FISH 559: Numerical Computing for Fisheries Assessment and Management (5 credits)

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Overview
The purpose of this course is to introduce students who are familiar with use of Bayesian and Maximum Likelihood methods for fitting models to address natural resource problems how to: a) use R to perform numerical analyses (numerical integration, numerical differentiation, root finding, etc.), b) use the AD Model Builder package to fit models to data, c) use WinBUGS to implement Bayesian hierarchical models, and d) use standard numerical techniques commonly encountered when using modeling to solve natural resource problems.

FORMAT
Two 2-hour lecture-laboratory sessions each week in which the instructor first introduces the theory behind the topic being discussed and illustrates the concepts using examples programmed in R, WinBUGS and AD Model Builder, and one 50-minute lecture session each week to cover the technical details of some of the methods in more detail. Depending on the topic, students apply the methods to additional examples during the lecture-laboratory sessions. Students are evaluated based on four assignments and a project. The assignments are based directly on the lecture material while the project is open-ended, with the aim that students apply the material covered in the course to a problem of their choosing.

LEARNING GOALS
- To know how to use R to fit linear mixed effects models.
- To be able to estimate the values for the parameters of a model using R and AD Model Builder.
- To be able to represent a posterior distribution using samples generated from a posterior distribution using WinBUGs and AD Model Builder.

TEXTS
There is no prescribed text – the material covered in class is covered in a variety of texts. A subset of these are:

1. Burnham, K.P. and D.R. Anderson. 1998. Model Selection and Inference: A Practical Information-theoretic Approach, Springer.
2. Gelman, A., Carlin, J.B., Stern, H.S. and D.B. Rubin. 1995. Bayesian Data Analysis, Chapman and Hall.
3. Linhart, H. and W. Zuchinni. 1986. Model Selection, John Wiley.
4. Pinheiro, J.C. and D.M. Bates. 2000. Mixed-Effects Models in S and S-PLUS, Springer.
5. Press, W.H., Flannery, B.P., Teukolsky, S.A. and W.T. Vetterling. 1988. Numerical Recipes: The Art of Scientific Computing, Cambridge University Press.
6. Venables, W.N. and B.D. Ripley. 2003. Modern Applied Statistics with S, Spinger-Verlag.

All the material is also covered in powerpoint slides and example R scripts, AD Model Builder programs, and WinBUGS files, which are posted on the class web-site.

Evaluation (Graded)
Grading is based on four assignments and a major project. There are no exams.

GRADING:
Assignments [60%]

Research Project: [40%]

CLASS SCHEDULE

Week	Topic	Assignments
Week 1	Introduction to R Numerical integration methods*	N/A
Week 2	Generalized linear models Nonlinear minimization methods*	Assignment #1 due
Week 3	Linear and nonlinear mixed models Numerical differentiation methods*	N/A
Week 4	AD Model Builder programming Finding roots numerically*	N/A
Week 5	Non-linear minimization in R ADMB and R	N/A
Week 6	ADMB and MCMC Random number generation and R Introduction to ADMB-RE*	Assignment #2 due
Week 7	Simulation and R Differentiation and integration in R Interpolation methods*	N/A
Week 8	WinBUGS Model selection methods *	Assignment #3 due
Week 9	WinBUGS	N/A
Week 10	Student presentations of projects	Assignment #4 due
Finals week	N/A	Project write up due