



More
PGFplots

Jennifer Wang

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to 3D plots
using
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Draw backs of
using
PGFPLOTS
for three
dimensional
plots

`addplot3[option]`
data;

reading in a
set of
coordinates as
input

reading in a
math
expression as
input

reading in a
file as input

More PGFplots

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July 26, 2010



Introduction to 3D plots using PGFPLOTS

Why using PGFPLOTS for 3D plots

- Consistent fonts
- Consistent styles
- High-quality outputs

Draw backs of using PGFPLOTS for three dimensional plots

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- PGFPLOTS' three dimensional routines are slow.
- The plot complexity of three dimensional plots is limited to relatively coarse resolutions.
- PGFPLOTS supports z buffering techniques up to a certain extend.



`addplot3 [options]{input data};`

The `addplot3` command accepts the same input methods as the `addplot` variant, including coordinates, expression plotting, files and tables.



`\addplot3 coordinates {...};`

coordinates in form of matrix
seperated by a line space

Code

```
\begin{tikzpicture}
\begin{axis}
\addplot[surf] coordinates{
(0,0,0) (1,0,0) (2,0,0) (3,0,0)

(0,1,0) (1,1,0.6) (2,1,0.7) (3,1,0.5)

(0,2,0) (1,2,0.7) (2,2,0.8) (3,2,0.5)
};
\end{axis}
\end{tikzpicture}
```



`\addplot3` coordinates {...};

coordinates in form of matrix
seperated by `\par`

Code

```
\begin{tikzpicture}
\begin{axis}
\addplot[surf] coordinates{
(0,0,0) (1,0,0) (2,0,0) (3,0,0)\par
(0,1,0) (1,1,0.6) (2,1,0.7) (3,1,0.5)\par
(0,2,0) (1,2,0.7) (2,2,0.8) (3,2,0.5)\par
};
\end{axis}
\end{tikzpicture}
```



`\addplot3` coordinates `{...}`;

coordinates in form of matrix

`mesh \rows = {integer}`

`mesh \cols = {integer}`

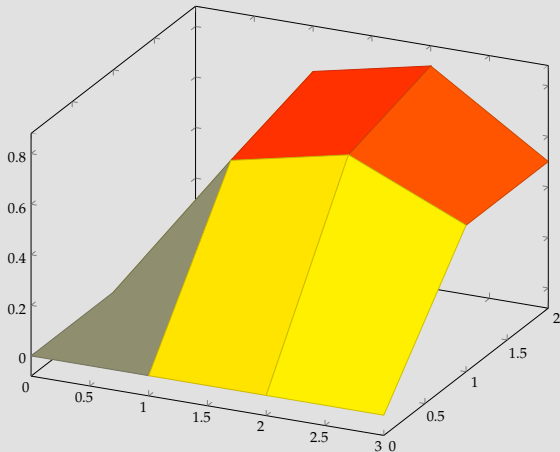
Code

```
\begin{tikzpicture}
\begin{axis}
\addplot3[surf,mesh/rows=3] coordinates{
% this also yields a 3x4 matrix
(0,0,0) (1,0,0) (2,0,0) (3,0,0)
(0,1,0) (1,1,0.6) (2,1,0.7) (3,1,0.5)
(0,2,0) (1,2,0.7) (2,2,0.8) (3,2,0.5)
};
\end{axis}
\end{tikzpicture}
```



`\addplot3 coordinates {...};`

Plot





`\addplot3 {math expression};`

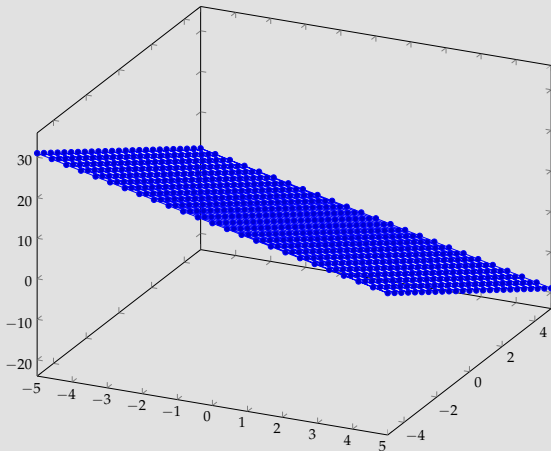
Code

```
\begin{tikzpicture}
  \begin{axis}
    \addplot3{6-2*x-3*y};
  \end{axis}
\end{tikzpicture}
```



```
\addplot3 {math expression};
```

Plot





`\addplot3 {math expression};`

controlling plotting area:

`Interval[x1,x2]: domain`

`Interval[y1,y2]: y domain`

controlling number of samples:

Number of samples in x direction: `samples`

Number of samples in y direction: `samples y`



`\addplot3 {math expression};`

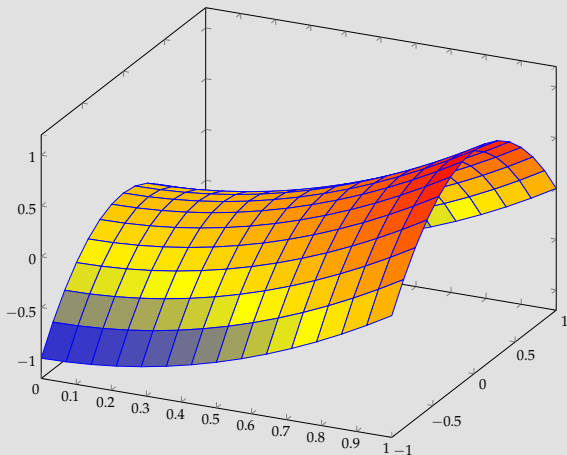
Code

```
\begin{tikzpicture}
\begin{axis}[colorbar]
\addplot3
[surf, faceted color=blue,
samples=15,
domain=0:1, y domain=-1:1]
{x^2 - y^2};
\end{axis}
\end{tikzpicture}
```



```
\addplot3 {math expression};
```

Plot





`\addplot file {file name};`

- generating file by notepad
- saving as .dat file
- needing to have at least 2 columns for 2D and 3 columns for 3D
- lines starting with % and # are ignored



`\addplot file {file name};`

Code

```
\begin{axis}  
\addplot file {plotdata.dat};  
\end{axis}  
\end{tikzpicture}
```

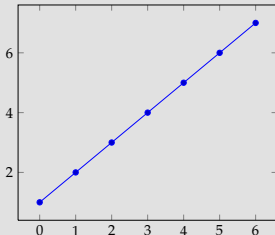
plotdata.dat

```
0 1  
1 2  
2 3  
3 4  
4 5  
6 7
```



`\addplot file {file name};`

Plot





`\addplot table [column selection] {file};`

- `plot table` similar to `plot file` .
- generating file by notepad
- saving as `.dat` file
- multiple columns
- plotting certain columns



`\addplot table [column selection] {file};`

Code

```
\begin{axis}  
\addplot table[x=a,y=c] {plottable.dat};  
\end{axis}  
\end{tikzpicture}
```

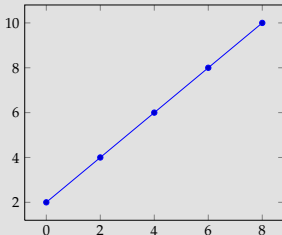
plottable.dat

```
a b c  
0 1 2  
2 3 4  
4 5 6  
6 7 8  
8 9 10
```



`\addplot table [column selection] {file};`

Plot





line plots for coordinates input

generated if input source has no matrix structure

Code

```
\begin{tikzpicture}
\begin{axis}[xlabel=$x$,ylabel=$y$]
\addplot3 coordinates{(0,0,0)(0,0.5,1)(0,1,0)};
\addplot3 coordinates{(0,1,0)(0.5,1,1)(1,1,0)};
\end{axis}
\end{tikzpicture}
```



line plots: generated if input source has no matrix structure

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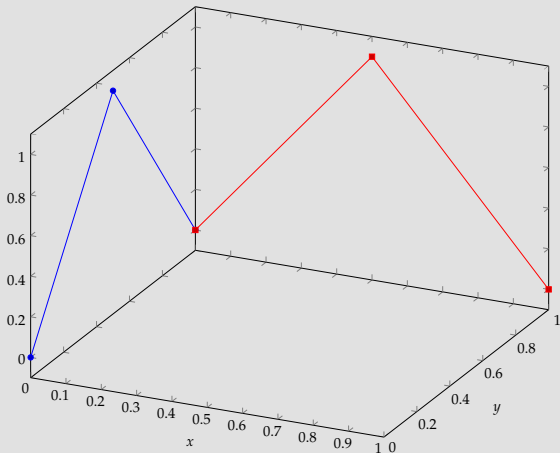
`addplot3[option
data;`

reading in a
set of
coordinates as
input

reading in a
math
expression as
input

reading in a
file as input

Plot





line plots for expression input

set `samples y=0` to disable the generation of a mesh

Code

```
\begin{tikzpicture}
\begin{axis}[view={60}{30}]
\addplot3+[domain=0:5*pi,samples=60,samples y=0]
({sin(deg(x))},
{cos(deg(x))},
{2*x/(5*pi)});
\end{axis}
\end{tikzpicture}
```



line plots for expression input

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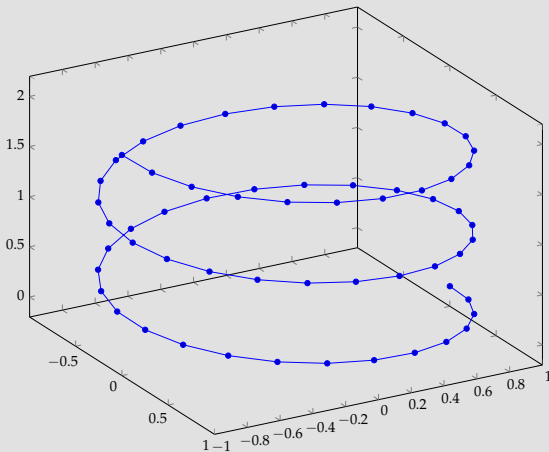
`addplot3[option
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`addplot3[option`
`data;`

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reading in a
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`addplot` + [options] does the same as `addplot` [options];
except that [options] are appended to the arguments which
would have been taken for `addplot` (the element of the
default list).



How does mesh plot work

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`addplot3[option
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- A mesh plot uses different color for each mesh segment. Each mesh segment gets the same color.
- The colour is determined using a color coordinate. In the initial configuration, the color coordinate is the z axis.
- This color coordinate is mapped linearly into the current color map to determine the color for each mesh segment.
- This works the same for surface plots and scatter plots.



addplot3[mesh]

Code

```
\begin{tikzpicture}  
\begin{axis}[colorbar]  
\addplot3[mesh] {x^2};  
\end{axis}  
\end{tikzpicture}
```



addplot3[mesh]

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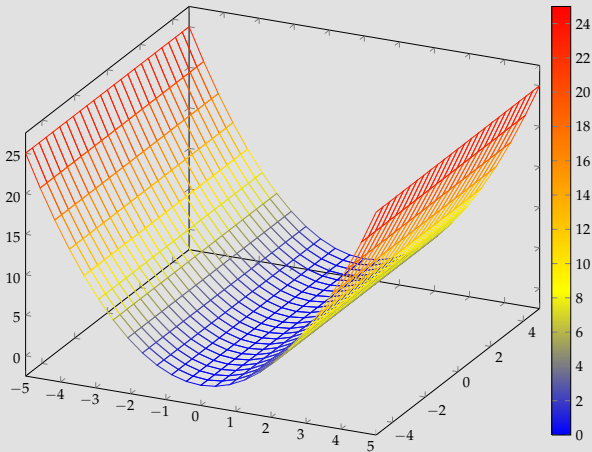
`addplot3[option
data;`

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input

reading in a
file as input

Plot





addplot3[mesh]

A mesh plot can be combined with markers or with the scatter key to draw markers in different colors.

Code

```
\begin{tikzpicture}
\begin{axis}
\addplot3+[mesh, scatter,
           samples=10, domain=0:1]
{x*(1-x)*y*(1-y)};
\end{axis}
\end{tikzpicture}
```



addplot3[mesh]

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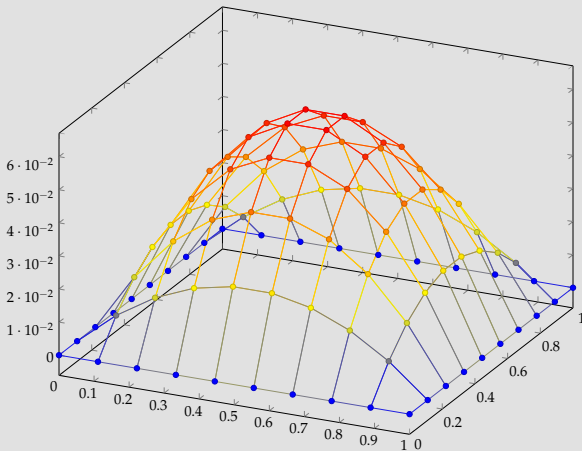
`addplot3[option
data;`

reading in a
set of
coordinates as
input

reading in a
math
expression as
input

reading in a
file as input

Plot





addplot3[surf]

Code

```
\begin{tikzpicture}  
\begin{axis}  
\addplot3[surf, faceted color=blue] {x+y};  
\end{axis}  
\end{tikzpicture}
```



addplot3[surf]

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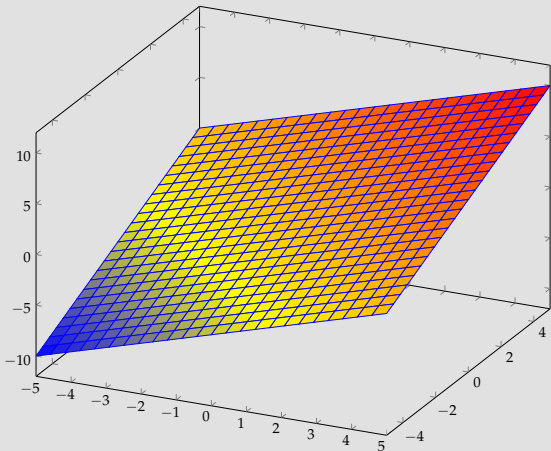
`addplot3[option
data;`

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How does z buffer work

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`addplot3[option
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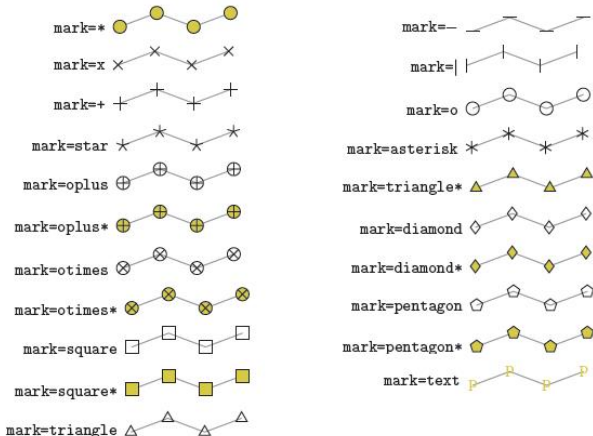
reading in a
math
expression as
input

reading in a
file as input

- A z buffer determines which parts of an image should be drawn in front of other parts.
- The z buffering algorithms of pgfplots apply only to a single `addplot` command. Different `addplot` commands will be drawn on top of each other, in the order of appearance.
- The choice `default` checks if we are currently working with a mesh or surface plot and uses `auto` in this case. If not, it sets `z buffer=none` .
- The choice `none` disables z buffering. This is also the case for two dimensional axes which don't need z buffering.



Different styles of markers





More styles of markers

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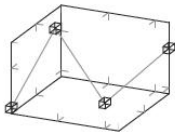
`addplot3[option
data;`

reading in a
set of
coordinates as
input

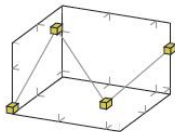
reading in a
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input

reading in a
file as input

`mark=cube`



`mark=cube*`





An example of using different marks

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`addplot3[option
data;`

reading in a
set of
coordinates as
input

reading in a
math
expression as
input

reading in a
file as input

Code

```
\begin{tikzpicture}
\begin{axis}[y=2cm]
\addplot [mark=otimes] coordinates
{(-2,0) (-1,1) (0,0) (1,1) (2,0)};
\end{axis}
\end{tikzpicture}

\tikzset{every mark/.append style={scale=2,
mark=otimes}}
\begin{tikzpicture}
\begin{axis}[y=2cm,mark=otimes]
\addplot coordinates
{(-2,0) (-1,1) (0,0) (1,1) (2,0)};
\end{axis}
\end{tikzpicture}
```



An example of using different marks

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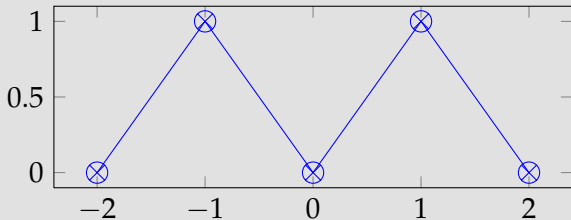
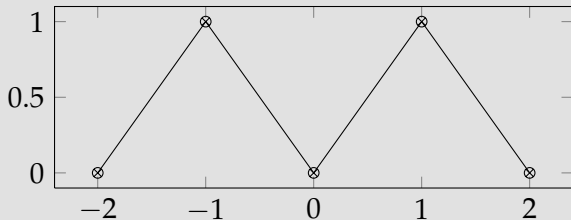
`addplot3[option
data;`

reading in a
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input

reading in a
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expression as
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reading in a
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Plot





Different styles of lines

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addplot3[option
data;

reading in a
set of
coordinates as
input

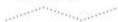
reading in a
math
expression as
input

reading in a
file as input

`/tikz/solid`



`/tikz/dotted`



`/tikz/densely dotted`



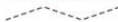
`/tikz/loosely dotted`



`/tikz/dashed`



`/tikz/densely dashed`



`/tikz/loosely dashed`





An example of using different line styles

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`addplot3[option
data;`

reading in a
set of
coordinates as
input

reading in a
math
expression as
input

reading in a
file as input

Code

```
\begin{tikzpicture}
\begin{axis}[y=2cm]
\addplot[mark=otimes,dashed] coordinates
{(-2,0) (-1,1) (0,0) (1,1) (2,0)};
\end{axis}
\end{tikzpicture}
```



An example of using different line styles

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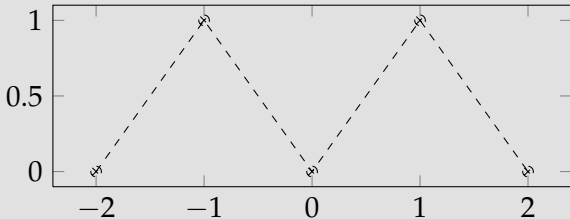
`addplot3[option
data;`

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reading in a
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Line width

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`addplot3[option`
`data;`

reading in a
set of
coordinates as
input

reading in a
math
expression as
input

reading in a
file as input

- thin
- ultra thin
- very thin
- semithick
- thick
- very thick
- ultra thick



Font size

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`addplot3[option
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reading in a
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expression as
input

reading in a
file as input

- Sets the font which is to be used for text in nodes (like tick labels, legends or descriptions).
- A font can be any L^AT_EX argument like `footnotesize` or `small \bfseries`.



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- The package `xcolor` defines a set of predefined colors, namely red, green, blue, cyan, magenta, yellow, black, gray, white, darkgray, lightgray, brown, lime, olive, orange, pink, purple, teal, violet.
- Besides predefined colors, it is possible to mix two (or more) colors. For example, `red!30!white` contains 30% of red and 70% of white. Consequently, one can build `red!70!white` to get 70% red and 30% white or `red!10!white` for 10% red and 90% white.
- A different type of color mixing is supported, which allows to take 100% of each component. For example, `rgb,2:red,1;green,1` will add 1/2 part red and 1/2 part green.



Color Maps

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- By using commands `colormap name = {color map name}` or `colormap \a` kind of colormap, it changes the current color map to the already defined map named.
- The predefined color map is hot.



Different color maps

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reading in a
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reading in a
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- hot



- bluered

- cool

- greenyellow

- redyellow

- violet

- blackwhite



An example of using a different axis background

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`addplot3[option
data;`

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set of
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expression as
input

reading in a
file as input

Code

```
\begin{tikzpicture}
\begin{axis}[
axis background/.style={fill=red!30!white}]
\addplot3[surf,y domain=0:1]
{sin(deg(x)) * y*(1-y)};
\end{axis}
\end{tikzpicture}
```



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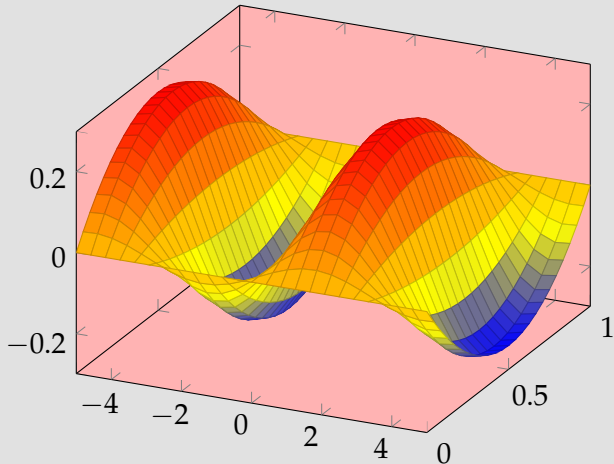
`addplot3[option
data;`

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file as input

Plot





`width={ }`

Sets the width of the final picture to `{ }`. If no height is specified, scaling will respect aspect ratios.

Code

```
\begin{tikzpicture}
\begin{axis} [width=3cm]
\addplot3{6-2*x-3*y};
\end{axis}
\end{tikzpicture}

\begin{tikzpicture}
\begin{axis} [width=6cm]
\addplot3{6-2*x-3*y};
\end{axis}
\end{tikzpicture}
```



width={ }

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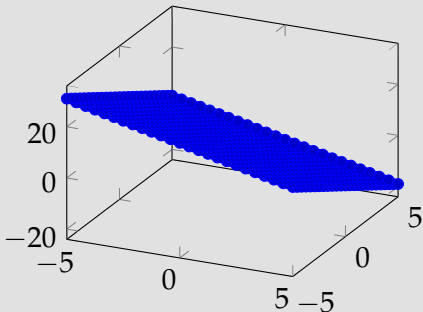
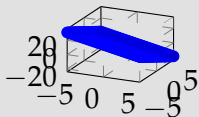
`addplot3[option
data;`

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file as input

Plot





scale={number}

width={ } only affects the width of one unit in x-direction or the height for one unit in y-direction. Axis labels and tick labels won't be resized.

We can use the `scale={number}` option to scale the complete picture.

Code

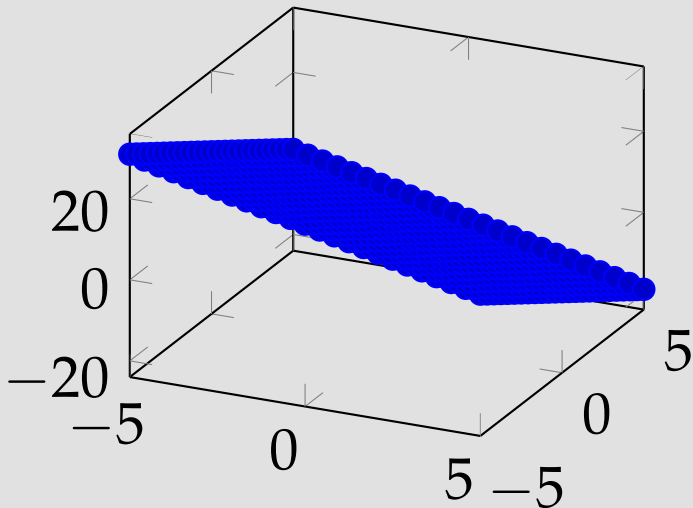
```
\begin{tikzpicture}[scale=2]
\begin{axis}
\addplot3{6-2*x-3*y};
\end{axis}
\end{tikzpicture}

\begin{tikzpicture}
\begin{axis}
\addplot3{6-2*x-3*y};
\end{axis}
\end{tikzpicture}
```



scale={number}

Plot scale=2





scale={number}

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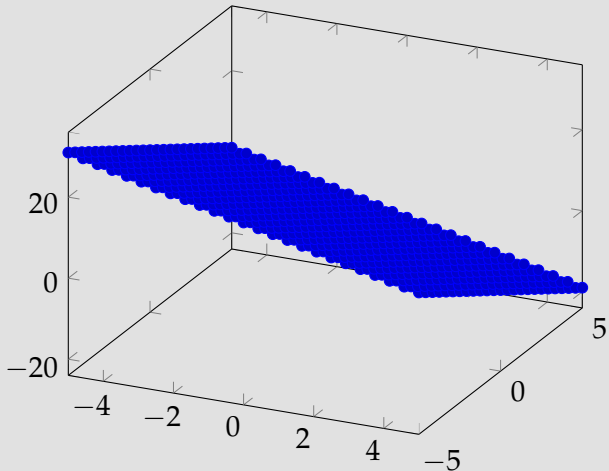
`addplot3[option
data;`

reading in a
set of
coordinates as
input

reading in a
math
expression as
input

reading in a
file as input

Plot no scaling





3D view configuration

More
PGFplots

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file as input

- use command `view = { azimuth } { elevation }`.
- The azimuth (first argument) is the horizontal angle which is rotated around the z axis.
- The elevation (second argument) is the vertical rotation around the (rotated) x axis.
- Default value is `{25}{30}`.



`view = { azimuth } { elevation }`

Code

```
\begin{tikzpicture}
\begin{axis}[view={0}{0},
xlabel=$x$,
ylabel=$z$,
title=View along the positive $y$ axis]
\addplot3[surf] {x};
\end{axis}
\end{tikzpicture}
```



$\text{view} = \{ \text{azimuth} \} \{ \text{elevation} \}$

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`addplot3[option
data;`

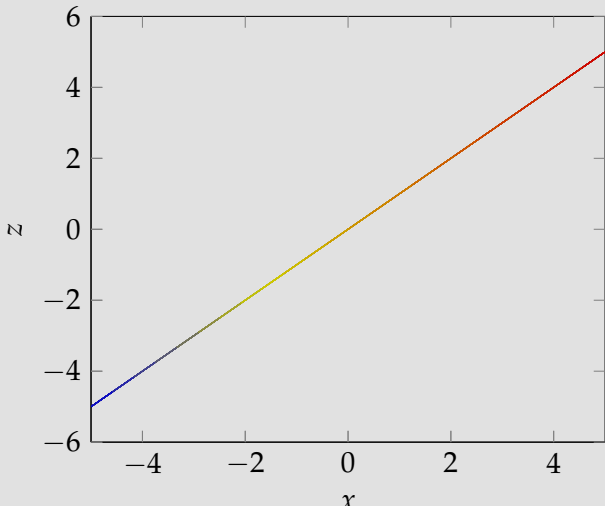
reading in a
set of
coordinates as
input

reading in a
math
expression as
input

reading in a
file as input

Plot

View along the positive y axis





`view = { azimuth } { elevation }`

Code

```
\begin{tikzpicture}
\begin{axis}[view={0}{90},
xlabel=$x$,
ylabel=$y$,
title=View from top]
\addplot3[surf] {x};
\end{axis}
\end{tikzpicture}
```



$\text{view} = \{ \text{azimuth} \} \{ \text{elevation} \}$

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data;`

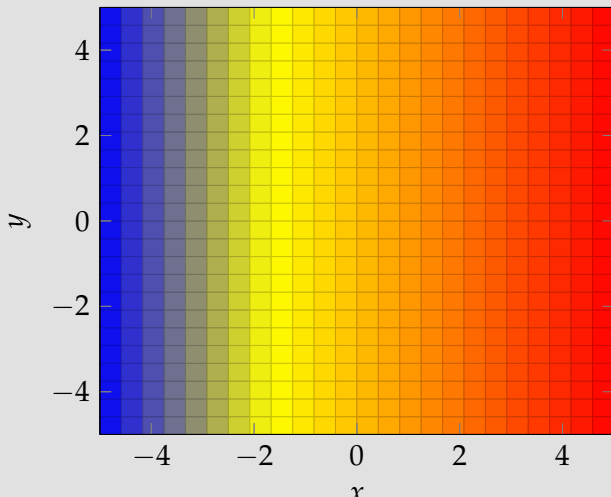
reading in a
set of
coordinates as
input

reading in a
math
expression as
input

reading in a
file as input

Plot

View from top





`view = { azimuth } { elevation }`

Code

```
\begin{tikzpicture}
\begin{axis}[view={-45}{45},
xlabel=$x$,ylabel=$y$,zlabel=$z$]
\addplot3[surf] {x};
\end{axis}
\end{tikzpicture}
```



view = { azimuth } { elevation }

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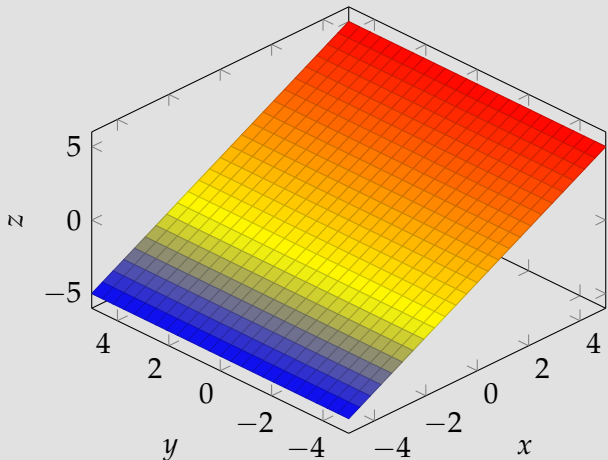
`addplot3[option
data;`

reading in a
set of
coordinates as
input

reading in a
math
expression as
input

reading in a
file as input

Plot





3D view configuration

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file as input

- use `view \h = { }` to change only horizontal rotating angle.
- use `view \v = { }` to change only vertical rotating angle.



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`addplot3[option`
`data;`

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math
expression as
input

reading in a
file as input

Questions