

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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- 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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-

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- First Generation (1967 – 1989)
- Second Generation (1990 – 2001)
- Third Generation (2002 –)
-

Overview

- First Generation (1967 – 1989)
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- Future

Overview

- First Generation (1967 – 1989)
- 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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1988 — Mathematica 1.0 (successor to SMP)

First Generation – Personal

- Carnegie Mellon University (1984)

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First Generation – Personal

- Carnegie Mellon University (1984)
 - Introduction to Numerical Analysis
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 - Homework 7, Question (a) [[PDF](#)]
 -

First Generation – Personal

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 - 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)

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Second Generation – Personal

- ODE PowerTool (2001)
 - Maple Application Center [[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

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2004 maplet
[Irreduc.maplet] [via MapleNet]

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2005 *Journal of Algorithms*, 55(1) 2005, pp. 21-28 (with Michael Filaseta)
[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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Practice: [Q1] [Q2] [Q3] [Q4] [Q5]

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Practice: [Q1] [Q2] [Q3] [Q4] [Q5]

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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- 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.