TSA Practical 4 Report

Task

For a given US Population dataset (1970-1990): (a) Import as time series. (b) Identify dominating component. (c) Apply square root transformation. (d) Estimate linear trend. (e) Remove estimated linear trend.

Analysis

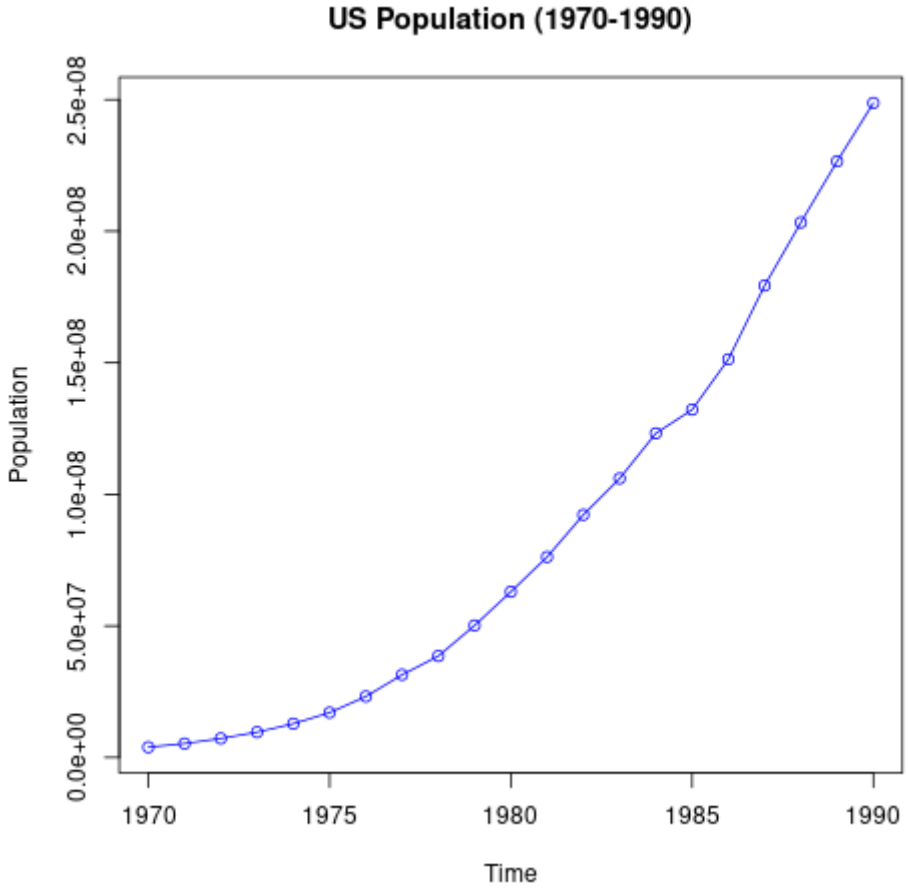
(a) Time Series Import

The data was imported with `start=1970` and `frequency=1` (Annual).

```
df <- read.csv("us_pop_1970.csv")
pop_ts <- ts(df$Population, start = 1970, frequency = 1)
```

(b) Dominating Component & (c) Transformation

The original data shows a very strong **Trend**. Square root transformation was applied as requested: `sqrt(pop_ts)`.



Original Plot:

(d) Estimate Linear Trend

A linear regression model `Population ~ Year` was fitted.

```
linear_model <- lm(pop_ts ~ time(pop_ts))
```

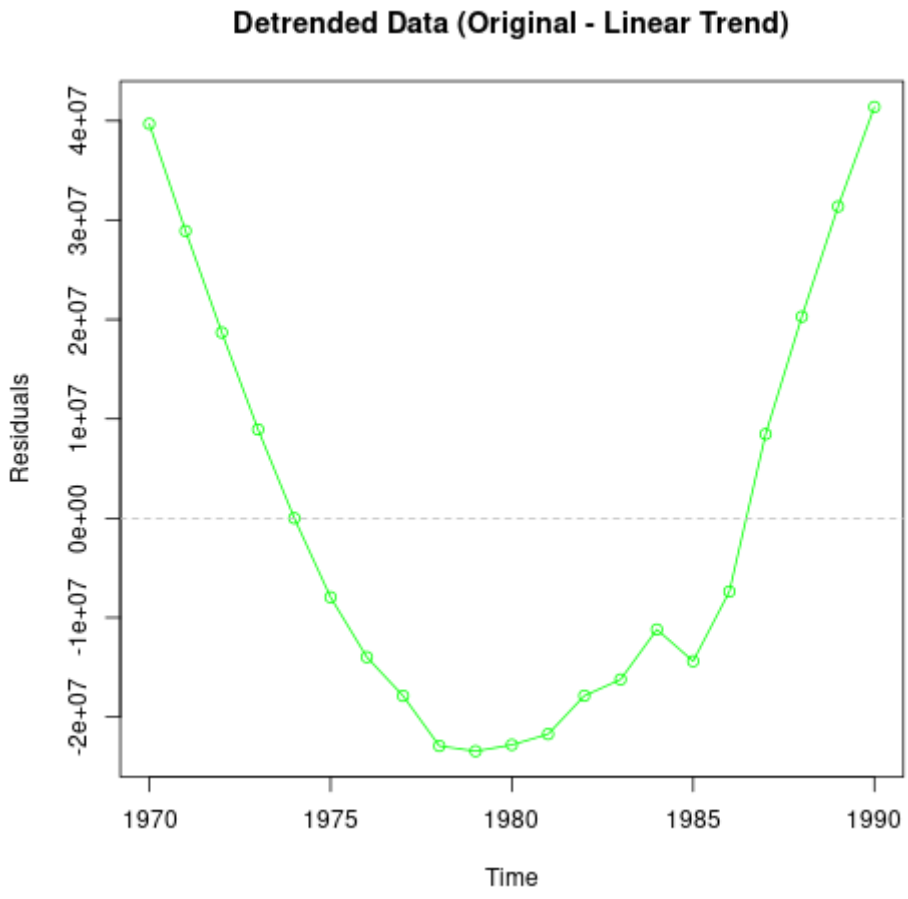
Results:

- **Intercept:** -2.398e+10
- **Slope:** 1.215e+07 (The population increases by approximately 12.15 million per year on average).
- **Formula:** $Population = -23,979,286,083.95 + 12,154,075.1 \times Year$
- **R-squared:** 0.9219 (Indicates a strong linear fit, though the curve suggests an exponential or quadratic nature might fit better).

(e) Remove Linear Trend (Detrending)

The estimated linear trend (fitted values) was subtracted from the data.

```
fitted_trend <- fitted(linear_model)
detrended_ts <- pop_ts - fitted_trend
```



Detrended Plot:

The detrended plot shows a "U" shape, indicating that the original growth was non-linear (likely exponential), and a simple linear trend removal left a quadratic residual structure.