1 3D Tools

TikZ Library 3dtools

```
\usetikzlibrary{3dtools} % LaTeX and plain TeX
\usetikzlibrary[3dtools] % ConTeXt
```

This library provides additional tools to create 3d–like pictures.

TikZ has the `3d` and `tpp` libraries which deal with the projections of three–dimensional drawings. This library provides some means to manipulate the coordinates. It supports linear combinations of vectors, vector and scalar products. **Note:** Hopefully this library is only temporary and its contents will be absorbed in slightly extended versions of the `3d` and `calc` libraries.

1.1 Coordinate computations

The `3dtools` library has some options and styles for coordinate computations.

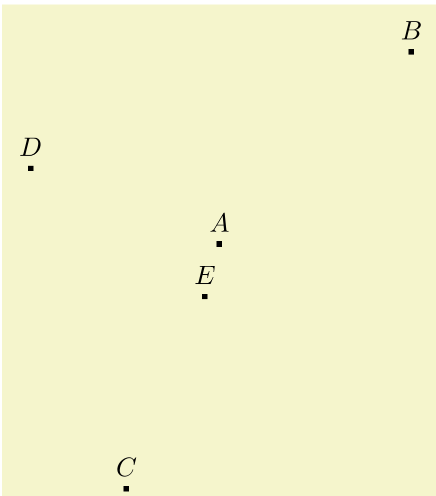
`/tikz/3d parse` (no value)

Parses and expression and inserts the result in form of a coordinate.

`/tikz/3d coordinate` (no value)

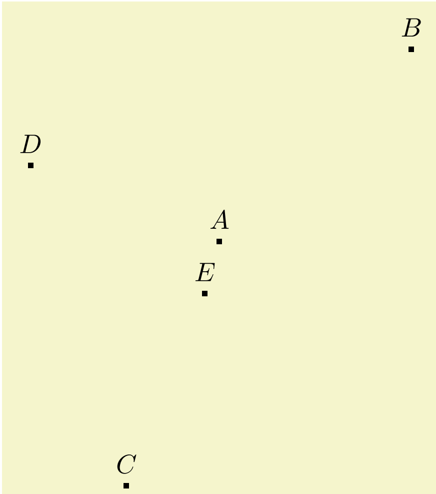
Allow one to define a 3d coordinate from other coordinates.

Both keys support both symbolic and explicit coordinates.




```
\begin{tikzpicture}
 \path (1,2,3) coordinate (A)
  (2,3,-1) coordinate (B)
  (-1,-2,1) coordinate (C)
  [3d parse={0.25*(1,2,3)x(B)}]
  coordinate(D)
  [3d parse={0.25*(C)x(B)}]
  coordinate(E);
 \path foreach \X in {A,...,E}
 {(\X) node[fill,inner sep=1pt,
 label=above:$\X$]{}};
\end{tikzpicture}
```

Notice that, as of now, only the syntax `\path (1,2,3) coordinate (A);` works, i.e. `\coordinate (A) at (1,2,3);` does *not* work, but leads to error messages.




```
\begin{tikzpicture}
 \path (1,2,3) coordinate (A)
  (2,3,-1) coordinate (B)
  (-1,-2,1) coordinate (C)
  [3d coordinate={(D)=0.25*(1,2,3)x(B)},
  3d coordinate={(E)=0.25*(C)x(B)}];
 \path foreach \X in {A,...,E}
 {(\X) node[fill,inner sep=1pt,
 label=above:$\X$]{}};
\end{tikzpicture}
```

The actual parsings are done by the function `\pgfmathtdparse` that allows one to parse 3d expressions. The supported vector operations are `+` (addition $+$), `-` (subtraction $-$), `*` (multiplication of the vector by a scalar), `x` (vector product $\times$) and `o` (scalar product).

`\pgfmathtdparse{`$\langle x\rangle$`}`

Parses 3d expressions.

0.0,0.0,1.0

```
\pgfmathtdparse{(1,0,0)x(0,1,0)}\pgfmathresult
```

In order to pretty-print the result one may want to use `\pgfmathprintvector`, and use the math function `TD` for parsing.

`\pgfmathprintvector{`$\langle x\rangle$`}`

Pretty-prints vectors.

$0.2\,\vec A-0.3\,\vec B+0.6\,\vec C=(-1,-1.7,1.5)$

```
\pgfmathparse{TD("0.2*(A)
-0.3*(B)+0.6*(C)")}%
$0.2\,\vec A-0.3\,\vec B+0.6\,\vec C
=(\pgfmathprintvector\pgfmathresult)$
```

The alert reader may wonder why this works, i.e. how would Ti*k*Z “know” what the coordinates A, B and C are. It works because the coordinates in Ti*k*Z are global, so they get remembered from the above example.

$(1,0,0)^T\times(0,1,0)^T=(0,0,1)^T$

```
\pgfmathparse{TD("(1,0,0)x(0,1,0)")}%
$(1,0,0)^T\times(0,1,0)^T=
(\pgfmathprintvector\pgfmathresult)^T$
```

$\vec A\cdot\vec B=5$

```
\pgfmathparse{TD("(A)o(B)")}%
$\vec A\cdot \vec B=
\pgfmathprintnumber\pgfmathresult$
```

Notice that, as of now, the only purpose of brackets `(...)` is to delimit vectors. Further, the addition `+` and subtraction `-` have a *higher* precedence than vector products `x` and scalar products `o`. That is, `(A)+(B)o(C)` gets interpreted as $(\vec{A}+\vec{B})\cdot\vec{C}$, and `(A)+(B)x(C)` as $(\vec{A}+\vec{B})\times\vec{C}$.

$(\vec{A}+\vec{B})\cdot\vec{C}=-11$

```
\pgfmathparse{TD("(A)+(B)o(C)")}%
$(\vec A+\vec B)\cdot\vec C=
\pgfmathprintnumber\pgfmathresult$
```

$(\vec{A}+\vec{B})\times\vec{C}=(9,-5,-1)$

```
\pgfmathparse{TD("(A)+(B)x(C)")}%
$(\vec A+\vec B)\times\vec C=
(\pgfmathprintvector\pgfmathresult)$
```

Moreover, any expression can only have either one `o` or one `x`, or none of these. Expressions with more of these can be accidentally right.

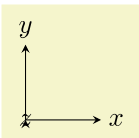
1.2 Orthonormal projections

This library can be used together with the `tikz-3dplot` package. It also has its own means to install orthonormal projections. Orthonormal projections emerge from subjecting 3-dimensional vectors to orthogonal transformations and projecting them to 2 dimensions. They are not to be confused with the perspective projections, which are more realistic and supported by the `tpp` library. Orthonormal projections may be thought of a limit of perspective projections at large distances, where large means that the distance of the observer is much larger than the dimensions of the objects that get depicted.

`/tikz/3d/install view` (no value)

Installs a 3d orthonormal projection.

The initial projection is such that x is right an y is up, as if we had no third direction.




```
\begin{tikzpicture}[3d/install view]
 \draw[-stealth] (0,0,0) -- (1,0,0)
  node[pos=1.2] {$x$};
 \draw[-stealth] (0,0,0) -- (0,1,0)
  node[pos=1.2] {$y$};
 \draw[-stealth] (0,0,0) -- (0,0,1)
  node[pos=1.2] {$z$};
\end{tikzpicture}
```

The 3d-like picture emerge by rotating the view. The conventions for the parametrization of the orthogonal rotations in terms of three rotation angles α, β and γ are

$$O(\alpha,\beta,\gamma)=\begin{pmatrix} s_\alpha\,c_\beta & s_\beta & -s_\alpha\,c_\gamma-c_\alpha\,s_\beta\,s_\gamma \\ c_\alpha\,c_\gamma-s_\alpha\,s_\beta\,s_\gamma & c_\beta\,s_\gamma & s_\alpha\,s_\gamma-c_\alpha\,c_\gamma\,s_\beta \\ -s_\alpha\,s_\beta\,c_\gamma-c_\alpha\,s_\gamma & c_\beta\,c_\gamma & c_\beta\,c_\gamma \end{pmatrix}\,.$$

Here, $c_\alpha:=\cos\alpha$, $s_\alpha:=\sin\alpha$ and so on.

`/tikz/3d/alpha` (initially `0`)

3d rotation angle.

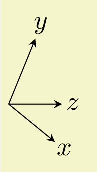
`/tikz/3d/beta` (initially `0`)

3d rotation angle.

`/tikz/3d/gamma` (initially `0`)

3d rotation angle.

The rotation angles can be used to define the view.




```
\begin{tikzpicture}[3d/install view={alpha=30,beta=45}]
 \draw[-stealth] (0,0,0) -- (1,0,0)
  node[pos=1.2] {$x$};
 \draw[-stealth] (0,0,0) -- (0,1,0)
  node[pos=1.2] {$y$};
 \draw[-stealth] (0,0,0) -- (0,0,1)
  node[pos=1.2] {$z$};
\end{tikzpicture}
```