Workshop: Biomath Computer Labs with WeBWorK

B.E.E.R - 2015

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Introduction

Introduction

- **Calculus for Biology**
  - Modeling and dynamical systems approach
  - **Computer Labs** - Use biological data - mostly solved with Excel
  - Biology students appreciate the value of math in their subject
  - **WeBWorK** - Improved HW and students more precise
- Graduate Mathematical Modeling
  - Use same/similar labs - Fewer attempts and less instruction
  - Problems often worked in **MatLab**
  - Prepares background concepts - fewer wrong steps
- **WeBWorK**
  - Easy to use - Students like immediate feedback
  - Great for class management, especially large classes

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Workshop - Exercise 1

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- Explore - Choose 1 or 2 problems **HW warmup**
- Find solutions and enter in **WeBWorK**
- Experience student joy of GREEN ANSWERS
- **Instructor**
  - Show management features - Detail to interested parties
  - Easy to prepare assignments
  - Easily modify to personal taste or create new problems
- **WeBWorK** - Available through **MAA**
  - OPL - Probably 50,000 problems
  - Constant improvements - Math Objects
  - Easy to install on Linux server - Need IT for security issues

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Typical Lab Presentation

Typical Lab Session

- Organize students - Random pairings
- Discuss material from previous lab
  - Relate important ideas students should understand
  - Discuss modeling and writing problems observed
- Brief over view of Lab problems (2 - 3)
  - Present key biological ideas (theory) in problems
  - Indicate key mathematical concepts required
- Main presentation
  - Show details of Excel or Maple for managing a similar problem
  - Discuss what is expected in the students' reports
  - Point to important concepts for study
  - Wander lab and answer individual problems

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Lab Problem – Beetle Population

Computer Lab Problem: Beetle Population Growth

- You are given data (slightly randomized) from study of grain beetles growing with limited resources
- Examine a series of models of the form

$$P_{n+1} = F(P_n)$$

- Use tools in Excel to fit **updating functions** from logistic, Beverton-Holt, and Ricker's models
- Study dynamical systems properties of the models – equilibria and stability
- Study properties of functions – extrema, asymptotes
- Examine time series of different models

An Excel Spreadsheet is available for **downloading**

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Discussion of Beetle Problem

Discussion of Beetle Problem

- What are the mathematical and biological questions?
- What problems do students encounter?
- What are expectations from the students?
- What are the **Student Learning Outcomes** from the Beetle Problem?

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Exploration Activity

Exploration Activity

- **Optimal Foraging**. A study of seagulls dropping clams is examined for optimal foraging strategies. (**ABiocLab9 Problem 3**)
- **Allegheny Forest**. Model volume of trees as a function of diameter or height. Compare linear and allometric models. (**ABiocLab3 Problem 3**)
- **Fourier Fit to Population**. Data on lynx or hares gathered by the Hudson Bay company are fit with a series of trigonometric functions, providing increasing accuracy with additional functions. (**ABioc2Lab7 Problem 3**)
- **SIR Model for Influenza**. A discrete dynamical system with susceptible and infected individuals is compared to CDC data for the spread of influenza. The model is used to examine different strategies to lessen the effect of the disease. (**ABioc2LabExtra Problem 2**)

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Discussion and Conclusions

- Several (10-15) senior biology students have described the Calculus for Biology as their "best course at SDSU"
- Numerous biology faculty have said they wish their Calculus had been taught this way
- WeBWorK is invaluable for individualized problems and immediate feedback
- Current Labs are adaptable to a range of classes

Future

- Adapt for Mainstream Calculus - Use **MatLab** and **Maple**
- Expand repertory of WeBWorK examples – Manage higher level courses
- Extend ideas to high schools - Student design of problems
- Build a strong community sharing ideas and problems

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