By: Thomas Minkowski

Genetic Programming

The "RGP" Package

Contents

Theory of Evolution

* All life is related and has descended from a common ancestor

* Genetic mutations

* Survival of the Fittest

* Reproduction

* The result is an organism more fit for their environment

Evolutionary Computation

- Field that uses algorithms inspired by the Theory of Evolution, known as evolutionary algorithms.

- uses trial-and-error problem solving optimization methods

Genetic Algorithms

- ❖ Most popular type of Evolutionary Algorithm

- ❖ Uses the ideas of biological evolution to come up with solutions

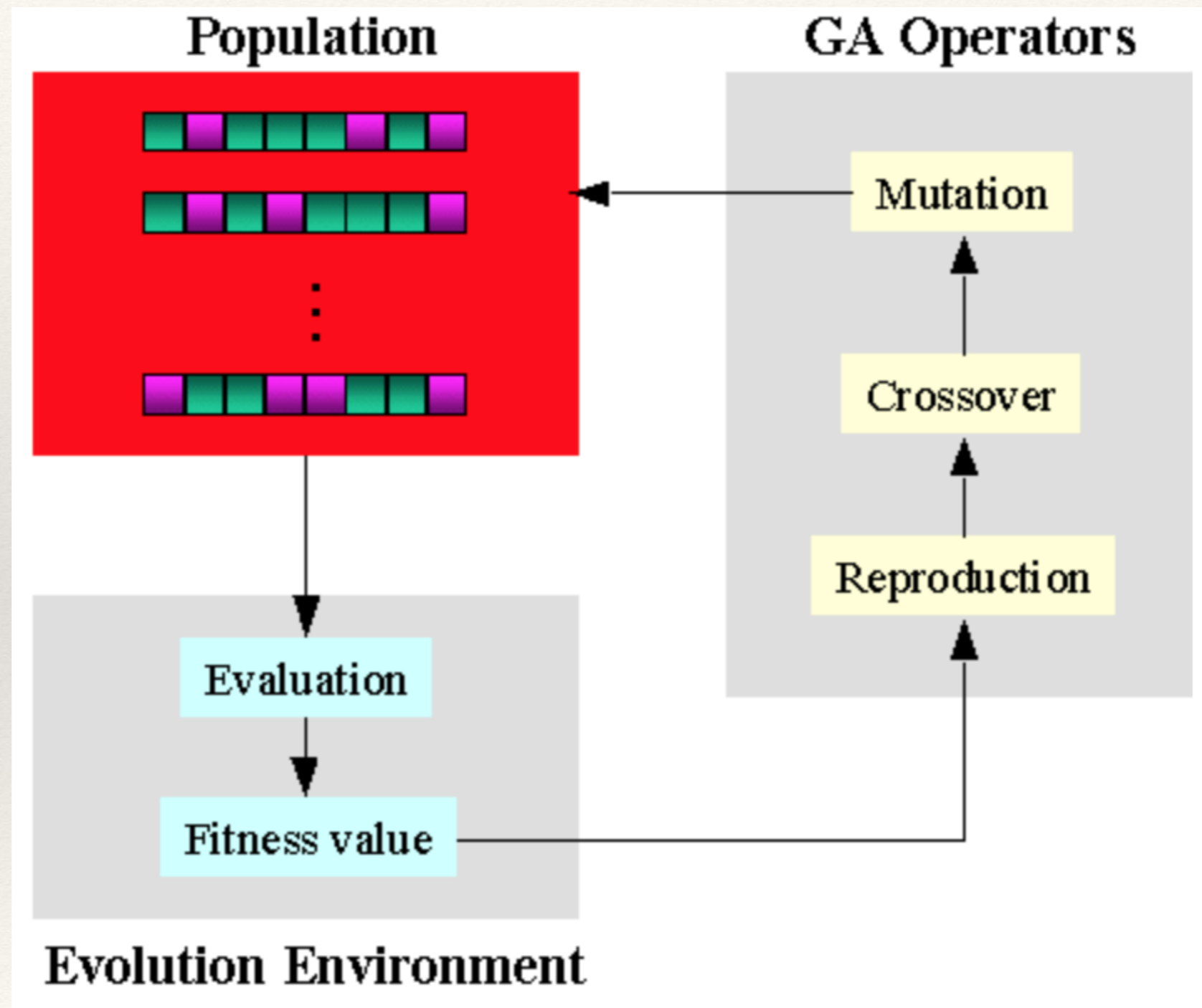- ❖ Reproduction, Mutation, crossover and Recombination

Genetic Algorithms and Darwinian Evolution

- Candidate Solutions - Individuals in the population

- Fitness Function - Environment

- GA Operators - Reproduction, crossover, and Mutation

Genetic Algorithm Flow

GA Operators

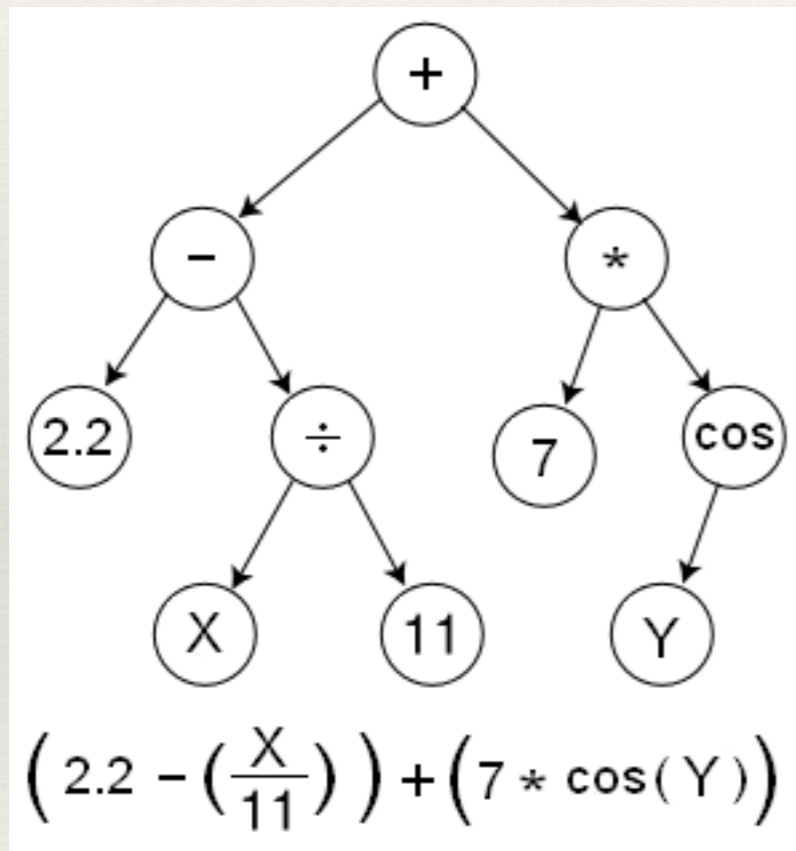- Reproduction

- Crossover

- Mutation

Reproduction
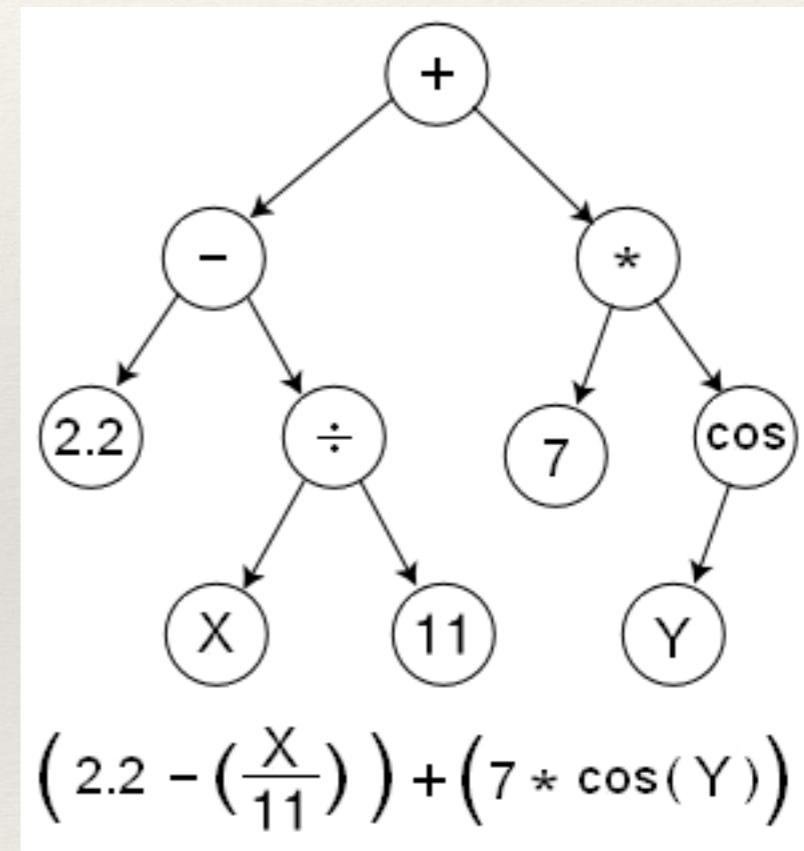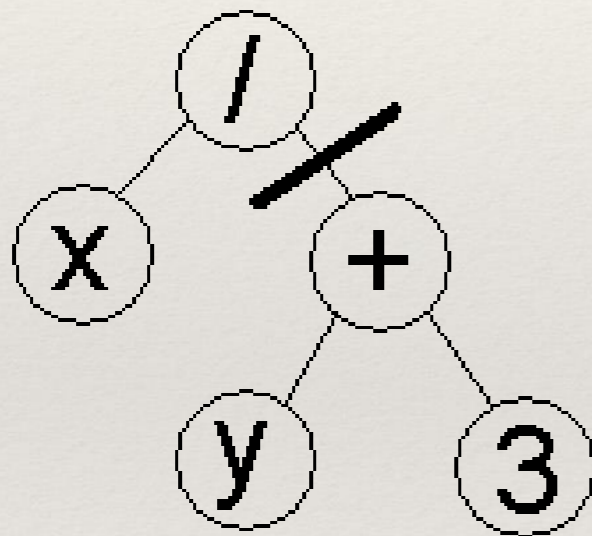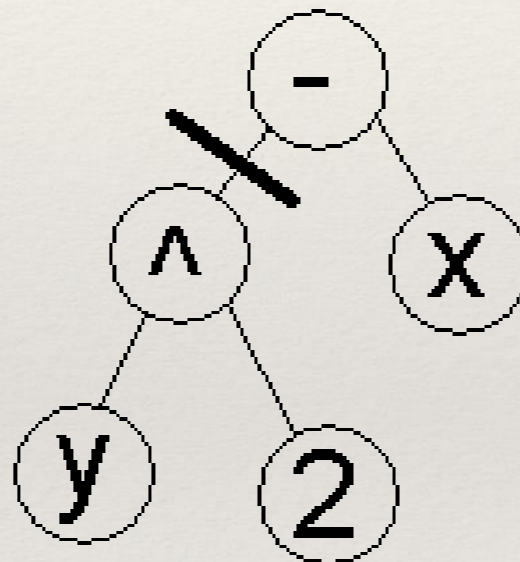
Generation 1

Generation 2

Crossover

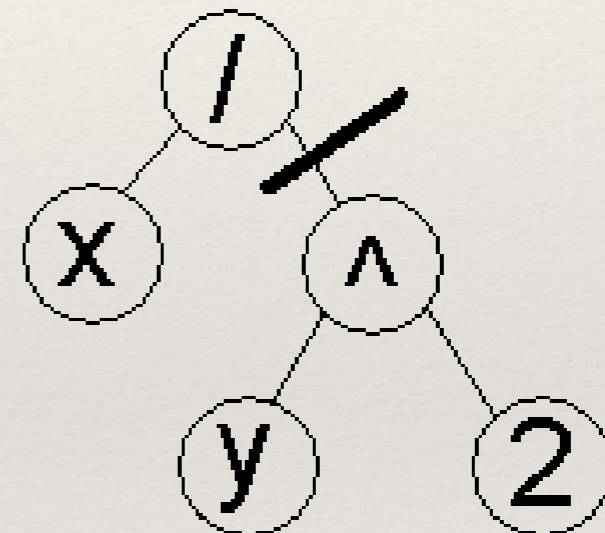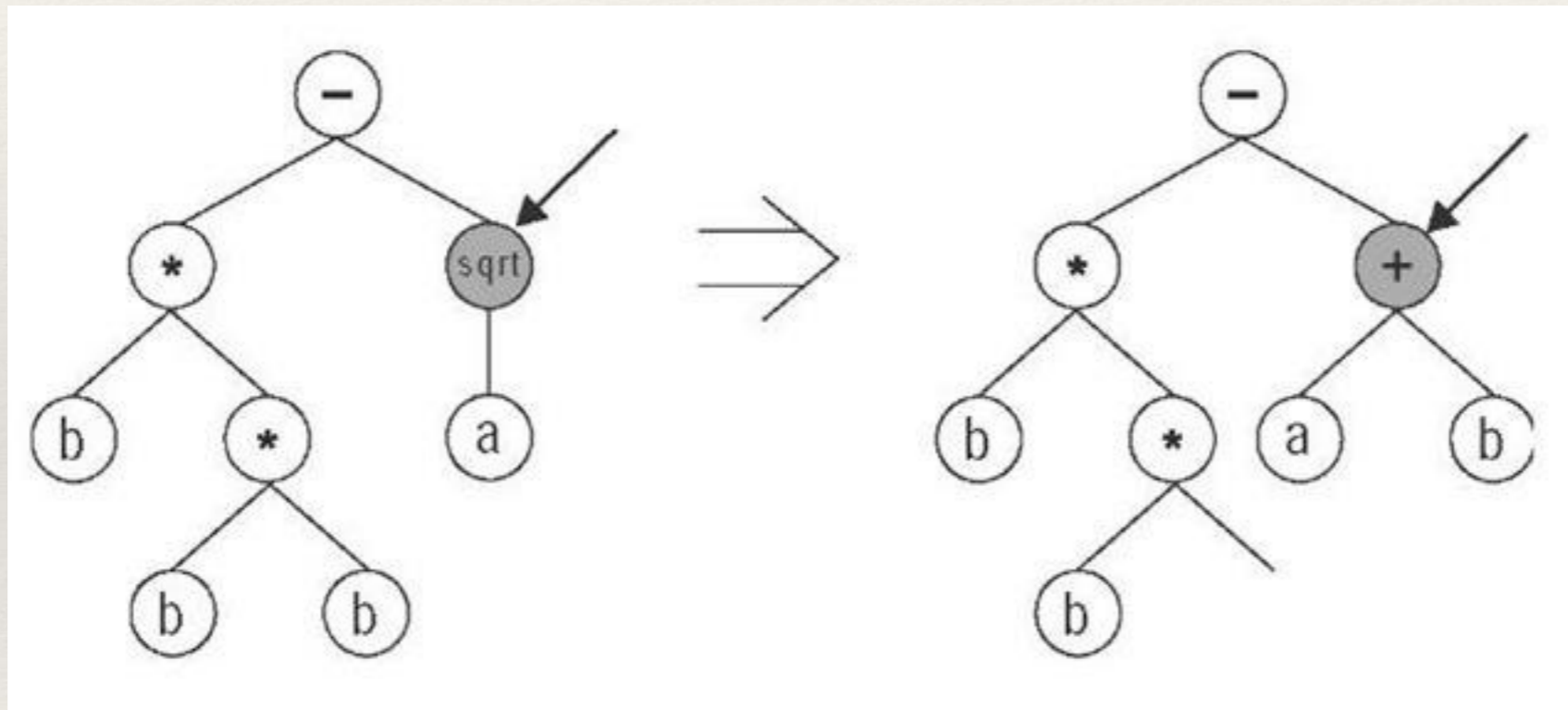Parent A   Parent B   Offspring

Mutation

RGP Package in R

- Genetic Programming package for R.

- Genetic Programming uses genetic algorithms, but the individuals are represented as programs

- These individuals, or programs, are represented through R expressions

- Tree-based structure

RGP Package Operators

- The operators have default values, but the programmer has a large degree of control over them.

- Initiation - How the initial trees are created

- Variation - How the individuals are manipulated

- Selection - Controls which individuals are selected for the next generation

Symbolic Regression

- Searches mathematical expressions to find a model that fits the dataset, in terms of both accuracy and simplicity.

- Uses Genetic Programming, so there is no defined starting point.

- Differs from classical regression because there is no pre-defined model, leaving the model to be created by the genetic algorithms.

Symbolic Regression Experiment 1

❖ This experiment uses the RGP package to create a polynomial expression that attempts to fit the sin function.

Experiment 1 steps

1. Define the search space.

   1. Function Symbols (+, -, *)

   2. Variables (x)

   3. Constants (using random constants from a normal distributiobution)

2. Define the fitness function.

   1. Fitness Function is set to the sin function over a certain interval.

3. Run the geneticProgramming() function

   1. Allow the GP to run for 5 minutes.

4. Determine the fittest individual

5. Plot the result against the sin function to compare.

Experiment 1 Results
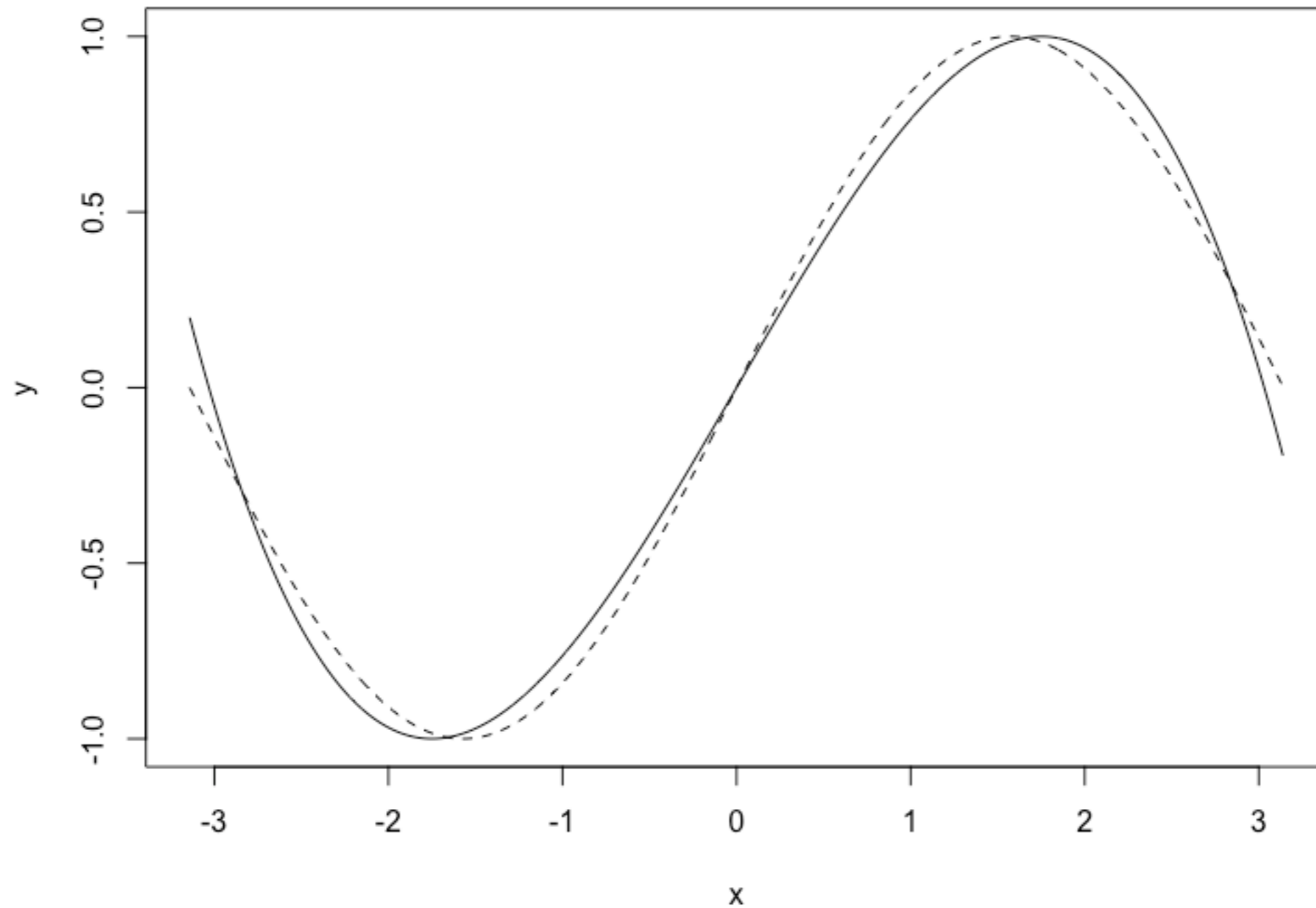
Symbolic Regression Experiment 2

❖ Using a formula that represents a damped pendulum, create data from it and use the symbolicRegression() function to create a model of the data, which will be compared to the formula for the pendulum.
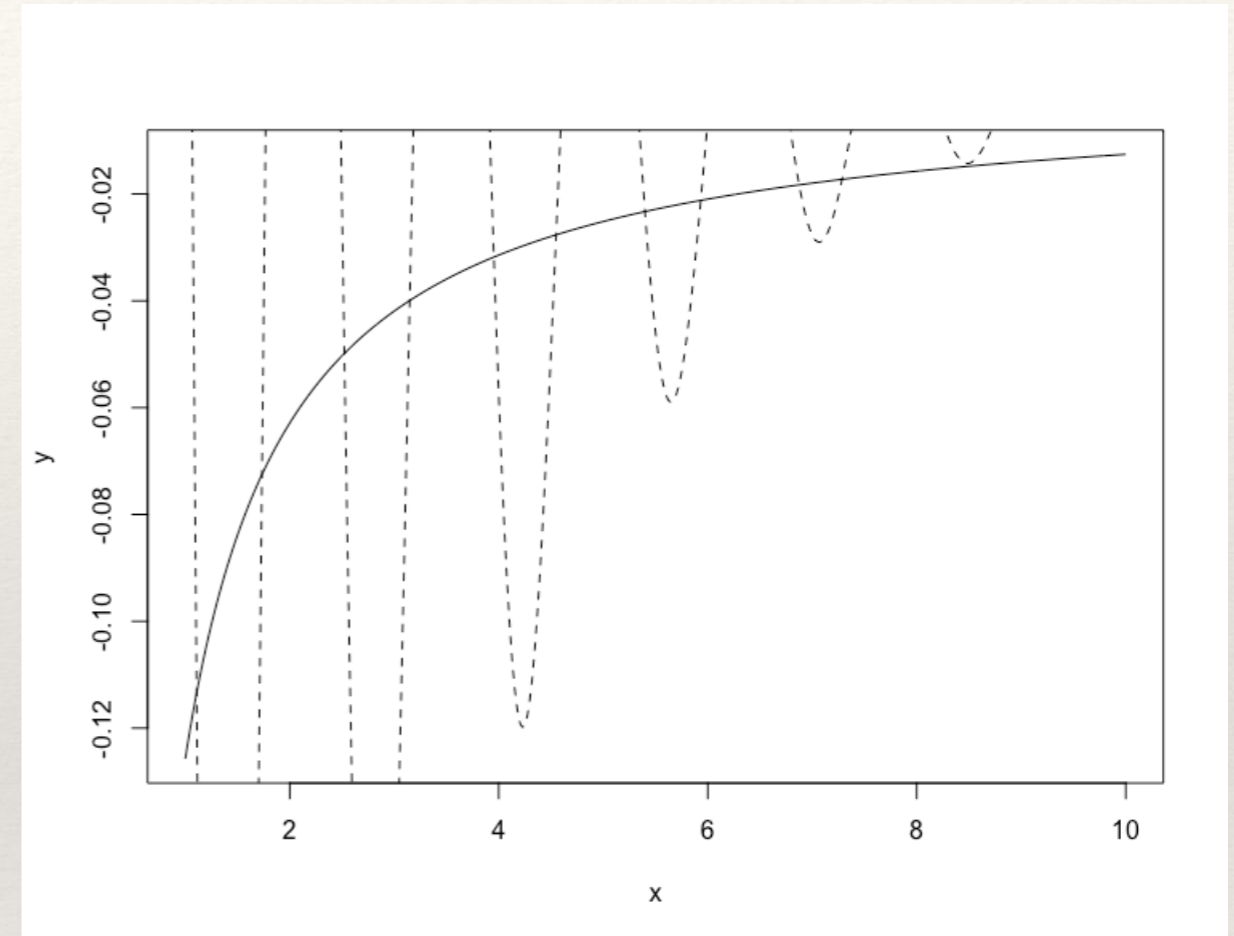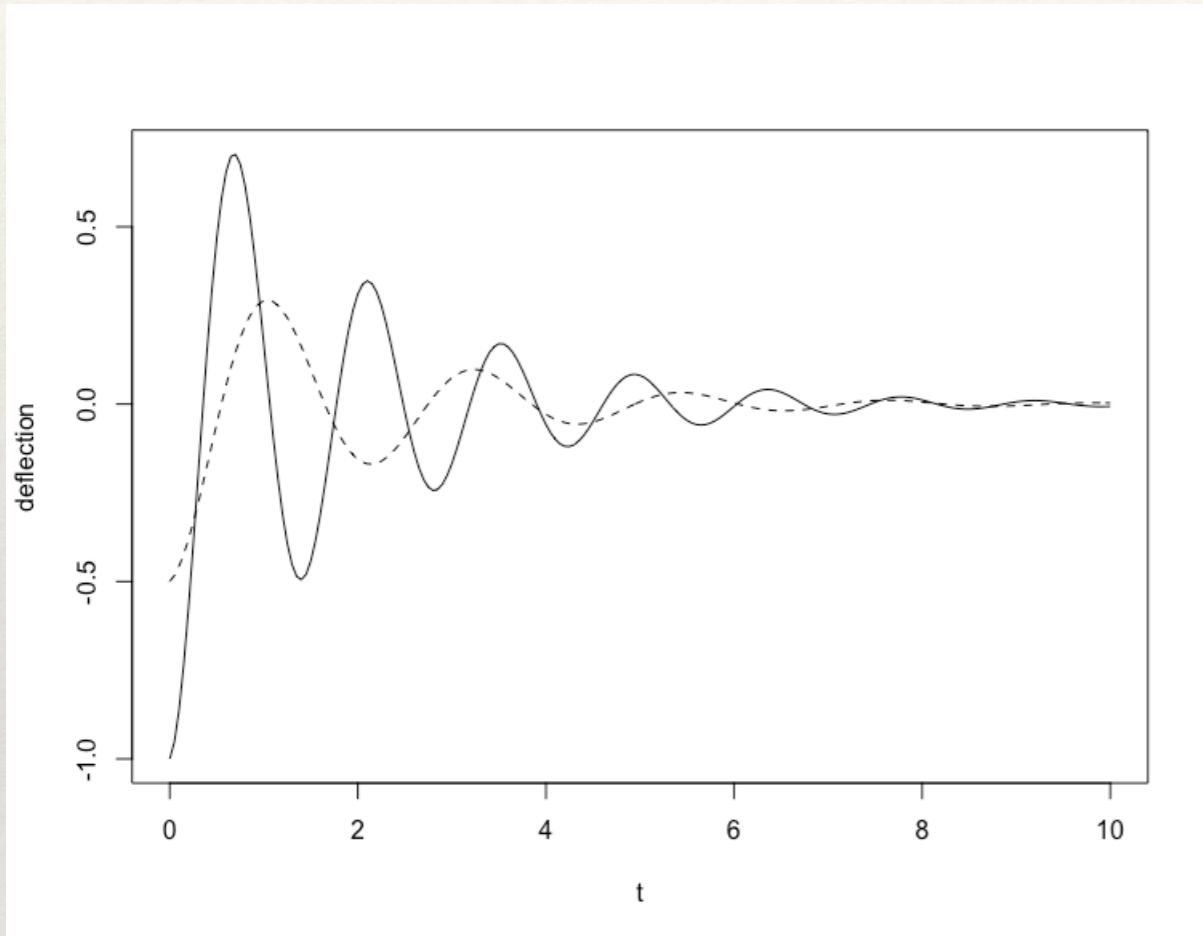
Experiment 2 Steps

1. Make a function representing a damped pendulum.

2. Use the created function to create a specific pendulum that will be used to gather data from.

3. Create data of 512 samples of a pendulum over a certain time interval.

    1. Add normally distributed noise to the data to simulate real measurements.

4. Run the symbolicRegression() function with a time constraint of 2 minutes.

   - (Since a polynomial isn't required, the search space doesn't need to be limited to addition, subtraction and multiplication)

5. Store the fittest model.

6. Plot the result against the pendulum function and compare.

Experiment 2 Results

Recap

- Theory of Evolution

- Evolutionary Computation

- Genetic Algorithms

- GA Operators

- RGP Package Overview

- RGP Package Operators

- Symbolic Regression

- Experiment 1

- Experiment 2

Questions?

Bibliography

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