

*Integrating a course
in CAS programming and/or use:
issues and impact of curriculum*

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October 2010

a CAS course at Université de Montréal

Basic characteristics

- one-credit course (1 one-hour lecture, 1 one-hour lab, about 2 h/w independent work)
- taken winter term of first year (of our 3-year BSc)
- compulsory for math majors
- evaluation: one midterm, one final
- success rate $> 85\%$

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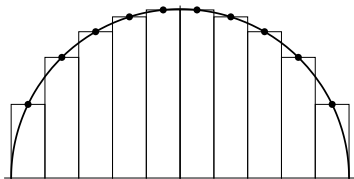
Goals

- give tools that can be used for the remaining 2 years of the BSc and beyond
 - basic mathematical tools (Sin, Cos, Exp, Log, Solve, Eigensystem, FindRoot)
 - some procedural programming (While, For, Do)
 - list manipulation (Table, Select, Drop, Prepend, Append, Flatten, Nest)
 - recursion
 - graphics primitives and animation (Point, Line, Circle, Polygon, Plot, ...)
- course should be non-traumatic; actually it should be fun (taken while taking first real analysis and probability courses)

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Examples of exam questions

- write a function `gcd[p_, q_]` that calculates the *gcd* of two integers, without using the built-in `GCD` (details of Euclid's algorithm is given in the question);
- calculate the n -th line of Pascal triangle from the $(n-1)$ -th one without using `For`, `While`, `Do`;
- some matrices M are such that $M^n = id$ for some $n \geq 1$. Write a function `order[m_]` that, given such a matrix M , obtains the smallest n such that $M^n = id$;
- reproduce the following figure.



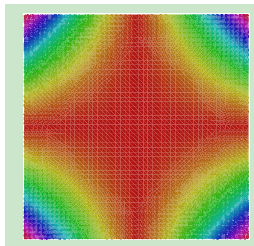
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Successes and difficulties

- students still use it the year after (!);
- more than half like it;
- lecture notes have gone back to the grindstone several times; last evaluations request only minor changes;
- those coming without any computer background find it extremely difficult; resources limited to help them;
- very little mathematics taught *per se*;
- use after course depends on colleagues;
- not many colleagues want to give the course; great many ex-students want to give it;
- disconnected from other math courses.

Symbolic Computations at the Junior Undergraduate Level

E.J. Janse van Rensburg
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Mathematical Modeling at the Junior Level?

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Accepted Wisdom...

- Open Ended Questions
- Less Structured Environment is Beneficial
- Writing Reports (Integrate Mathematical and Writing Skills)

The Basic Goals

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But....

- Fifty Students – One Instructor
- Grading Hundreds of Reports
- Group Efforts versus Individual Work?
- Computing or Mathematical Skills (or both)?

Open Ended Type Question

Open Ended Investigations at the Junior Level?

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Example of an Open Ended Type Question

The equation

$$|x| + B|y| = C$$

where $B > 0$ and $C > 0$, is the equation of a infinite prism in Three Space.

- Compute volumes of various intersecting prisms

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Skills

- Rotations, translation of prisms
- Implicit 3d-plotting, visualization
- Integration
- Presentation skills

Re-Adjusted Goals

Adjusted Goals: More Modest and Tightly Focused

- Calculus and Algebra with Maple, Data Structures
- Focused Symbolic and Numerical Problems

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- Conditional Statements and Procedures

$$f(x) = \begin{cases} \text{Statement 1,} & \text{if Condition 1;} \\ \text{Statement 2,} & \text{if Condition 2;} \\ \dots & \dots \\ \text{Default,} & \text{Otherwise.} \end{cases}$$

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- Elementary Modeling (through take-home assignments)

Testing and Feedback, Advantages and Disadvantages

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- 1 Eg. Determine the number of positive integer solutions to $x_1 + x_2 + x_3 = 101$ if $0 < x_1 < x_2 < x_3$.

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- 1 Data-Structures and Procedures
- 2 Simple compartmental modeling, for example Predator-Prey modeling

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Advantages

- Can handle 50 students
- Less (much less!) grading of reports
- Individual work is emphasized (over group efforts)
- Efficient use of physical plant
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Disadvantages

- Modeling Aspect is underplayed, perhaps significantly so
- Offset by Senior Courses in Modeling
- Report Writing and Presentation Skills are lost