STAT 509 Homework 9 Solution

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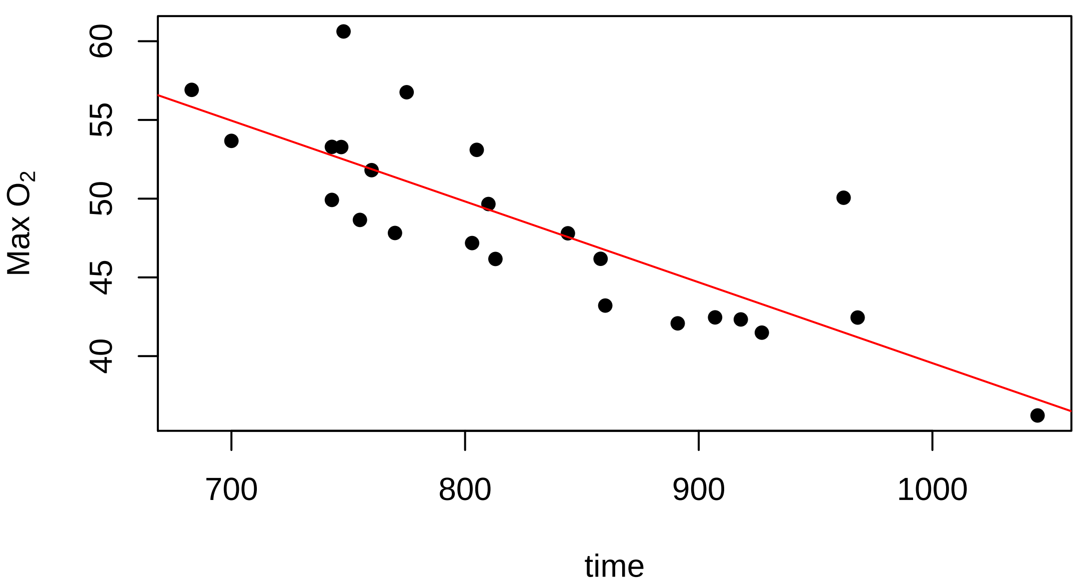
Problem 1

First of all, input the data in R and conduct the linear regression analysis.

```
oxgen=c(42.33,36.23,53.29,53.10,49.66,47.18,42.08,41.49,56.91,
        50.06,46.17,47.80,42.45,46.18,48.65,42.46,43.21,53.67,
        47.82,51.81,60.62,49.92,53.28,56.76)
time=c(918,1045,743,805,810,803,891,927,683,962,813,844,
       968,858,755,907,860,700,770,760,748,743,747,775)
fit1=lm(oxgen~time)
plot(time,oxgen,pch=16,xlab="time",ylab = expression(paste("Max ",O[2])))
abline(fit1,col="red")
```



(a) Note that $b_0 = 90.9$ and $b_1 = -0.05$. The scatterplot with the fitted linear line shows that there is a decreasing trend between the two-mile run time and the maximum oxygen uptake, and the linear regression fits well for the data.

(b) Since the p-value for $H_0 : \beta_1 = 0$ is $1.46^{-6} < 0.05$, reject $H_)$. We have sufficient evidence to conclude that the time it takes to run two miles have a significant influence on maximum oxygen.

(c) 90% confidence interval for $E(Y|X = 900)$ is

```r
predict(fit1,data.frame(time=900),level=0.9,interval="confidence")
```

```
##     fit   lwr   upr
## 1 44.69 43.11 46.27
```

We are 90% confident that the population mean maximum oxygen uptake for men who run two miles in 900 seconds is between 43.1 and 46.27.

(d) 90% confidence interval for $Y|X = 900$ is

```r
predict(fit1,data.frame(time=900),level=0.9,interval="prediction")
```

```
##     fit   lwr  upr
## 1 44.69 38.48 50.9
```

We are 90% confident that the maximum oxygen uptake for an individual male who runs two miles in 900 seconds is between 38.48 and 50.9.

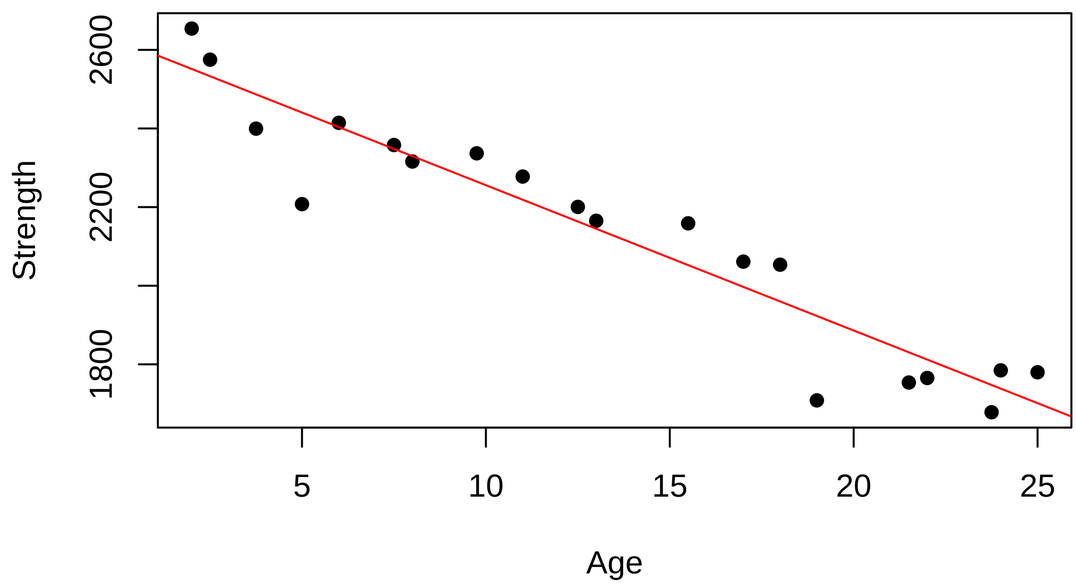
Problem 2

First of all, input the data in R and conduct the linear regression analysis.

```r
rocket=data.frame(matrix(c( 2158.70, 15.50, 1678.15, 23.75, 2316.00, 8.00,
                 2061.30, 17.00, 2207.50, 5.00,  1708.30, 19.00,
                 1784.70, 24.00, 2575.00, 2.50, 2357.90, 7.50,
                 2277.70, 11.00, 2165.20, 13.00, 2399.55, 3.75,
                 1779.80, 25.00, 2336.75, 9.75, 1765.30, 22.00,
                 2053.50, 18.00, 2414.40, 6.00, 2200.50, 12.50,
                 2654.20, 2.00, 1753.70, 21.50),20,2,byrow = TRUE))
colnames(rocket)=c("Strength","Age")
attach(rocket)
fit2=lm(Strength~Age,data = rocket)
summary(fit2)
```

```
##
## Call:
## lm(formula = Strength ~ Age, data = rocket)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -233.1  -52.5   28.7   66.1  106.2
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2625.39      45.35    57.9  < 2e-16 ***
## Age           -36.96       2.97   -12.5  2.8e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 99.1 on 18 degrees of freedom
## Multiple R-squared:  0.896,  Adjusted R-squared:  0.89
## F-statistic:  155 on 1 and 18 DF,  p-value: 2.75e-10
```

```r
plot(Age,Strength,pch=16,xlab="Age",ylab = "Strength")
abline(fit2,col="red")
```



(a) Note that $b_0 = 2625.385$ and $b_1 = -36.96$. The scatterplot with the fitted linear line shows that there is a decreasing trend between the age of the propellants and the shear strength of bond, and the linear regression fits well for the data.

(b) Since the p-value for $H_0 : \beta_1 = 0$ is $2.75^{-10} < 0.05$, reject $H_)$. We have sufficient evidence to conclude that the shear strngth of the bond is linearly related to the age of the propellant in the population.

(c) 90% confidence interval for $E(Y|X = 20)$ is

```r
predict(fit2,data.frame(Age=20),level=0.95,interval="confidence")
```

```
##    fit  lwr  upr
## 1 1886 1824 1949
```

We are 90% confident that the population mean shear strength of a motor made from the propellant that is 20 weeks old is between 1823.78 and 1948.52.

(d) 90% confidence interval for $Y|X = 900$ is

```r
predict(fit2,data.frame(Age=20),level=0.95,interval="prediction")
```

```
##    fit  lwr  upr
## 1 1886 1669 2103
```

We are 90% confident that the shear strength of a motor made from an individual propellant that is 20 weeks old is between 1668.9 and 2103.4.