

M@th Desktop and MD Tools

Mathematics and Mathematica Made Easy for Students

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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)

Text [Save] [Print] [Copy] [Paste] [Undo] [Redo] [Zoom: 100%]

MDTools

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

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

New Title [Open/Close]

Input >

```
vars = MDEnterVar [ ] ; [Add Var]
```

equations =

Input > MDEnterEqn [] == [] ; [Add Equation]

```
Solve [equations, vars]
```

```
vars = MDEnterVar [x, y] ; [Add Var]
```

```
equations = MDEnterEqn [3 x^2 - x == Log[y],
```

Input > x == 2 Log[y] ; [Add Equation]

```
Solve [equations, vars]
```

```
{ {x -> 0, y -> 1}, {x -> 1/2, y -> e^{1/4}} }
```

LINEAR ALGEBRA [Close]

Title Section ? Internet

MDTools
LINEAR ALGEBRA

α β π E I more

Vectors [?]

$\begin{pmatrix} a & b \\ c & d \end{pmatrix}$ m x n Matrix Clear Var

EVALUATE NUM

Matrices

Mat. Mat Scal * Mat

Det $()^{-1}$ Eigensys [?]

I_n O^T O^\dagger

Solving Equations

Solve NSolve

$A \cdot \vec{x} = \vec{b}$ SelectSol [?]

Vectors

\cdot \times Length [?]

Mat. Vec Scal * Vec [?]

[Close]

INTEGRATION [Close]

Title Section ? Internet

MDTools
INTEGRATION

Elementary Func

α π E I ∞ more

$\frac{a}{b}$ a^a \sqrt{a} $\sqrt[n]{a}$ Clear Var

EVALUATE NUM

Integrals

$\int a dx$ $\int a dx$ $\int_0^a a dx$ [?]

$\int_0^a \int_0^a a dx dx$ [?]

Diff. Equations

DSolve y y' y'' [?]

NDSolve Solve & Plot [?]

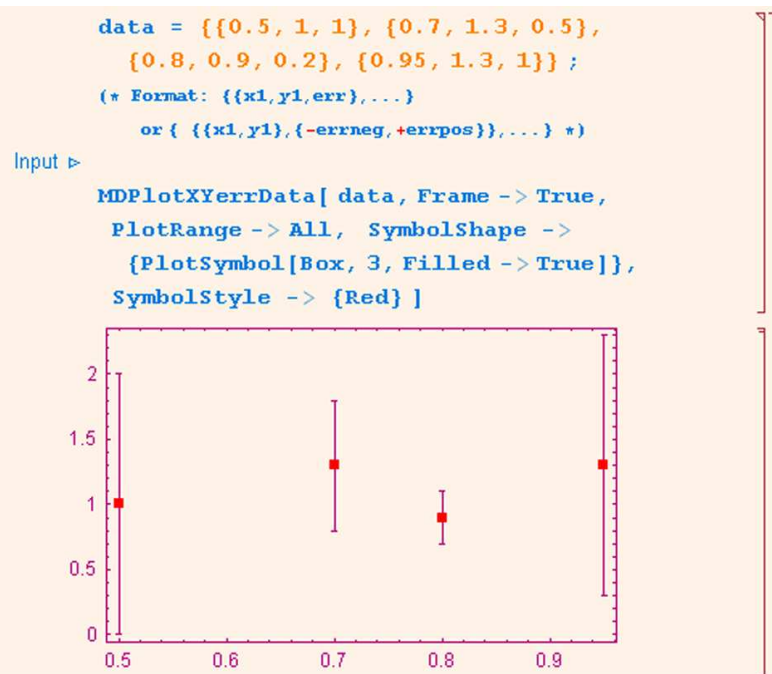
Fourier Series

a_n b_n c_n [?]

[Close]

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

```
Clear[f, x];  
f[x_] =  $x^2$ ;  
x0 = 0.5;  
order = 3;  
  
Series[f[x], {x, x0, order}]
```

Taylor series expansion

```
Clear[x]; var = {x};  
data = {{0.5, 1}, {0.7, 1.3}, {0.8, 0.9}, {0.95, 1.3}};  
Input > 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.

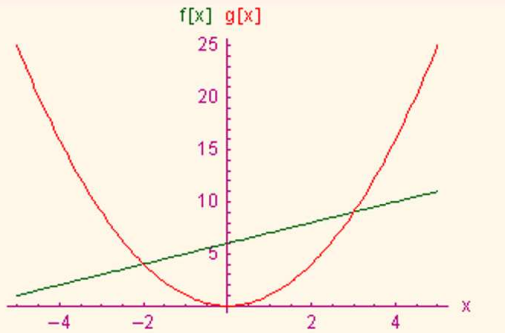
Switch to func of y ;

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, $x \in (-5, 5)$.

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 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.

Palette

Area Between Curves

Functions

- Def 2 Curves
 - Plot
 - Show Area
- Def 3 Curves
 - Plot
 - Show Area
- Intersect
 - $\int_a^b (f - g)$
- EVALUATE**

Tools

- Elementary Func**
 - Plot
 - Alg
 - Symb
 - π e a^a \int_a^a d
- Answer** **Note**
- N[]** **Prettify**

Select

- MOVIE
- DEFINITION
- EXAMPLE
- EXERCISES
- SUMMARY

Links

- Exercise Pool
- ?

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

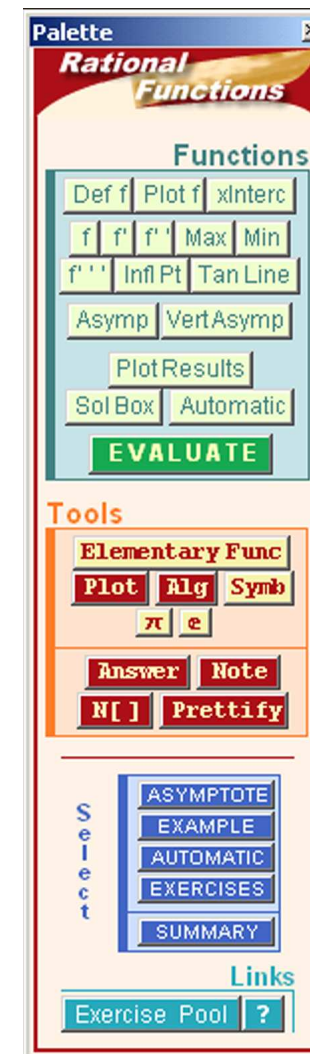
SUMMARY

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: $S = 2\pi \int_c^d y \sqrt{1 + (f'[y])^2} dy$



Palette

Rational Functions

Functions

Def f | Plot f | xInterc
f | f' | f'' | Max | Min
f''' | InfPt | TanLine
Asymp | VertAsymp
PlotResults
Sol Box | Automatic
EVALUATE

Tools

Elementary Func
Plot | Alg | Symb
 π | e
Answer | Note
N[] | Prettify

Select

ASYMPTOTE
EXAMPLE
AUTOMATIC
EXERCISES
SUMMARY

Links
Exercise Pool | ?

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.