High-Level Programming Tools for Interactive Mathematics

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Lecturers are best suited to preparing the most appropriate materials for their students.

More specifically …
The Bottom Line

- Mathematics lecturers are best suited to preparing *mathematically* appropriate materials for their *mathematics* students.
Outline

- Disclaimers
- Traditional Tools
- Higher-Level Tools
- Immediate Needs
- Examples
- Final Remarks
Disclaimers

- We are mathematicians who want to use digital media to communicate mathematics to the world
- We want to communicate research results to a wider audience
- We want to utilize the benefits of the digital era to improve my teaching
Traditional Tools

- **Computer Algebra (CAS)**
  - Excellent tools for *doing* mathematics
  - Far from optimal for *communicating* mathematics
  - Not universally available, not intuitive, not robust

- **Examples**
  - Maple (http://www.maplesoft.com)
  - Mathematica (http://www.wolfram.com)
  - ...
Traditional Tools

- CGI scripts and forms
  - Requires extensive knowledge of CGI / HTML / …
  - Non-trivial to connect CAS to web applications
  - License and security concerns

- Example
  - irreducibility test for lacunary polynomials
    [ http://www.math.sc.edu/~filaseta/irreduc.html ]

  424 lines of CGI + 327 lines of Maple + …
Traditional Tools

- **Java**
  - Requires programming expertise
  - Much greater control over effects and actions
  - Same concerns about CAS connectivity, license, and security

- **Example**
  - Tracing the locus of the vertex of a parabola
    [ParabolaVertex.html]

225 lines of Java code
Higher-Level Tools

- Maplets
  - front-end to Java
  - still problematic to program

- Example
  - Antiderivative calculator
    [ Antideriv.mw ] [ Antideriv.maplet ]
    16 lines of Maple
Higher-Level Tools

- **Embedded Components**
  - more intuitive and graphical
  - weak on features

- **Example**
  - Irreducibility test for lacunary polynomials
    (w/ Michael Filaseta, J Algorithms, 2005; support from NSA)
    [ http://maplenet.math.sc.edu/research/Irreduc.mw ] [ MapleNet ]

  0 lines of visible Maple code
Higher-Level Tools

● Geometry Expressions
  - typical dynamic geometry interface
  - with built-in symbolics

● Example
  - Shrinking circle
    [ ShrinkCircle.gx ]
    0 commands ( <5 minutes total time )
    *** add symbolic formula for distance
    *** copy to Maple worksheet
Immediate Needs

- User-Interface: Layout Design
  - Graphical
  - Intuitive
  - Flexible
  - Robust
  - ...

Immediate Needs

- User-Interface: Functionality
  - Dynamic layout
  - Full use of traditional Java effects
    - Color and image effects
    - Default text as instruction
    - Popups
    - ...

Immediate Needs

- Full integration with Internet via hyperlinks
  - to external webpages
  - to online documents

- Inter-application communication
  - grading / course management software

- Universal availability
Examples

- Maplets for Calculus
  [ http://www.math.sc.edu/calclab/M4C/ ] [ MapleNet ]
  - Textbook independent (both + and -)
  - Nearly complete coverage
  - No grading capability

- 32,327 lines of Maple programming in 70 files
  (not counting the HTML, …)
Examples

- WebALT
  - http://www.webalt.net/
  - http://www.webalt.com/
  - Complete online courses
  - Affordable
  - Multilingual
Examples

- Maplets for WebALT Calculus (secure)
  - Currently in pre-alpha version
  - For additional information, including access, contact WebALT or the authors
Mathematics lecturers are best suited to preparing mathematically appropriate materials for their mathematics students.

- Good mathematics requires good communication
- Development tools must support mathematical communication
- No intrusive overhead
- Expectations increase as technology improves