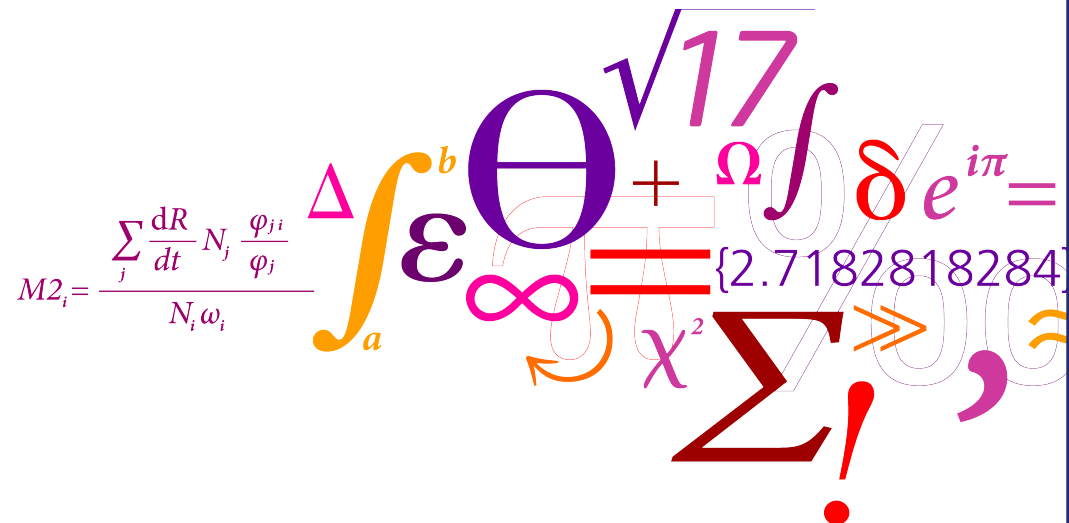


Welcome to Fish stock assessment: SAM and TMB

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$$M2_i = \frac{\sum_j \frac{dR}{dt} N_j \frac{\varphi_{ji}}{\varphi_j}}{N_i \omega_i}$$

$$\Delta \int_a^b \epsilon \Theta^{\sqrt{17}} + \Omega \int \delta e^{i\pi} = \{2.7182818284\}$$

$$\infty = \chi^2 \sum !$$

Preliminary agenda

Day 1: Intro and basics

- ICES presentation (30m)
- Intro (what is TMB, what is SAM)
- First simple TMB example
- Parameters
- Data
- Basic parametric assessment model (study basic model implementation, add small improvements)

Day 2: SAM basic use and foundation

- Ways to run SAM (basic sam, web, R, git)
- Multivariate normal distribution
- Intro to random effects

Day 3: Processes in SAM

- Recruitment & Survival (a) Explain, (b) Implement, (c) Study SAM configuration
- Fishing mortality (a) Explain, (b) Implement, (c) Study SAM configuration

Day 4: Observations in SAM

- Catches, total catches, Biomass indices
- Surveys, tagging, missing, and correlations

Day 5: Validation and forecast

- Validating assessment models (e.g. observation and process residuals, leave out, retrospective, simulation, prediction based, jit)
- Forecast scenario options

Time and place

Time:

Monday 12 Oct. 2020 — Friday 16 Oct. 2020
each day from 9—17:30 (CET)

Place:

By your computer^a

^aConsider sitting together during exercises — where it is safe and where more participants are joining from the same institute

Format adapted for online course

- Course is a mixture of lectures and exercises
- Each day the lecture parts are recorded for participants in different time zones^a
- On days 2-6 the time from 16-17:30 is dedicated to questions mainly from participants in other time zones^b
- All participants are welcome to join all parts.
- Questions can be asked at all times by interrupting - please do!
- Questions can also be asked by writing in the chat box

This will be difficult — but we will do our best

^aThe plan is that the participants in very different time zones view the lectures and work on the exercises offline and then join and ask questions online the following day

^bNotice that we are available on Saturday for questions regarding Friday's exercises

Prepare for course by installing:

Basic R: Follow the instructions for your platform here <https://cran.r-project.org/>

TMB including R-tools: Follow the instructions on <https://github.com/kaskr/adcomp/wiki/Download>. Notice that on win and mac you need to install R-tools. Pay close attention to the instructions.

devtools: Install the package `devtools` by typing the following in your R:

```
> install.packages('devtools')
```

Test installation Type the following lines to test that it is all working:

```
> devtools::install_github('fishfollower/SAM/stockassessment')
```

```
> library(stockassessment)
```

```
> example(sam.fit)
```

```
> fit
```

```
> #Should output: SAM model: log likelihood is -145.5167 Convergence OK
```

See you soon

- If all went well you should be setup to run all examples and exercises needed in the course
- If you got strange error messages, then please contact an@aqua.dtu.dk or olavbr@nr.no
- Special requests or questions w.r.t. the agenda — please don't hesitate to ask.
- Looking forward to “seeing” you all soon.

Appendix: Linear regression in TMB - 1

Run the following example, where each line is explained below, to prepare yourself for the TMB syntax ahead of the course.

- 10 observations are assumed to follow a linear regression model:
- Copy the following lines to a plain text file named `linreg.dat`

```
1  x    y
2  -1   1.4
3  0    4.7
4  1    5.1
5  2    8.3
6  3    9.0
7  4   14.5
8  5   14.0
9  6   13.4
10 7   19.2
11 8   18
```

`linreg.dat`

- Two columns of paired (x, y) observations
- The model we want to fit is $y_i = \alpha + \beta x_i + \varepsilon_i$, where $\varepsilon_i \sim \mathcal{N}(0, \sigma^2)$ all independent.

Appendix: Linear regression in TMB - 2

- Copy the following lines to a plain text file named linreg.cpp

```
1  #include <TMB.hpp>
2
3  template<class Type>
4  Type objective_function<Type>::operator() ()
5  {
6      DATA_VECTOR(x)
7      DATA_VECTOR(y);
8
9      PARAMETER(alpha);
10     PARAMETER(beta);
11     PARAMETER(logSigma);
12     vector<Type> pred=alpha+beta*x;
13     Type ans=-sum(dnorm(y,pred,exp(logSigma),true));
14     ADREPORT(pred);
15
16     return ans;
17 }
```

linreg.cpp

- The first five lines are obligatory syntax
- lines 6 and 7 reads data from R data object (names must match)
- lines 9-11 reads parameters from R parameter object (names must match)
- line 12 calculates the linear prediction (line 14 reports it back to R)
- line 13 calculates negative log likelihood and line 16 returns it.

Appendix: Linear regression in TMB - 3

- Try to run the following lines in R

```
1  dat<-read.table("linreg.dat", header=TRUE)
2
3  library(TMB)
4  compile("linreg.cpp")
5  dyn.load(dynlib("linreg"))
6
7  data <- list(x=dat$x,y=dat$y)
8  parameters <- list(
9    alpha=0,
10   beta=0,
11   logSigma=0
12 )
13
14 obj <- MakeADFun(data,parameters,DLL="linreg")
15 obj$fn()
16 obj$gr()
17 system.time(opt <- nlminb(obj$par,obj$fn,obj$gr))
18 rep <- sdreport(obj)
```

linreg.R

- line 1 reads the data from the text file into R
- lines 3-5 loads TMB, compiles the function we defined and links it into our R-session.
- lines 3-5 loads TMB, compiles the function we defined and links it into our R-session.
- lines 7-12 defines two lists one with data objects and one with initial values for the model parameters.
- lines 14 defines the model object from the data list, parameter list, and the negative log likelihood function
- line 15 evaluates the function value (at the initial parameters)
- line 16 evaluates the function gradient (at the initial parameters)
- line 17 optimizes w.r.t. the model parameters
- line 18 gives summary of model results