Forecasting with ARIMA models

FISH 550 – Applied Time Series Analysis Download Rmd

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6 Apr 2023

Forecasting with an ARIMA model

The basic idea of forecasting with an ARIMA model to estimate the parameters and forecast forward.

For example, let's say we want to forecast with this ARIMA(2,1,0) model:

$$y_t = \mu + \beta_1 y_{t-1} + \beta_2 y_{t-2} + e_t$$

where $y_t = x_t - x_{t-1}$, the first difference.

`Arima()` would write this model:

$$(y_t - m) = \beta_1 (y_{t-1} - m) + \beta_2 (y_{t-2} - m) + e_t$$

The relationship between μ and m is $\mu = m(1 - \beta_1 - \beta_2)$.

Let's estimate the β's for this model from the anchovy data.

```
fit <- forecast::Arima(anchovyts, order=c(2,1,0), include.c
coef(fit)
```

```
##          ar1          ar2        drift
## -0.53850433 -0.44732522  0.05367062
```

```
mu <- coef(fit)[3]*(1-coef(fit)[1]-coef(fit)[2])
mu
```

```
##     drift
## 0.1065807
```

So we will forecast with this model:

$$y_t = 0.1065807 - 0.53850433 y_{t-1} - 0.44732522 y_{t-2} + e_t$$

To get our forecast for 1990, we do this

$$(x_{90} - x_{89}) = 0.106 - 0.538(x_{89} - x_{88}) - 0.447(x_{88} - x_{87})$$

Thus

$$x_{90} = x_{89} + 0.106 - 0.538(x_{89} - x_{88}) - 0.447(x_{88} - x_{87})$$

Here is R code to do that:

```
anchovyts[26]+mu+coef(fit)[1]*(anchovyts[26]-anchovyts[25])+
  coef(fit)[2]*(anchovyts[25]-anchovyts[24])
```

```
##    drift
## 9.962083
```

Forecasting with `forecast()`

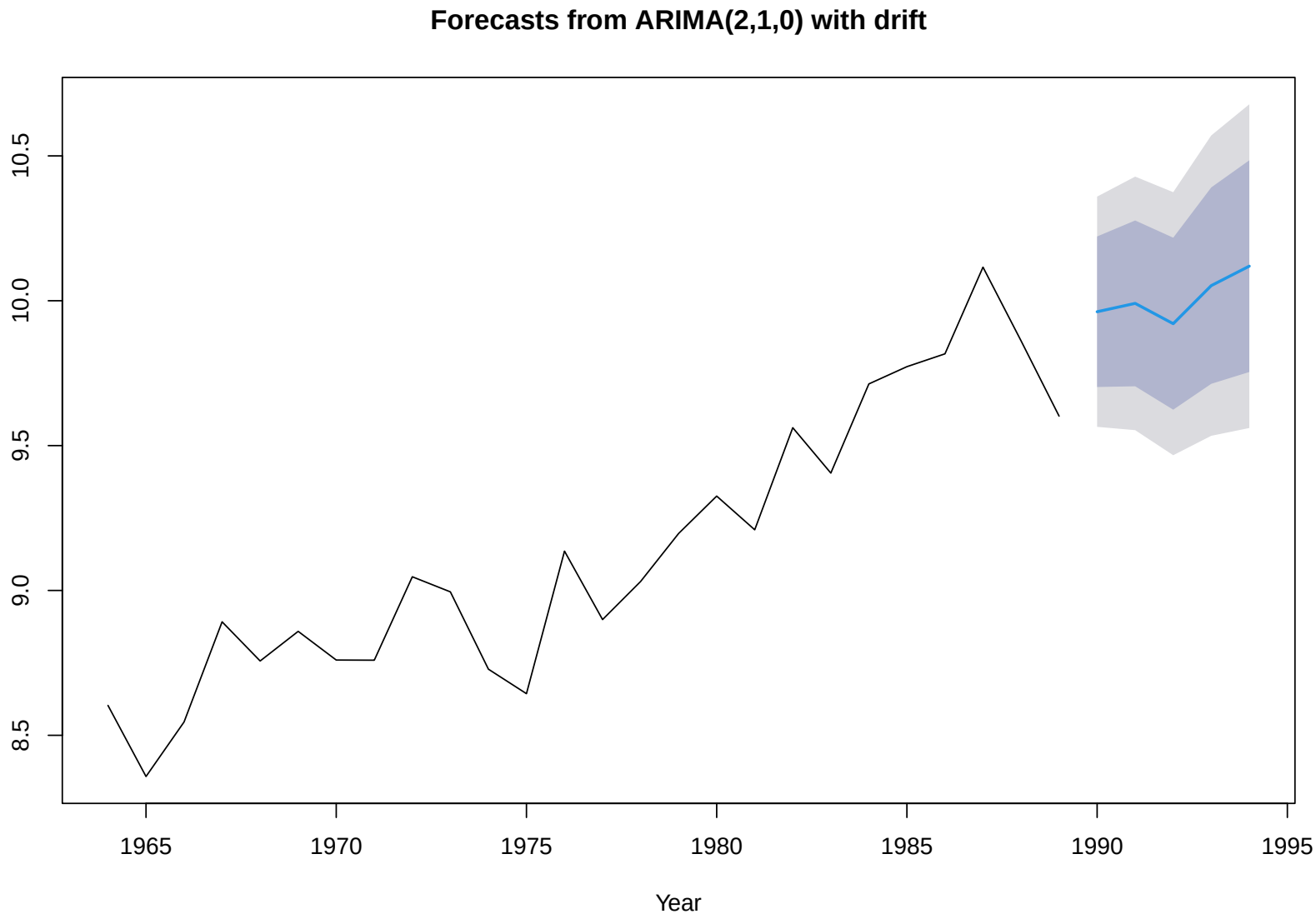
`forecast(fit, h=h)` automates the forecast calculations for us and computes the upper and lower prediction intervals. Prediction intervals include uncertainty in parameter estimates plus the process error uncertainty.

```
fr <- forecast::forecast(fit, h=5)
fr
```

```
##      Point Forecast    Lo 80    Hi 80    Lo 95    Hi 95
## 1990       9.962083 9.702309 10.22186 9.564793 10.35937
## 1991       9.990922 9.704819 10.27703 9.553365 10.42848
## 1992       9.920798 9.623984 10.21761 9.466861 10.37473
## 1993      10.052240 9.713327 10.39115 9.533917 10.57056
## 1994      10.119407 9.754101 10.48471 9.560719 10.67809
```

Plotting our forecasts

```
plot(fr, xlab="Year")
```



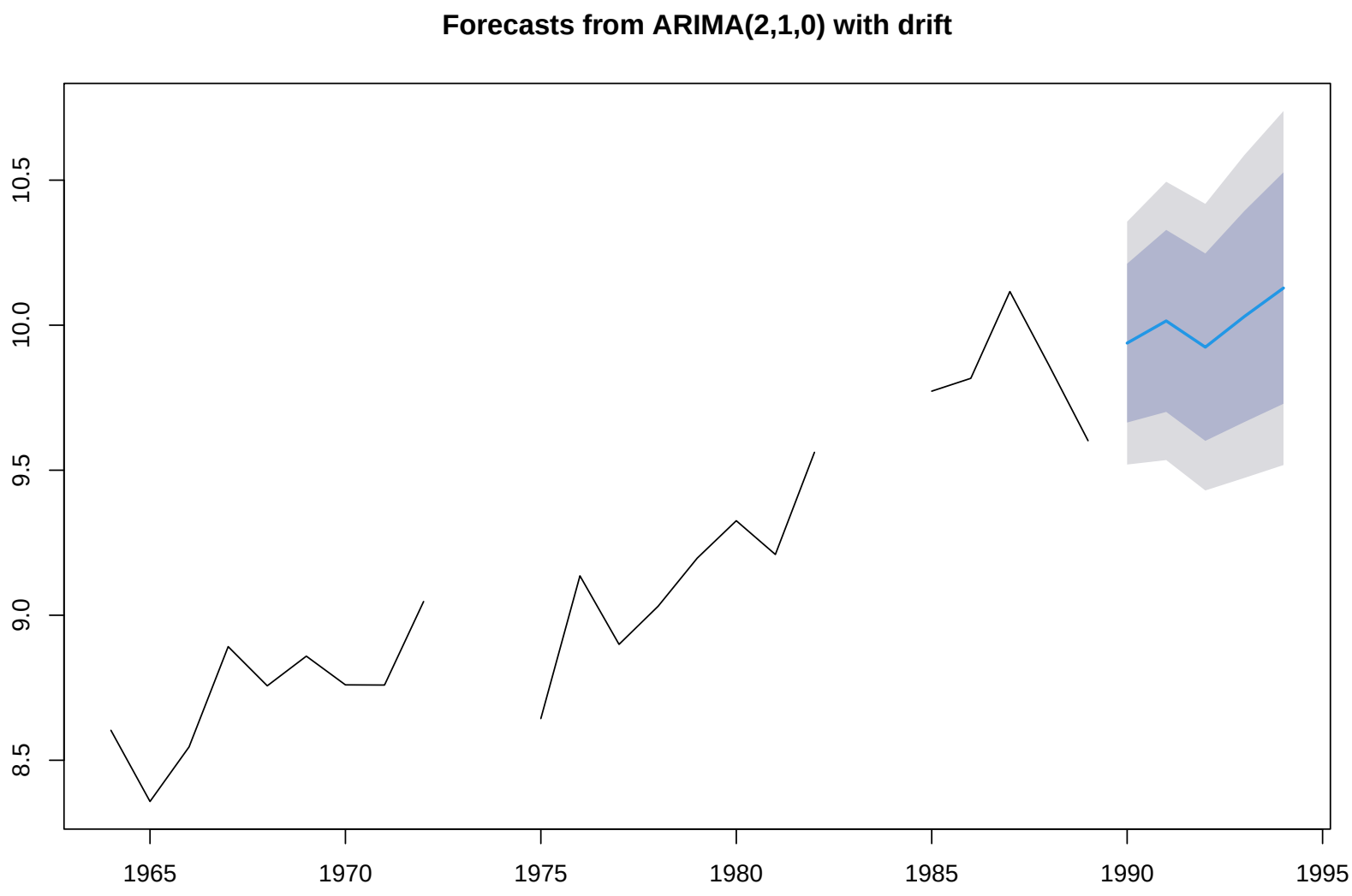
Missing values

Missing values are allowed for `forecast::Arima()`. We can produce forecasts with the same code.

```
anchovy.miss <- anchovyts
anchovy.miss[10:11] <- NA
anchovy.miss[20:21] <- NA
fit <- forecast::Arima(anchovy.miss, order=c(2,1,0), inclu
fr <- forecast::forecast(fit, h=5)
fr
```

```
##      Point Forecast    Lo 80    Hi 80    Lo 95    Hi 95
## 1990       9.938269 9.664479 10.21206 9.519543 10.35700
## 1991      10.014686 9.700961 10.32841 9.534885 10.49449
## 1992       9.924208 9.601147 10.24727 9.430129 10.41829
## 1993      10.029988 9.666069 10.39391 9.473421 10.58656
## 1994      10.128066 9.729066 10.52707 9.517848 10.73828
```

```
plot(fr)
```


Forecasts from ARIMA(2,1,0) with drift
10.5
10.0
9.5
9.0
8.5
1965
1970
1975
1980
1985
1990
1995

Using auto.arima()

We can let forecast to select the ARIMA model:

```
anchovy.miss <- anchovyts
anchovy.miss[10:11] <- NA
anchovy.miss[20:21] <- NA
fit <- forecast::auto.arima(anchovy.miss)
fit
```

```
## Series: anchovy.miss
## ARIMA(0,1,1) with drift
##
## Coefficients:
##           ma1   drift
##       -0.7240  0.0548
## s.e.   0.2283  0.0125
##
## sigma^2 = 0.04355:  log likelihood = 3.52
## AIC=-1.03   AICc=0.11   BIC=2.63
```

```r
fr <- forecast::forecast(fit, h=5)
plot(fr)
```