2DAR selectivity for Stock Synthesis

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Introduction

This document demonstrates how to use the stand-alone TMB code mentioned in Xu et al. (2019) to estimate the two correlation coefficients for selectivity devs (rho_a and rho_t) outside Stock Synthesis. The SS files for this example code can be found here.

Tuning SigmaS

The tuning algorithm is based on Equation 19 in Xu et al. (2019). Estimated selectivity devs and their standard errors can be found in the report file. They are saved as a csv file in this example but they can also be directly extracted in R using r4ss. SigmaS_new should be used in new the control file as the new SigmaS until it is close to the value specified in the current control file.

```
Selex_devs <- read.csv("D:/OneDrive - IATTC/Git/2DAR4ss/SS files/Selex_devs.csv", header = TRUE)
head(Selex_devs)
```

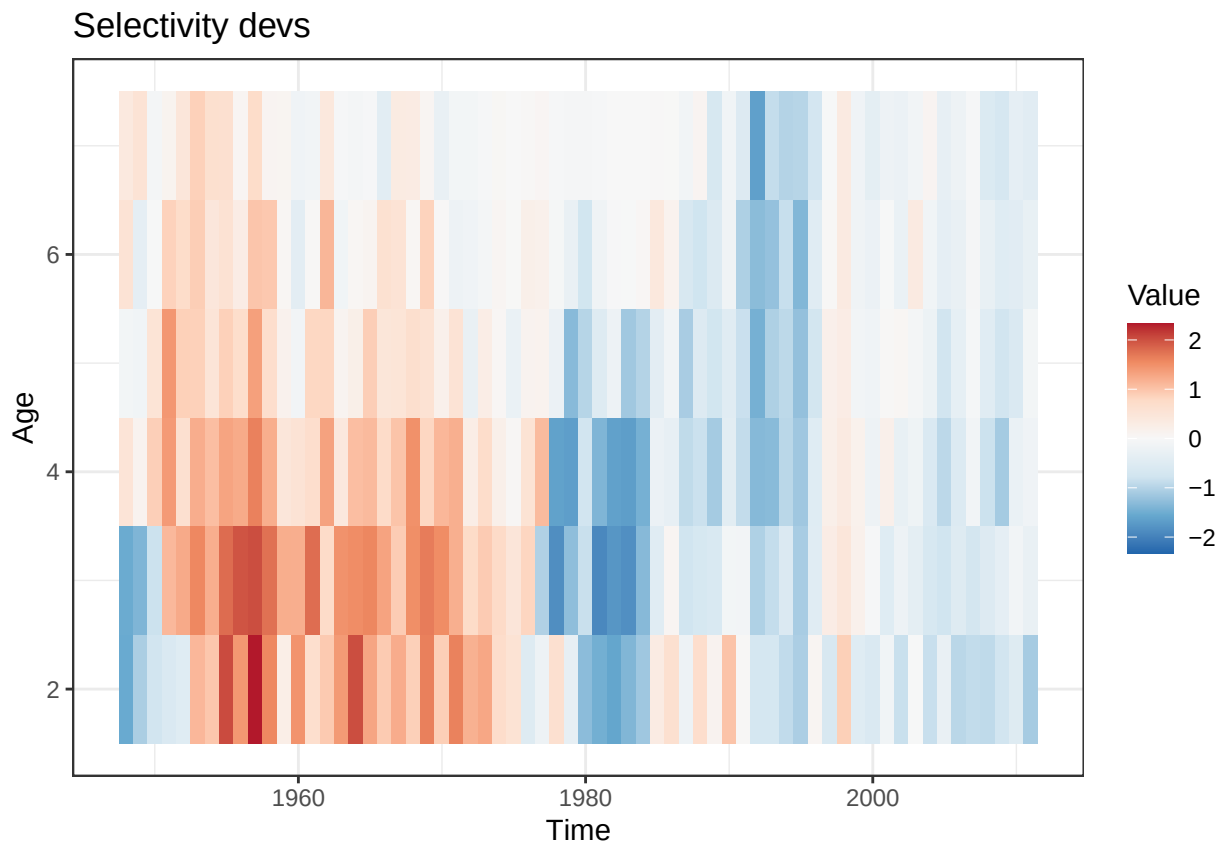
```
##   Num                  Label     Value Active_Cnt Phase Min Max Init Used
## 1 203 Fishery_ARDEV_y1948_a1 -1.538020        149     5 -10  10    0    0
## 2 204 Fishery_ARDEV_y1948_a2 -1.528980        150     5 -10  10    0    0
## 3 205 Fishery_ARDEV_y1948_a3  0.516889        151     5 -10  10    0    0
## 4 206 Fishery_ARDEV_y1948_a4 -0.103545        152     5 -10  10    0    0
## 5 207 Fishery_ARDEV_y1948_a5  0.540970        153     5 -10  10    0    0
## 6 208 Fishery_ARDEV_y1948_a6  0.390612        154     5 -10  10    0    0
##   Status Parm_StDev  Gradient Pr_type
## 1    act   0.607388 -1.99e-08     dev
## 2    act   0.606005 -1.56e-07     dev
## 3    act   0.276867 -1.25e-07     dev
## 4    act   0.333144 -5.05e-08     dev
## 5    act   0.291907 -1.44e-07     dev
## 6    act   0.299511 -5.43e-08     dev
```

```
# first check the 2D surface of selectivity devs - they appear to be highly correlated in age and time
library(ggplot2)
```

```
## Warning: package 'ggplot2' was built under R version 4.2.3
```

```
Selex_devs$Age <- 2:7
Selex_devs$Time <- rep(1948:2011, each = 6)
ggplot(data = Selex_devs) +
```

```
  geom_tile(aes(x = Time, y = Age, fill = Value)) +
  scale_fill_distiller(palette = "RdBu", limits = c(-1,1)*max(abs(Selex_devs$Value))) +
  ggtitle("Selectivity devs") +
  theme_bw()
```




```
SigmaS_new <-
  sqrt(sd(Selex_devs$Value) ^ 2 + sum(Selex_devs$Parm_StDev ^ 2) / nrow(Selex_devs)) # Equation 19
b <-
  1 - sum(Selex_devs$Parm_StDev ^ 2) / nrow(Selex_devs) / SigmaS_new ^ 2 # Equation 20
```

Estimating autocorrelation coefficients

The two autocorrelation coefficients can be estimated after the tuning is finished. A stand-alone TMB code is developed to estimate rho_a and rho_t. You need to install the R package *TMB* to compile the code on your machine.

```
library(TMB)
```

```
## Warning: package 'TMB' was built under R version 4.2.3
```

```
setwd("D:/OneDrive - IATTC/Git/2DAR4ss/User Manual/")

compile("2DAR_Selex.cpp")
```

```
## [1] 0
```

```
dyn.load("2DAR_Selex.dll")

# format Selex_devs as a matrix
Nages = 6 # 6 age bins
Nyears = 64 # 64 time steps

Selex_devs_matrix <- matrix(Selex_devs$Value, nrow = Nages)

Obj <-
  MakeADFun(
    data = list(
      "Nyears" = Nyears,
      "Nages" = Nages,
      "SDev_hat" = Selex_devs_matrix
    ),
    parameters = list(
      "rho_a" = -log(1 / 0.5 - 1),
      "rho_t" = -log(1 / 0.5 - 1),
      "ln_SigmaS" = log(0.96) # SigmaR is fixed at 0.96 based on the tuning above
    ),
    map = list(ln_SigmaS = factor(NA)), # SigmaR is not estimated here
    random = NULL
  )
```

```
## Constructing atomic invpd
```

```
Upr = rep(Inf, length(Obj$par))
Lwr = rep(-Inf, length(Obj$par))

Opt = nlminb(
  start = Obj$par,
  objective = Obj$fn,
  gradient = Obj$gr,
  upper = Upr,
  lower = Lwr
)
```

```
## outer mgc:  45.18449
## outer mgc:  16.30322
## outer mgc:  3.895717
## outer mgc:  6.698107
## outer mgc:  5.917633
## outer mgc:  0.1636427
## outer mgc:  0.1641171
## outer mgc:  0.003624227
## outer mgc:  3.462539e-06
## outer mgc:  2.078394e-08
```

```
# rho_a and rho_t are estimated to be:
exp(Opt$par) / (exp(Opt$par) + 1)
```

```
##     rho_a     rho_t
## 0.4735453 0.8123478
```

Xu, Haikun, James T. Thorson, Richard D. Methot, and Ian G. Taylor. 2019. "A New Semi-Parametric Method for Autocorrelated Age- and Time-Varying Selectivity in Age-Structured Assessment Models." *Canadian Journal of Fisheries and Aquatic Sciences* 76 (2): 268–85. https://doi.org/10.1139/cjfas-2017-0446.