

NumericPlots - plot numeric data with latex

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Plotting numeric data is a task which often has to be done for scientific papers. In \LaTeX , however, it is only possible to include graphics created with an external program. The pstricks-packages provide many commands to generate graphics in \LaTeX . To generate simple graphics from numeric data, however, it is difficult to use. This package provides a simpler interface for the pstricks-package to plot numeric data.

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Part I.

Introduction

Plotting numeric data is a task which often has to be done for scientific papers. In \LaTeX , however, it is only possible to include graphics created with an external program. The pstricks-packages provide very many commands to generate graphics in \LaTeX . To generate simple graphics from numeric data, however, it is difficult to use. This package provides a simpler interface for the pstricks-package to plot numeric data.

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Part II.

Using the package

1. Basic Functionality

The package `NumericPlots`
`\usepackage{NumericPlots}`
is intended to be used to plot numeric data which may, e.g., be exported from Matlab by `export2latex.m`. The data must be defined in the form

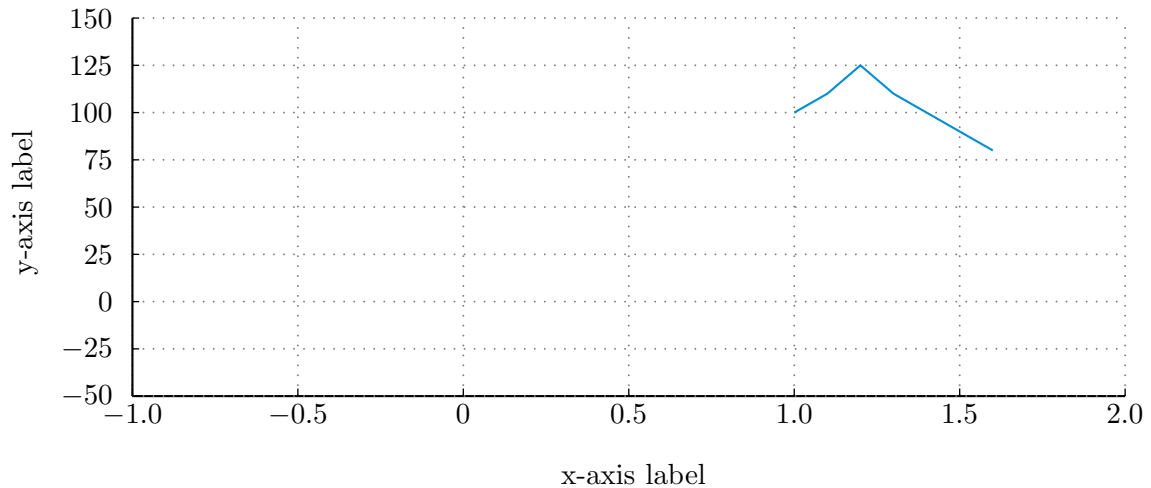
```
\def\IdentI{  
1.0 1.0e2  
1.1 11e1  
1.2 1.25e2  
1.3 110  
1.4 100  
1.5 90  
1.6 80  
}
```

where the first column contains the x, the second column the y-data.

1.1. plots

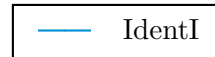
The easiest plot may be done by

```
\begin{NumericDataPlot}{\textwidth}{5cm}  
\setxAxis{xMin=-1, xMax=2, Dx=0.5}  
\setyAxis{yMin=-50, yMax=150, Dy=25}  
  
\plotxAxis{x-axis label}  
\plotyAxis{y-axis label}  
  
\listplot[style=StdLineStyleA]{\IdentI}  
\end{NumericDataPlot}
```



if you want to add a legend, you simply call

```
\LegendDefinition{
\LegLine{style=StdLineStyleA} & IdentI
}
```

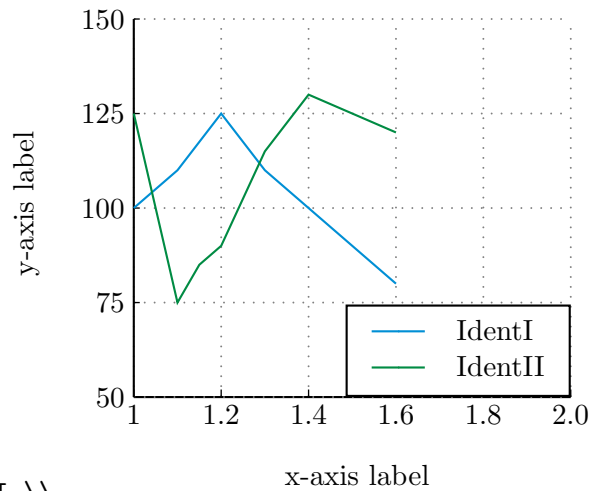


To plot multiple data in one plot call

```
\begin{NumericDataPlot}
  {\textwidth}{5cm}
\setxAxis
  {xMin=1, xMax=2, Dx=0.2}
\setyAxis
  {yMin=50, yMax=150, Dy=25}

\plotxAxis{x-axis label}
\plotyAxis{y-axis label}

\listplot[style=StdLineStyleA]
  {\IdentI}
\listplot[style=StdLineStyleB]
  {\IdentII}
```



```
\putSE{\LegendDefinition{
\LegLine{style=StdLineStyleA} & IdentI \
\LegLine{style=StdLineStyleB} & IdentII
}}
\end{NumericDataPlot}
```

1.2. Label and TickLabels

The commands `plotxAxis` and `plotyAxis` take the options `NoLabel`, `NoTicks`, `NoTickLabel` as well as `LabelOption` and `TickLabelOption` which may be used to eliminate or change the look of the labels.

Standard values for `LabelOption` and `TickLabelOption` may be set by `\newcommand{\StdLabelOption}{\}` and `\newcommand{\StdTickLabelOption}{\small}`.

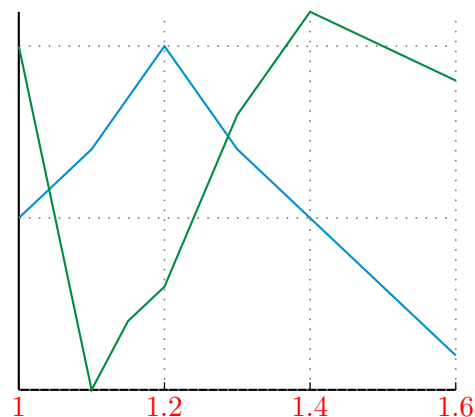
The option `xLabelSep` for `\plotxAxis` (and `yLabelSep` for `\plotyAxis`) may be used to set the separation between the axis and the label. Standard value is 10pt for the x-label and 20pt for the y-label.

```
\begin{NumericDataPlot}{\textwidth}{5cm}
\setxAxis{xMin=1, xMax=1.6, Dx=0.2}
\setyAxis{yMin=75, yMax=130, Dy=25}
```

```
\plotxAxis
[LabelOption=\LARGE,%
TickLabelOption=\color{red},%
xLabelSep=40pt]
{x-axis label}
\plotyAxis
[NoLabel, NoTicks, NoTickLabel]
{y-axis label}
```

```
\listplot[style=StdLineStyleA]{\IdentI}
\listplot[style=StdLineStyleB]{\IdentII}
```

```
\end{NumericDataPlot}
```



x-axis label

1.3. Place “Objects” in the plot.

There are basically two different options to place objects in the plot. To understand the difference one has to keep in mind that the axis have two different coordinate systems. One is the system defined by `xMin`, `xMax`, `yMin` and `yMax` (referred to as “DataCoordinateSystem”), the other is the system defined by `xCoordMin`, `xCoordMax`, `yCoordMin` and `yCoordMax` (referred to as “PictureCoordinateSystem”), see section 2.

It is now possible to place stuff in the graph with the DataCoordinates with the command `NDPput`, see the following example.

```

\begin{NumericDataPlot}
  {\textwidth}{5cm}
\setxAxis
  {xMin=1, xMax=2, Dx=0.2}
\setyAxis
  {yMin=50, yMax=150, Dy=25}

\plotxAxis{x-axis label}
\plotyAxis[NoLabel]{}

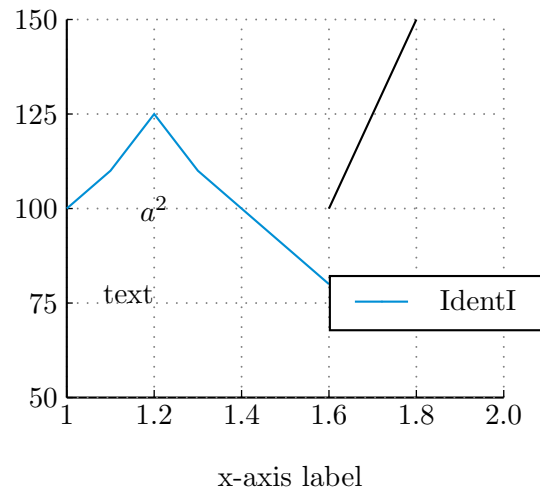
\listplot[style=StdLineStyleA]
  {\IdentI}

% put some stuff somewhere
\NDPput[x=1.2, y=75, RefPoint=br]{text}
\NDPput[x=1.2, y=100]{ $a^2$ }

% or put nodes...
\NDPput[x=1.6, y=100]{\pnode{A}}
\NDPput[x=1.8, y=150]{\pnode{B}}
% ...and draw a line between them
\ncline{A}{B}

% or put the legend at a specific position
\NDPput[x=1.8, y=75]{\LegendDefinition{
\LegLine{style=StdLineStyleA} & IdentI
}}
\end{NumericDataPlot}

```



Alternatively, stuff can be placed within the plot with `\rput`.

```

\begin{NumericDataPlot}
  {\textwidth}{5cm}
\setxAxis
  {xMin=1, xMax=1.6, Dx=0.2}
\setyAxis
  {yMin=50, yMax=150, Dy=25}

\plotxAxis{x-axis label}
\plotyAxis[NoLabel]{}

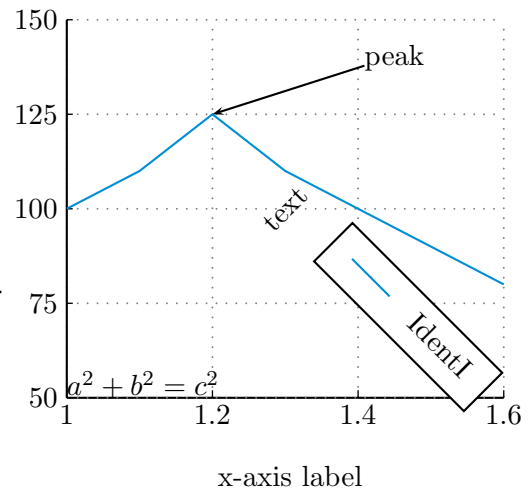
\listplot[style=StdLineStyleA]
  {\IdentI}

% put text in the middle of the plot
\rput{45}(500,500){text}
% put a formula in the lower left corner
\rput[b1](0,0){$a^2+b^2=c^2$}

% or put nodes...
\NDPput[x=1.2, y=125]{\pnode{A}}
\rput(750,900){\Rnode{B}{peak}}
% ...and draw a line between them
\ncline{<-}{A}{B}

% or put the legend at a specific position
\rput{-45}(750,250){\LegendDefinition{
\LegLine{style=StdLineStyleA} & IdentI
}}
\end{NumericDataPlot}

```



1.4. Line Styles

1.5. Legend

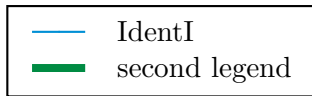
The legend may be created with `\LegendDefinition`. The command takes the two optional arguments `nrCols` and `LabelOrientation=[l|c|r]`. The mandatory argument is the definition of a table as demonstrated in the following examples.

```

\LegendDefinition{
\LegLine{style=StdLineStyleA} & IdentI\
\LegLine{style=StdLineStyleB, linewidth=3pt} & second legend

```

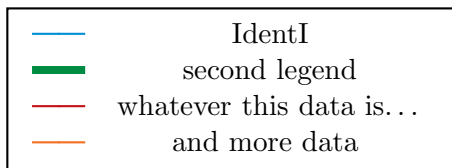
}



```
\LegendDefinition[nrCols=2]{  
\LegLine{style=StdLineStyleA} & IdentI &  
\LegLine{style=StdLineStyleB, linewidth=3pt} & legend 2  
}
```



```
\LegendDefinition[LabelOrientation=c]{  
\LegLine{style=StdLineStyleA} & IdentI\\  
\LegLine{style=StdLineStyleB, linewidth=3pt} & legend 2 \\  
\LegLine{style=StdLineStyleC} & whatever this data is\ldots\\  
\LegLine{style=StdLineStyleD} & and more data  
}
```



1.6. Add Lines to the Plot

Horizontal and vertical lines may be added to the plot with the commands `\NDPhline{coord}` and `\NDPvline{coord}`. It is also possible to put nodes and draw lines between them, see placing stuff...


```

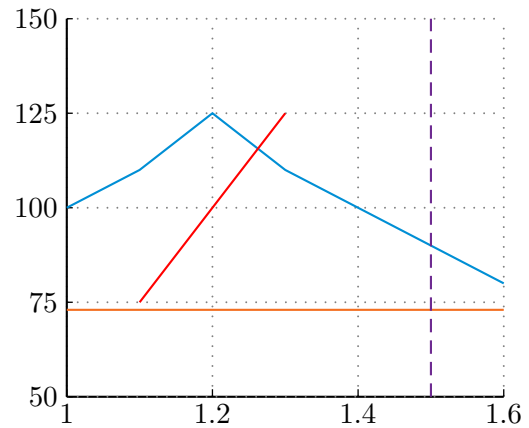
\begin{NumericDataPlot}
  {\textwidth}{5cm}
\setxAxis
  {xMin=1, xMax=1.6, Dx=0.2}
\setyAxis
  {yMin=50, yMax=150, Dy=25}

\plotxAxis[NoLabel]{}
\plotyAxis[NoLabel]{}

\listplot[style=StdLineStyleA]
  {\IdentI}

\NDPhline[linecolor=LineColorD]{73}
\NDPvline[linecolor=LineColorE, linestyle=dashed]{1.5}
\NDPline[linecolor=red]{1.1}{75}{1.3}{125}
\end{NumericDataPlot}

```



1.7. Grid

One may choose not to plot the grid with the option `NoGrid` for the commands `\plotxAxis` and `\plotyAxis`.

If the grid is plotted with the axis it may happen that the grid is plotted over the axis. To avoid this, plot the grid first and then plot the axis as shown.

```

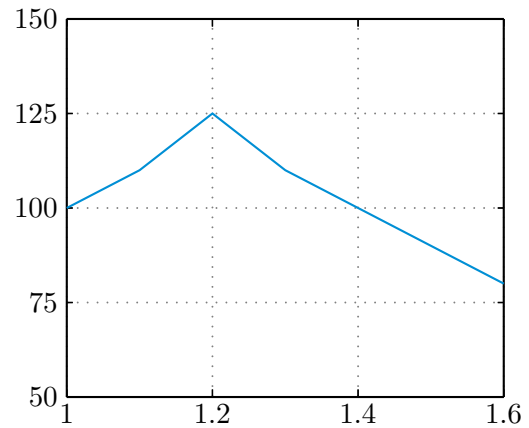
\begin{NumericDataPlot}
  {\textwidth}{5cm}
\setxAxis
  {xMin=1, xMax=1.6, Dx=0.2}
\setyAxis
  {yMin=50, yMax=150, Dy=25}

\plotxGrid
\plotyGrid
\plotxAxis
[NoLabel, NoGrid, AxisStyle=Boxed]{}
\plotyAxis
[NoLabel, NoGrid, AxisStyle=Boxed]{}

\listplot[style=StdLineStyleA]
  {\IdentI}

\end{NumericDataPlot}

```



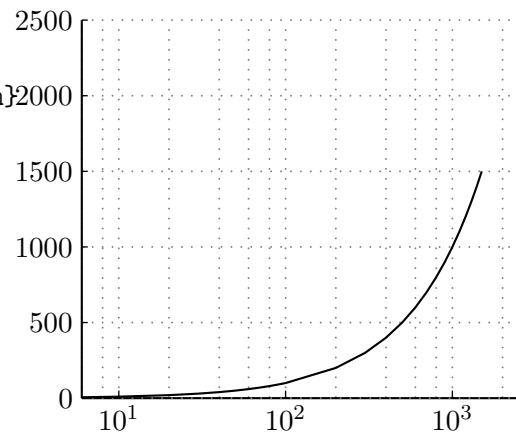
1.8. Logarithmic axes

```

\begin{NumericDataPlot}{\textwidth}{5cm}
\setxAxis
  {xMin=6, xMax=2500, Dx=10, xLog}
\setyAxis
  {yMin=0, yMax=2500, Dy=500}
\plotxAxis{}
\plotyAxis{}

\listplot{\LogData}
\end{NumericDataPlot}

```

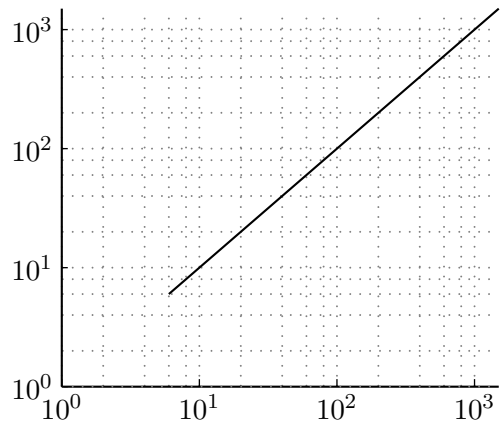


```

\begin{NumericDataPlot}{\textwidth}{5cm}
\setxAxis
  {xMin=1, xMax=1500, Dx=10, xLog}
\setyAxis
  {yMin=1, yMax=1500, Dy=10, yLog}
\plotxAxis{}
\plotyAxis{}

\listplot{\LogData}
\end{NumericDataPlot}

```



1.9. export2latex.m

The function `export2latex(data, filename, [options])` may be used to export data from Matlab to be used with `NumericPlots.sty`. The function takes the two parameters `data` and `filename`, where `filename` is the name of the file where the data should be stored with full path but without extension. `data` is a structure with the three entries `x`, `y`, and `ident`, where `x` are the x-data, `y` the y-data and `ident` is an identifier to have access to the data in Latex. To access the data in Latex the command `\Data<ident>` is used.

The parameter `data` may be provided as an `1xK` array if each entry of the array is a structure with the entries `x`, `y` and `ident`. There may be an additional entry `descr`.

- `data(1,i).x = Xi`
- `data(1,i).y = Yi`
- `data(1,i).ident = Identifier`
- `(data(1,i).descr = Description)`

Identifier must be a valid Latex command name, which basically means it must be a string without numbers.

For every entry of `data`, `X` and `Y` must be arrays of the same size $M \times N$. If $M > 1$, each column of the array is exported to the file and the identifier is expanded by the roman representation of the column number.

It might be useful to do a `interp1` before exporting the data to get smaller files and to use less of T_EX's memory. (→ script Patrick!?)

The optional parameter `options` might be used to control which additional information is provided in the output file.

- `options.DataBoundaries` [true] If set to true, the output file contains the commands `\DataXmin`, `\DataXmax`, `\DataYmin` and `\DataYmax` which may be used to define the axis.
- `options.AxisBoundaries` [false] If set to true, the output file contains the commands `\DataXminAxis`, `\DataXmaxAxis`, `\DataYminAxis` and `\DataYmaxAxis` which may be used to define the axis. In contrary to the `DataBoundaries` the `AxisBoundaries` add an additional gap of `options.AxisBoundariesGap` [10] percent of the full scale to the data boundaries such that the plot doesn't touch the axis.

2. Multiple plots in one picture

`xPicMin`, `xPicMax`, `yPicMin` and `yPicMax` are the inner coordinates of one picture. The position of the axes are defined in this coordinate system via `xCoordMin`, `xCoordMax`, `yCoordMin` and `yCoordMax`.

Example:

```
% input data and define linestyles
\input{DataTestRealData}
\newsstyle{Database}{linecolor=LineColorA, linestyle=none, dotstyle=*,
showpoints=true, dotsize=5pt}
\newsstyle{Result}{linecolor=LineColorB, linestyle=none, dotstyle=+,
showpoints=true, dotsize=10pt}

\begin{center}
\begin{NumericDataPlot}[xPicMin=0, xPicMax=1050,
yPicMin=0, yPicMax=1450]{\textwidth}{0.75\textheight}

% --- definition of the axis and the grid ---
% set the axis of the lower left corner
\setxAxis{xMin=2, xMax=17, Dx=4, xCoordMin=0, xCoordMax=500}
\setyAxis{yMin=20, yMax=70, Dy=20, yCoordMin=0, yCoordMax=500}

% plot the axis of the lower left corner
\plotxAxis{Stichnummer}
\plotyAxis{$F_{roll}$ in $\mega\newton$}

\listplot[style=Database]{\DataDBforce}
\listplot[style=Result]{\DataRESforce}
\listplot[style=StdLineStyleC]{\DataDBforceC}
\listplot[style=StdLineStyleD]{\DataDBforceD}
\listplot[style=StdLineStyleE]{\DataDBforceE}
\listplot[style=StdLineStyleF]{\DataDBforceF}
\listplot[style=StdLineStyleG]{\DataDBforceG}

% set the y-axis for the plot in the middle of the left side
% x-axis remains the same
\setyAxis{yMin=20, yMax=70, Dy=20, yCoordMin=550, yCoordMax=1050}
% plot the axis (x-axis without ticklabels and label
\plotxAxis[NoTickLabel, NoLabel]{}
\plotyAxis{$F_{roll}$ in $\mega\newton$}
```

```

\rput[t]{0}(250,550){a) Ein plot}

\listplot[style=Database]{\DataDBforce}
\listplot[style=Result]{\DataRESforce}

% set axis for the plot at the right side
\setxAxis{xMin=2, xMax=17, Dx=4, xCoordMin=600, xCoordMax=1050}
\setyAxis{yMin=20, yMax=70, Dy=10, yCoordMin=0, yCoordMax=1050}

% plot the axis at the right side (y-axis without label)
\plotxAxis{Stichnummer}
\plotyAxis[NoLabel, TickSep=10]{ $F_{\text{roll}}$  in  $\text{mega}\text{newton}$ }

\listplot[style=Database]{\DataDBforce}
\listplot[style=Result]{\DataRESforce}
\listplot[style=StdLineStyleC]{\DataDBforceC}
\listplot[style=StdLineStyleD]{\DataDBforceD}
\listplot[style=StdLineStyleE]{\DataDBforceE}
\listplot[style=StdLineStyleF]{\DataDBforceF}
\listplot[style=StdLineStyleG]{\DataDBforceG}

% set the axis for the plot at the top
\setxAxis{xMin=8, xMax=17, Dx=1, xCoordMin=0, xCoordMax=1050}
\setyAxis{yMin=35, yMax=65, Dy=10, y0=40, yCoordMin=1150, yCoordMax=1450}

% plot the axis for the plot at the top
\plotxAxis[NoLabel]{Stichnummer}
\plotyAxis[NoLabel]{ $F_{\text{roll}}$  in  $\text{mega}\text{newton}$ }

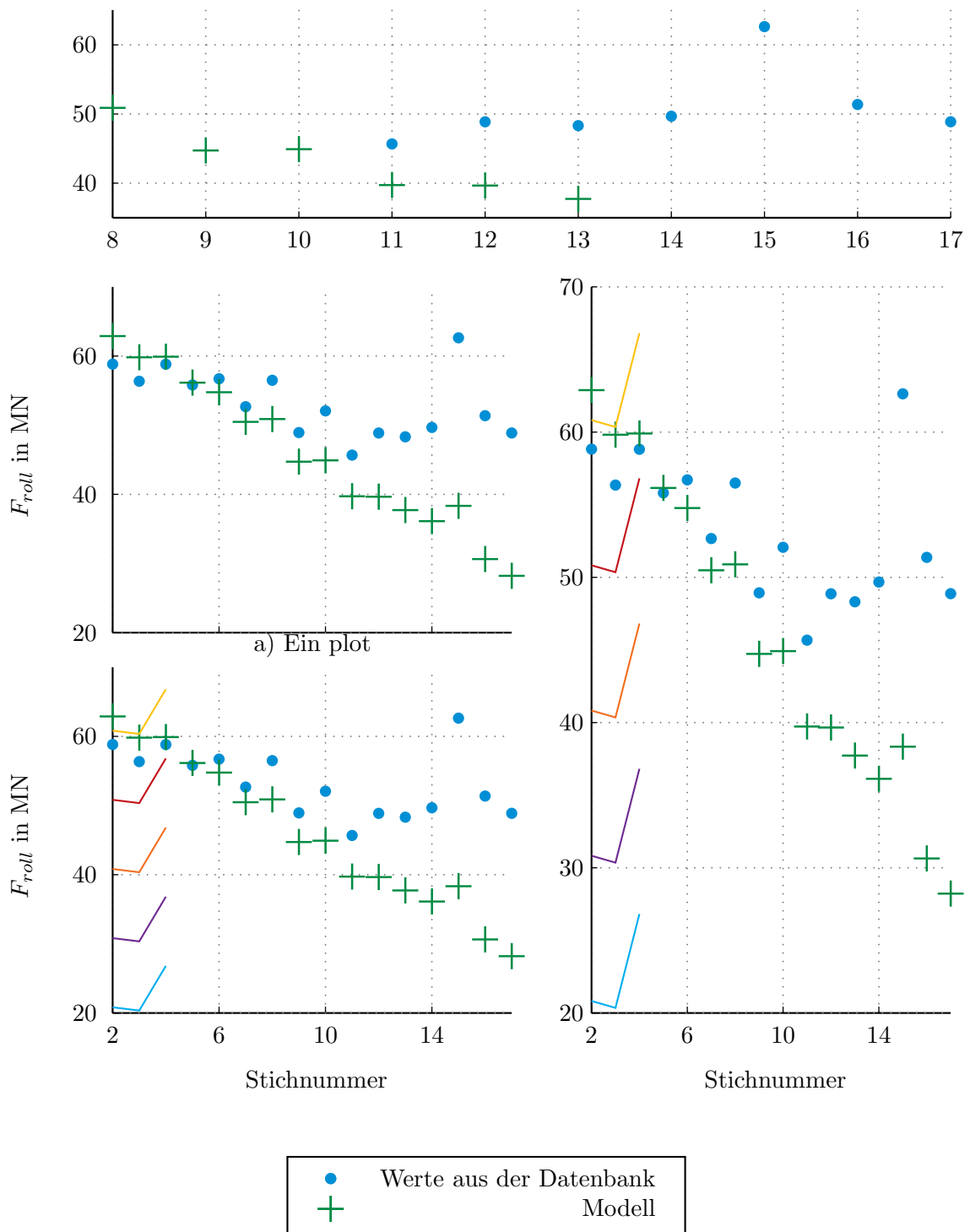
% plot only part of the data
\listplot[style=Database, xStart=11, xEnd=17]{\DataDBforce}
\listplot[style=Result, xStart=8, xEnd=13]{\DataRESforce}

\end{NumericDataPlot}

% put legend outside of the plot
\LegendDefinition[nrCols=1, LabelOrientation=r]{
\LegLine{Database} & Werte aus der Datenbank \\
\LegLine{Result} & Modell}

\end{center}

```



3. package options

4. list of commands and options

5. Options

5.1. General

These are the options for the environment `NumericDataPlot`.

- `xPicMin [0], yPicMin[0], xPicMax[1000], yPicMax[1000]`
- `TickLength [2]` defines the length of the ticks in mm
- `llx[-1.5cm], lly[-1.25cm], urx[2pt], ury[2pt]`

6. Technical Details

This section should just give some hints how to use the different coordinate system.

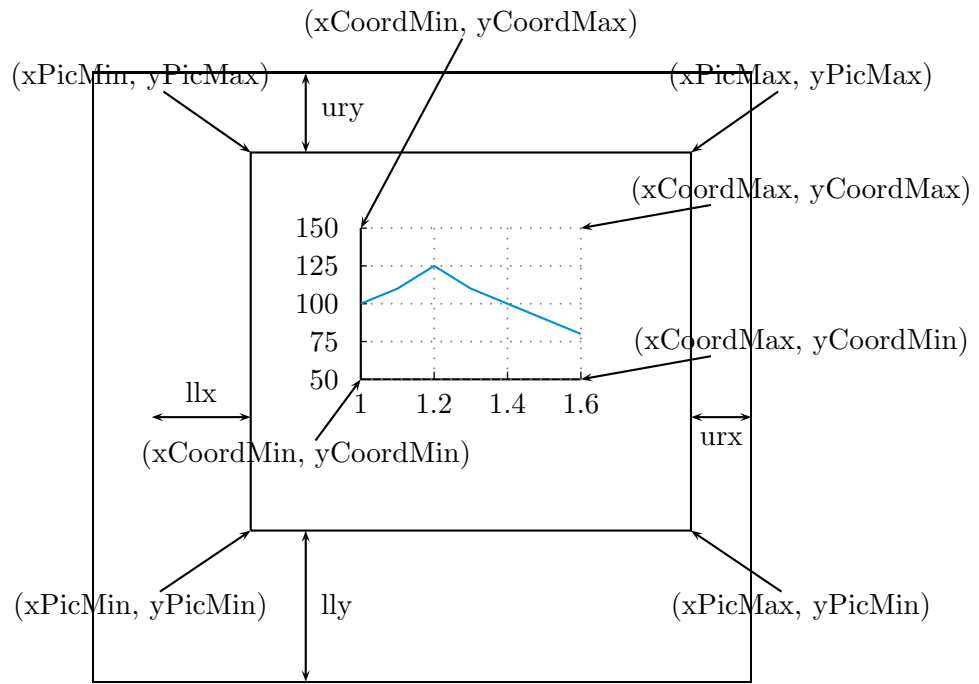
A new plot is created with the environment `NumericDataPlot`. The options are illustrated in the following example.

```
\begin{NumericDataPlot}
[xPicMin=300, xPicMax=700]
  {\textwidth}{5cm}
\setxAxis
  {xMin=1, xMax=1.6, Dx=0.2}
\setyAxis
  {yMin=50, yMax=150, Dy=25}

\plotxAxis[NoLabel]{}
\plotyAxis[NoLabel]{}

\listplot[style=StdLineStyleA]
  {\IdentI}

\NDPhline[linecolor=LineColorD]{73}
\NDPvline[linecolor=LineColorE, linestyle=dashed]{1.5}
\end{NumericDataPlot}
```

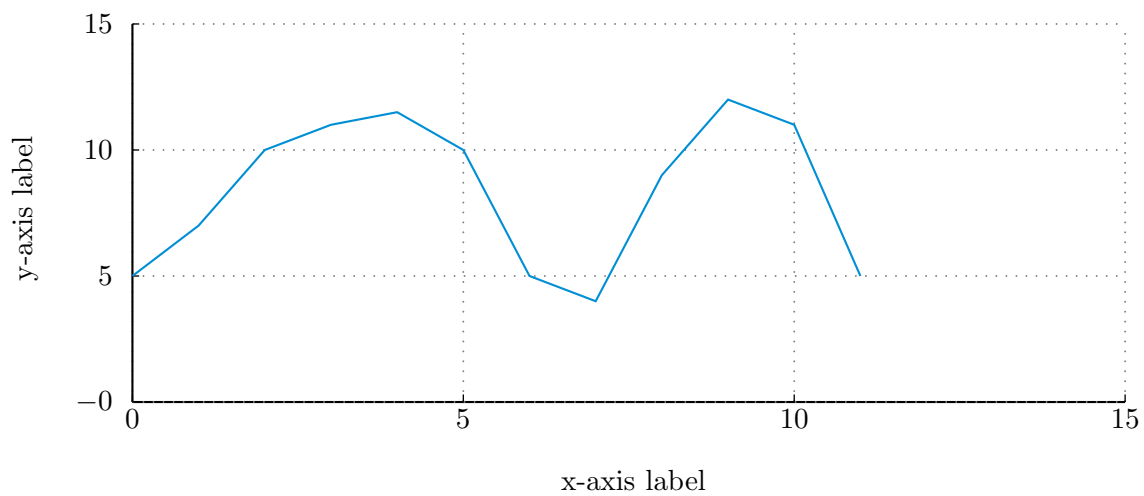
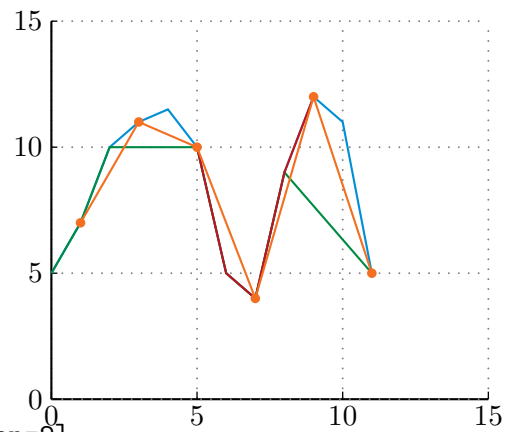


Part III.

Examples

7. Further Examples

```
\listplot  
[style=StdLineStyleA]  
{\MoreData}  
\listplot  
[style=StdLineStyleB, yEnd=10]  
{\MoreData}  
\listplot  
[style=StdLineStyleC, xStart=5, xEnd=9]  
{\MoreData}  
\listplot  
[style=StdLineStyleD, showpoints=true, nStep=2]  
{\MoreData}
```



7.1. Fill area between plots

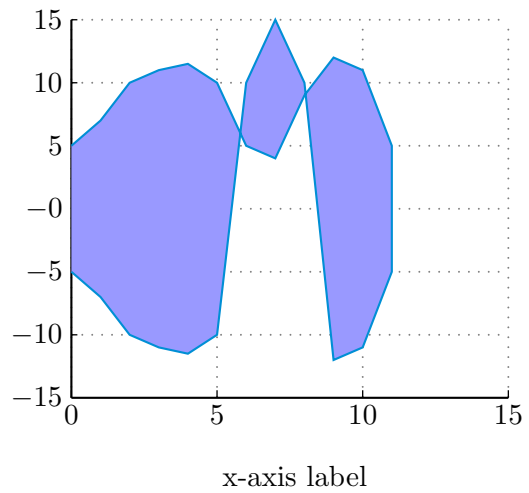
```

\begin{NumericDataPlot}%
{\textwidth}{5cm}
\setxAxis
{xMin=0, xMax=15, Dx=5, x0=0}
\setyAxis
{yMin=-15, yMax=15, Dy=5, y0=10}

\plotxAxis{x-axis label}
\plotyAxis[NoLabel]{}

\pscustom%
[style=StdLineStyleA, fillstyle=solid, %
fillcolor=blue!40]{%
\listplot{\MoreData}%
\listplot[ChangeOrder]{\MoreDataI}%
}
\end{NumericDataPlot}

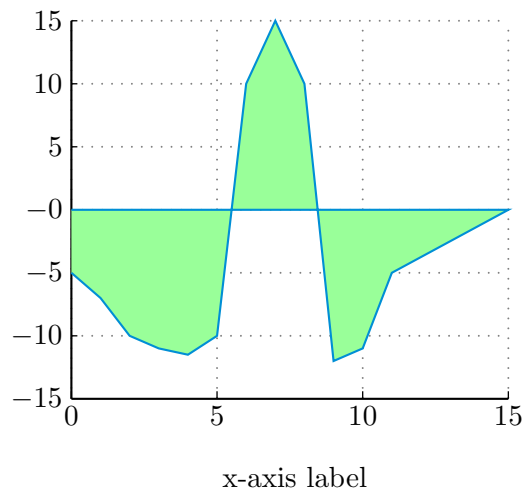
```



```

...
\pscustom%
[style=StdLineStyleA, fillstyle=solid, %
fillcolor=green!40]{%
\NDPhline{0}
\listplot[ChangeOrder]{\MoreDataI}%
}
...

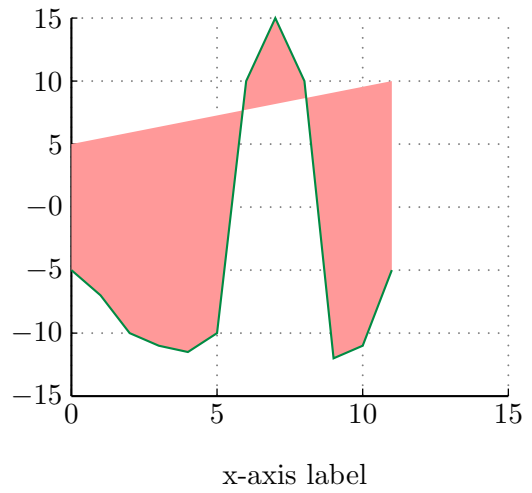
```



```

...
\pscustom%
[style=StdLineStyleA, fillstyle=solid, %
fillcolor=red!40]{%
\NDPline{0}{5}{11}{10}
\listplot[ChangeOrder]{\MoreDataI}%
}
...

```



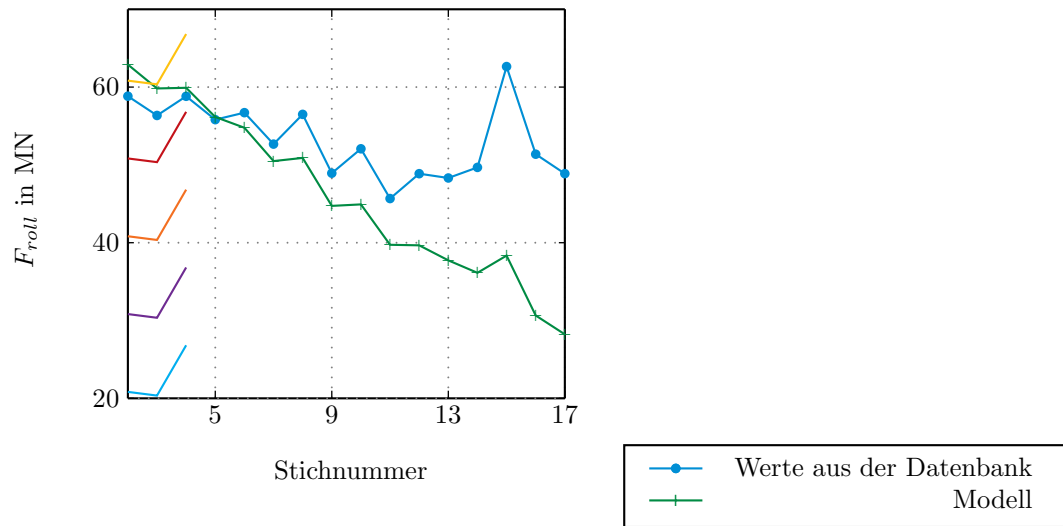


Figure 1: Test.

8. Some test plots

Part IV.

Version

9. History

- 18.05.2010
 - added LabelOption to plotAxis
 - added TickLabelOption to plotAxis
 - added possibility to change StdLabelOption
 - added possibility to change StdTickLabelOption
- 11.06.2010
 - expanded documentation
 - changed the command LegLine.
 - added the commands `plotxGrid` and `plotyGrid`. The grids may now be plotted before the axis to avoid overlapping of the grid and the axis.
- 17.06.2010
 - changed `export2latex`: check for the necessary precision before exporting the data
- 21.06.2010
 - added option for logarithmic axes
- 05.07.2010
 - added command `NDPline`
 - added instructions to fill areas between plots to documentation
- 03.08.2010

- added options to `export2latex.m`
- 05.08.2010
 - new calculation of tick lengths
 - length of the ticks may now be given in mm, see 5.1