Integrating Modeling and Computing in Calculus.

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(FUNDED BY THE HHMI GRANT)
BACKGROUND

• COURSE: LB 118 (FIRST SEMESTER CALCULUS I)

• TIME: Fall 2015 (PILOT COURSE)

• TEXTBOOK:
  – CALCULUS FOR THE LIFE SCIENCES: A MODELING APPROACH
  – BY CORNETTE & ACKERMAN, IOWA STATE
  – PUBLISHED BY MAA

• STUDENTS: LBC (PREDEOMINANTLY LIFE SCIENCE MAJORS)

• ENROLLMENT: 52
GOALS

• Develop students'
  – analytical thinking and quantitative skills
  – ability to create and interpret mathematical models

• Relevance of calculus in understanding biological systems

• Increase students' enthusiasm and interest in learning calculus

• Encourage students to take more advanced mathematics courses
DESIRED OUTCOMES

• Proficiency in:
  – Creating
  – Interpreting
  – Applying MATHEMATICAL MODELS

• Improved Attitude towards Mathematics & Statistics

• Experience Working with Computer Software to Solve Calculus Problems
WHAT WE HAVE DONE SO FAR

• Integrated:
  – Models from Biology, Physics, Chemistry
  – Data \(\rightarrow\) Model \(\rightarrow\) Calculus

• Pre & Post Attitude Surveys

• Worksheets to Assess Performance
EXAMPLE: The level of medication in the body

L-Dopa is a widely used medication for controlling the symptoms of Parkinson’s disease. The following data give the amount $L$ of L-Dopa in the blood stream, in nanograms per milliliter, $t$ minutes after the drug is absorbed into the blood.
<table>
<thead>
<tr>
<th>Time in Minutes</th>
<th>Time Index (t)</th>
<th>L(t)</th>
<th>L(t+1)-L(t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>2950</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>2600</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>2</td>
<td>1550</td>
<td></td>
</tr>
<tr>
<td>60</td>
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<td>1100</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>4</td>
<td>900</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>5</td>
<td>725</td>
<td></td>
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<td>120</td>
<td>6</td>
<td>600</td>
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<td>10</td>
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</tr>
<tr>
<td>220</td>
<td>11</td>
<td>225</td>
<td></td>
</tr>
</tbody>
</table>
EXAMPLE

• Give a verbal description of $L(t+1) - L(t)$.

• What kind of mathematical model (s) (functions) will be appropriate to predict the amount of L-Dope in the blood stream at any time $t$? State at least two possible functions.

• To help you answer this question, generate some plots using R. For example, plot
  
  – $L(t)$ versus $t$
  – $L(t+1) - L(t)$ versus $t$
  – $L(t+1) - L(t)$ versus $L(t)$
EXAMPLE

• Derive a mathematical model

• Use your model to predict the level of L-Dopa in the blood 4 hours after the dose is absorbed.

• Predict how long it will take until the level of L-Dopa is down to 100 nanograms per milliliters.

• Does your model give better estimate for low values of t or higher values of t? Comment on the accuracy of your model and possible sources of error.
CALCULUS TOPICS

• Functions

• Limits (at “Infinity”??)

• Rate of Change (Derivative)
REFLECTIONS AND OBSTACLES

• Takes a lot of class time

• Challenge using a software

• Students’ frustration of not “getting the right answer”

• Students’ perception that writing is not required in a math class
FUTURE PLANS

• A similar course will be taught in spring 2016

• We will continue to collect more student data

• Analysis of students’ responses (to be conducted in the summer)

THANK YOU