Differentiation Drill

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Overview

This lab uses Maple to help you practice your differentiation skills. Three different user interfaces are introduced.

- The *Derivatives* tutor takes a user-specified function, finds the first and second derivatives, and plots the function and derivatives on a specified domain.

- The *Differentiation Methods* tutor shows the step-by-step application of the differentiation rules involved in finding the derivative of a user-specified function.

- The *DerivativeDrill* maplet allows the user to select types of functions and rules and then generates random problems of this type; the user has to enter the correct derivative. This maplet also provides practice entering mathematical expressions in Maple syntax.

Used properly, these are excellent tools for helping students hone their understanding of derivatives and their differentiation skills.

Maple Essentials

- Important Maple commands introduced in this lab are:

Command	Description	Example
`diff(f(x),x$n)`	find nth derivative of f(x)	`diff(x^8,x$4);diff(x*cos(x),x$98);`
`ln`	(natural) logarithm function, $\ln x$	`ln(x); ln(2*x-exp(x)); ln(3);`
`log`	(natural) logarithm function, $\ln x$	`log(x); log(2*x-exp(x));log(3);`
`log[a]`	base a logarithm function, $\log_a x$	`log[10](x); log[3](x); log[3](9);`

- The *Derivatives* tutor is started from the Maple user interface under the Tools menu:

Tools → Tutors → Calculus - Single Variable → Derivatives ...

*Be sure to enter the function correctly and specify a reasonable domain by entering appropriate values in the boxes labeled **a =** and **b =**. The **Display** button displays the first and second derivatives and plots the function and derivatives (make sure boxes below them are checked) on the specified domain. The plot shows how the derivatives can be used to determine the concavity and intervals of increase and decrease. This is a great tool to use when you need to check your answer to a problem in the text.*

- The *Differentiation Methods* tutor is started from the Maple user interface under the Tools menu:

Tools → Tutors → Calculus - Single Variable → Differentiation Methods ...

*This tutor is designed to help you practice the individual steps involved in finding the derivative of a given function. Do not be afraid to use **Get Hint** and **Next Step** — particularly when the hint suggests using the* Rewrite *rule. Also, you might find it useful to mark the* Constant *and* Constant Multiple *rules as being understood (see the **Understood Rules** menu).*

- The *DerivativeDrill* maplet is available from the course website:

`http://people.math.sc.edu/calclab/141L-S19/labs/` → DerivativeDrill

This maplet generates random differentiation problems using the types of functions and differentiation rules that you select and checks if you correctly find the derivative. Start slowly and build to more complicated expressions as you gain confidence in your differentiation skills.

Related course material/Preparation

§3.3, §3.5, §3.6, and §3.8. Prior to the beginning of this lab, be sure you know the basic differentiation rules

Activities

Here are a few extended questions to get you started.

1. For each of the functions listed below, use the *Derivatives* tutor to find the first and second derivatives. Plot the function and derivatives on an appropriate window $[a, b] \times [c, d]$. (See the **Directions** below.) Notice the differences between the original graph and its derivatives. Examine the plot to see how the derivatives can be used to find the inflection points of $f(x)$ and determine where $f(x)$ is increasing, decreasing, concave up, and concave down.

   (a) $f(x) = x^2 + 4x - 6$
   (b) $f(x) = \frac{1}{3}x^3 - x^2 - 3x + 4$
   (c) $f(x) = 3(x^4 - x^3 - x^2 + x)$
   (d) $f(x) = \ln(\frac{1}{x})$
   (e) $f(x) = \dfrac{1}{\ln x}$
   (f) $f(x) = \ln(x^2)$
   (g) $f(x) = (\ln x)^2$
   (h) $f(x) = x \ln x$

   Directions:

   - Launch the *Derivatives* tutor.
   - Enter your function, say, $x^2 + 4x - 6$ as $f(x)$ and specify an interval for x, say, $a = -5$ and $b = 5$.
   - Click on **Plot Options**.
     (a) Check **Enable user-defined ranges**.
     (b) Change the window ranges to, say, $[-5, 5] \times [-10, 10]$.
     (c) Click **OK**.
   - Click **Display**. Check the plot and then go back to **Plot Options** to adjust the window ranges if needed.
   - If you click **Close**, Maple will return your graph to the worksheet.

2. List the rules (in an order that can be applied) involved in finding the derivatives of each of the following. (Use the *Differentiation Methods* tutor.)

   (a) $y = x \sin x$
   (b) $y = \ln(x^3 + 3x^2 + 7)$
   (c) $y = x \cos^2 x$
   (d) $y = \frac{x^2 \sin x}{\cos x}$
   (e) $y = \sin(\cos(x^3))$

3. Find the third derivative of $y = xe^x$. What is $\frac{d^{100}y}{dx^{100}}$?

4. Use the *DerivativeDrill* maplet with polynomial, trigonometric, exponential, and logarithmic functions that utilize the power, product, quotient, and chain rules. Start with only one rule per problem. As you gain confidence, allow up to 2 rules in each problem.

Assignment

Complete lab activities and your lab instructor will give other assignment for each section.