**Week 2**

This week we are practicing using TMB objects and fitting two models. The concepts are related to the coding problems. Some of the problems are based on A. Nielson lectures.

**Concepts:**

1.What are the TMB data types? How to define number, vector, matrix, array, integer, integer vector, integer matrix, integer array, factor, string in TMB?

2. Why is data dimension important? How do you check what is read in the computer memory?

3. What is the difference between REPORT() and ADREPORT()?

4. Write a few ways to read from data files.

5. We talked about setting bounds for the variance parameter in the last meeting. Suggest how to use transformation to parameterize a parameter that is

a) only positive

b) only negative

c) between 2 and 5

d) an increasing vector

6. How to specify multiple parameters for TMB?

7. What is the map argument of the MakeADFun?

8. What is simulation testing? Why do we need it?

9. What are stock-recruitment relationship?

10. What is a Basic Kalman Filter?

**Coding**

Question 1: Parameter bounds

For a single probability parameter, we can use the inverse logit transformation

where .

For a probability vector , what would be the transformation look like? Assume we observe the vector (128, 158, 92, 122) from a 4-dimensional multinomial distribution.

Hint: the last probability can be written as 1-

Question 2: Practice with map argument

Consider the R-built in data set InsectSprays

We will use the model , where

This can be implemented as

![A screenshot of a cell phone

Description automatically generated]()

Use the map argument to test the hypothesis that spray .

Can the mean count for the spray ‘A’, ‘B’, ‘F’ be assumed to be 15?

Hint: Try to test these hypotheses without modifying the cpp file.

Question 3: Beverton-Holt curve

The stock recruit curve is



where R = recruits and SSB = spawning biomass and assuming iid normal error on log scale.

Find the bevholt.dat and fit the above stock recruit curve to the data to find log(A) and log(B).

Plot MLE fit to the data.

Re-optimize model from a grid of starting points:

a) log(A) between c(-5,10) and log(B) between c(-15,0)

b) Use 100 steps for each (10000 total initial conditions)

c) Check if they all find the same minimum

d) How much variation are there in the number of evaluations?

Question 4: A state-space model

Find the data set in rw.dat

Observation vector Y generated from:

where and are all independent.

Notice λ vector is unobserved.

We wish to estimate λ and the model parameters ().

Hint: We can construct the Basic Kalman Filter or we can use joint likelihood to solve by Laplace approximation in TMB. We’ll show both ways at the meeting.