Practical 4: Trend Analysis of US Population Time Series

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Practical 4: Trend Analysis of US Population Time Series

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1. Objective

To analyze the US population time series by applying transformation, estimating a linear trend, and studying the detrended series.

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2. Dataset and R Code

```
rm(list = ls())

year <- 1970:1990

population <- c(
  3929214, 5308483, 7239881, 9638453, 12860702,
  17063353, 23191876, 31443321, 38558371, 50189209,
  62979666, 76212168, 92228496, 106021537, 123202624,
  132164569, 151325798, 179323175, 203302031,
  226542203, 248709873
)

population_ts <- ts(population, start = 1970, frequency = 1)

population_sqrt <- sqrt(population_ts)

time_index <- time(population_ts)
trend_model <- lm(population_ts ~ time_index)
estimated_trend <- trend_model$fitted.values

detrended_population <- population_ts - estimated_trend
```

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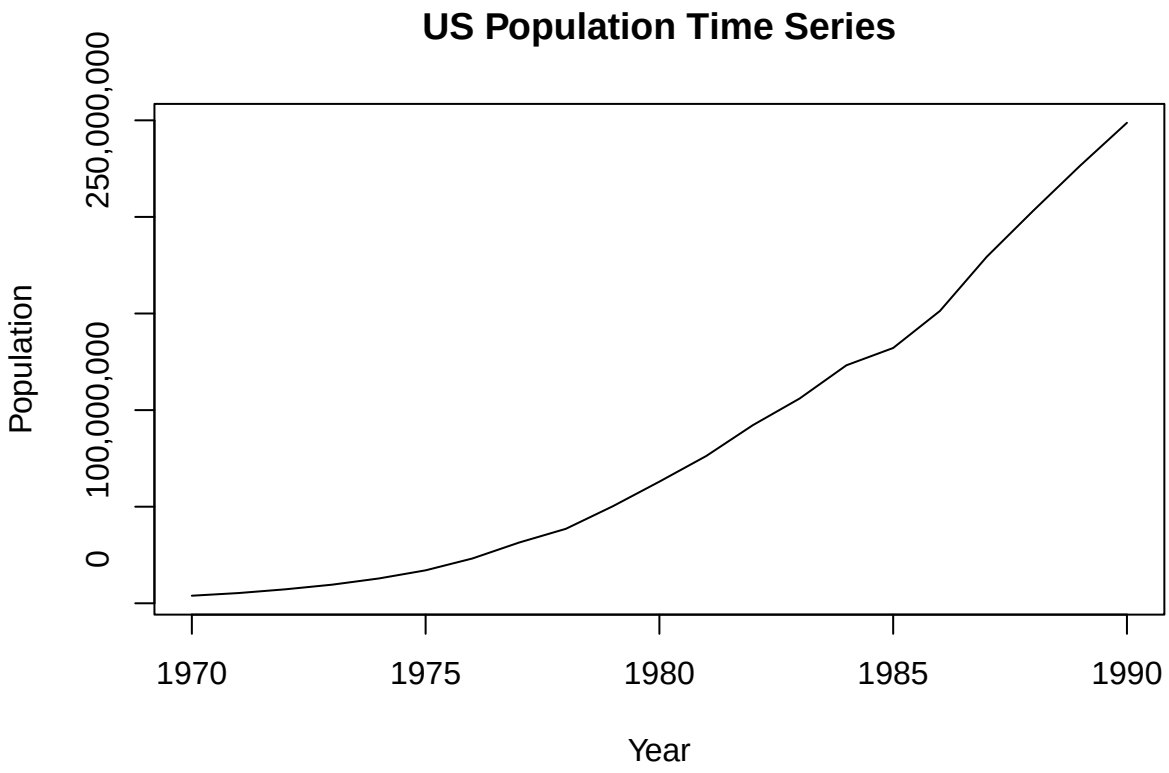
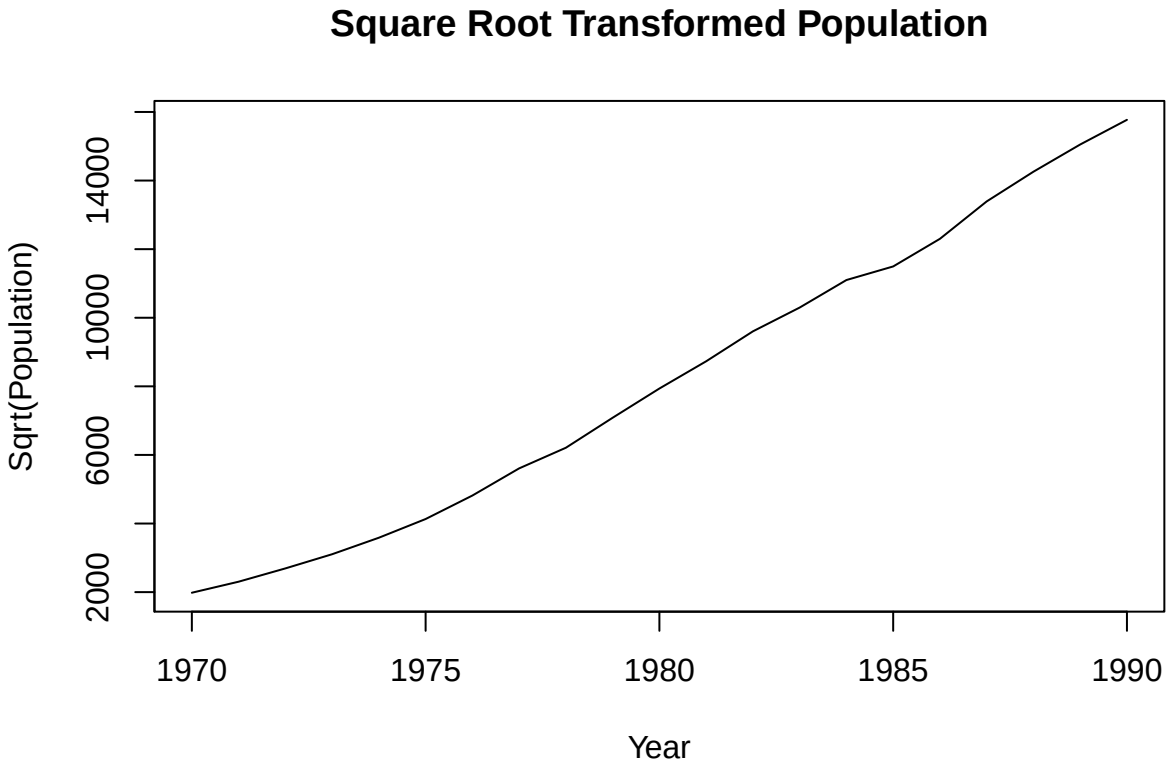
3. Output

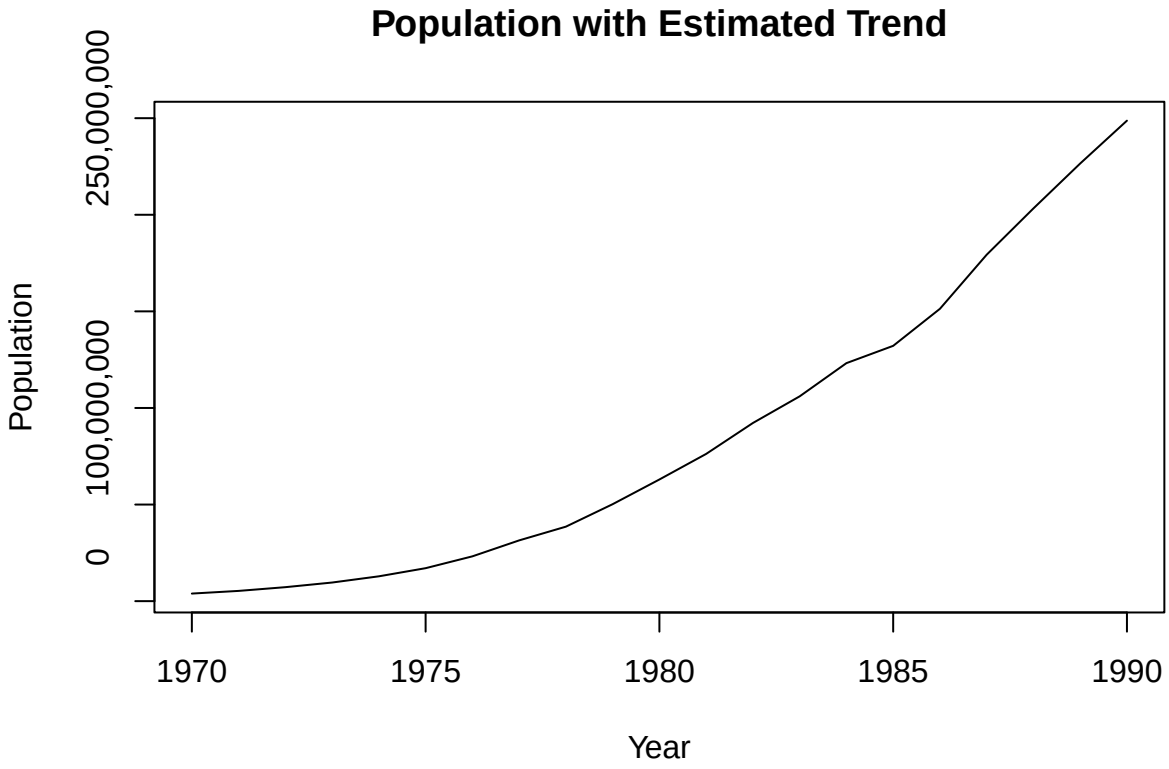
3.1 Original Time Series



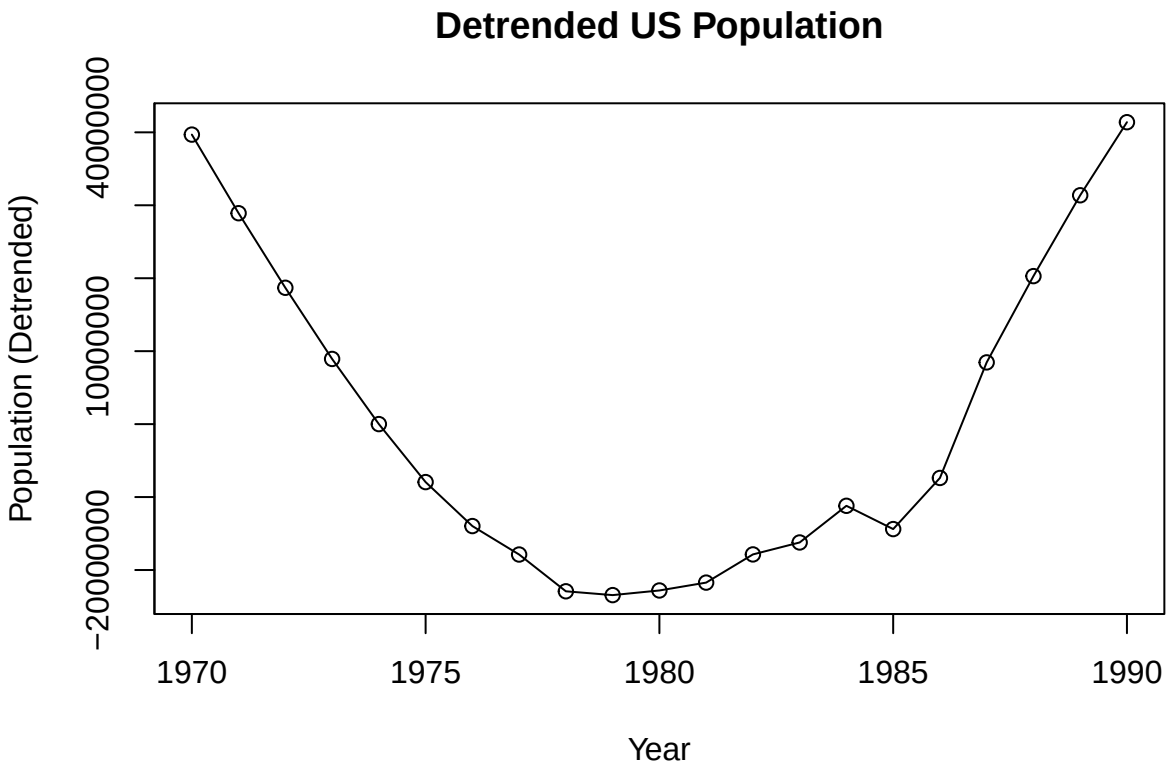
3.2 Square Root Transformation



3.3 Estimated Linear Trend



3.4 Detrended Time Series



3.5 Regression Summary

```
##
## Call:
## lm(formula = population_ts ~ time_index)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -23439335 -17862273  -7948891  18689863  41386503
##
## Coefficients:
##                 Estimate   Std. Error t value         Pr(>|t|)
## (Intercept) -23979286084   1606756899  -14.92 0.00000000000602 ***
## time_index      12154075       811490   14.98 0.00000000000565 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 22520000 on 19 degrees of freedom
## Multiple R-squared:  0.9219, Adjusted R-squared:  0.9178
## F-statistic: 224.3 on 1 and 19 DF,  p-value: 0.000000000005651
```

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4. Conclusion

The US population time series shows a strong upward trend. The square root transformation stabilizes variation in the data. Linear regression estimates the long-term trend, and detrending reveals short-term fluctuations in the series.