Teaching ODEs with Insightmaker

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Class Parameters

- ▶ Calculus II (single variable) prerequisite.
- ▶ Mostly a service course for Engineering.
- ▶ Modeling focused, but perhaps not "modeling first". Maybe "modified modeling first".
- ▶ Using versions of SIMIODE scenarios and/or scenarios in SIMIODE textbook, which students are encouraged but not required to buy.

Possible Student Outcomes

Possible student outcomes: A student comes away thinking one of two things

1. A differential equation in a bunch of stuff with an equals sign. Solving one means applying some procedure according to how it looks. At the beginning you do integrals, then quit for some reason.

2. A differential equation is a mathematical model relating changing quantities. Every symbol in a differential equation has a specific contextual meaning. Solving a differential equation means finding values of the changing quantities one way or another. I can do things that I am interested in using differential equations.

System Dynamics/Stock-Flow Modeling

Stock-flow models have the following components:

- **stocks ↔ dependent variables**
- **variables ↔ parameters and other quantities derived from the model**
- **links:** A link is an arrow between a stock, flow, and/or variable that allows the linked object to be used in the formula for the object to which the link points.

Briefly, the key formula to manage a stock-flow model is the following:

$$\text{Time Derivative of a Stock} = \sum \text{Inflows} - \sum \text{Outflows}$$

System Dynamics Software (functional)

Free ones

- ▶ Insightmaker: Easy to use and online (this is the one I will discuss today).
- ▶ StochSD: Free, based on Insightmaker, downloadable locally

Not free

- ▶ Simulink: From Mathworks, works well with Matlab, kind of painful to use in an ODE class.
- ▶ Stella: Free online version available, but limited.

The remainder of this talk will use material posted at

It contains:

▶ An integral to see how *Insightmaker* (at Insightmaker.com) works.

▶ Basic workflow of a modeling problem with Insightmaker (the Hill-Keller sprint model)

▶ Drug dosage with step functions$\rightarrow \delta$-function.