Volts Dataset Analysis with Transformation

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Capacitor voltage. A capacitor was charged with a 9-volt battery and then a voltmeter recorded the voltage as the capacitor was discharged. Measurements were taken every 0.02 second. The data are in the file Volts.

Objectives a,b,c,d,e,f

(a) Create a scatter plot of Voltage vs Time.
(b) Fit a SLR to predict Voltage from Time, with its summary.
(c) Display diagnostic plots for checking conditions

- the residual vs fitted
- Normal Q-Q

(d) Transform Voltage using a log transformation and create scatter plot of transformed model.
(e) Fit a SLR to predict log(Voltage) from Time, with its summary of the model.
(f) Display diagnostic plots for checking conditions of transformed model

- the residual vs fitted
- Normal Q-Q

(g) Check for any outliers and or influential points via Cook's Distance and Residuals vs Leverage plots

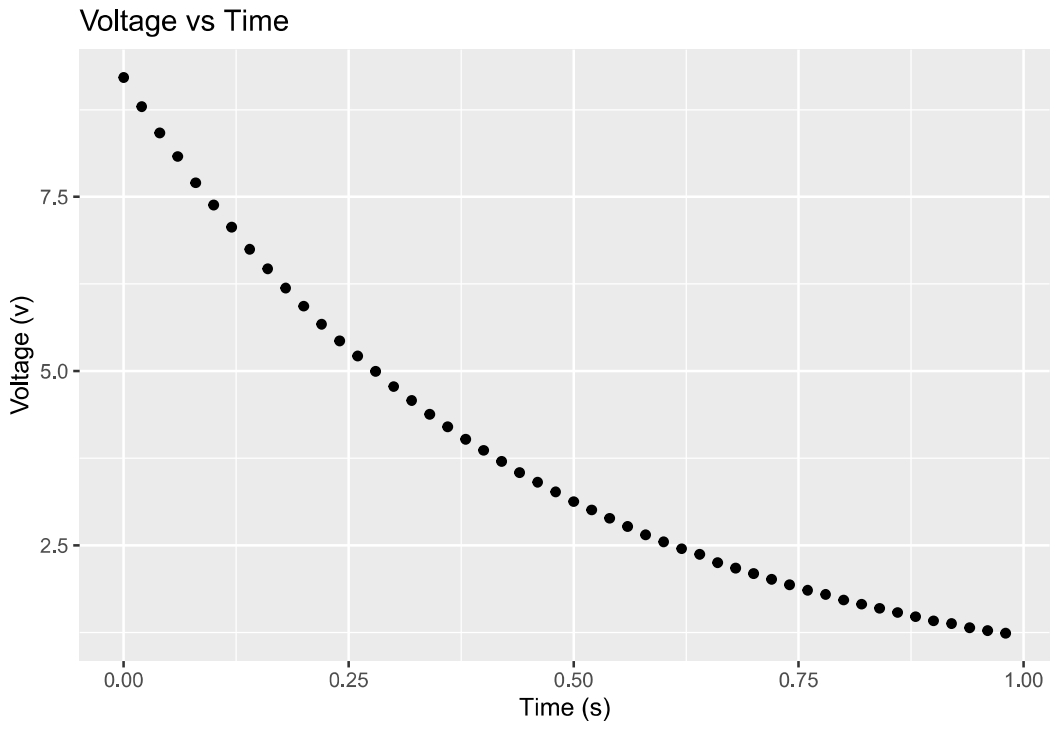
```
library(Stat2Data)

# Summary of first 5 rows of data
data("Volts")
head(Volts, n=5)
```

```
##   Voltage Time
## 1  9.2128 0.00
## 2  8.7952 0.02
## 3  8.4175 0.04
## 4  8.0795 0.06
## 5  7.7018 0.08
```

```
# (a) ggplot to form the scatterplot
library(ggplot2)
```

```
## Warning: package 'ggplot2' was built under R version 4.4.3
```

```r
ggplot(Volts, aes(x = Time, y = Voltage)) +
  geom_point() +
  labs(title = "Voltage vs Time",
       x = "Time (s)",
       y = "Voltage (v)")
```

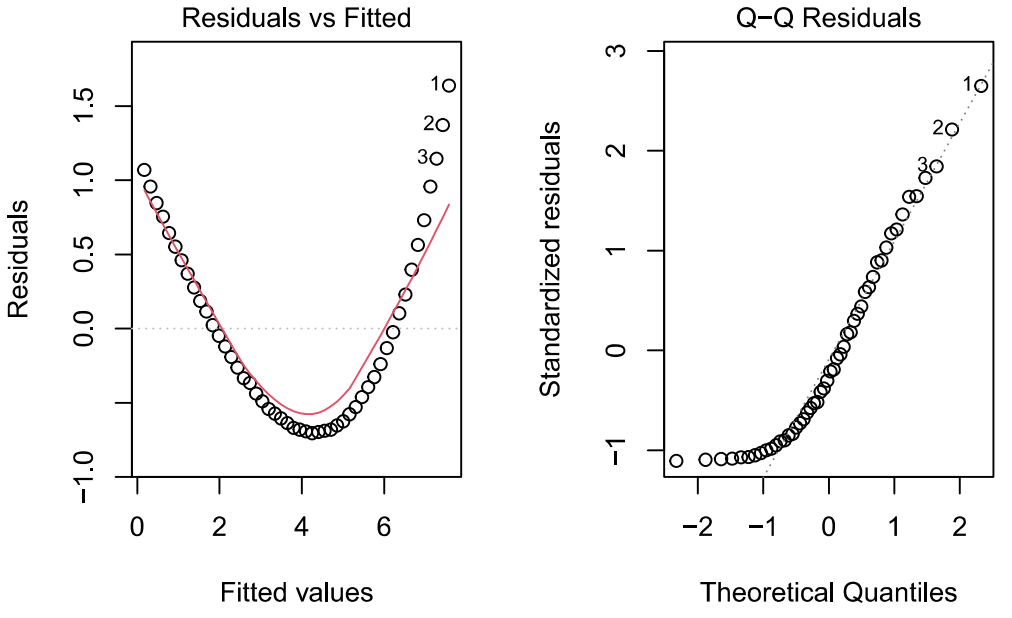



```r
# (b) Fitting of a simple linear regression model and its summary

SLR <- lm(Voltage ~ Time, data = Volts)
summary(SLR)
```

```
##
## Call:
## lm(formula = Voltage ~ Time, data = Volts)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.7046 -0.5655 -0.1618  0.4446  1.6375
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   7.5753     0.1793   42.24   <2e-16 ***
## Time         -7.5549     0.3154  -23.95   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Residual standard error: 0.6436 on 48 degrees of freedom
## Multiple R-squared:  0.9228, Adjusted R-squared:  0.9212
## F-statistic: 573.9 on 1 and 48 DF,  p-value: < 2.2e-16
```

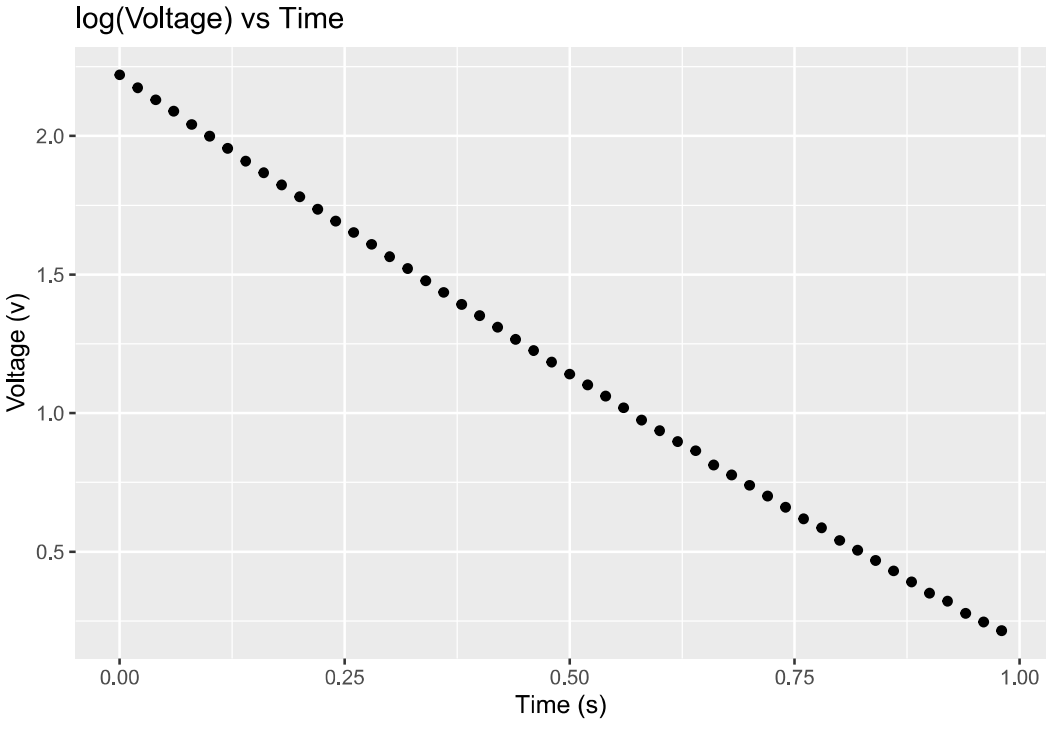
```
# (c) Residual vs Fitted plot and QQ plot
par(mfrow=c(1,2))
plot(SLR,which=1:2)
```




```
par(mfrow=c(1,1))

# (d) Log-transformation of Y into new scatter plot
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```r
volts2 = mutate(Volts,logVoltage=log(Voltage))

ggplot(volts2, aes(x = Time, y = logVoltage)) +
  geom_point() +
  labs(title = "log(Voltage) vs Time",
       x = "Time (s)",
       y = "Voltage (v)")
```

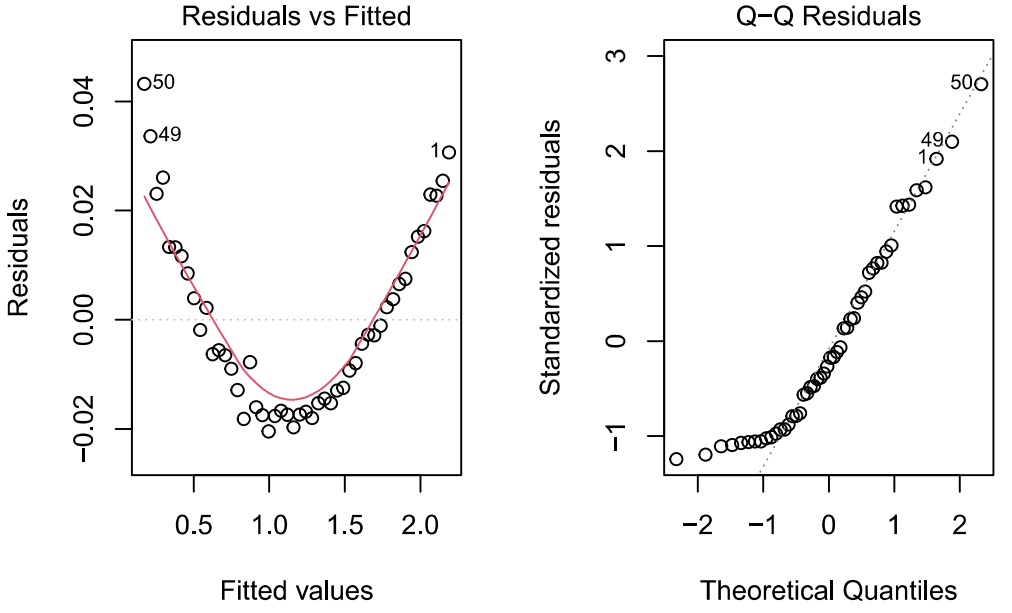



```r
# (e) Refitting of simple linear regression model to the log-transformed Y
SLR2 <- lm(logVoltage ~ Time, data = volts2)
summary(SLR2)
```

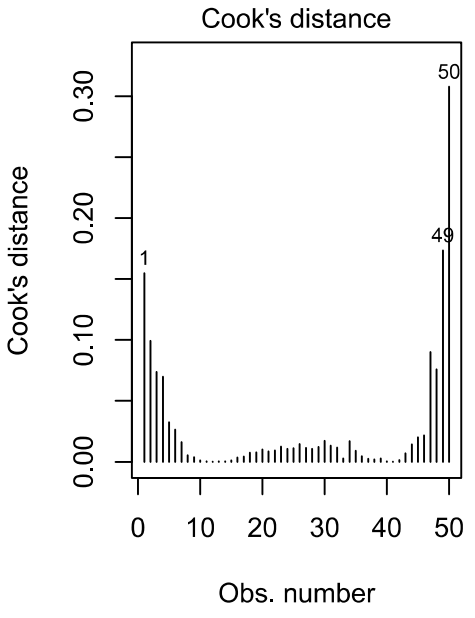
```
##
## Call:
## lm(formula = logVoltage ~ Time, data = volts2)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.020448 -0.015084 -0.003621  0.012190  0.043212
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.189945   0.004637   472.3   <2e-16 ***
## Time        -2.059065   0.008154  -252.5   <2e-16 ***
## ---
```

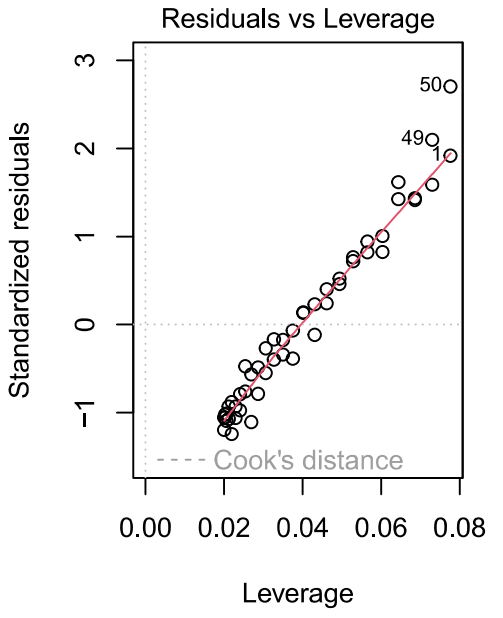
```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.01664 on 48 degrees of freedom
## Multiple R-squared:  0.9992, Adjusted R-squared:  0.9992
## F-statistic: 6.377e+04 on 1 and 48 DF,  p-value: < 2.2e-16
```

```r
# (f) Residual vs Fitted and QQ plot on the transformed Y.
par(mfrow=c(1,2))
plot(SLR2,which=1:2)
```




```r
par(mfrow=c(1,1))

# (g) Cook's distance and Residuals vs Leverage plots
par(mfrow=c(1,2))
plot(SLR2,which=4:5)
```


Cook's distance
Cook's distance
0.00
0.10
0.20
0.30
1
49
50
0
10
20
30
40
50
Obs. number


Residuals vs Leverage
Standardized residuals
−1
0
1
2
3
50
49
1
Cook's distance
0.00
0.02
0.04
0.06
0.08
Leverage