Recent Developments in Computer Algebra Technology and Their Impact on Mathematical Research and Teaching

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Theorem

*Ultimate success of the use of technology in mathematics education requires a paradigm shift.*
Outline of the Proof

To appreciate the current state of computer algebra systems (CAS) and to influence future developments of these systems it is instructive to look back in time.

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To appreciate the current state of computer algebra systems (CAS) and to influence future developments of these systems it is instructive to look back in time.

- Long-term view shows how much progress has been made.
- Short-term view shows where current efforts are concentrated.
- Together, the future becomes clearer
Overview
Overview

• First Generation (1967 – 1989)
Overview

• First Generation (1967 – 1989)

• Second Generation (1990 – 2001)

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Overview

- Second Generation (1990 – 2001)
- Third Generation (2002 – )
Overview

- Second Generation (1990 – 2001)
- Third Generation (2002 – )
- Future
Overview

- Second Generation (1990 – 2001)
- Third Generation (2002 – )
- Future . . . Near and Distant???
First Generation (1967–1989)

1967
1979
1980
1988
First Generation (1967–1989)

1967 — MACSYMA project begins at MIT

1979

1980

1988
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First Generation (1967–1989)

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1980 — Maple project commences at U. of Waterloo

1988 — Mathematica 1.0 (successor to SMP)
First Generation – Personal

First Generation – Personal

  - Introduction to Numerical Analysis
First Generation – Personal

  - Introduction to Numerical Analysis
  - Homework 7, Question (a) [PDF]
First Generation – Personal

  - Introduction to Numerical Analysis
  - Homework 7, Question (a) [PDF]
  - Solution:
    - [MACSYMA] (5 minutes)
    - [Maple 9.5] (2.5 seconds)
    - [Maple 10] (0.3 seconds)
Second Generation (1990–2001)

• first appearance of graphical user interface (GUI)

• supporting literature becomes more abundant, and higher quality

• materials shared via Internet, growth of WWW

• educational usage becomes more feasible

• still not really practical for education
Second Generation – Personal

- ODE PowerTool (2001)
Second Generation – Personal

- ODE PowerTool (2001)
  - Maple Application Center [WWW]
Second Generation – Personal

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  - Maple Application Center [WWW]
  - Education PowerTools [WWW]
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  - ODE Powertool [WWW]
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  - Lesson 6: Bifurcations
    [Maple 8] [Maple 9.5]
Third Generation (2002–present)

- less reliance on syntax (more student-friendly)
- better interaction between applications
- standalone web-based applets
- testing and assessment
Third Generation – Personal

- Irreducibility Tests for 0-1 Polynomials
- Calculus I with Maple in Blackboard
- Lab Materials/Projects for Calculus
Irreducibility Tests for 0-1 Polynomials

2000

2004

2005
Irreducibility Tests for 0-1 Polynomials

2000 cgi-based Web forms

[Irreduc]

2004

2005
Irreducibility Tests for 0-1 Polynomials

2000 cgi-based Web forms
   [Irreduc]

2004 maplet
   [Irreduc.maplet] [via MapleNet]

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   [URL: http://www.math.sc.edu/~meade/papers/JAlgFilasetaMeade.pdf]
Irreducibility Tests for 0-1 Polynomials

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pure research, but ...
Calculus I with Maple in Blackboard
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- Blackboard-based self-contained course
- [Home] [Unit] [Lessons] [Homework / Quizzes / Exams]
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- MapleTA
  Practice: [Q1] [Q2] [Q3] [Q4] [Q5]
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- MapleTA
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many shortcomings, but . . .
http://www.math.sc.edu/calclab/

- Lab Materials / Projects for Calculus I and II
- Bonus Labs for Vector Calculus
- Lab Materials for Numerical Linear Algebra
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improving . . .
State of the Art in CAS
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- Maplets for Calculus [WWW]
State of the Art in CAS

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- Maple 10
State of the Art in CAS

- Maplets for Calculus [WWW]

- Maple 10
  - Palettes, 2d input, handwriting recognition
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  - Worksheet based assessment [Maple 10]
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and primed to take advantage of new possibilities!
What’s Coming? (What I want?)

- Tablet and handheld PC’s
- Natural language recognition
- Inter-application portability
- Easy user customization
- Improved testing and assessment
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What’s on your (technology) wish list?
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Proof

The process is iterative, and not monotone, every step is progress. This conference, and others like it, are evidence of the vitality of this endeavor. Each of us has a role to play in the overall plan. Our efforts have meaning for all “users” of mathematics: students, instructors, researchers — everyone.