On the Use of Computer Algebra Syntax in the Calculus Classroom

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On the Use of Computer Algebra Syntax in the Calculus Classroom

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Abstract

In this talk, the idea of using computer algebra syntax in a calculus course will be presented. The presenter believes that students, to a certain degree, can become acquainted with CAS conventions and syntax before ever sitting down and wrestling with such software.

Moreover, this intentional syntactical use might lead to better understanding of the composition of functions, and thus better understanding of the concepts of the Chain Rule (for derivatives) and the Substitution Method (for antiderivatives).

The presenter will show some sample assignments as well as discuss the pros and cons of such an idea. There will be time for general discussion of this notion both during the presentation time, and hopefully afterwards for any interested parties.

The Main Issues

- Student understanding of composition of functions and order of operations

- The steep learning curve of *Mathematica* (or any other CAS)

- Students' electronic communication of mathematics (e.g. via email, on message boards, etc.)

Ideas and Implementation

- Compare/contrast mathematical notation and computer algebra syntax

$$\int \sin(3x)dx$$

vs.

`Integrate[Sin[3x],x]`

- Occasional but consistent use of *Mathematica* syntax in class

- Guidelines for electronic communication of mathematics

- Any others?

Pros and Cons

- Cons

1. The *Mathematica* learning curve
2. Isn't calculus hard enough already?

- Pros

1. Fewer mathematically ambiguous emails!
2. Students are forced to think about composition of functions
3. Math/CS majors are introduced to conventions of a programming language

Math 132 **_Name:___________________________**

November 11, 2002 **_Attempt Number:_____**

Gateway Exam

You may spend as much time on this exam as you wish, but once you begin working on it, you may not consult any resources (including calculators and Russ!) until you have completed it. Your exam will be graded before you leave.

Evaluate each antiderivative. SHOW ALL OF YOUR WORK!

1. $\int (3-8x)^{11} dx$

2. $\int \frac{t^3-3t+1}{t} dt$

3. $\int x \sin(x) dx$

4. $\int_{x=1}^{x=3} \left(x^2 + \frac{5}{\sqrt{x}}\right) dx$

5. $\int_{-\infty}^{0} e^{3x} dx$

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Evaluate each antiderivative. SHOW ALL OF YOUR WORK!

1. `Integrate[(3-8x)^11,x]`

2. `Integrate[(t^3-3t+1)/t,t]`

3. `Integrate[x*Sin[x],x]`

4. `Integrate[x^2+5/Sqrt[x],{x,1,3}]`

5. `Integrate[Exp[3x],{x,-Infinity,0}]`

Guidelines for Mathematical Emails

In this course, I strongly encourage you to come to my office hours for help with homework or preparation for exams. However, the use of email as a form of communication is also encouraged. The following is a list of “translations” of mathematical notation into pure text format. I would encourage everyone to become familiar with these conventions and to use them in any mathematical email correspondence with me.

1. $\sin(x)$ $\longrightarrow$ `Sin[x]`
2. $\sin(x^2)$ $\longrightarrow$ `Sin[x^2]`
3. $\sin^2(x)$ $\longrightarrow$ `Sin[x]^2`
4. e^x $\longrightarrow$ `Exp[x]`
5. e^{31x} $\longrightarrow$ `Exp[31x]`
6. $\ln(x)$ $\longrightarrow$ `Log[x]`
7. $\log_7(x)$ $\longrightarrow$ `Log[7,x]`
8. $\sqrt{x}$ $\longrightarrow$ `Sqrt[x]`
9. $\sqrt[3]{x}$ $\longrightarrow$ `x^(1/3)`
10. $|x|$ $\longrightarrow$ `Abs[x]`
11. $\pi \approx 3.142$ $\longrightarrow$ `Pi`
12. $e \approx 2.718$ $\longrightarrow$ `E` or `Exp[1]`
13. $i = \sqrt{-1}$ $\longrightarrow$ `I`

-----Original Message-----
From: Andrew C Hartwig
Sent: Wednesday, February 12, 2003 5:10 PM
To: Russell Goodman
Subject: RE: YO Questions

Prof G

Can I legally move the five out front with this expression

u^5 * ln 5u to

5 integral u^5 * ln u

Andy

-----Original Message-----
From: Russell Goodman
Sent: Fri 10/11/2002 8:38 AM
To: Sundance Visser
Subject: RE: calculus

Sunny:

SNIP

On #16, substitution does work. Let w = 5u, so that dw = 5du AND u = (1/5)w. The integral then becomes:

```
Integrate[(w/5)^5*Log[w]*(1/5),w]
   =Integrate[(w^5/5^5)*(1/5)*Log[w],w]
   =Integrate[(w^5/5^6)*Log[w],w]
   =(1/5^6)*Integrate[w^5*Log[w],w]
```

It's a bit ugly, but I hope that helps!!

Take care,
Prof. G.

Dr. Russ Goodman
goodmanr@central.edu
http://www.central.edu/homepages/goodmanr

From: Russell Goodman
Sent: Tuesday, October 08, 2002 10:52 AM
To: Brady E Kurtz
Subject: RE: 7.2 homework questions

SNIP

Anyway... The derivative of (Log[t])^2 requires the Chain Rule:

D[Log[t]^2,t] = 2Log[t]*(1/t)

Now, if you meant problem #35 (like others have asked about), use the hint:

D[ArcSin[u^2],u] = 2u/Sqrt[1-u^4], where Sqrt means square root.

SNIP

Hope this helps!!
Prof. G.

Dr. Russ Goodman
goodmanr@central.edu
http://www.central.edu/homepages/goodmanr

From: Russell Goodman
Sent: Wednesday, March 19, 2003 2:30 PM
Subject: [Calc 2] Mathematica Help

I realized a few minutes ago that Mathematica's "Solve" command doesn't work too well when using functions like Cosh[x], so here's an alternative, if you need it.

If I were trying to solve the equation 15Cosh[45/x]-x^2=0, I would want to use the following Mathematica command, called "FindRoot":

```
FindRoot[15Cosh[45/x]-x^2 == 0, {x,20}]
```

The {x,20} part just tells Mathematica what variable you're using and it also gives it a "starting x-value" to try, just like the "Guess" that the TI-83 asks you for when doing certain things. I just guessed x=20 to start off with.

Take care,
Prof. G.

Dr. Russ Goodman
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