

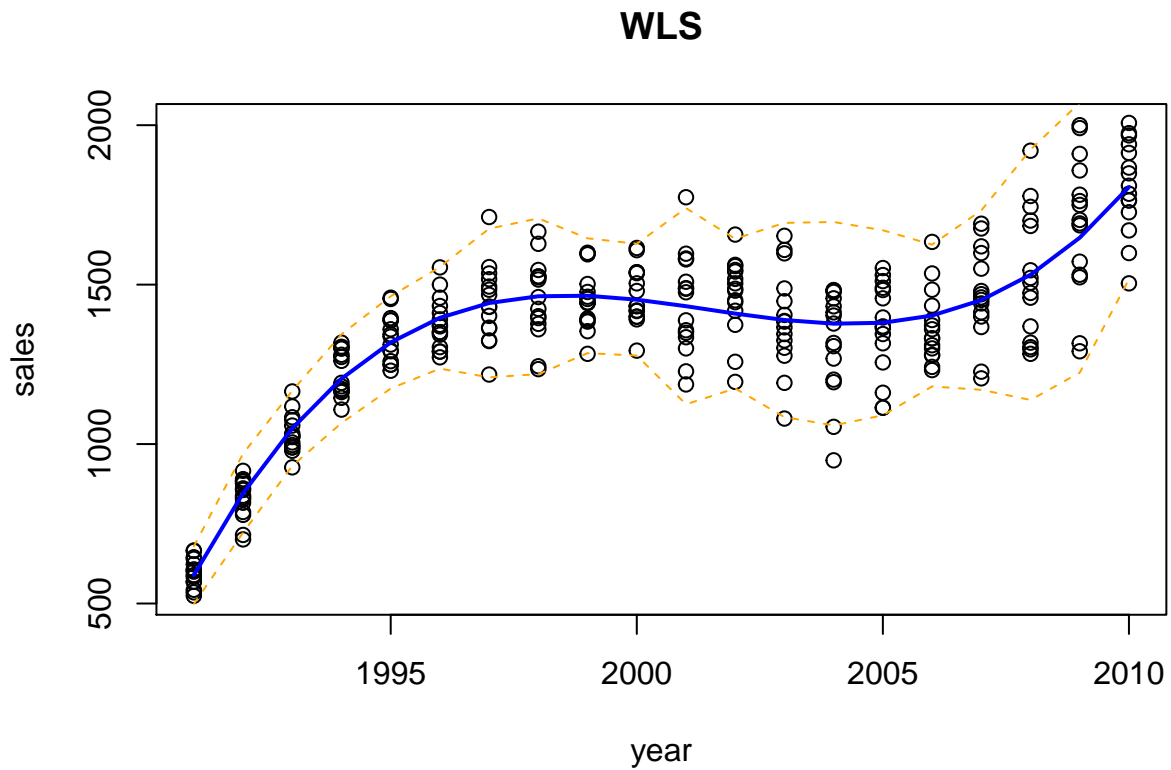
q4 (a)

```
w3 = vector(length = length(sales$Year))
j = 1
for(i in sales$Year) {
  w3[j] = 1 / sigma2.y[i - 1991 + 1]
  j = j + 1
}

wls3 = lm(sales$Sales~poly(sales$Year, 3), weight = w3)

plot(sales$Year, sales$Sales, xlab = "year", ylab = "sales", main = "WLS")
lines(sales$Year, predict(wls3), type="l", col="blue", lwd=2)

pred_interval3 <- predict(wls3, newdata = data.frame(year=sales$Year),
                          interval="prediction", level = 0.95, weight = w3)
lines(sales$Year, pred_interval3[,2], col="orange", lty=2)
lines(sales$Year, pred_interval3[,3], col="orange", lty=2)
```



(b)

```
summary(lm(sales$Sales~poly(sales$Year, 3)))
```

```
##
## Call:
## lm(formula = sales$Sales ~ poly(sales$Year, 3))
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -423.04  -65.69   -5.62   80.61  385.48
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      1353.230      7.274  186.03  <2e-16 ***
## poly(sales$Year, 3)1  3556.664     125.992   28.23  <2e-16 ***
## poly(sales$Year, 3)2 -1360.367     125.992  -10.80  <2e-16 ***
## poly(sales$Year, 3)3  2504.458     125.992   19.88  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 126 on 296 degrees of freedom
## Multiple R-squared:  0.8155, Adjusted R-squared:  0.8137
## F-statistic: 436.2 on 3 and 296 DF,  p-value: < 2.2e-16
```

```
summary(wls1)
```

```
##
## Call:
## lm(formula = sales$Sales ~ poly(sales$Year, 3), weights = w1)
##
## Weighted Residuals:
##      Min       1Q   Median       3Q      Max
## -63774  -7812    218    7676   65474
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      1351.11      12.71  106.285  < 2e-16 ***
## poly(sales$Year, 3)1  3618.85     278.86   12.977  < 2e-16 ***
## poly(sales$Year, 3)2 -1437.25     262.23   -5.481  9.06e-08 ***
## poly(sales$Year, 3)3  2590.38     198.69   13.037  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 18570 on 296 degrees of freedom
## Multiple R-squared:  0.5588, Adjusted R-squared:  0.5544
## F-statistic: 125 on 3 and 296 DF,  p-value: < 2.2e-16
```

```
summary(wls2)
```

```
##
## Call:
## lm(formula = sales$Sales ~ poly(sales$Year, 3), weights = w2)
##
## Weighted Residuals:
##      Min       1Q   Median       3Q      Max
```

```
## -3.3973 -0.6591 -0.0504  0.7152  3.4570
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      1353.230      7.992 169.312 <2e-16 ***
## poly(sales$Year, 3)1  3556.664     138.434  25.692 <2e-16 ***
## poly(sales$Year, 3)2 -1360.367     138.434  -9.827 <2e-16 ***
## poly(sales$Year, 3)3  2384.622     105.498  22.604 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.089 on 296 degrees of freedom
## Multiple R-squared:  0.9578, Adjusted R-squared:  0.9574
## F-statistic: 2240 on 3 and 296 DF, p-value: < 2.2e-16
```

```
summary(wls3)
```

```
##
## Call:
## lm(formula = sales$Sales ~ poly(sales$Year, 3), weights = w3)
##
## Weighted Residuals:
##      Min       1Q   Median       3Q      Max
## -2.64046 -0.64234 -0.05533  0.70605  2.27259
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      1352.749      6.831  198.04 <2e-16 ***
## poly(sales$Year, 3)1  3524.757     119.961  29.38 <2e-16 ***
## poly(sales$Year, 3)2 -1397.098     118.093 -11.83 <2e-16 ***
## poly(sales$Year, 3)3  2418.002      98.417  24.57 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.9953 on 296 degrees of freedom
## Multiple R-squared:  0.9359, Adjusted R-squared:  0.9353
## F-statistic: 1441 on 3 and 296 DF, p-value: < 2.2e-16
```

the std. errors of the model chosen in question 2 are 7.274, 125.992, 125.992, 125.992.

the std. errors of the first model in question 3(c) are 12.71, 278.86, 262.23, 198.69.

the std. errors of the second model in question 3(c) are 7.992, 138.434, 138.434, 105.498.

the std. errors of the model in question 4(a) are 6.831, 119.961, 118.093, 98.417.

The model in 4(a) has the lowest std. error among all parameters. I will choose the model in 4(a).