M@th Desktop and MD Tools

Mathematics and Mathematica Made Easy for Students

Reinhold Kainhofer (kainhofer@deltasoft.at)

Reinhard Simonovits (simonovits@deltasoft.at)

Deltasoft Simonovits KEG

Elisabethstrasse 42, A-8010 Graz, Austria

http://www.deltasoft.at/

PrimMath[2003], Zagreb, 26 September 2003

MDTools and M@th Desktop

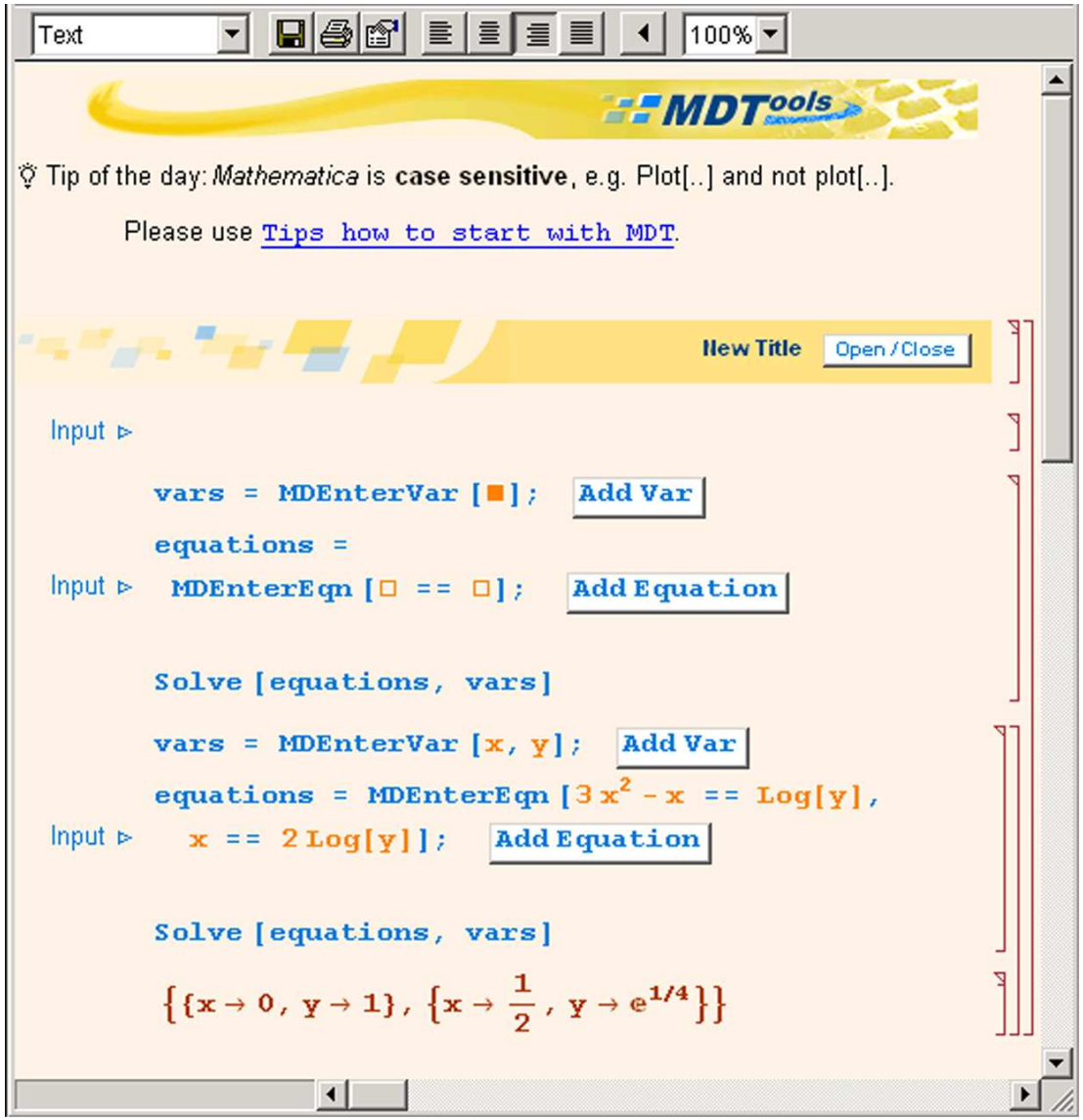
- MD Tools:
  - Palettes with function templates to ease Mathematica for students
  - Templates help the user avoid syntax errors and give them a well-structured input
  - Covers linear algebra, algebra, differentiation, integration, statistics
- M@th Desktop:
  - Full-feature blended learning software: Notebooks explaining the topics
  - Modules for linear algebra, differentiation, integration, and statistics.
  - Intended for use in class

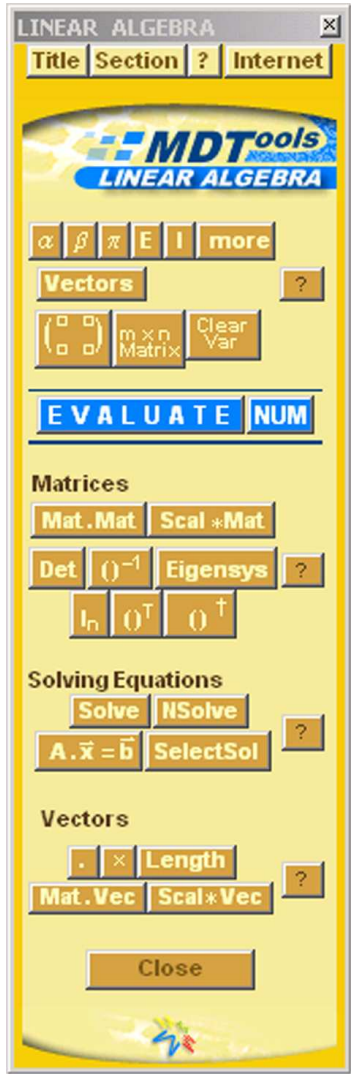
The didactic concept

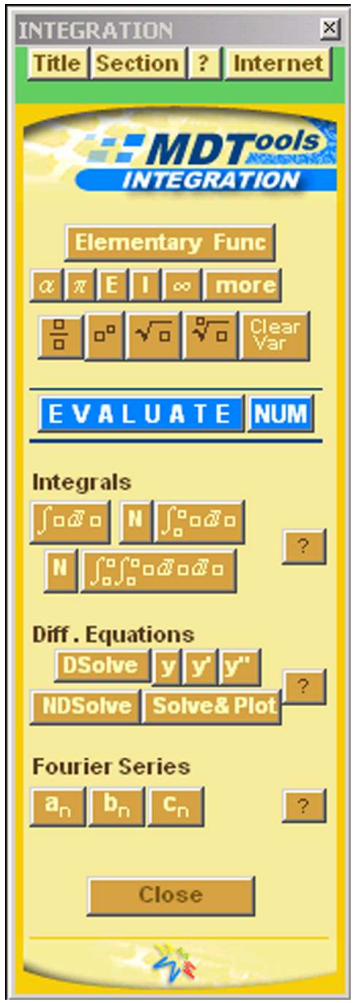
- "Blended learning": Students use the computer as a tool, but the teacher is not replaced by the software, rather complemented
- The computer (Mathematica) can do the "boring", tedious calculations, the students can concentrate on the important issues.
- The computer must only be used once the students understand the theory, too, and also can do the calculations by hand.

We present two add-on modules for Mathematica, which make Mathematica easier to use for high school / undergraduate students, and implement the didactic concept of blended learning.

M@th Desktop Tools (MDTools)





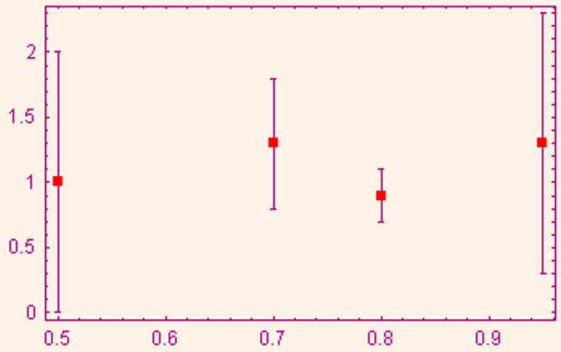


The concept of MDTools

- Only tools to ease the use of Mathematica for students' every-day tasks (common calculations)
- Palettes provide templates, the user works in a notebooks
- Helper palettes provide additional tools
- Fully integrated into Mathematica (e.g. menu)

```
Input ▹
data = {{0.5, 1, 1}, {0.7, 1.3, 0.5},
  {0.8, 0.9, 0.2}, {0.95, 1.3, 1}} ;
(* Format: {{x1,y1,err},...}
   or { {{x1,y1},{-errneg,+errpos}},...} *)

MDPlotXYerrData[ data, Frame -> True,
 PlotRange -> All,  SymbolShape ->
  {PlotSymbol[Box, 3, Filled -> True]},
 SymbolStyle -> {Red} ]
```



Plotting error plots

```
Input ▹
Clear[f, x];
f[x_] = ■ ;
x0 = □ ;
order = □ ;

Series[f[x], {x, x0, order}]
```

Taylor series expansion

```
Input ▹
Clear[x]; var = {x};
data = ■ ;
functions = {1, x, x^2, x^3};

resultFunction =
 Fit[ data, functions, var] // Chop
```

Least-squares fit of a polynomial

M@th Desktop: Full-feature blended learning software

3.1 Area Between Two Curves

Open / Close

Rail Example Find the area of the plane region between two rails given by $f[x] = x + 6$, $g[x] = x^2$

Solution: Use the formula for the area between two curves.

The Def 2 Curves button lets you define the functions f and g.

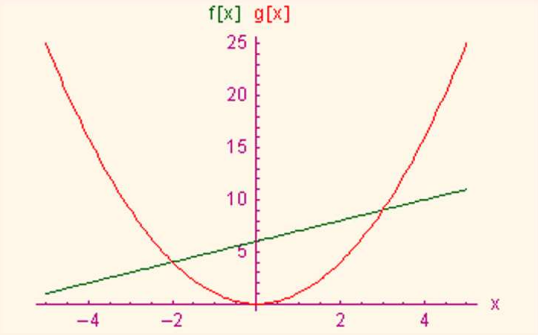
Switch to func of y;

Input ▹
```
Clear[f, g, x];
{f[x_] = x + 6 , g[x_] = x^2 }
```
$\{6 + x, x^2\}$

Plot the two curves.

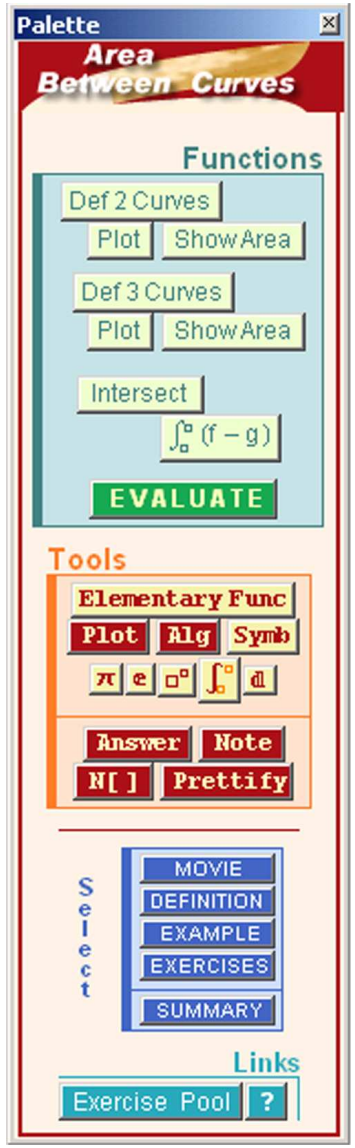
The Plot button enables you to visualize the functions and the area. Choose x as the variable, x ∈ {-5,5}.

Input ▹
```
Clear[var, x, y];
varname = x;
MDIPlotfAndg[
 {f[var], g[var]}, {var, -5, 5}, Label → varname];
```



Determine the intersection points of the two curves. These are the integration bounds.

The Intersect button will give you the points of intersection ot f[x] and g[x]. If Nsolve does not work, switch to FindRoot and look at your plot to get an appropriate starting value.



The concept of M@th Desktop

- Consists of several modules (Lin. Alg., Diff./Int., Statistics) containing several smaller topics
- Each topic presented in a notebook, accompanied by a palette with function templates
- Teacher not replaced, but complemented (needs to guide the students, students still need to understand the foundations).
- Blended learning: Both, teacher and computer are important. Using the computer and MD is more like a school textbook combined with a powerful calculator, but the teacher still has to explain the topics with its help.
- Each notebook also contains lots of exercises.

Some more screenshots of M@th Desktop in action

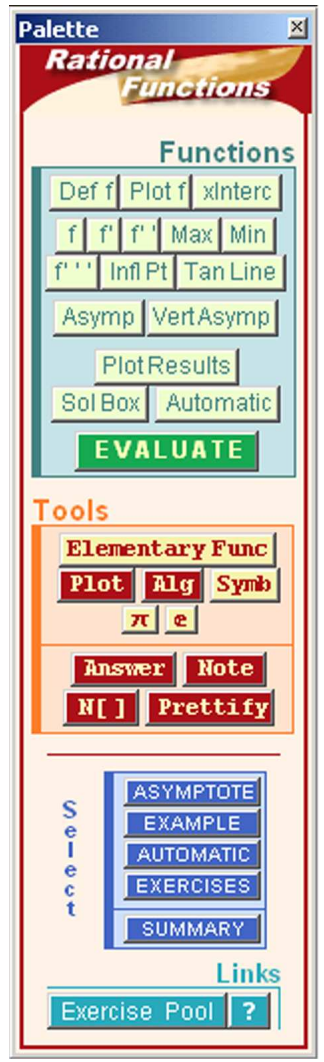
SUMMARY

Let **y = f[x]** be a continuously differentiable function on the interval [a, b]. The **area S** of the **surface of revolution** formed by revolving the graph of f about the

- **x-axis** is: $S = 2\pi \int_a^b f[x] \sqrt{1 + (f'[x])^2}\, dx$
- **y-axis** is: $S = 2\pi \int_a^b x \sqrt{1 + (f'[x])^2}\, dx$

Let **x = f[y]** be a continuously differentiable function on the interval [c, d]. The **area S** of the **surface of revolution** formed by revolving the graph of f about the

- **y-axis** is: $S = 2\pi \int_c^d f[y] \sqrt{1 + (f'[y])^2}\, dy$
- **x-axis** is: $S = 2\pi \int_c^d y \sqrt{1 + (f'[y])^2}\, dy$



Further comments, conclusion

- Heavily used in the EU Project "Computer Algebra and the Web: Modern Tools for Understanding Mathematics"
- Several diploma theses have been written about M@th Desktop (at the University of Graz, Austria)
- Successfully applied in schools in Austria and Germany already.

Conclusion

- MD Tools: Palette-based add-on providing tools covering most of the topics needed in high school and as undergraduate.
- M@th Desktop: Full-feature teaching software for math classes in high school and University. Can also be used by the student on his/her own. Each topic provided in its own notebook with exercises plus palette.