Differentiation Maplets

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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 its derivative and plots the function and its derivative 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.

Maple Essentials

- Important Maple commands introduced in this lab are:

Command	Description	Example
`exp`	exponential function, e^x	`exp(x); exp(2*x-1); exp(-1);`
`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 9.5 user interface under the Tools menu:

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

    *This tutor plots a given function and its derivative. Be sure to specify a reasonable domain by entering appropriate values in the boxes labeled $a =$ and $b =$. The **Display** button displays the formula for the derivative and plots the function and derivative on the specified domain. Look at the plot to see how the derivative can be used to determine where the function is increasing, decreasing, concave up, and concave down. 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 9.5 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 the **Hint** and **Apply Hint** — particularly when the hint suggests using the* Rewrite *rule. Also, you might find it useful to mark the* Constant, Constant Multiple, *and* Identity *rules as being understood (see the **Understood Rules** menu).*

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

    http://www.math.sc.edu/calclab/141L-F05/labs → DerivativeDrill (TAMU/USC)

    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

§3.3, §3.4, §3.5, §3.6, §4.1, §4.2, and §4.3 of the textbook. Prior to the beginning of this lab, be sure you know the basic differentiation rules (including implicit differentiation and logarithmic differentiation).

Activities

- Here are a few extended questions to get you started.

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

    2. For each of the functions listed below, use the `Derivatives` tutor to find the derivative and plot the function and derivative for $-3 \leq x \leq 3$.
        (a) $y = x \cos x$
        (b) $y = \ln(x^2 + 1)$
        (c) $y = e^x$
        (d) $y = x^3 - x^2 - 3x + 4$

        Examine the graphs, how can you tell which curve is the derivative and which is the original function?

    3. For each of the functions listed below, find the derivative and plot the function and derivative for $0 < x \leq A$ for an appropriate choice of A.
        (a) $y = \ln\left(\dfrac{1}{x}\right)$
        (b) $y = \dfrac{1}{\ln x}$ (where is the vertical asymptote?)
        (c) $y = \ln\left(x^2\right)$
        (d) $y = (\ln x)^2$
        (e) $y = \dfrac{\ln x}{x}$.
        (f) $y = x \ln x$.

        How are these four functions related to their derivatives?

    4. List the rules 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) $y = 3x^4 + x \cos x^2$
        (d) $y = \frac{x^2 \sin^2 x}{\cos x}$
        (e) $y = x^\pi$
        (f) $y = \pi^x$
        (g) $y = x^x$
        (h) $y = \pi^\pi$.

    5. Let $F(x) = x^3 + 3x^2 + 7$ and $G(x) = \tan(x^2 + 1)$. Find the derivatives of $F(x)G(x)$, $\dfrac{F(x)}{G(x)}$, and $(F \circ G)(x)$.

    6. Find the first five derivatives of $y = xe^x$. What is $\dfrac{d^{100}y}{dx^{100}}$?

Assignment

There is no assignment based this lab. However, you should spend some time with those Maplets to help you further practice your differentiation skills.