Homework3

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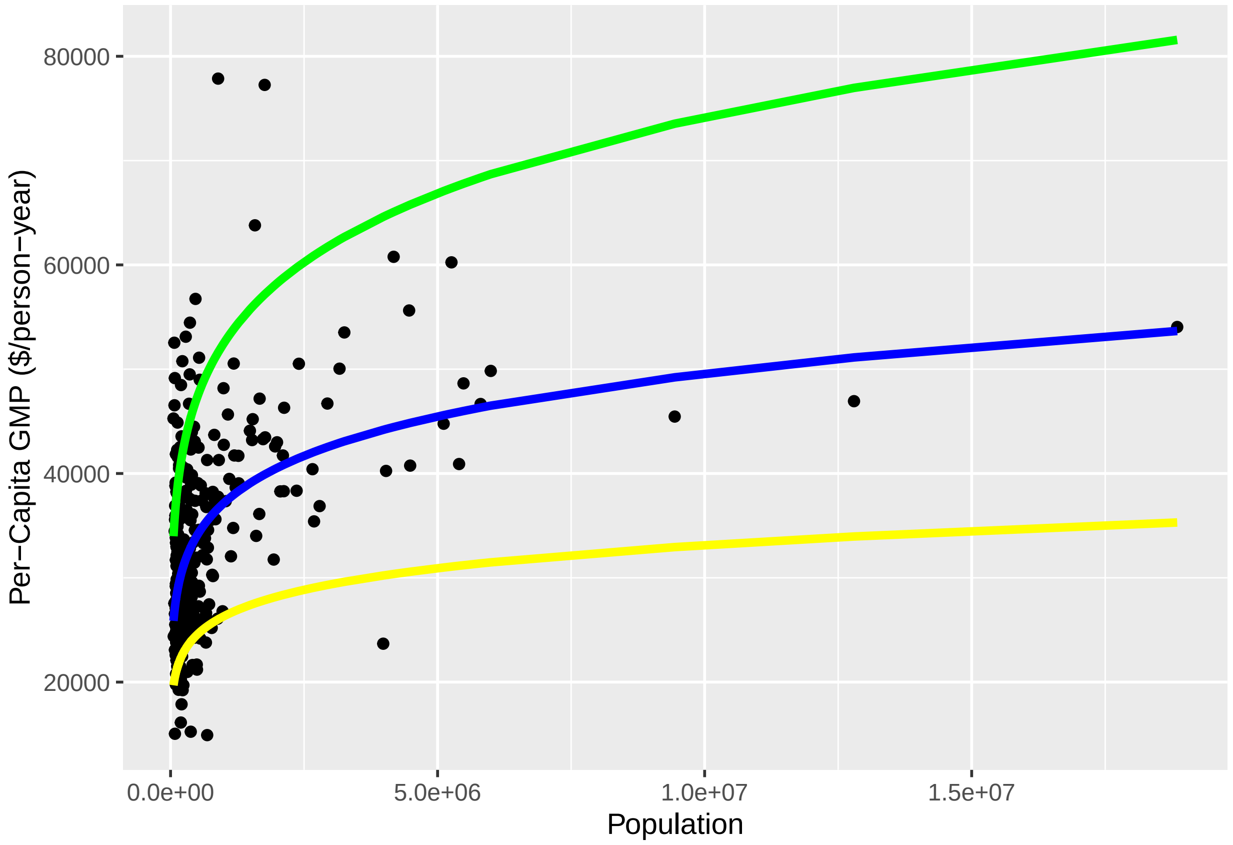
```r
gmp <- read.table("data/gmp.dat")
gmp$pop <- round(gmp$gmp/gmp$pcgmp)
```

1.

```r
nlmfit1 = 6611*(gmp$gmp/gmp$pcgmp)^(1/8)
nlmfit2 = 6611*(gmp$gmp/gmp$pcgmp)^(0.1)
nlmfit3 = 6611*(gmp$gmp/gmp$pcgmp)^(0.15)
ggplot(data = gmp) +
  geom_point(aes(x = pop, y = pcgmp))+
  labs(x = "Population", y = "Per-Capita GMP ($/person-year)")+
  geom_line(aes(x = pop, y = nlmfit1), col = 'blue', size = 1.5)+
  geom_line(aes(x = pop, y = nlmfit2), col = 'yellow', size = 1.5)+
  geom_line(aes(x = pop, y = nlmfit3), col = 'green', size = 1.5)
```



2.

```r
mse <- function(x,N,Y){
  if(missing(N)) N <- gmp$pop
  if(missing(Y)) Y <- gmp$pcgmp
  mse <- sum((Y-x[1]*N^x[2])^2)/length(Y)
  return(mse)
}
mse(c(6611,0.15))
```

```
## [1] 207057513
```

```r
mse(c(5000,0.10))
```

```
## [1] 298459914
```

4.

```r
nlm1 <- nlm(mse, c(y0 = 6611, a = 0.15))
nlm2 <- nlm(mse, c(y0 = 6611, a = 1/8))
nlm3 <- nlm(mse, c(y0 = 5000, a = 0.10))

nlm1$minimum
```

```
## [1] 61857060
```

```r
nlm1$estimate
```

```
## [1] 6610.9999997    0.1263182
```

```r
nlm2$minimum
```

```
## [1] 61857060
```

```r
nlm2$estimate
```

```
## [1] 6611.0000000    0.1263177
```

```r
nlm3$minimum
```

```
## [1] 62521484
```

```r
nlm3$estimate
```

```
## [1] 5000.0000008    0.1475913
```

`minimum` represents the value of the estimated minimum of `mse()` from the given starting value. `estimate` represents the point at which the minimum value of `mse()` is obtained.

5.

```
plm <- function(x,N,Y){
  nlm_result <- nlm(mse,x)
  plm <- list(nlm_result$estimate[1], nlm_result$estimate[2],nlm_result$minimum)
  names(plm) <- c("final guess for y0","final guss for a", "final value of MSE")
  return(plm)
}
```

Apply `plm()` function to given starting values:

```
plm(c(6611,0.15))
```

```
## $`final guess for y0`
## [1] 6611
##
## $`final guss for a`
## [1] 0.1263182
##
## $`final value of MSE`
## [1] 61857060
```

```
plm(c(5000,0.10))
```

```
## $`final guess for y0`
## [1] 5000
##
## $`final guss for a`
## [1] 0.1475913
##
## $`final value of MSE`
## [1] 62521484
```

Two parameter estimates are different because the `plm()` function finds the local optimum.Estimate with starting values `y0 = 6611, a = 0.15` has the lower MSE.

6.a.

```
mean_pcgmp <- mean(gmp$pcgmp)
sem <- sd(gmp$pcgmp)/sqrt(length(gmp$pcgmp))
mean_pcgmp
```

```
## [1] 32922.53
```

```
sem
```

```
## [1] 481.9195
```

b.

```
except_mean <- function(i){
  return(mean(gmp$pcgmp[-i]))
}
```

c.

```
jackknifed.means <- c()
for (i in 1:length(gmp$pcgmp)){
  jackknifed.means[i] <- except_mean(i)
}
```

d.

```
mean1 <- mean(jackknifed.means)
#jackknife variance
n <- length(gmp$pcgmp)
jackknifed.variance <- (n-1)*sum((jackknifed.means-mean1)^2)/n
#jackknife standard error
jackknifed.sem <- sqrt(jackknifed.variance)
jackknifed.sem
```

```
## [1] 481.9195
```

Compare jackknifed standard error with `sem` in (a):

```
abs(jackknifed.sem - sem)
```

```
## [1] 1.875833e-12
```

7.

```
plm.jackknife <- function(x,N = gmp$pop,Y = gmp$pcgmp){
  except_plm <- function(j){
    return(plm(x,N[-j],Y[-j]))
  }
  jackknifed.plm.y0 <- c()
  for (j in 1:length(N)){
    jackknifed.plm.y0[j] <- except_plm(j)[[1]]
  }
  jackknifed.plm.a <- c()
  for (j in 1:length(N)){
    jackknifed.plm.a[j] <- except_plm(j)[[2]]
  }
  mean2 <- mean(jackknifed.plm.y0)
  mean3 <- mean(jackknifed.plm.a)
  #jackknife variance
  m <- length(N)
  jackknifed.variance.plm.y0 <- (m-1)*sum((jackknifed.plm.y0 - mean2)^2)/m
  jackknifed.variance.plm.a <- (m-1)*sum((jackknifed.plm.a - mean3)^2)/m
  result <- c(sqrt(jackknifed.variance.plm.y0),sqrt(jackknifed.variance.plm.a))
  names(result) <- c("se for y0","se for a")
  return(result)
}
```

8.

```r
gmp2013 <- read.table("data/gmp-2013.dat")
gmp2013$pop <- round(gmp2013$gmp/gmp2013$pcgmp)
```

Apply `plm()` and `plm.jackknife` functions:

```r
plm(c(6611,0.15),gmp2013$pop,gmp2013$pcgmp)
```

```
## $`final guess for y0`
## [1] 6611
##
## $`final guss for a`
## [1] 0.1263182
##
## $`final value of MSE`
## [1] 61857060
```

```r
plm.jackknife(c(6611,0.15),gmp2013$pop,gmp2013$pcgmp)
```

```
## se for y0  se for a
##         0         0
```