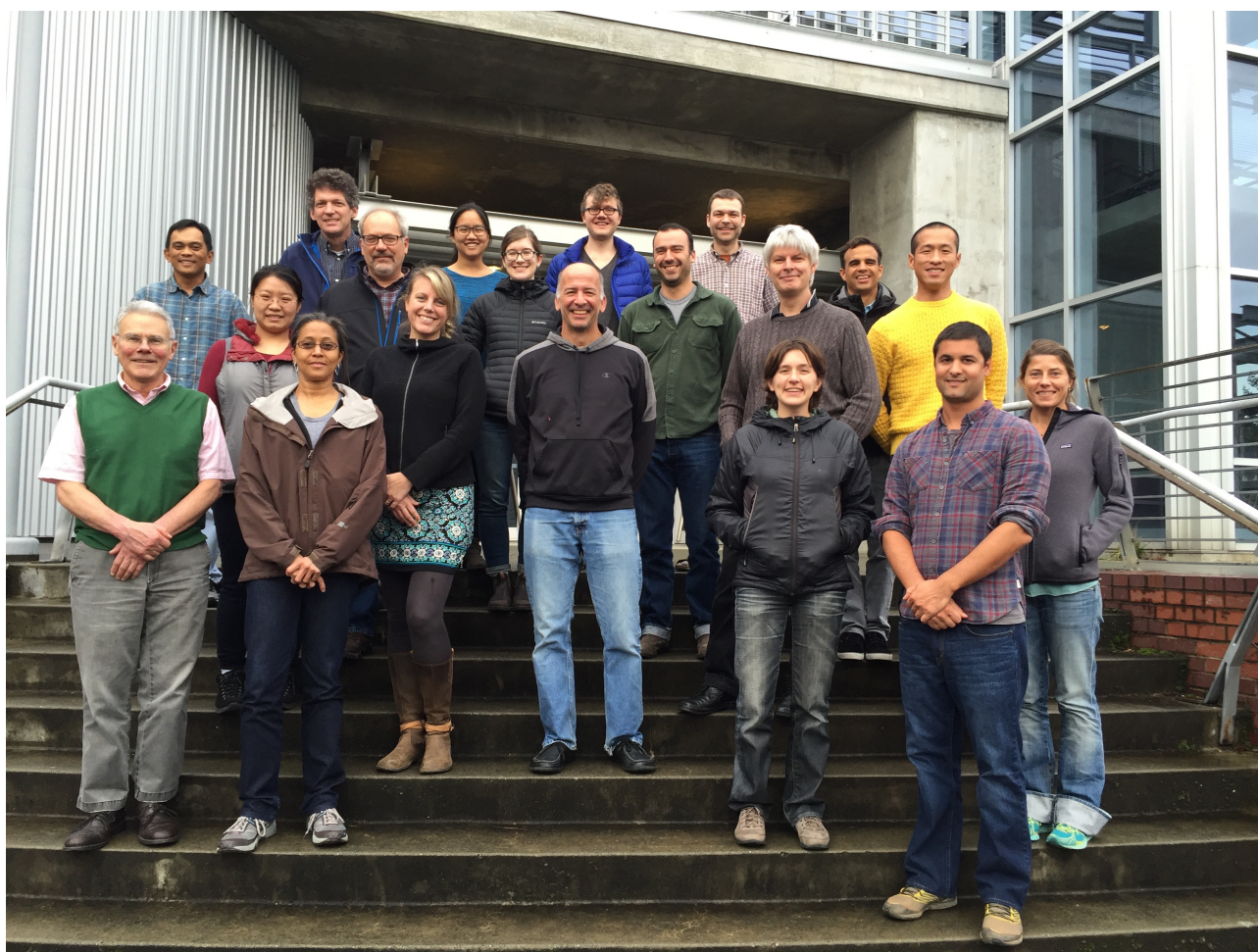# Report from the Introductory
TMB (and ADMB Comparison) Workshop

University of Washington, Seattle

8-12 February 2016

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Organizer: Jim Ianelli

Introduction

The main objectives of this workshop were to:

- Teach the basics of TMB to new users
- Demonstrate more advanced spatio-temporal modelling techniques in TMB to people with a background in TMB and/or random-effects modelling
- Make contributions to the TMB project
- Reach out to the Seattle community of statistical modellers

Participants came from several branches of NOAA, the University of Washington, and elsewhere. All work was organized and archived on GitHub:

 https://github.com/TMB-ADMB-Workshops/Feb2016

The directories on the GitHub site contain all presentation slides and examples that were created for this workshop.

Summary

Template Model Builder (TMB) advances practices developed in ADMB by improving ways to deal with random effects and a wider range of contributed libraries. The goal of this introductory workshop was to help familiarize participants with approaches to model development in TMB. Contrasts with ADMB were be covered, though participants were not required to be proficient in ADMB. Participants were assumed to have a background in applied statistics and statistical computing. Specifically, some experience fitting nonlinear models to data (in stock assessment or elsewhere) and basic programming skills. Participation was open to NOAA staff, UW students, and other interested scientists.

Activities

- Overview of different ways to install and update TMB, incl. GitHub repository access
- Overview of TMB workflow and alternative working environments
- Demonstrations and exercises, starting with simple models and gradually adding complexity
- Statistical techniques to evaluate uncertainty and the use of random effects, as well as debugging
- User-specific applications
- Identify areas where enhancements to TMB documentation and training are needed

Format

The general structure of the workshop was that mornings consisted of lectures and demonstrations (how to build TMB models), while afternoons were used for explorations of different software components (how to contribute to TMB development). Throughout the workshop, participants got an overview of the existing TMB documentation and identified where enhancements were needed.

The afternoons did not follow a rigid structure, so participants could focus on a particular software component in their area of expertise and interest. In particular, from Wednesday afternoon participants started to implement models of interest for their own research.

Schedule

Day	AM/PM	Activity
Mon	am	Intro to TMB, building simple models
Mon	pm	Closer look at installation, GitHub, RStudio/Emacs/other
Tue	am	Working with parameters, nonlinear models
Tue	pm	Anatomy of the TMB package, objects, and overall design, group projects (breakouts?)
Tue (Fat)	ppm	Mardi gras celebration...
Wed	am	Group project updates, stock assessment models, debugging, uncertainty estimates, MCMC developments
Wed	pm	Debugging in TMB, contributing to the development, working on projects from groups
Thu	am	Group project updates, random effects, geostatistical methods
Thu	pm	Related C++ libraries and R packages, CppAD, glmmTMB
Fri	am	Group project updates, geostatistical and spatio-temporal models continued
Fri	pm	Wrap-up, general discussion

Presentations

Slides from several presentations were made available on the workshop GitHub repository:

- software.pdf - overview of TMB, installation, and components (day 1)
- data.pdf - importing data into TMB, exporting results from TMB (day 1)
- par.pdf - declaring parameters, passing initial values (day 1)
- nonlinear.pdf - creating simple nonlinear models (day 2)
- Intro_to_random_effects.pptx - likelihood, AD, random effects (day 3)
- MCMC_in_TMB.pptx - Hamiltonian Monte Carlo, No-U-Turn Sampler (day 3)

The presentations on spatio-temporal models and other topics used examples (listed below) and the whiteboard to demonstrate statistical computing techniques.

On Friday, Laura Dwyer-Lindgren from the UW Institute for Health Metrics and Evaluation presented her ongoing research project, implementing a spatio-temporal model in TMB to model sources of mortalities in the United States. One of the collaborators in this research project is Brad Bell, the creator of CppAD that is a core software component of TMB.

Examples

A considerable number of TMB example models were uploaded to the workshop GitHub repository. Some models existed before the workshop, while others were developed and experimented with during the workshop:

- andre - Schafer, sex-specific von Bertalanffy
- bevholt - Beverton-Holt
- catage - statistical catch-at-age
- linreg-debug - experiment with debugging
- linreg-triple - experiment with function from another c++ file
- linreg - linear regression
- mcmc - demonstrate Hamiltonian Monte Carlo and No-U-Turn Sampler
- mini - a minimal example, both in ADMB and TMB
- poll - statistical catch-at-age
- ricker - Ricker
- rrm - run reconstruction model
- sam - states-space assessment model
- scalar - basic single-parameter model
- schaefer - Schaefer
- srw - simple random walk
- state space schaefer models - experiment with Schaefer and random effects
- vonbert - von Bertalanffy
- wt - weight-at-age prediction with random effects

Breakout Topics

During the breakout sessions, subgroups investigated several topics of interest, related to TMB and statistical computing. The topics included:

- Calling C++ function from external file. A simple C++ function triple() that calculates f(x)=3x was created in a source file triple.cpp, with a corresponding header file triple.h. A subgroup then experimented with calling this function from the main model source file. See example 'linreg-triple'.

- Schaefer model with random effects. A subgroup experimented with alternative ways to apply random effects to a Schafer model. One approach is to let one parameter (such as r) vary in time. Another approach is to let the change in population size be subject to an annual random effect. Other approaches were also discussed. See example 'state space schaefer models'.

- Installation and basic usage. As the workshop week progressed, the focus topics become gradually more advanced. A subgroup of new users had a breakout session to review the installation and basic modelling procedures in TMB, also to help participants that had not been able to make it to the first two days.

- Overview of existing documentation. Workshop participants found existing documentation in many different places, so one subgroup made an effort to get an overview of TMB help resources. The findings were compiled and uploaded to the workshop GitHub repository, in a document called vignette.md. One of the findings was that the TMB Wiki page (https://github.com/kaskr/adcomp/wiki) provides a compact overview and links to existing help resources.

- Debugging tools. A subgroup experimented with tools to debug TMB models, and the possibility to write an R helper function to streamline the debugging procedure. See example 'linreg-debug'.

Besides the above breakout topics, several subgroups shared expertise and ideas in discussions and on the whiteboard.

Contributions to the TMB project

Direct contributions to the TMB project were in the form of 'code snippets' that were uploaded to the main TMB Github repository along with documentation. The edit history of the 'code snippets' area of the TMB project shows considerable editing activity during the workshop week.

Participants

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Remote access participants:

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NWFSC / Newport lab
SWFSC (Huihua, 5-10 people)

Discussion

Overall, the workshop was very successful. All participants increased their abilities to use TMB to develop and run a variety of statistical models.

An increasing number of researchers (UW and NOAA in Seattle, as well as others) are now using TMB for their research projects. University lectures and exercises are being prepared at UW using TMB as a platform. The sessions on advanced spatio-temporal modelling techniques were of great interest to seasoned modellers in the group, both within and outside fisheries applications.

Since TMB was first introduced at the 5th ADMB developers workshop in Reykjavik 2013, there has been an increasing demand for a TMB workshop to be held in Seattle. The workshop was well received, and besides being educational, it was also a milestone to align the infrastructure and development efforts of the ADMB and TMB projects.