High School Students Using Computer Programming to Explore Physics

Michael Crocker, NSF GK-12 Graduate Fellow, Notre Dame extended Research Community (NDeRC), U. of Notre Dame
Dr. Patrick Malone, NDeRC K-12 Teacher, Trinity School at Greenlawn

1. Goals

Get the Students Hooked

- Developed for and taught to high school Juniors who had no previous programming experience
- Start programming lessons in a way that gets the students excited about programming
- Alice software is a way to introduce programming concepts to students without the usual roadblocks
  - No syntax or compile errors
  - Students create 3D worlds and tell stories

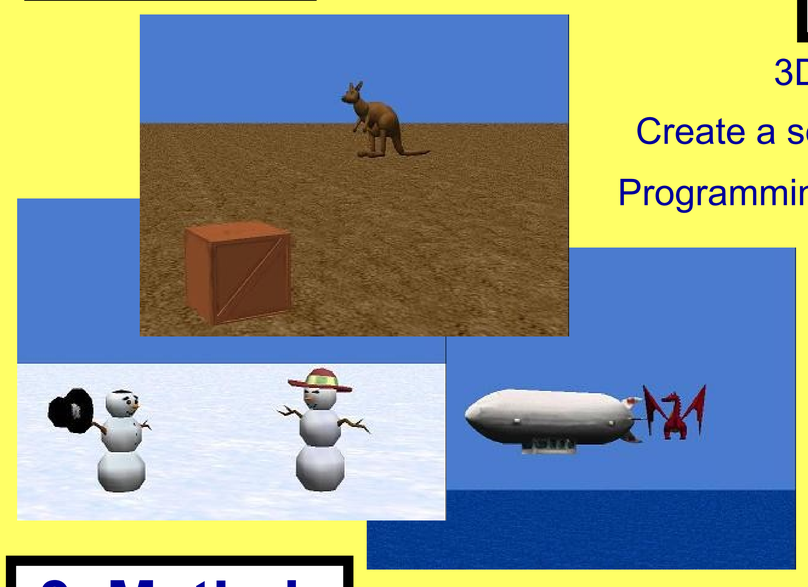
Teach Programming Skills

- Teaching programming concepts should be separate from learning a programming language
- Alice teaches all important programming concepts
  - Variables, functions, parameters
  - Loops, conditionals, operators
  - Objects, attributes, methods
  - Basic data structures and element-wise operations
  - Algorithmic thinking!

Utilize Those Skills in Physics

- Teach the students to create MatLab GUIs
  - Interactive, Visual
  - Adjust parameters to see change
- Use programming skills to create GUI tools to model physical systems
  - Position, Velocity, Acceleration
  - 2D Projectile Motion
  - Forces, Tension

2. Alice



Alice Worlds

3D Objects and Animation

Create a sequence of actions for the objects

Programming Techniques for complex actions

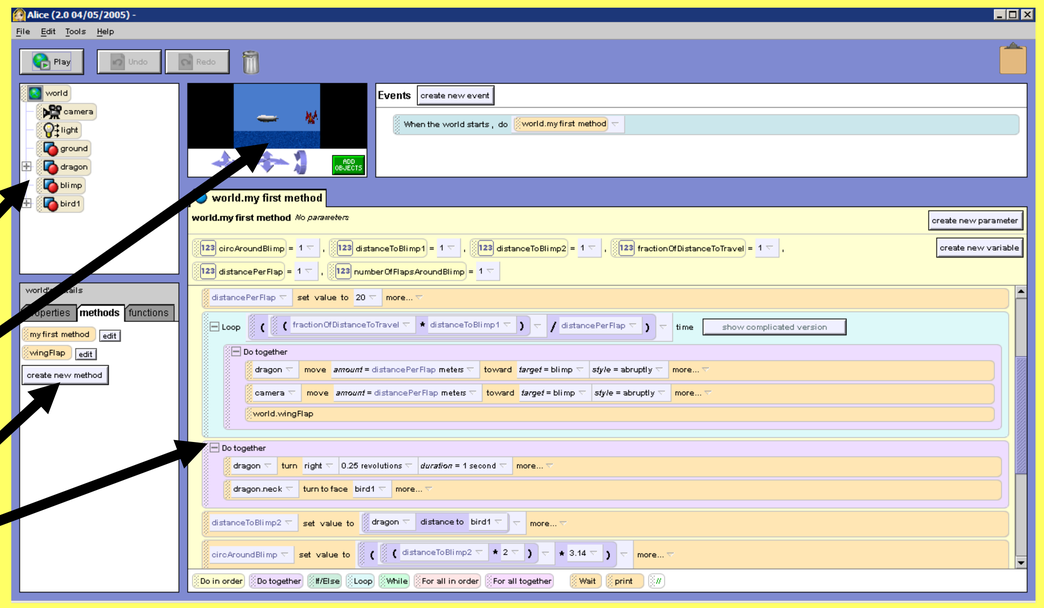
Alice Environment

Object Tree

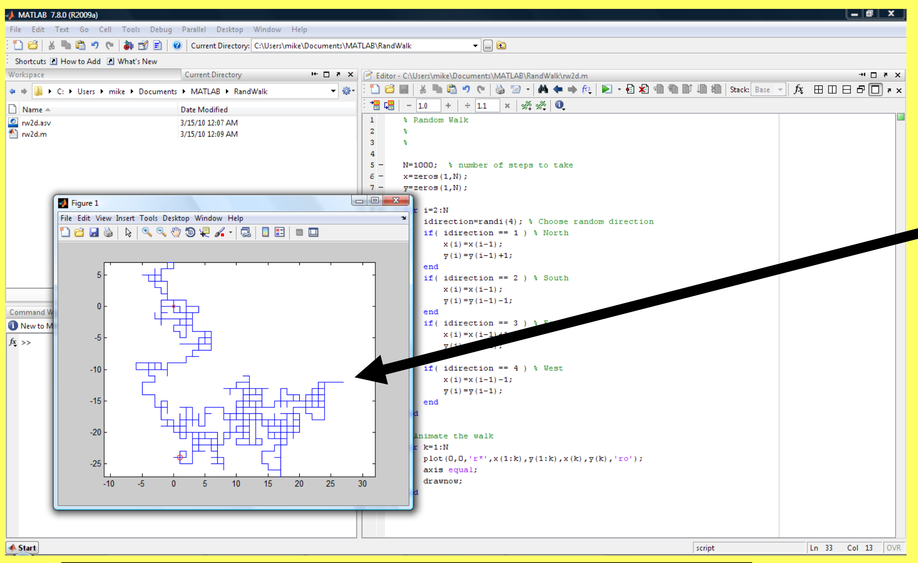
World View

Functions and Methods

“Code” View



3. MatLab



MatLab Programming

Learn MatLab Environment, Language, and Syntax Rules

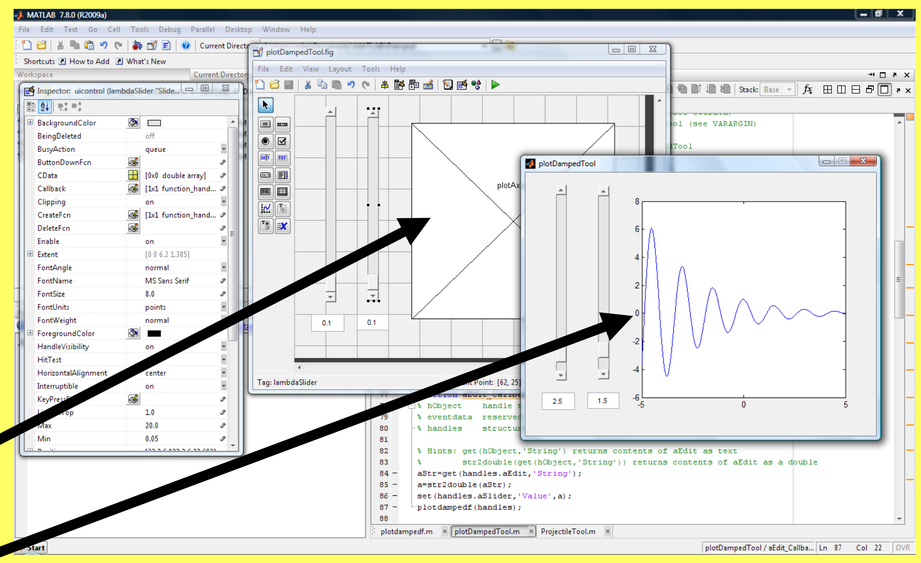
Data Structures, Plots, I/O, etc.

MatLab GUI Tools

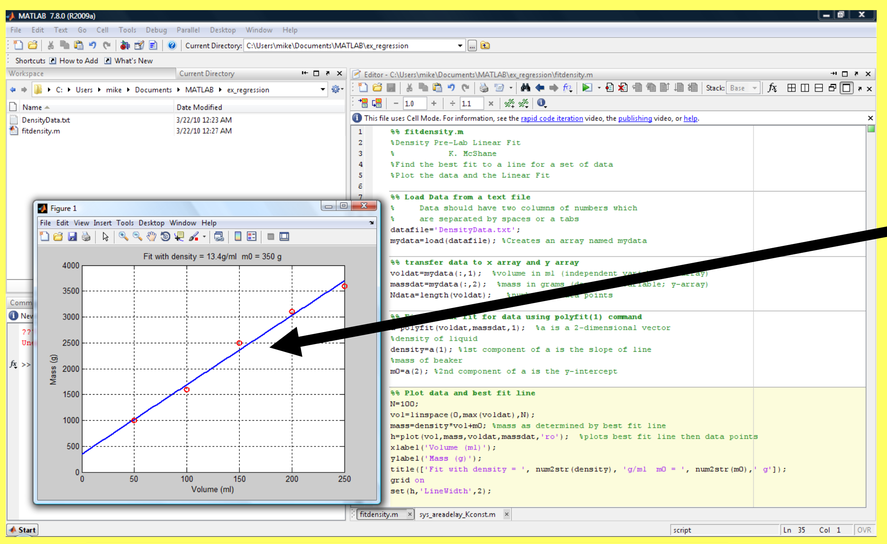
Learn To Create Tools Using Guide

Setup Tools with Editable Parameters

Plots Updated as Parameters are Varied with GUI Interface



4. MatLab for Physics



Experimental Data Analysis

Load Experimental Data in MatLab

Polynomial Best-Fit Regression (Coefficients)

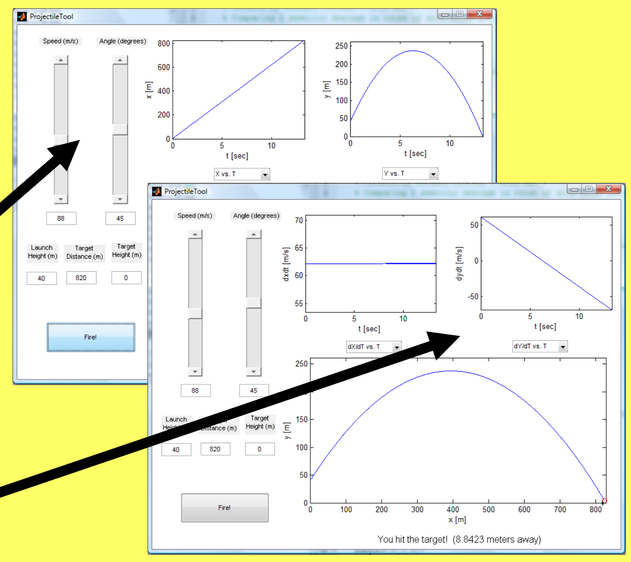
Plot Regression and Datapoints Together

Projectile Motion

Adjust parameters to explore system

Includes: Target Distance, Initial Velocity, Launch Height and Angle

View Position/Velocity in 2 Dimensions



5. Lessons Learned

Student Engagement

- Alice gets students of all interests excited about programming
- Students learn programming as a requirement to create animated stories
- Discover the creative power of programming

Gradual Introduction of New Topics

- Alice – Rich in programming concepts without syntax pitfalls
- MatLab – Full intro. to programming using everyday examples
- Physics – Students are introduced to simple kinematic systems
- MatLab GUIs – Curves are dynamically updated with buttons, etc.
- Simulation – Students integrate programming and science in a tool that models a physical system that can provide deeper insights

Computers as Science Tools

- Students learn science concepts through MatLab tools:
  - Analysis of data *en masse*
  - Data regression
  - “Simulation” of 2-D projectile motion
  - Different ways to view results (plots, tables, etc.)

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