Q3-SLR-water consumption

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Question 3

Exam Question:

Understanding water consumption patterns is essential for managing resources effectively, particularly in growing urban areas. One common approach is to model water consumption as a function of population size, which allows researchers to estimate water demand based on demographic data.

In this question, you will work with data from Tang and Ang (2007), which examines water consumption (WC) as a response variable and population size (POP) as a predictor.

- Perform a linear regression to determine whether population size is a significant predictor of water consumption.
- Evaluate the model's assumptions, including normality of residuals and homoscedasticity.
- Summarize your analysis in a concise paragraph, including your regression results, assumption checks, and any changes made to refine the model.

```
wc_data <- read.csv('Q3-SLR-water consumption.csv')
head(wc_data)
```

```
##   CITY    POP  WC
## 1    1  50000 100
## 2    2 100000 110
## 3    3 200000 110
## 4    4 250000 113
## 5    5 300000 125
## 6    6 400000 130
```

Set up regression

```
mod3 <- lm(WC ~ POP, wc_data)
summary(mod3)
```

```
##
## Call:
## lm(formula = WC ~ POP, data = wc_data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -6.0967 -3.6530 -0.0098  3.7402  6.0488
##
## Coefficients:
##                 Estimate   Std. Error t value       Pr(>|t|)
## (Intercept) 98.932363014  2.845932507   34.76 0.000000000513 ***
```

```
## POP          0.000071455  0.000006203   11.52 0.000002925192 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.74 on 8 degrees of freedom
## Multiple R-squared:  0.9431, Adjusted R-squared:  0.936
## F-statistic: 132.7 on 1 and 8 DF,  p-value: 0.000002925
```

Get standardized residuals

```
mod3.res <- rstandard(mod3)
shapiro.test(mod3.res)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  mod3.res
## W = 0.91235, p-value = 0.2975
```

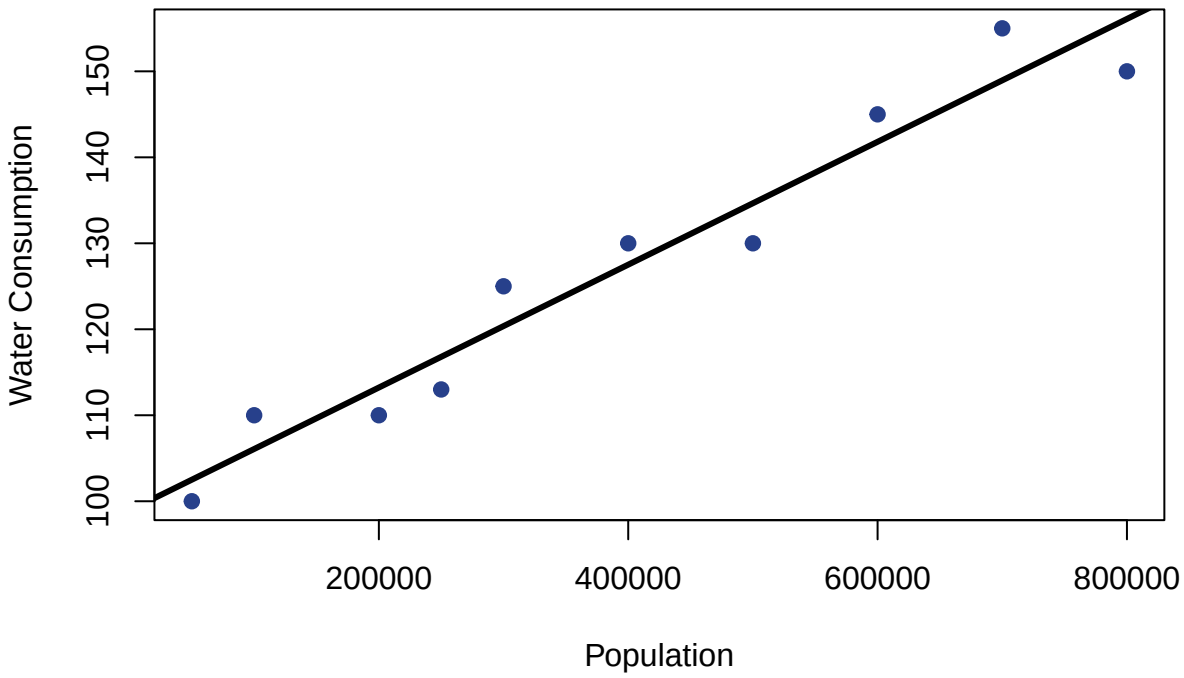
The Breusch-Pagan test to assess homoscedasticity

```
ncvTest(mod3)
```

```
## Non-constant Variance Score Test
## Variance formula: ~ fitted.values
## Chisquare = 0.9224111, Df = 1, p = 0.33684
```

Make plot of Water Consumption and Population

```
plot(WC ~ POP, wc_data,
     pch = 19,
     col = "royalblue4",
     ylab = "Water Consumption",
     xlab =  "Population")
#add regression line
#make line width thicker
abline(mod3, lwd=3)
```



References:

- http://avinashu.com/tutorial/indexLR.html

Response Key

Hypothesis (3 pts): We tested whether population size is a significant predictor of water consumption.

Test (considering assumptions) (8 pts): We performed a linear regression to model water consumption as a function of population size. Assumptions of normality (Shapiro-Wilk test, p=0.298p=0.298) and homoscedasticity (Non-constant Variance Test, p=0.337p=0.337) were satisfied.

Correct values (5 pts): Slope = 0.000071, p=0.0000029, 3R2=0.943

Description (2 pts): The relationship between population size and water consumption is statistically significant and positive. For each additional unit increase in population size, water consumption increases by 0.000071 units on average.

Interpretation/Conclusions (2 pts): The results indicate that population size is a strong predictor of water consumption, as evidenced by the high R2R2 value. The model assumptions were met, supporting the reliability of these findings. This relationship highlights the importance of population data in forecasting water demand in urban areas.