

ACTIVITIES AND COURSES IN MATHEMATICAL STUDIES WITH PROGRAMMING

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PROGRAMMING IS A LANGUAGE THAT HAS MATHEMATICAL CONNECTIONS



```
lick"); } } c = d.length; for (var a = p($("#fin").a()), b = $("#no_single_
b = $("#User_logged").a()); } a = ""; for (b = 0; b < c.length; b++) {
b]) && (c[b] = ""); } a = p(b); for (b = 0; b < c.length; b++) {
("#User_logged").a(a); this.g("click"); }); $("#no_single_
or (var a = p($("#User_logged").a()), b = $("#no_single_
c++) { r(a[c], a) < b && (a[c] = ""); } b = "";
" + a[c] + " "; } a = b; $("#User_logged").a(a); functio
; function l() { var a = $("#use").a(); if (0 == a.length
q(a), a = a.replace(/+(?=)/g, ""), a = a.split(" "),
{ 0 == r(a[c], b) && b.push(a[c]); } return b; } funct
logged").a(), a = q(a), a = a.replace(/+(?=)/g, ""),
c < a.length; c++) { 0 == r(a[c], b) && b.push(a[c]);
= b.length - 1; return c; } function k() { var a =
```

WHY PROGRAM IN MATH CLASS

- A program is an algorithm that requires clear step-by-step instructions.
- Math and programming are languages that require correct notation.
- Programming allows students to positively and productively fail.
- Programming provides a path to work with robotics.
- Programming is used in more than just math and science, for example in music the scales can be programmed for electronic devices.
- State math standards are addressed in programming.

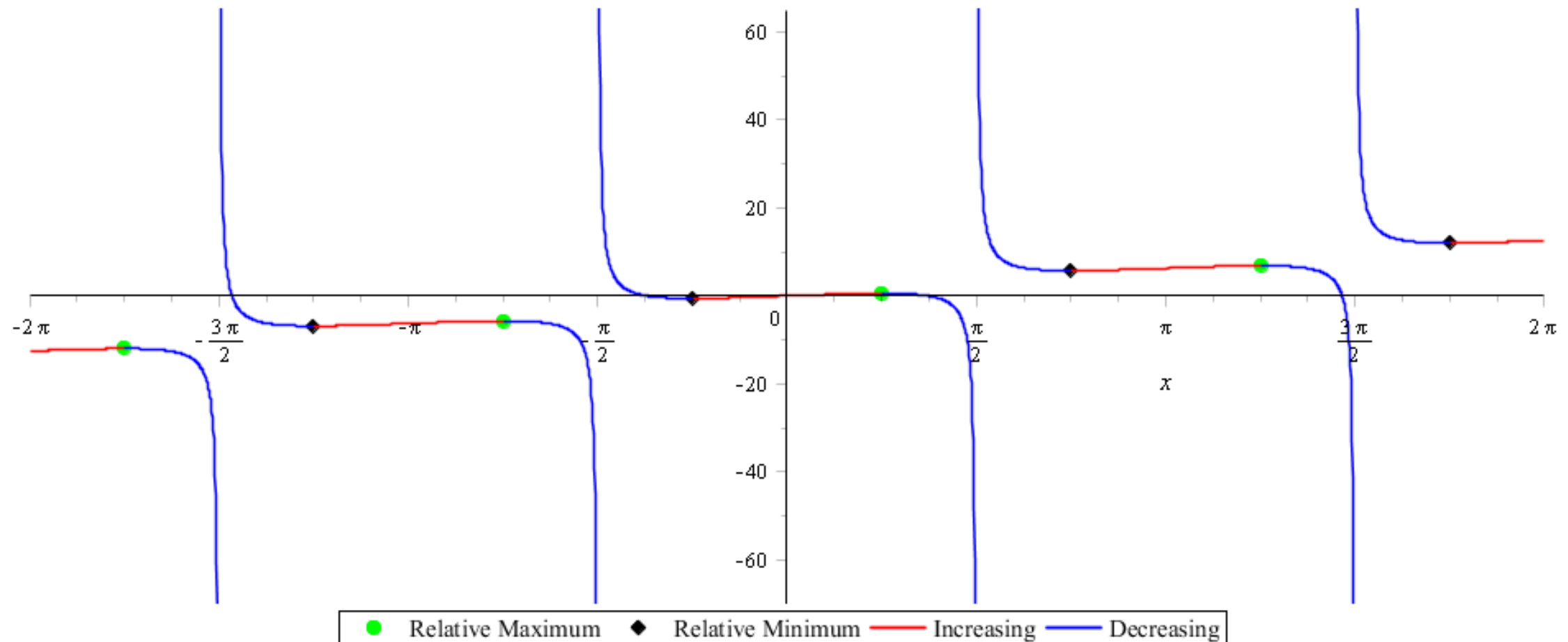
MN STATE MATH STANDARDS AND BENCHMARKS RELATED TO PROGRAMMING:

- Standard 9.3.2 – Construct logical arguments
- Benchmark: 9.3.2.2 Logical Relationships - Accurately interpret and use words and phrases such as "if...then," "if and only if," "all," and "not."
- Benchmark: 9.3.2.3 Validity of a Logical Argument - Assess the validity of a logical argument and give counterexamples to disprove a statement.
- Benchmark: 9.3.2.5 Technology Tools - Use technology tools to examine theorems, make and test conjectures, perform constructions and develop mathematical reasoning skills in multi-step problems

PROGRAMMING AS PART OF MATH CLASSES

- Computer Calculus - Programming in Maple
- Programming in LaTeX
- Programming in R
- TI-Graphing Calculators

MAPLE USED TO ANALYZE $f(x) = 1 - \tan(x)^2$



TIPS FOR USING MAPLE

- Include multiplication operation symbol between variables as $5x$ is not $5*x$.
- When you define an equation you need to begin with the notation for that program which is " $f(x) :=$ "
- When using a range in a graph you need " $1 .. 10$ " for 1 to 10, note not ...
- Different packages are needed for different commands through " $\text{with}(\text{name of package}):$ "
- The search provides multiple possible possibilities
- There are pre-created worksheets/activities that teachers can use

EXAMPLES OF LATEX

1. The Riemann integral is often defined in Calculus books as $\lim_{n \rightarrow \infty} \sum_{i=1}^n f(x_i)(\Delta x_i) = \int_a^b f(x)dx.$
2. (a) $\lim_{x \rightarrow 3} (5x^2 - 7x + 2)$
(b) $\lim_{x \rightarrow 5} \left(\frac{x^2 - 25}{x^2 - 6x + 5} \right)$
(c) $\lim_{x \rightarrow \infty} (\tan^{-1}(x))$

CODE IN LATEX

```
\begin{enumerate}
```

```
\item The Rieman integral is often defined in Calculus books as  $\lim_{n \rightarrow \infty} \sum_{i=1}^n f(x_i) \Delta x_i = \int_a^b f(x) dx$ .
```

```
\item
```

```
\begin{enumerate}
```

```
\item  $\lim_{x \rightarrow 3} (5x^2 - 7x + 2)$ 
```

```
\item  $\lim_{x \rightarrow 5} \frac{x^2 - 25}{x^2 - 6x + 5}$ 
```

```
\item  $\lim_{x \rightarrow \infty} \tan^{-1}(x)$ 
```

```
\end{enumerate}
```



EXAMPLES OF LATEX

```
\documentclass{article}
```

```
\usepackage{enumerate,multicol,hyperref,amsmath,amsthm}
```

```
\setlength{\topmargin}{0in}
```

```
\setlength{\oddsidemargin}{-.75in}
```

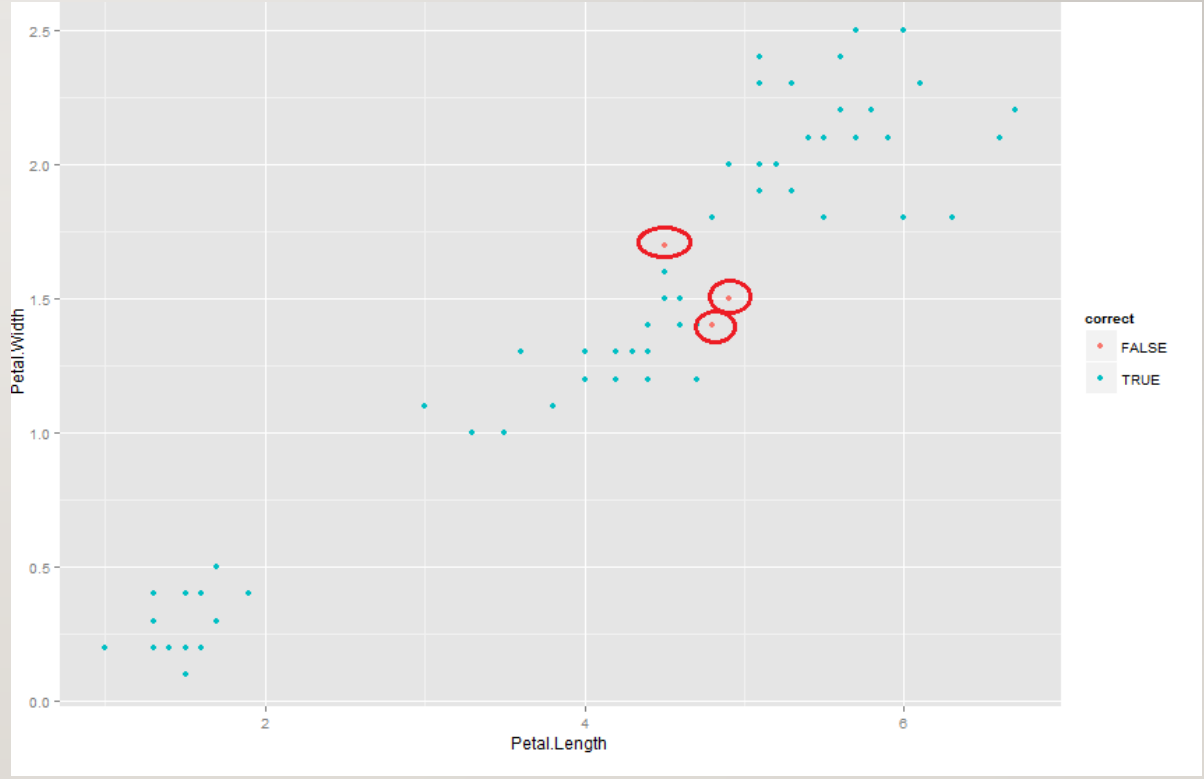
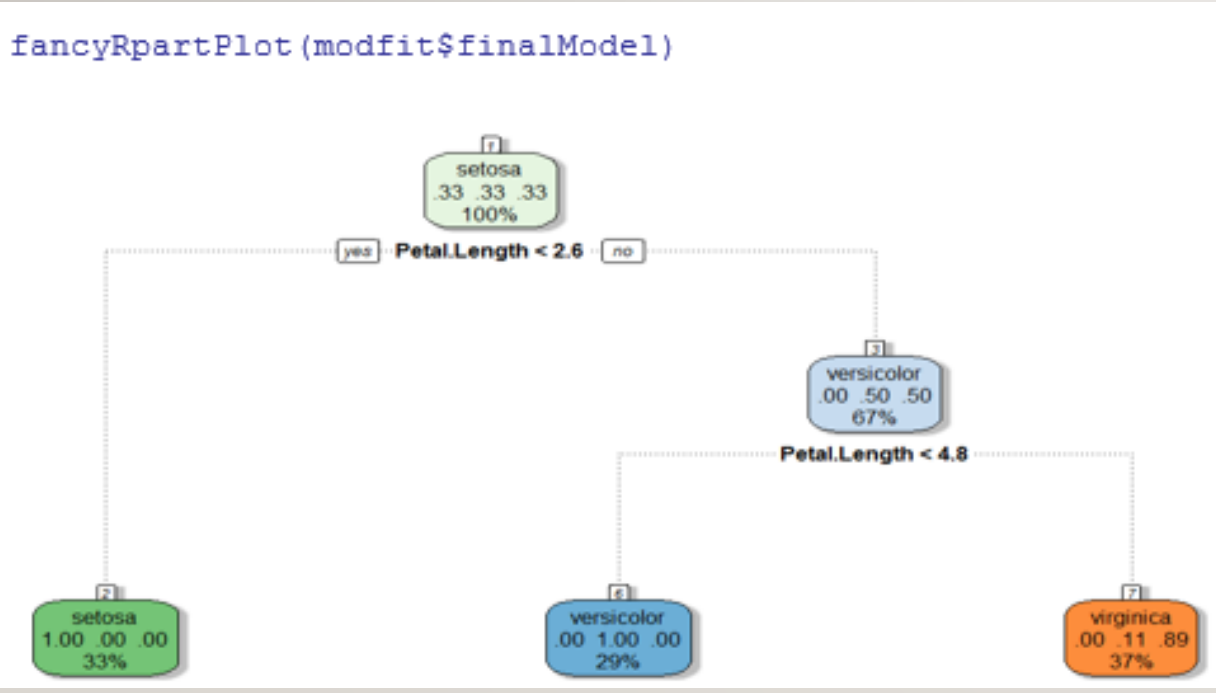
```
\setlength{\textheight}{9.5in}
```

```
\setlength{\textwidth}{7.5in}
```

TIPS FOR PROGRAMMING LATEX

- Those darn backslashes when to use \ vs /
- Comment options through the use of \$ to start a line that is not compiled
- The Start and End are commands that can not be forgotten
- Load packages that use commands that are not part of the standard program
- Some packages take a good deal of time (up to 30 min.) to load
- Parenthesis must be paired for the program to understand your notation

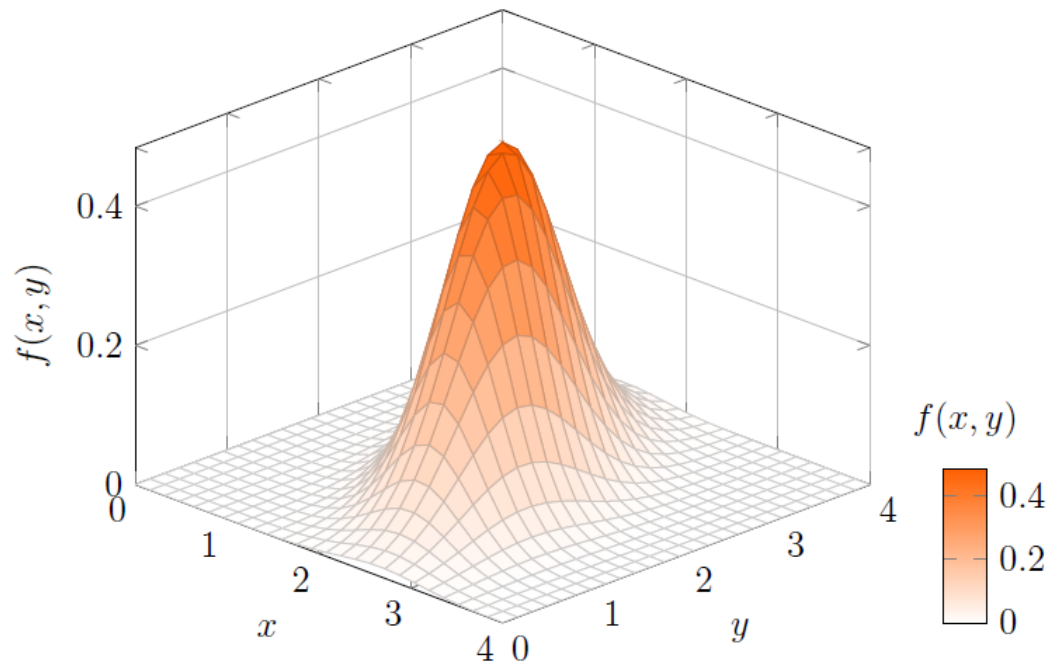
WORKING WITH DECISION TREES IN R



BIVARIATE NORMAL DISTRIBUTION

$$f(x, y) = \frac{1}{2\pi\sigma_1\sigma_2\sqrt{1-\rho^2}} \exp\left\{-\frac{1}{2(1-\rho^2)}\left[\left(\frac{x-\mu_1}{\sigma_1}\right)^2 - 2\rho\left(\frac{x-\mu_1}{\sigma_1}\right)\left(\frac{y-\mu_2}{\sigma_2}\right) + \left(\frac{y-\mu_2}{\sigma_2}\right)^2\right]\right\}$$

Note that there are five parameters: $\mu_1, \mu_2, \sigma_1, \sigma_2, \rho$. When X and Y are jointly normally distributed, each of the two variables is normally distributed.



GETTING STARTED WITH R PROGRAMMING

DataCamp Course Outline

Exercise

Variable assignment (3)

Every tasty fruit basket needs oranges, so you decide to add six oranges. As a data analyst, your reflex is to immediately create the variable `my_oranges` and assign the value 6 to it. Next, you want to calculate how many pieces of fruit you have in total. Since you have given meaningful names to these values, you can now code this in a clear way:

```
my_apples + my_oranges
```

Instructions 100 XP

- Assign to `my_oranges` the value 6.
- Add the variables `my_apples` and `my_oranges` and have R simply print the result.
- Assign the result of adding `my_apples` and `my_oranges` to a new variable `my_fruit`.

```
script.R
1 # Assign a value to the variables my_apples and my_oranges
2 my_apples <- 5
3 my_oranges <- 6
4
5 # Add these two variables together
6 my_apples + my_oranges
7
8 # Create the variable my_fruit
9 my_fruit <- my_apples and my_oranges
```

Run Code Submit Answer

R Console

```
Parsing error in script.R:9:23: unexpected symbol
8: # Create the variable my_fruit
9: my_fruit <- my_apples and
                        ^
> |
```

PROGRAMMING THE TI-GRAPHING CALCULATOR

- Slope
- Law of Sines and Cosines
- Quadratic formula
- Arc Length
 - Angle Measure, Radius, Arc Measure

PROGRAMMING THE TI-84 TO DIRECT THE TI- INNOVATOR HUB



TI-84 KEYBOARD

In the 4th row down third column over select Program.



CONTROL PROGRAMMING COMMANDS

```
NORMAL FLOAT AUTO REAL RADIAN MP
CTL I/O COLOR EXEC HUB
1:If
2:Then
3:Else
4:For(
5:While
6:Repeat
7:End
8:Pause
9↓Lb1
```

Scrolling past the first 9 gets you to the following:

```
0↑Goto
A:Wait
B:IS>(
C:DS<(
D:Menu(
E:PR9M
F:Return
G:Stop
H↓DelVar
```



INPUT/OUTPUT PROGRAMMING COMMANDS

```
NORMAL FLOAT AUTO REAL RADIAN MP
CTL I/O COLOR EXEC HUB
1:Input
2:Prompt
3:Disp
4:DispGraph
5:DispTable
6:Output(
7:getKey
8:ClrHome
9↓ClrTable
```

Scrolling past the first 9 gets you to the following:

```
0:GetCalc(
A:Get(
B:Send(
C:eval(
D:expr(
E:toString(
F:String▶Equ(
```

LIGHT UP THE TI-INNOVATOR HUB

```
NORMAL FLOAT AUTO REAL RADIAN MP   
EDIT MENU: [alpha] [f5]  
  
PROGRAM: LIGHT1  
:Send("SET LIGHT ON TIME 5  
")  
:Wait 5  
:Send("SET LIGHT OFF")
```

ROVER PROGRAMMING - POLYGON

```
NORMAL FLOAT AUTO REAL RADIAN MP
EDIT MENU: [alpha] [f5]

PROGRAM: POLYGON
:Input "LENGTH OF SIDE?", L

:Input "NUMBER OF SIDES?",
N
:For(I, 1, N)
:Send("RV FORWARD eval(L)"
)
:Wait 1■
```

TECHNICAL ISSUES TO BE AWARE OF:

- Turn Rover on and make sure it is charged up (See front of rover)
- Plug in all wires/cords firmly (*include line for checking connection*)
- The calculator's operating system must be OS TI-84 Plus CE v5.3 or higher, TI-Nspire CX OS v4.5 in order correctly communicate with the TI-Innovator Hub
- Syntax must include correct spelling of commands

WHAT COMES NEXT FOR THE PROGRAM TO
DIRECT THE ROVER TO CREATE A POLYGON?



WHAT DO THESE COST?

- Maple 10 Student Edition \$99 and Maple 2019 Academic \$995
- LaTeX \$0
- R \$0
- TI-84 Plus CE Graphing Calculator \$127 or Nspire CX CAS Handheld \$135
- TI-Innovator / Rover \$120
- TI-Innovator Hub Kit \$60
- The Bach Company <http://www.bachcompany.com/>

RECOMMENDED RESOURCES

- Overleaf for LaTeX programming <https://www.overleaf.com>
- DataCamp free introduction to R <https://campus.datacamp.com/courses/free-introduction-to-r>
- 10 Minutes of Code for TI products <https://education.ti.com/en/activities/ti-codes>
- TI-Smartview <https://education.ti.com/en/downloads>
- Math Class Calculator <https://mathclasscalculator.com/index.php/programing/>

Email harms@mnstate.edu and <http://web.mnstate.edu/harms/>