M@th Desktop and MD Tools
Mathematics and Mathematica Made Easy for Students

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PrimMath[2003], Zagreb, 26 September 2003
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.
Tip of the day: *Mathematica* is case sensitive, e.g. Plot[...] and not plot[...].

Please use [Tips how to start with MDT](#).

```math
vars = MDEntrVar [ ]; Add Var

equations =
Input > MDEntrEqn [ ] == [ ]; Add Equation

Solve [equations, vars]

vars = MDEntrVar [x, y ]; Add Var

equations = MDEntrEqn [3 x^2 - x == Log[y],
Input > x == 2 Log[y]; Add Equation

Solve [equations, vars]

\{x \to 0, y \to 1\}, \{x \to \frac{1}{2}, y \to e^{1/4}\}\}
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)

Plotting error plots

```
data = {{0.5, 1, 1}, {0.7, 1.3, 0.5}, {0.8, 0.9, 0.2}, {0.95, 1.3, 1}};
Clear[f, x]; f[x_] = □;
ex0 = □;
Series[f[x], {x, x0, order}]
```

Taylor series expansion

```
Clear[x]; var = {x};
data = □;
functions = {1, x, x^2, x^3};
resultFunction = Fit[data, functions, var] // Chop
```

Least-squares fit of a polynomial
3.1 Area Between Two Curves

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

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

The `Def 2 Curves` button lets you define the functions \( f \) and \( g \).

\[ \text{Switch to func of } y \]

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

Plot the two curves.

The `Plot` button enables you to visualize the functions and the area. Choose \( n \) as the variable, \( n \in (-5, 5) \).

```
Clear[var, x, y];
varname = x;
NDPlotfandg[]
\{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 of \( f(x) \) 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**: 
  \[ S = 2\pi \int_{a}^{b} f(x) \sqrt{1 + (f'(x))^2} \, dx \]

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

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**: 
  \[ S = 2\pi \int_{c}^{d} f(y) \sqrt{1 + (f'(y))^2} \, dy \]

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