Pre-Service Math Teachers Are Math Majors: Mathematical Modeling Education For Everyone

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Mathematical Modeling with Preservice (and In-Service) Teachers

Math Modeling in the Common Core

❑ Modeling links classroom mathematics and statistics to everyday life, work, and decision-making.

❑ Modeling is the process of choosing and using appropriate mathematics and statistics to analyze empirical situations, to understand them better, and to improve decisions.

❑ Quantities and their relationships in physical, economic, public policy, social, and everyday situations can be modeled using mathematical and statistical methods.

❑ When making mathematical models, technology is valuable for varying assumptions, exploring consequences, and comparing predictions with data.

❑ I am not telling you anything you didn't already know.

Mathematics and the Life Sciences: Initiatives, Programs, Curricula

What if students in your first Calculus class . . .

❑ didn't have their success in the course be dependent on their Algebra skills?

❑ weren't penalized for not taking Calculus in High School?

❑ weren't just repeating what they saw in High School?

❑ were able to make direct connections between what they are learning in your class and their major interests?

Mathematics and the Life Sciences: Initiatives, Programs, Curricula

First Course – Modeling Calculus

What is a derivative?

What is a differential equation?

What is an integral?

How can we find solutions of differential equations?
◦ Slope Fields / Phase Lines
◦ Euler's Method / Improved Euler's Method / Runge-Kutta (4)

How do we use differential equations to model the real world?

Once we have a differential equations model of the real world, how can we
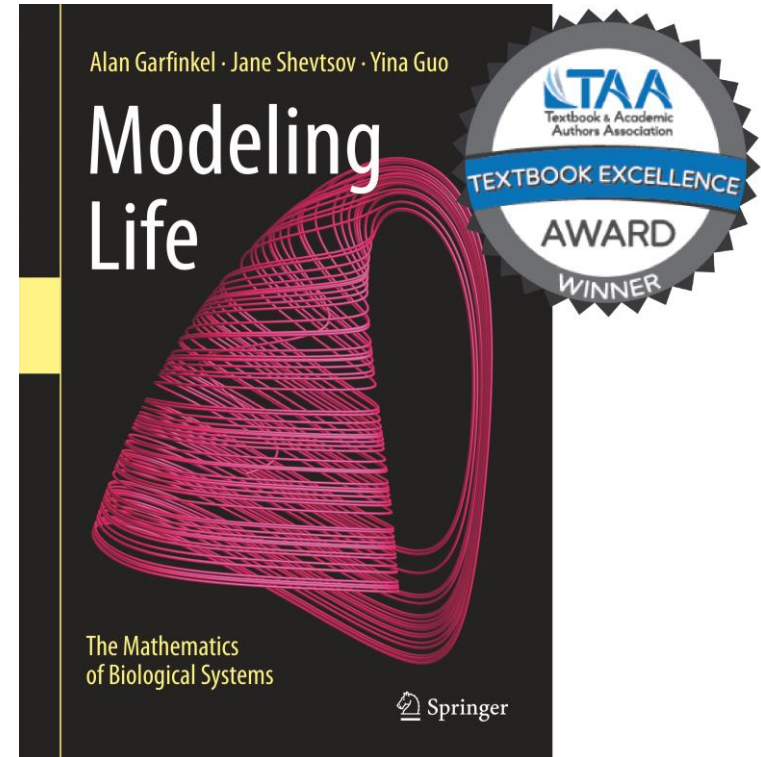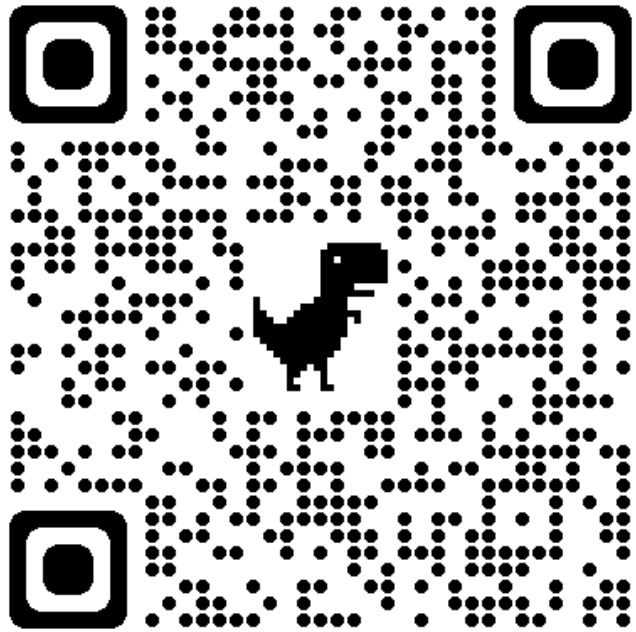◦ Test it?
◦ Improve it?

Problem → Formulate ← Validate → Report
Formulate → Compute → Interpret → Validate
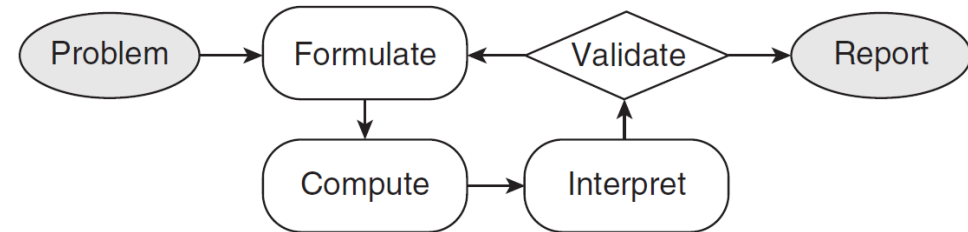
Second Course – Analytic Calculus

All the analytic techniques of calculus you need in 14 weeks.

◦ 1 week pre-calculus

◦ 6 weeks differential calculus

◦ 6 weeks integral calculus

◦ 1 week sequences and series

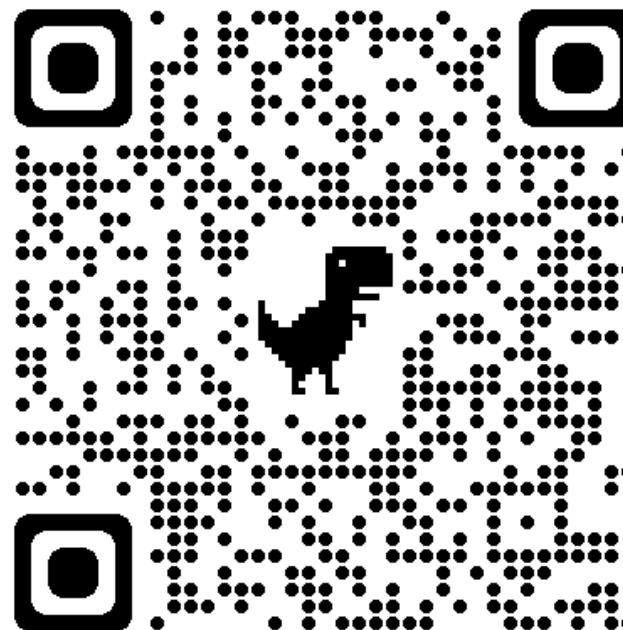Not trying to get students further than we expect from AP Calculus AB curriculum.

Mathematics and the Life Sciences: Initiatives, Programs, Curricula

U.C.L.A. L.S. 30 – Modeling Life

MODULE (S2)

First Course – Modeling Calculus

What is a derivative?

What is a differential equation?
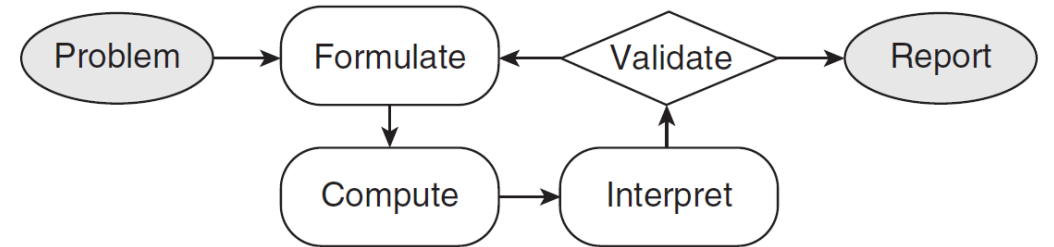
What is an integral?

How can we find solutions of differential equations?
- Slope Fields / Phase Lines
- Euler's Method / Improved Euler's Method / Runge-Kutta (4)

How do we use differential equations to model the real world?

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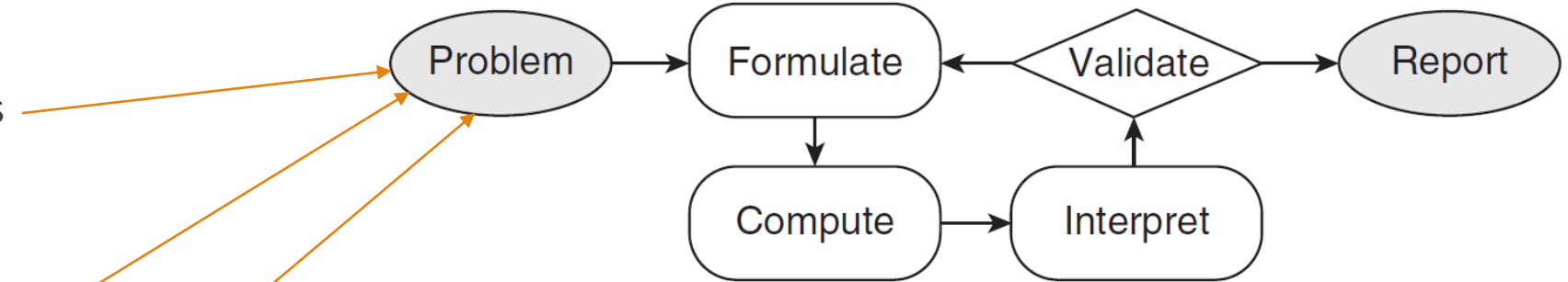
Models and Calculus

First Order ODE
- ◦ Populations
- ◦ Drug Doses
- ◦ Multiple Drug Doses

Second Order ODE
- ◦ Falling Bodies
- ◦ Spring Motion
- ◦ Bungee Jumping

Systems of First Order ODE
- ◦ Multiple Populations
- ◦ Epidemiology
- ◦ Disease transmission with animal vectors

Problem → Formulate → Compute → Interpret → Validate → Report
Validate → Formulate

Mathematics and the Life Sciences: Initiatives, Programs, Curricula

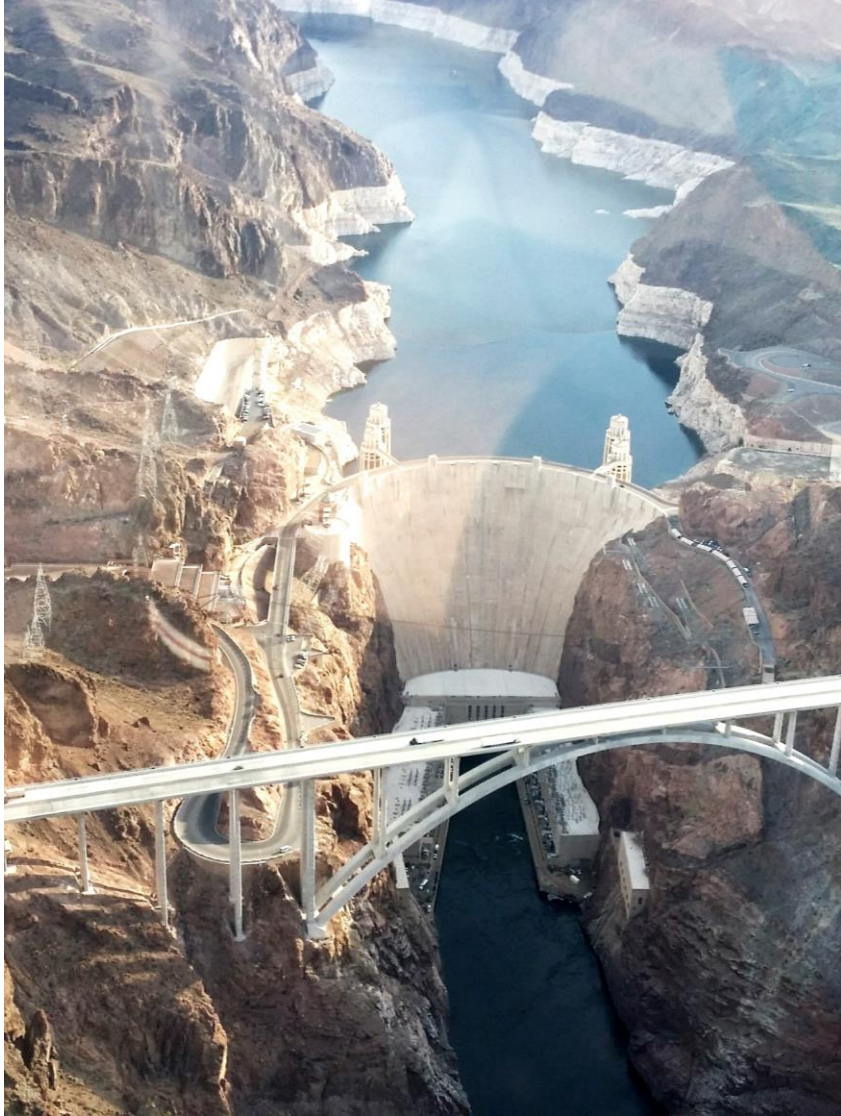# First Projects

Cholera Spread

IV vs. oral drug administration

Multiple compartment model

Kidney failure

Model your own drug

Pollution elimination from lake systems

Second Project

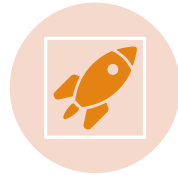Create a ``great ride,'' that is, getting close to the ground without hitting it.

- How heavy is your rider?

- How tall is your rider?

- How far from the ground are you starting?

- Where on the body is the cord attached?

- How accurate do you have to be?

Third Projects

Electrical Circuits

Rocket Motion
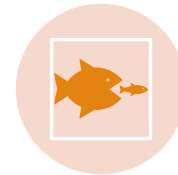
Hot Air Balloons

Pendulums

Chronic Wasting Disease in Deer

BioAccumulation

Pan Water Cycle

Rumor Mill

Final Projects

Find a differential equations model in a journal article from your major/disciplinary interest.

A. Read the article and identify the relevant variables, differential equation(s), constants, and relationships.

B. Replicate the model in VenSim PLE©

C. Interpret your results in the context of the original article

D. Improve the model based on your results.

E. Write a report on your project.

F. Present your project to the class.

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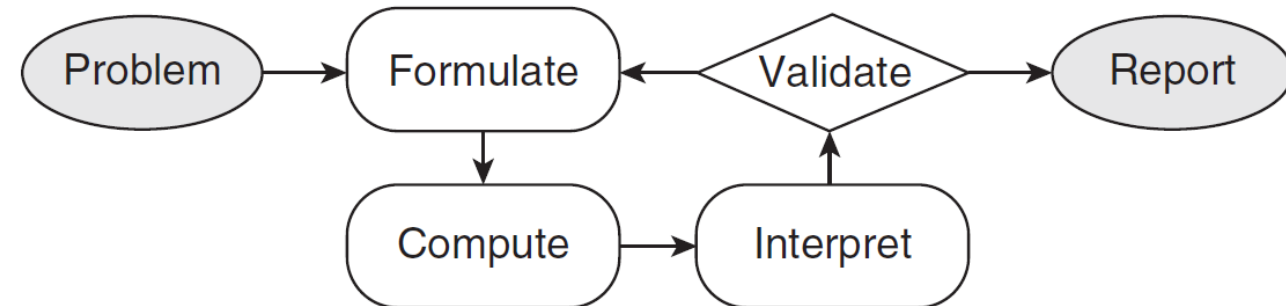
Final Projects 2018-2019

Chemical Kinetics

Rabies Spread in China

Modeling HIV in T-Cells

Pulsed Vaccinations

Cholera Spread

MERS-CoV Epidemic Model

Exploited Marine Fish Populations Incorporating Alternative Prey

Unemployment in Portugal

Observer-Dependent Model for Analyzing Subjective Parameters for Disease Spread

Salmonella Transmission in Dairy Cattle

Virus Dynamics in HIV Infection

Resources

bit.ly/modeling-calculus

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