Time Series Analysis

Time Series Analysis is a powerful technique for understanding patterns in our data by decomposing data into different cyclic trends. It can be used to predict how a variable will change in the future by using the data in the past.

```
# Time Series Analysis

# Load packages
library(ggplot2)
library(forecast)
library(colortools)

# Load data
setwd("/cloud/project/Time Series Analysis")
monthly_milk <- read.csv("Month_Milk.csv")

head(monthly_milk)
```

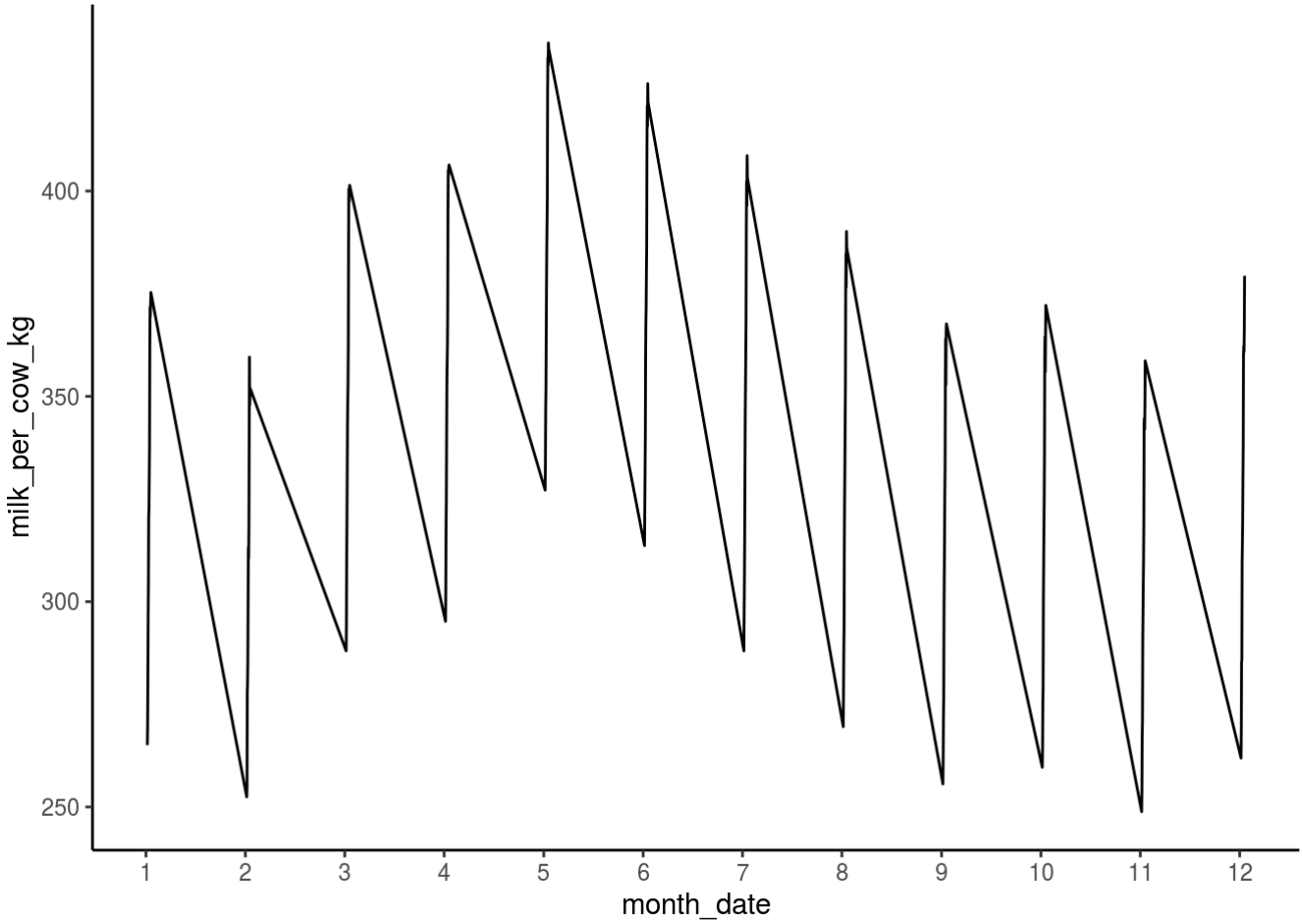
	month <fctr>	milk_per_cow_kg <dbl>
1	1/1/06	265.05
2	2/1/06	252.45
3	3/1/06	288.00
4	4/1/06	295.20
5	5/1/06	327.15
6	6/1/06	313.65

6 rows

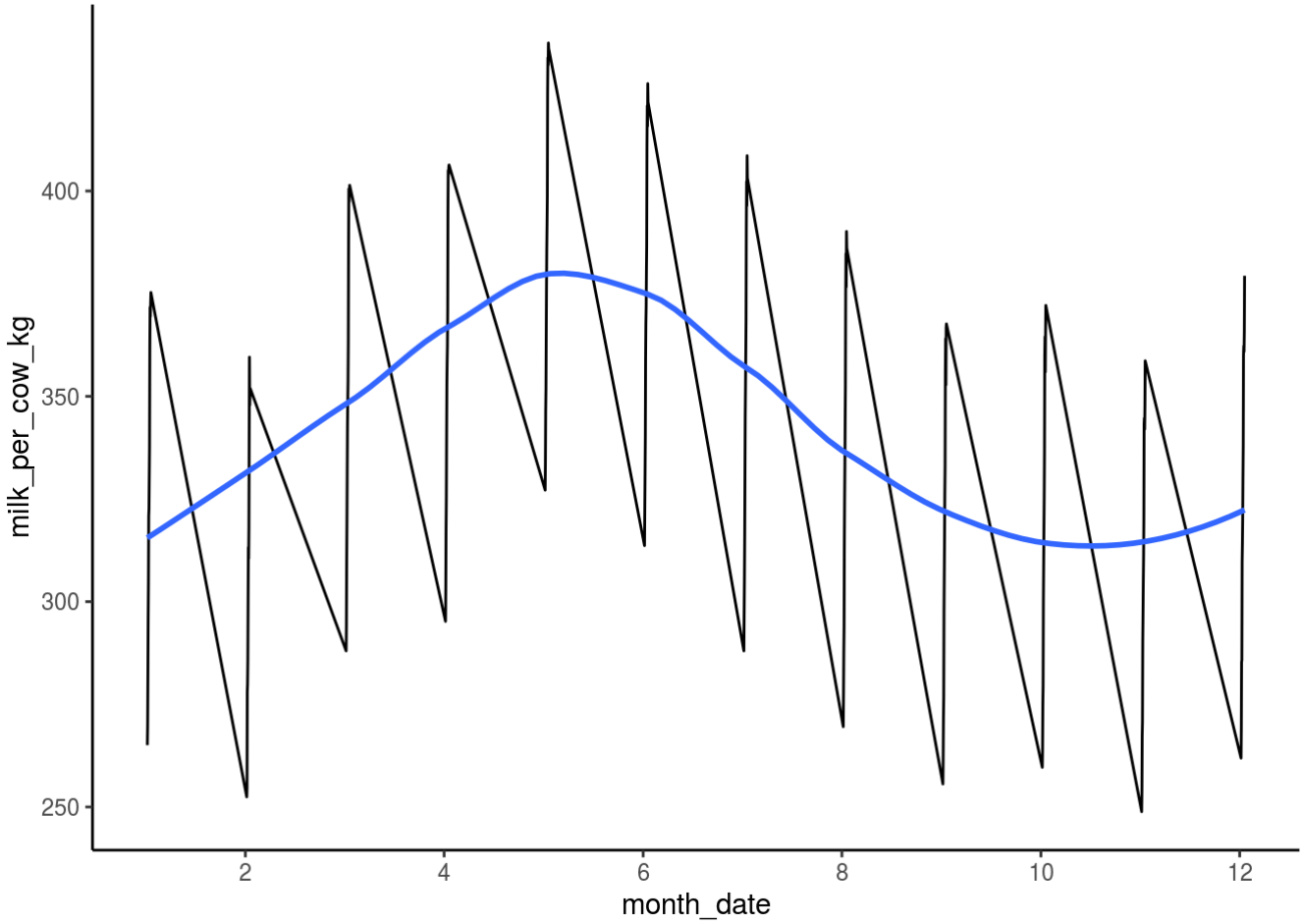
```
# Format date
# Monthly_Milk
monthly_milk$month_date <- format(monthly_milk$month_date, format = "%Y-%B-%u")
monthly_milk$month_date <- as.Date(monthly_milk$month)
class(monthly_milk$month_date)
```

```
## [1] "Date"
```

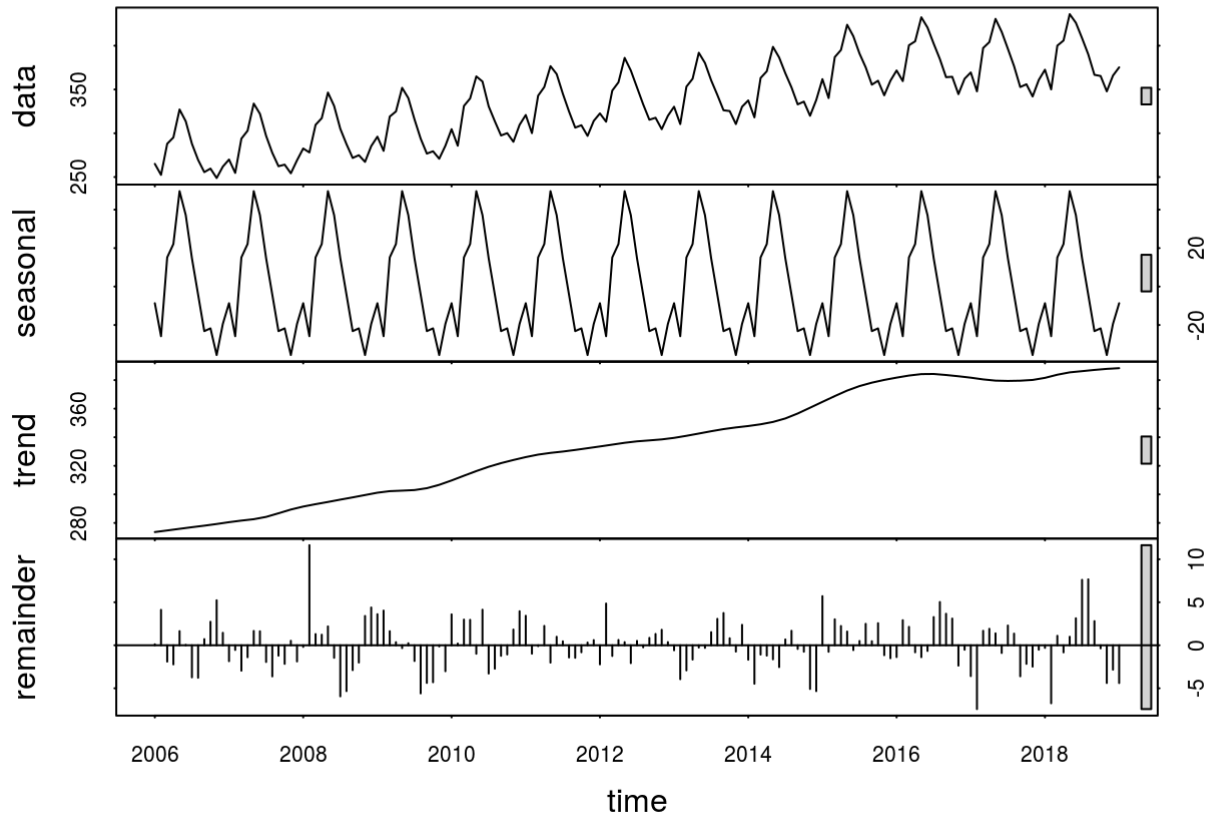
```
# Plot time series data ------------------------------------
# Using scale_x_date
ggplot(monthly_milk, aes(x = month_date, y = milk_per_cow_kg)) +
         geom_line() +
         scale_x_date(date_labels = "%Y", date_breaks = "1 year") +
         theme_classic()
```



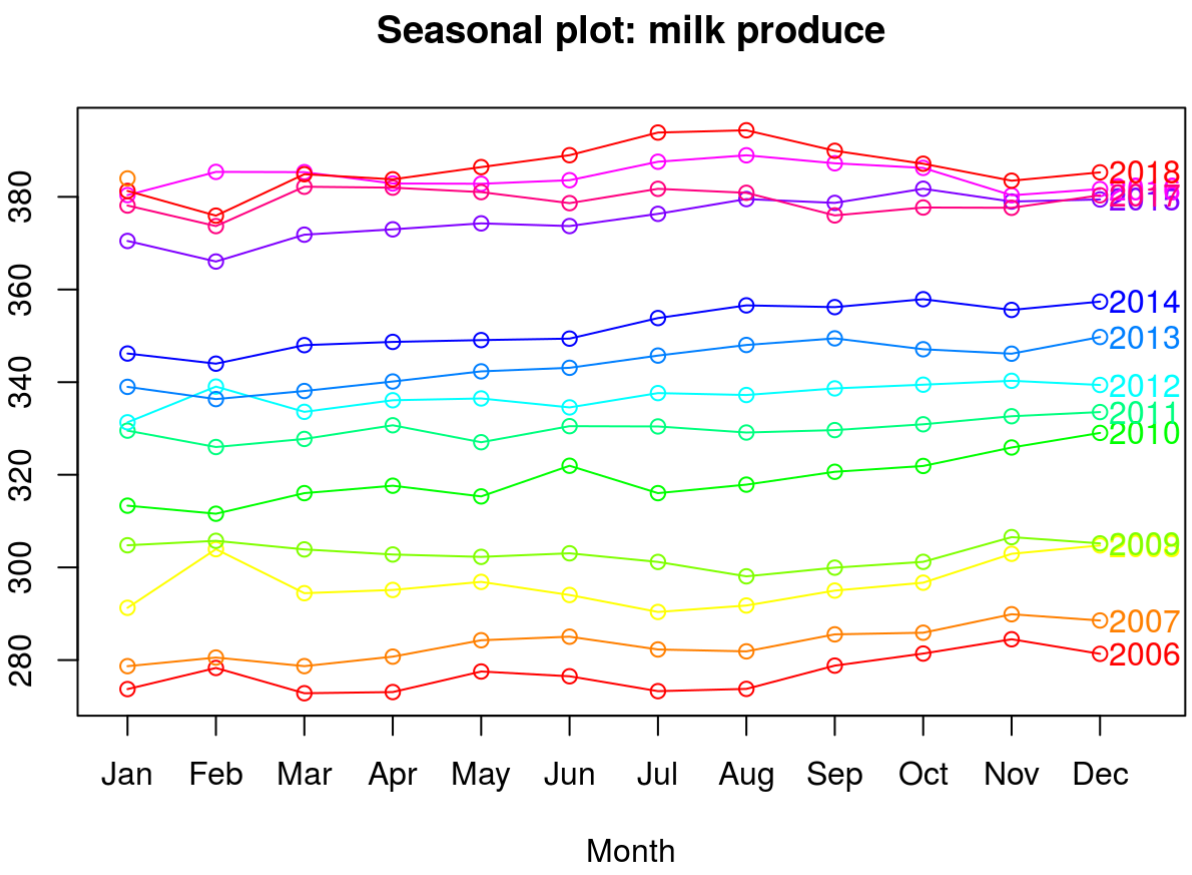

```
# View trend using loess smooth
ggplot(monthly_milk, aes(x = month_date, y = milk_per_cow_kg)) +
  geom_line() +
  geom_smooth(method = "loess", se = FALSE, span = 0.6) +
  theme_classic()
```




```
# Using ts objects to decompose trends ----------------------
# Transform to `ts` class
monthly_milk_ts <- ts(monthly_milk$milk_per_cow_kg, start = 2006, end = 2019, frequency
 = 12)
# Decompose using `stl()`
monthly_milk_stl <- stl(monthly_milk_ts, s.window = "period")
# Plot
plot(monthly_milk_stl)
```



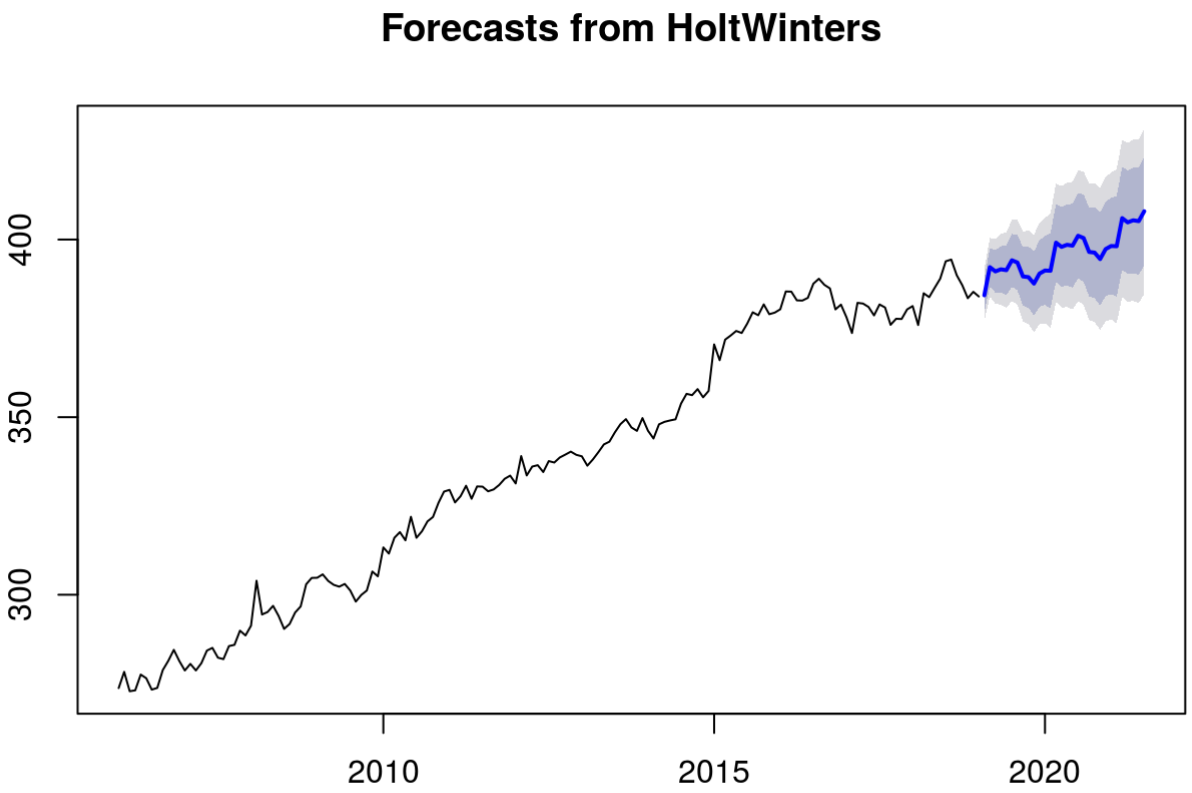

```
# Note:1=original data, 2=estimated seasonal, 3=estimated smooth trend, 4=estimated irre
gular
# de-seasonalize
ts.season <- seasadj(monthly_milk_stl)
seasonplot(ts.season, 12, col = rainbow(12), year.labels = TRUE, main = "Seasonal plot:
 milk produce")
```




```
# Forcasting ------------------------------------------------
# Exponential Models
# simple exponential - model level
fit <- HoltWinters(ts.season, beta = FALSE, gamma = FALSE)
# double exponential - model, trend
fit <- HoltWinters(ts.season, gamma = FALSE)
# triple exponential - model, trend, seasonal components
fit <- HoltWinters(ts.season)
# Predict
forecast(fit, 30)
```

```
##          Point Forecast    Lo 80    Hi 80    Lo 95    Hi 95
## Feb 2019       384.3155 379.5661 389.0648 377.0520 391.5789
## Mar 2019       392.2322 386.8440 397.6204 383.9917 400.4727
## Apr 2019       391.0409 385.0820 396.9998 381.9275 400.1543
## May 2019       391.6255 385.1459 398.1051 381.7158 401.5352
## Jun 2019       391.3841 384.4226 398.3455 380.7375 402.0306
## Jul 2019       394.1696 386.7576 401.5817 382.8340 405.5053
## Aug 2019       393.5319 385.6952 401.3686 381.5467 405.5171
## Sep 2019       389.6169 381.3773 397.8565 377.0156 402.2182
## Oct 2019       389.4235 380.7999 398.0471 376.2348 402.6122
## Nov 2019       387.6087 378.6174 396.6000 373.8577 401.3597
## Dec 2019       390.4210 381.0765 399.7655 376.1298 404.7121
## Jan 2020       391.2870 381.6022 400.9718 376.4754 406.0987
## Feb 2020       391.2173 380.6474 401.7872 375.0520 407.3826
## Mar 2020       399.1340 388.2621 410.0060 382.5068 415.7613
## Apr 2020       397.9427 386.7769 409.1086 380.8660 415.0194
## May 2020       398.5273 387.0752 409.9795 381.0127 416.0419
## Jun 2020       398.2859 386.5544 410.0174 380.3441 416.2277
## Jul 2020       401.0715 389.0671 413.0759 382.7124 419.4306
## Aug 2020       400.4337 388.1626 412.7049 381.6666 419.2009
## Sep 2020       396.5187 383.9865 409.0510 377.3523 415.6852
## Oct 2020       396.3253 383.5373 409.1134 376.7677 415.8829
## Nov 2020       394.5105 381.4717 407.5493 374.5694 414.4516
## Dec 2020       397.3228 384.0380 410.6076 377.0054 417.6402
## Jan 2021       398.1888 384.6625 411.7152 377.5020 418.8756
## Feb 2021       398.1191 383.9455 412.2927 376.4425 419.7958
## Mar 2021       406.0359 391.6356 420.4361 384.0126 428.0591
## Apr 2021       404.8446 390.2212 419.4679 382.4800 427.2091
## May 2021       405.4292 390.5860 420.2723 382.7285 428.1298
## Jun 2021       405.1877 390.1280 420.2475 382.1558 428.2196
## Jul 2021       407.9733 392.7001 423.2466 384.6149 431.3317
```

```
plot(forecast(fit, 30))
```



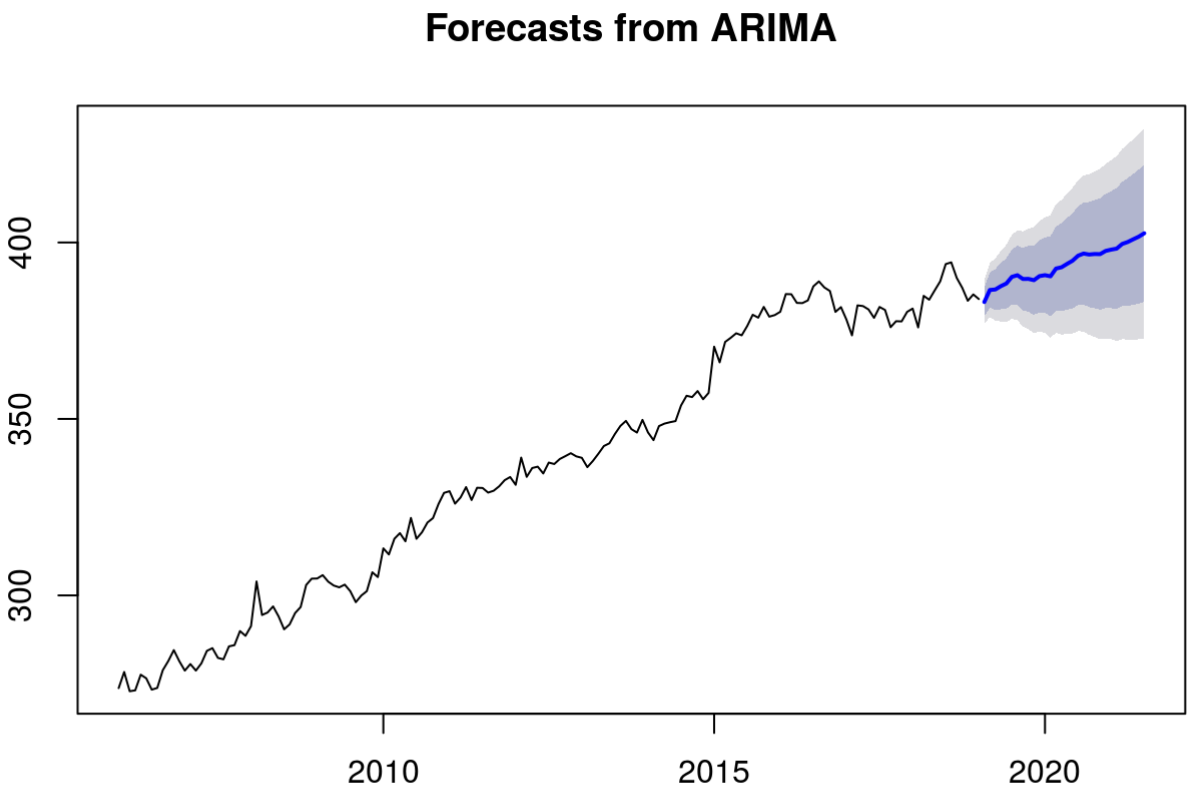

```
# Automated forecasting
fit <- ets(ts.season) #Error, Trend, Seasonality
fit <- auto.arima(ts.season)
accuracy(fit)
```

```
##                       ME     RMSE      MAE          MPE      MAPE      MASE
## Training set 0.01182874 3.101203 2.337315 0.003530265 0.7017556 0.2347677
##                     ACF1
## Training set 0.00803112
```

```
forecast(fit, 30)
```

```
##          Point Forecast    Lo 80    Hi 80    Lo 95    Hi 95
## Feb 2019       383.1411 379.0886 387.1936 376.9433 389.3389
## Mar 2019       386.5432 381.5376 391.5488 378.8878 394.1986
## Apr 2019       386.6928 380.9026 392.4830 377.8374 395.5481
## May 2019       387.6316 381.1058 394.1574 377.6512 397.6119
## Jun 2019       388.3891 381.2130 395.5651 377.4143 399.3639
## Jul 2019       390.2665 382.4950 398.0381 378.3810 402.1521
## Aug 2019       390.7323 382.4069 399.0578 377.9997 403.4650
## Sep 2019       389.6637 380.8191 398.5082 376.1371 403.1902
## Oct 2019       389.6879 380.3531 399.0227 375.4116 403.9643
## Nov 2019       389.3243 379.5237 399.1249 374.3356 404.3130
## Dec 2019       390.4762 380.2311 400.7214 374.8076 406.1449
## Jan 2020       390.7440 380.0727 401.4153 374.4237 407.0643
## Feb 2020       390.4178 379.0624 401.7733 373.0511 407.7845
## Mar 2020       392.6191 380.6959 404.5424 374.3842 410.8541
## Apr 2020       392.9832 380.5198 405.4465 373.9221 412.0442
## May 2020       393.9378 380.9506 406.9249 374.0756 413.7999
## Jun 2020       394.8445 381.3553 408.3337 374.2145 415.4744
## Jul 2020       396.2570 382.2839 410.2301 374.8869 417.6271
## Aug 2020       396.8677 382.4267 411.3087 374.7821 418.9533
## Sep 2020       396.5919 381.6978 411.4861 373.8134 419.3705
## Oct 2020       396.7394 381.4056 412.0733 373.2883 420.1905
## Nov 2020       396.7048 380.9434 412.4661 372.5999 420.8097
## Dec 2020       397.6132 381.4356 413.7907 372.8718 422.3545
## Jan 2021       397.9798 381.3965 414.5630 372.6178 423.3417
## Feb 2021       398.2676 381.1371 415.3981 372.0688 424.4664
## Mar 2021       399.5864 381.9682 417.2046 372.6417 426.5311
## Apr 2021       400.1368 382.0451 418.2285 372.4679 427.8057
## May 2021       400.9057 382.3489 419.4624 372.5256 429.2858
## Jun 2021       401.6438 382.6343 420.6533 372.5713 430.7163
## Jul 2021       402.6184 383.1667 422.0701 372.8696 432.3672
```

```
plot(forecast(fit, 30), main = "Forecasts from ARIMA")
```


Forecasts from ARIMA
400
350
300
2010
2015
2020