549   
## 95 -8.70e-03 0.019610 1.138 4.85e-05 0.0549   
## 96 1.24e-01 -0.279505 1.032 9.73e-03 0.0549   
## 97 -5.27e-02 0.118877 1.118 1.78e-03 0.0549   
## 98 3.53e-02 -0.079566 1.129 7.98e-04 0.0549   
## 99 2.01e-03 -0.111039 1.082 1.55e-03 0.0323   
## 100 3.36e-03 -0.185935 1.031 4.32e-03 0.0323   
## 101 6.63e-04 -0.036651 1.108 1.69e-04 0.0323   
## 102 6.13e-03 -0.338689 0.867 1.40e-02 0.0323   
## 103 6.63e-04 -0.036651 1.108 1.69e-04 0.0323   
## 104 2.01e-03 -0.111039 1.082 1.55e-03 0.0323   
## 105 3.36e-03 -0.185935 1.031 4.32e-03 0.0323   
## 106 2.01e-03 -0.111039 1.082 1.55e-03 0.0323   
## 107 -4.88e-02 -0.114336 1.115 1.65e-03 0.0522   
## 108 3.35e-02 0.078519 1.126 7.77e-04 0.0522   
## 109 -7.62e-03 -0.017867 1.135 4.03e-05 0.0522   
## 110 3.35e-02 0.078519 1.126 7.77e-04 0.0522   
## 111 -4.88e-02 -0.114336 1.115 1.65e-03 0.0522   
## 112 -4.88e-02 -0.114336 1.115 1.65e-03 0.0522   
## 113 3.35e-02 0.078519 1.126 7.77e-04 0.0522   
## 114 1.59e-01 0.371721 0.946 1.70e-02 0.0522   
## 115 1.91e-01 0.325816 1.145 1.33e-02 0.1147   
## 116 4.69e-01 0.800891 0.852 7.74e-02 0.1147   
## 117 1.10e-02 0.018798 1.215 4.46e-05 0.1147   
## 118 -7.85e-02 -0.134188 1.203 2.27e-03 0.1147



# Outlier Analysis :   
influencePlot(reg.model, id.n=3) # A user friendly representation of the above



## StudRes Hat CookD  
## 20 2.5893409 0.06854839 0.058636381  
## 28 -1.0900732 0.14838710 0.025836436  
## 29 -0.2180011 0.14838710 0.001044139  
## 56 0.4261559 0.14754098 0.003958488  
## 86 2.9924850 0.12261380 0.145881093  
## 88 2.5853837 0.12019231 0.108534435  
## 116 2.2250583 0.11469780 0.077398288

Below observations are severly influencing the model.

data[c(20,28,29,56,86,88,116),]

## day time logcells  
## 20 1 3 10  
## 28 1 4 0  
## 29 1 4 2  
## 56 2 4 3  
## 86 3 4 9  
## 88 4 0 13  
## 116 4 4 7

Data points 28, 86 are contradicting to our understanding, i.e When the exposure is maximum, cells count should be low. however in Data point 86, cell count is 9. This could have caused due to contamination or incorrect results capture.

## Model - 2

# Deleting 20,28,29,56,86,88,116 data points   
reg.model2<-lm(logcells~(time+day+day\*time),data=data[-c(20,28,29,56,86,88,116),])  
summary(reg.model2)

##   
## Call:  
## lm(formula = logcells ~ (time + day + day \* time), data = data[-c(20,   
## 28, 29, 56, 86, 88, 116), ])  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -4.6958 -1.5337 -0.2231 1.2497 5.3042   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 8.16857 0.77996 10.473 < 2e-16 \*\*\*  
## time -1.47275 0.40804 -3.609 0.000476 \*\*\*  
## day2 -2.16857 1.14458 -1.895 0.060945 .   
## day3 -1.21543 1.10134 -1.104 0.272341   
## day4 -1.53759 1.14859 -1.339 0.183623   
## time:day2 0.43429 0.56359 0.771 0.442724   
## time:day3 0.06355 0.53374 0.119 0.905462   
## time:day4 0.21346 0.54420 0.392 0.695692   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 2.248 on 103 degrees of freedom  
## Multiple R-squared: 0.3712, Adjusted R-squared: 0.3284   
## F-statistic: 8.685 on 7 and 103 DF, p-value: 2.387e-08

Prediction accuracy increased to 32% after removal of outlier datapoints. Many of the interaction variables are insignificant, and their importance can be checked by performing stepwise model selectoin by AIC

# Perform stepwise Model selection  
library("MASS")  
stepAIC(reg.model2)

## Start: AIC=187.5  
## logcells ~ (time + day + day \* time)  
##   
## Df Sum of Sq RSS AIC  
## - time:day 3 3.7645 524.17 182.3  
## <none> 520.40 187.5  
##   
## Step: AIC=182.3  
## logcells ~ time + day  
##   
## Df Sum of Sq RSS AIC  
## <none> 524.17 182.30  
## - day 3 31.663 555.83 182.81  
## - time 1 244.651 768.82 222.82

##   
## Call:  
## lm(formula = logcells ~ time + day, data = data[-c(20, 28, 29,   
## 56, 86, 88, 116), ])  
##   
## Coefficients:  
## (Intercept) time day2 day3 day4   
## 7.892 -1.297 -1.411 -1.151 -1.184

AIC is lowest, when the model includes time and day variable, without interaction. Lets build the final model and check the prediction accuracy of the model.

## Model - 3

# Deleting 20,28,29,56,86,88,116 data points and day and time are the only predictors  
reg.model3<-lm(logcells~(time+day),data=data[-c(20,28,29,56,86,88,116),])  
summary(reg.model3)

##   
## Call:  
## lm(formula = logcells ~ (time + day), data = data[-c(20, 28,   
## 29, 56, 86, 88, 116), ])  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -4.5945 -1.4999 -0.2974 1.2591 5.4055   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 7.8915 0.5242 15.055 < 2e-16 \*\*\*  
## time -1.2971 0.1844 -7.034 2.05e-10 \*\*\*  
## day2 -1.4113 0.6078 -2.322 0.0222 \*   
## day3 -1.1507 0.6084 -1.891 0.0613 .   
## day4 -1.1837 0.6065 -1.952 0.0536 .   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 2.224 on 106 degrees of freedom  
## Multiple R-squared: 0.3666, Adjusted R-squared: 0.3427   
## F-statistic: 15.34 on 4 and 106 DF, p-value: 6.289e-10

Prediction accuracy jumped to 34%.

# Conclusion

1. Every unit increase of exposure time, reduces cells count by 1.3
2. day2, day3, day4 are having significant influence on cell count, which indicates there is definitely an external influence which impacted the experiment.
3. It is advisable to perform the experiment in a controlled environment for better results and predictability.