tzplot: An Intuitive Approach

In-Sung Cho

2022/05/17

공주대학교 문서작성워크숍 2022

한국텍학회 · 한국텍사용자그룹(http://ktug.org)

Table of Contents

1 Introduction: An intuitive approach

딱 보면 안다

```
\tzline(0,0)(3,1)
```

```
\tzcoor(0,0)(A)
\tzcoor(3,1)(B)
\tzline(A)(B)

\tzcoor*(0,0)(A)
```

```
\tzcircle(1,1)(1cm)     \tzcircle[fill](1,1)(1cm)

\tzcdot(0,0)(1.2pt)     \tzcdot*(3,1)(1.2pt)
\tzcdot(0,0)            \tzcdot*(3,1)

% node circles
\tzdot(0,0)(2.4pt)      \tzdot*(3,1)(2.4pt)
\tzdot(0,0)             \tzdot*(3,1)

\tzcoor*(0,0)(A)(2.4pt)
```

Guess!

```
\tzellipse(1,1)(2cm and 1cm)

\tzrectangle(1,1)(4,3)  \tzframe(1,1)(4,3)
\tzhelplines(0,0)(4,3)  %% two coordinates
\tzhelplines(4,3)       %% one coordinate

\tzarc(0,0)(30:120:1cm)
\tzwedge(0,0)(30:60:1cm)

\tzarc'(0,0)(30:120:1cm)   % swap version
\tzwedge'(0,0)(30:60:1cm)  % swap version
```

Guess!

```
\def\Fx{(\x)^2-1}
\tzfn\Fx[0:2]

\tztangentat{Fx}{1}[0:3]
```

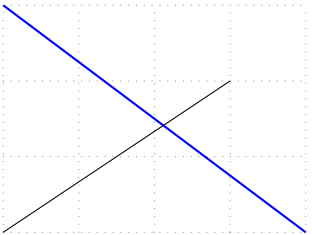
2 Linking two points

```
\tzline(0,0)(3,2)
\tzto(0,0)(3,2)

% curves
\tzto[bend left](0,0)(3,2)
\tzarcfrom(1,1)(30:60:1cm)
  cf. \tzarc(1,1)(30:60:1cm)
\tzbezier(0,0)(1,1)(3,2)
\tzbezier(0,0)(1,1)(2,0)(3,2)
\tzparabola(0,0)(2,4)
\tzparabola(0,3)(2,0)(3,2)
```

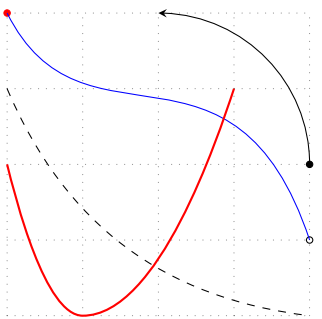
```
\tzline(0,0)(3,2) % works like:
  \draw (0,0) -- (3,2);
```

```
\tzto(0,0)(3,2) % works like:
  \draw (0,0) to (3,2);
```

```
% lines
\begin{tikzpicture}
\tzhelplines(4,3)
\tzline(0,0)(3,2)
\tzto[thick,blue](0,3)(4,0)
\end{tikzpicture}
```



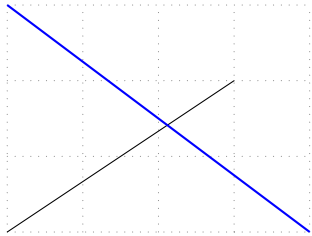
```
% curves
\begin{tikzpicture}
\tzhelplines(4,4)
\tzto[bend right,dashed](0,3)(4,0)
\tzdot*[red](0,4)        \tzdot(4,1)
\tzbezier[blue](0,4)(1,2)(3,4)(4,1)
\tzparabola[red,thick](0,2)(1,0)(3,3)
\tzcoor*(4,2)(A)
\tzarcfrom[->](A)(0:90:2cm)
\end{tikzpicture}
```



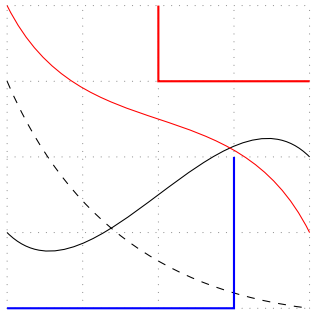
\tzlink

```
\tzlink(0,0)(3,2) = \tzlink(0,0)[to](3,2)
\tzlink[bend left](0,0)(3,2)
\tzlink(0,0)[to[bend left]](3,2)

\tzlink(0,0)[--](3,2)
\tzlink(0,0)[|-](3,2)
\tzlink(0,0)[-|](3,2)

\tzlink(0,0)[.. controls (1,1) .. ](3,2)
\tzlink(0,0)[edge[bend left]](3,2)
```

```
% \tzlink: connecting with straight lines
\begin{tikzpicture}
\tzhelplines(4,3)
\tzlink(0,0)(3,2)
\tzlink[thick,blue](0,3)(4,0)
\end{tikzpicture}
```

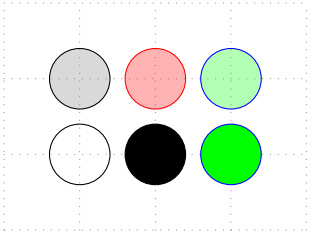


```
% \tzlink: connecting two points
\begin{tikzpicture}
\tzhelplines(4,4)
\tzlink(0,1)[to[out=-45]](4,2)
\tzlink[dashed](0,3)[edge[bend right]](4,0)
\tzlink[red](0,4)[..controls (1,2) and (3,3)..](4,1)
\tzlink[thick,blue](0,0)[-|](3,2)
\tzlink[thick,red](2,4)[|-](4,3)
\end{tikzpicture}
```



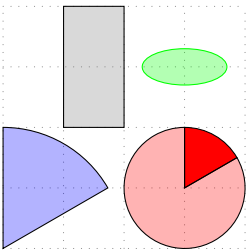
3 Filling: Starred versions

```
\begin{tikzpicture}
\tzhelplines(4,3)
\tzcircle(1,1)(4mm)
\tzcircle[fill](2,1)(4mm)
\tzcircle[blue,fill=green](3,1)(4mm)
% starred version
\tzcircle*(1,2)(4mm)
\tzcircle*[red](2,2)(4mm)
\tzcircle*[blue,fill=green](3,2)(4mm)
\end{tikzpicture}
```



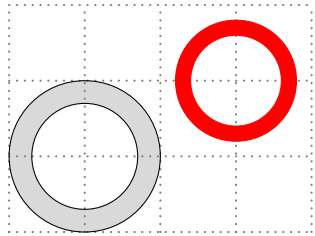
```
\tzcircle*(1,1)(1cm) % works like:
  \draw [black!50,fill opacity=.3,text opacity=1] (1,1) circle (1cm);
```

```
\begin{tikzpicture}[scale=.8]
\tzhelplines(4,4)
\tzrectangle*(1,2)(2,4)
\tzwedge* [fill=blue](0,0)(30:90:2cm)
\tzwedge  [fill=red] (3,1)(30:90:1cm)
\tzwedge*'[fill=red] (3,1)(30:90:1cm) % swap version
\tzellipse*[green](3,3)(7mm and 3mm)
\end{tikzpicture}
```

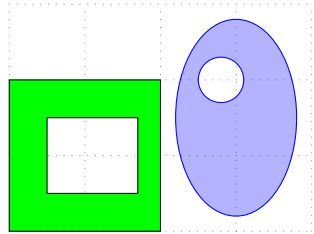


Fun with \tzring

```
% \tzring(*): even odd rule
\begin{tikzpicture}
\tzhelplines[thick](4,3)
\tzring*(1,1)(1cm)(1,1)(.7cm)
\tzring[red,fill](3,2)(8mm)(3,2)(6mm)
\end{tikzpicture}
```



```
% \tzrectanglering(*), \tzellipsering(*)
\begin{tikzpicture}
\tzhelplines(4,3)
\tzrectanglering[fill=green](0,0)(2,2)(.5,.5)(1.7,1.5)
\tzellipsering*[blue](3,1.5)(8mm and 13mm)
                     (2.8,2)(3mm and 3mm)
\end{tikzpicture}
```



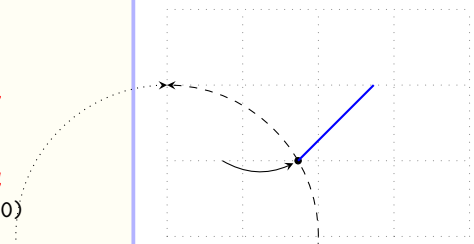
4 Relative coordinates: Plus versions

```
\tzline+(1,1)(3,1)
```

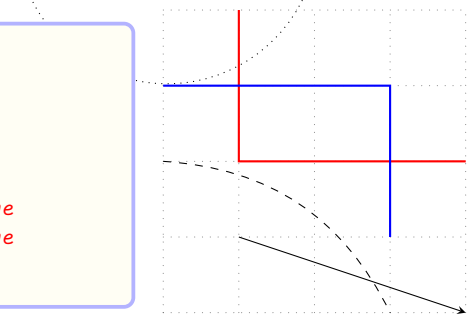
```
\tzline+(1,1)(3,1)
\tzline+(30:2cm)(1,1)  % useful

\tzto+(1,1)(3,1)
\tzlink+(1,1)(3,1)

\tzrectangle+(1,1)(3,2)
\tzframe+(1,1)(3,2) = \tzbox+(1,1)(3,2)

\tzparabola+(0,3)(1,-2)(3,1)
\tzbezier+(0,1)(1,-1)(-2,1)(3,2)
```

```
\tzline+(1,1)(3,1) % works like:
  \draw (1,1) -- ++(3,1);
```

```
\begin{tikzpicture}
\tzhelplines*(4,3) % bounding box
\tzarc [->,dashed](0,0)(0:90:2cm)
\tzarc'[->,dotted](0,0)(0:90:2cm) % swap version
\tzcoor*(30:2cm)(A)
\tzline+[blue,thick](A)(1,1)
% styles with two arguments: tzshorten, tzextend
\tzto+[<-,bend left,tzshorten={2pt}{0pt}](A)(-1,0)
\end{tikzpicture}
```



```
% \tzlink(coor1)<++>(coor2): relative
\begin{tikzpicture}
\tzhelplines(4,4)
\tzto+[dashed,bend left](0,2)(3,-2)
\tzlink+[thick,red](1,4)[|-](3,-2)
\tzlink[->](1,1)<++>(3,-1)              % relative
\tzlink[thick,blue](0,3)[-|]<++>(3,-2) % relative
\end{tikzpicture}
```



5 Putting text: Nodes

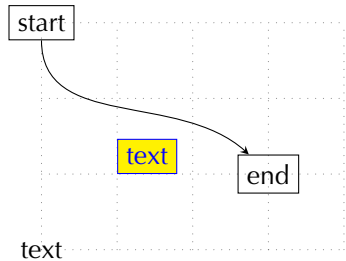
```
% main nodes
\path (0,0) node [right,red] {text};

% label nodes (for main nodes)
\path (0,0) node [right,label={[red]90:text2}] {text};

% label nodes (for coordinates and points)
\path (0,0) node [label={[red]above:text2}] {};
```

5.1 `\tznode(*)` and abbreviations to place main nodes

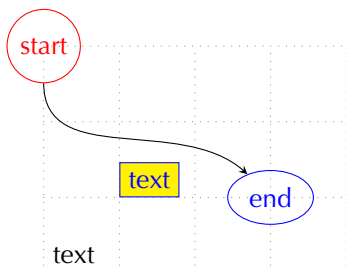
```
\tznode(0,0){text}

\tznode*(1,1){text}[ar]  %% abbreviations

% node coordinates
\tznode*(0,0)(A){start}
\tznode*(3,1)(B){end}
\tzline(A)(B)
```

```
\tznode(0,0){text} % works like:
  \path (0,0) node {text};
\tznode*(0,0)(A){start}[ar] % works like:
  \path (0,0) node (A) [draw,above right] {start};
```

```
% \tznode*: [draw,rectangle] (default)
\begin{tikzpicture}
\tzhelplines(4,3)
\tznode(0,0){text}
\tznode*(1,1){text}[ar,blue,fill=yellow]
\tznode*(0,3)(A){start}
\tznode*(3,1)(B){end}
\tzto[->,out=-90](A)(B)
\end{tikzpicture}
```




```
% nodes: circle, ellipse
\begin{tikzpicture}
\tzhelplines(4,3)
\path (0,0) node [ar] {text};        % abbreviations
\tznode*(1,1){text}[ar,blue,fill=yellow]
\tznode*(0,3)(A){start}[red,circle] % circle
\tznode*(3,1)(B){end}[blue,ellipse] % ellipse
\tzto[->,out=-90](A)(B)
\end{tikzpicture}
```

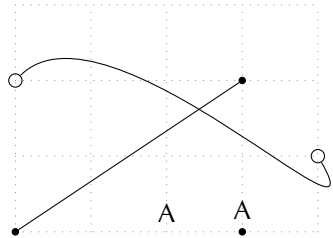


Abbreviations: `\usepackage{tzplot}`

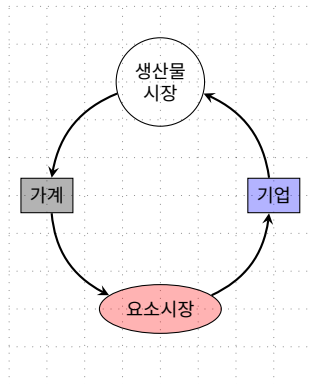
- 'Styles' to place 'main nodes': `[a]`, `[b]`, `[c]`*entered*, `[l]`, `[r]`, `[ar]`, `[al]`, `[br]`, `[bl]`
- You can use these abbreviations with any valid `tikz` commands, but not for 'label nodes.'

5.2 \tznodedot(*), \tznodecircle(*), \tznodeframe(*), \tznodeellipse(*)

```
% \tznodedot(*)
\begin{tikzpicture}
\tzhelplines(4,3)
\tznodedot*(0,0)(A) \tznodedot*(3,2)(B)
\tzline(A)(B) \tzcoor(2,0)(A){A} \tzcoor*(3,0)(A){A}
\tznodedot(0,2)(C)(5pt) \tznodedot(4,1)(D)(5pt)
\tzto[out=45,in=-60](C)(D)
\end{tikzpicture}
```




```
\begin{tikzpicture}[scale=.5,font=\scriptsize]
\tzhelplines(8,10)
\tznodecircle(4,8)(PM){생산물\\시장}[align=center]
\tznodeellipse*[red](4,2)(FM){요소시장}
\tznodeframe*(1,5)(H){가계}
\tznodeframe*[blue](7,5)(F){기업}
\tzto[->,thick,bend right=30](F)(PM)
\tzto[->,thick,bend right=30](PM)(H)
\tzto[->,thick,bend right=30](H)(FM)
\tzto[->,thick,bend right=30](FM)(F)
\end{tikzpicture}
```

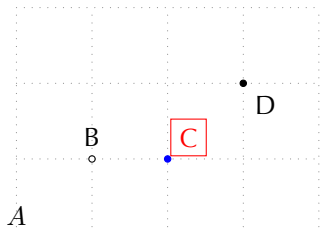


```
\tzdot*(0,0){$A$}[90]

\tzcoor(0,0)(A){$A$}[90]

\tzdot(0,0){$A$}[[red]90]
```

```
\tzcoor(0,0)(A){$A$}[[red]90] % works like:
  \path (0,0) coordinate (A) [label={[red]90:$A$}] {};
```

```
% default = [90] or [above]
\tzdot*(0,0){$A$} % works like:
  \path (0,0) node [draw,circle,fill,inner sep=0pt,
                    minimum size=2.4pt,label={90:{$A$}}] {};
```

```
\begin{tikzpicture}
\tzhelplines(4,3)
\tzcoor(0,0)(A){$A$}
\tzdot(1,1){B}
\tzdot*[blue](2,1){C}[[draw,red]45]
\tzcoor*(3,2)(D){D}[br] % [below right] or [-45]
\end{tikzpicture}
```



'Text replacement' to place 'label nodes':

- You can use `[a]` for `[above]`, `[ar]` for `[above right]`, and so on, instead of angles.
- You can use these abridged text 'only with' `\tz<...>` macros to place 'label nodes.'

5.4 Putting text next to lines or curves

Text at the end of lines: about the last coordinate

\tzline(0,0)(3,2){text}[r]

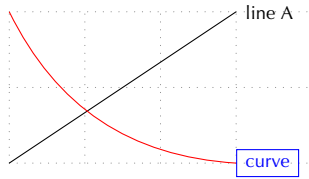
```
\tzline(0,0)(3,2){text}[r] % works like:
  \draw (0,0) -- (3,2) node [right] {text};
```

Text next to lines: between coordinates

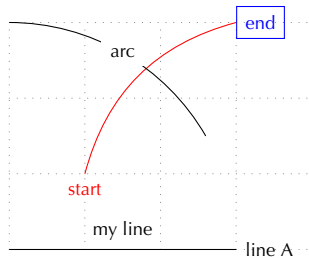
\tzline(0,0){text}[a](3,2)

```
\tzline(0,0){text}[a](3,2) % works like:
  \draw (0,0) -- node [above] {text} (3,2);
```

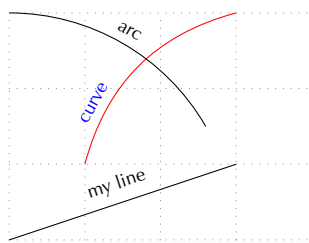
```
\begin{tikzpicture}[font=\scriptsize]
\tzhelplines(4,2)
\tzline(0,0)(3,2){line A}[r]
\tzto[bend right,red](0,2)(3,0){curve}[r,blue,draw]
\end{tikzpicture}
```




```
\begin{tikzpicture}[font=\scriptsize]
\tzhelplines(4,3)
\tzline(0,0){my line}(3,0){line A}[r]
\tzto[bend left,red](1,1){start}[b,at start]
                     (3,3){end}[r,blue,draw]
\tzarc(0,0)(30:90:3cm){arc}[fill=white,midway]
\end{tikzpicture}
```




```
\begin{tikzpicture}[font=\scriptsize]
\tzhelplines(4,3)
\tzline(0,0){my line}[a,sloped](3,1)
\tzto[bend left,red]
     (1,1){curve}[a,blue,sloped,near start](3,3)
\tzarc(0,0)(30:90:3cm){arc}[midway,a,sloped]
\end{tikzpicture}
```



6 <shift coor>

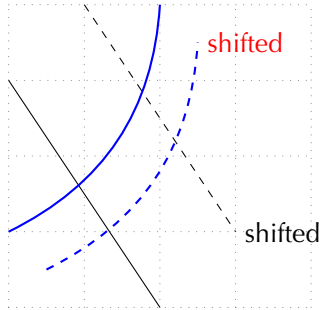
after main option or
immediately before ″path name″ if it exists

```
\tzline<1,1>(0,3)(2,0)
```

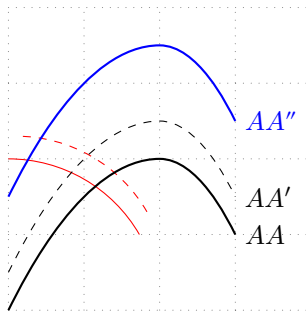
```
\tzline[dashed]<1,1>(0,3)(2,0)
```

```
\tzline[dashed]<1,1>"path name"(0,3)(2,0)
```

```
% <shift coor>
\begin{tikzpicture}
\tzhelplines(4,4)
\tzline                (0,3)(2,0)
\tzline[dashed]<1,1>(0,3)(2,0){shifted}[r]
\tzto+[thick,blue,bend right](0,1)(2,3)
\tzto+[thick,blue,bend right,dashed]<.5,-.5>
                    (0,1)(2,3){shifted}[r,red]
\end{tikzpicture}
```



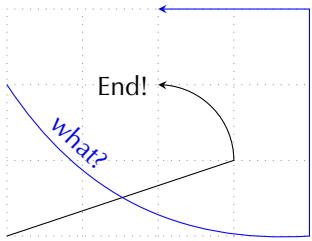

```
% <shift coor>
\begin{tikzpicture}
\tzhelplines(4,4)
\tzarc[red]                 (0,0)(30:90:2cm)
\tzarc[red,dashed]<.1,.3>(0,0)(30:90:2cm)
\tzparabola[thick](0,0)(2,2)(3,1){$AA$}[r]
\tzparabola[dashed]<0,.5>(0,0)(2,2)(3,1){$AA'$}[r]
\tzparabola[thick,blue]<0,1.5>(0,0)(2,2)(3,1){$AA"$}[r]
\end{tikzpicture}
```



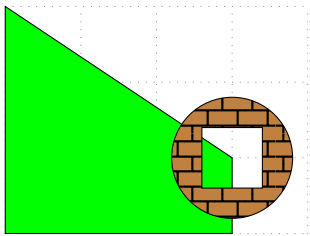
7 `<code.append>`

at the very end

```
% <code.append>
\begin{tikzpicture}
\tzhelplines(4,3)
\tzline[->](0,0)(3,1)<arc (0:90:1cm) node [l] {End!}>
\tzto[->,blue,bend right]
     (0,2){what?}[near start,sloped](4,0)<|- ++(-2,3)>
\end{tikzpicture}
```



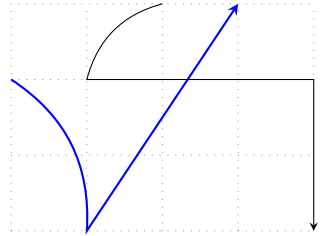

```
% <code.append>
\begin{tikzpicture}
\tzhelplines(4,3)
\tzline[fill=green]
       (0,3)(3,1)<-- (3,0) -- (0,0) -- cycle>
\tzring[pattern=bricks,preaction={fill=brown}]
       (3,1)(8mm)<(2.6,.6) rectangle ++(.8,.8)>
\end{tikzpicture}
```



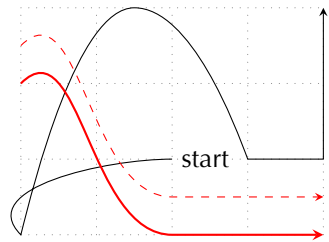
8 Extending paths: `\tz<···>AtBegin`, `\tz<···>AtEnd`

before macros

```
% \tz<...>AtBegin
\begin{tikzpicture}
\tzhelplines(4,3)
\tzlineAtBegin{(0,2) to [bend left]}
\tzline[->,blue,thick](1,0)(3,3)
\tzlinkAtBegin{(2,3) to [bend right]}
\tzlink+[->](1,2)[-|](3,-2)
\end{tikzpicture}
```



```
% \tz<...>AtBegin, \tz<...>AtEnd
\begin{tikzpicture}
\tzhelplines(4,3)
\tzparabolaAtBegin{(2,1) node [r] {start} to [out=180]}
\tzparabolaAtEnd{-| ++(1,2)}
\tzparabola[->](0,0)(1.5,3)(3,1)
\tztoAtEnd{--([turn]0:2cm)}
\tzto[->,in=180,red,thick](0,2)(2,0)
% shift
\tztoAtEnd{--([turn]0:2cm)}
\tzto[->,in=180,red,dashed]<0,.5>(0,2)(2,0)
\end{tikzpicture}
```

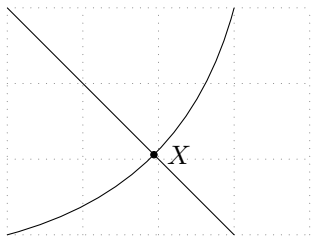


9 `"path name"`

immediately before the first mandatory argument or
immediately before the first coordinate

```
\tzline[name path=AA](0,0)(3,2)

\tzline"AA"(0,0)(3,2)
\tzline[blue]<1,1>"AA"(0,0)(3,2)

% special case:
\def\Foo{3-\x}
\tzfn\Foo[0:3]  % same as \tzfn"Foo"\Foo[0:3]
```

```
% "path name"
\begin{tikzpicture}
\tzhelplines(4,3)
\tzto[bend right]"AA"(0,0)(3,3)
\def\Fx{3-\x} \tzfn\Fx[0:3]
\tzXpoint*{AA}{Fx}(X){$X$}[0]
\end{tikzpicture}
```



10 Summary: The order of optional arguments

```
(<coor>) {<text>}  [<pos>,<opt>]
(<coor>) {<label>} [[<opt>]<angle>]

\tzline[<opt>]<shift>"<path>"(<coor1>)(<coor2>)
```

10.1 Labels for coordinates and points

- `\tzcoor(0,0)(A){$A$}[[red]90]`: 좌표나 점의 label 위치는 각도
- 각도 대신, short text replacement 사용 가능: 단, `tzplot` 매크로에만 적용
- `\tzdot*(0,0){$A$}[90](5pt)`: dot size는 (보통) 맨 뒤

10.2 Text next to connecting lines and curves

- `\tzline(0,0)(3,1){line A}[r]`: 맨 끝 좌표 주변에 text
- `\tzline(0,0){my line}[a](3,1)`: 좌표 사이 연결 operation (lines or curves)에 text
- abbreviated styles: `tikz` 매크로에도 사용 가능

10.3 More options

- `\tzcoor[<opt>]<shift coor>(<coor>)(<coor name>){<label>}[<angle>]`
- `\tzdot*[<opt>]<shift coor>(<coor>){<label>}[<angle>](<dot size>)`
- `\tzline[<opt>]<shift coor>"<path name>"`
  `(<coor1>){<text>}[<opt>](<coor2>){<text>}[<opt>]<code.append>`
- `\tzlink[<opt>]<shift coor>"<path name>"`
  `(<coor1>)[<link style>]{<text>}[<opt>]<++>(<coor2>)<code.append>`
- `\tzframe*+(1,1)(3,1)`: star(*)가 먼저 온다.

11 Many coordinates: Semicolon versions

- How many?
- Until `tzplot` macros meet a semicolon (;).
- Do not forget ‘;’ to indicate the end of repetition.

11.1 Many coordinates and dots

```
\tzcoors(0,0)(A)
        (1,1)(B)
        (2,1)(C)
        (3,2)(D) ;
```

```
\tzcoors(0,0)(A){$A$}[180]
        (1,1)(B){$B$}[135]
        (2,1)(C){$C$}[45]
        (3,2)(D){$D$}[0] ;
```

```
\tzdots*(0,0)
        (1,1)
        (2,1)
        (3,2) ;
```

```
\tzdots*(0,0){$A$}[180]
        (1,1){$B$}[135]
        (2,1){$C$}[45]
        (3,2){$D$}[0] ; (5pt)
```

- (<dot size>) after the semicolon.
- See also \tzcoorsquick(*).

11.2 Connecting many points: `\tzlines`

```
\tzlines (coor-1)...(coor-n) ;
\tzlines+(coor-1)...(coor-n) ;
```

- repeating pattern: `(coor){<text>}[<opt>]`

```
\tztos (coor-1)...(coor-n) ;
\tztos+(coor-1)...(coor-n) ;
```

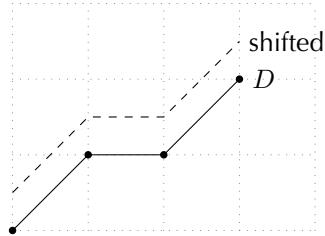
- repeating pattern: `(coor)[<to opt>]{<text>}[<opt>]`

```
\tzlinks (coor-1)...(coor-n) ;
\tzlinks+(coor-1)...(coor-n) ;
```

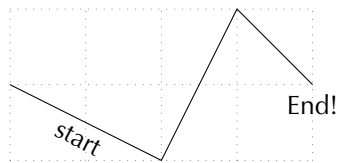
- repeating pattern: `(coor)[<link style>]{<text>}[<opt>]<++>`

- 맨 끝 `{<text>}[<opt>]`: 맨 끝 좌표에 대한 text
- 좌표 사이의 `{<text>}[<opt>]`: 연결 operation에 대한 text

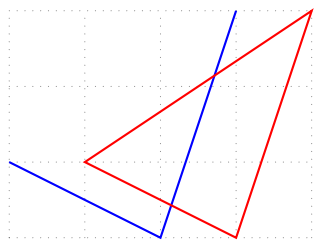
```
% \tzcoors, \tzlines
\begin{tikzpicture}
\tzhelplines(4,3)
\tzcoors*(0,0)(A)(1,1)(B)(2,1)(C)(3,2)(D){$D$}[0];
\tzlines(A)(B)(C)(D);
\tzlines[dashed]<0,.5>(A)(B)(C)(D){shifted}[r];
\end{tikzpicture}
```




```
% \tzlines+
\begin{tikzpicture}
\tzhelplines*(4,2)
\tzlines+(0,1){start}[b,sloped]
         (2,-1)(1,2)(1,-1){End!}[b];
\end{tikzpicture}
```

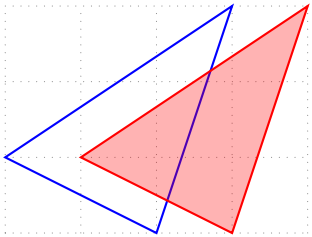



```
% <code.append> after semicolon
\begin{tikzpicture}
\tzhelplines(4,3)
\tzlines[blue,thick]     (0,1)(2,0)(3,3);
\tzlines[red,thick]<1,0>(0,1)(2,0)(3,3); <--cycle>
\end{tikzpicture}
```

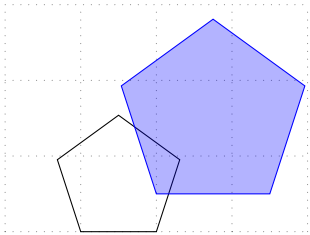


11.3 \tzpolygon: <--cycle> version of \tzlines

```
% \tzpolygon(*)
\begin{tikzpicture}
\tzhelplines(4,3)
\tzpolygon[blue,thick]     (0,1)(2,0)(3,3);
\tzpolygon*[red,thick]<1,0>(0,1)(2,0)(3,3);
\end{tikzpicture}
```

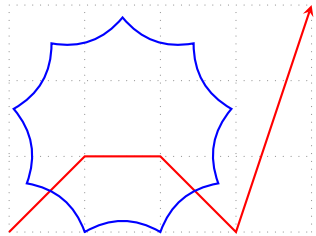


```
% \tzpolygon(*)
\begin{tikzpicture}
\tzhelplines(4,3)
\tzpolygon(1,0)(2,0)
        ([turn]72:1cm)([turn]72:1cm)([turn]72:1cm);
\tzpolygon*[blue](2,.5)(3.5,.5)
        ([turn]72:15mm)([turn]72:15mm)([turn]72:15mm);
\end{tikzpicture}
```

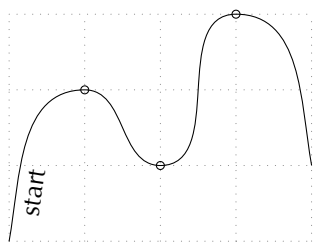


11.4 \tztos

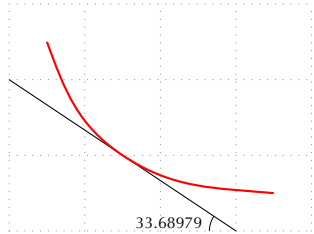
```
% \tztos
\begin{tikzpicture}
\tzhelplines(4,3)
\tztos[->,thick,red](0,0)(1,1)(2,1)(3,0)(4,3);
\def\Ang{70}
\tztos[thick,blue,bend left]
  (1,0)(2,0)([turn]\Ang:1cm)([turn]\Ang:1cm)
  ([turn]\Ang:1cm)([turn]\Ang:1cm)([turn]\Ang:1cm)
  ([turn]\Ang:1cm)([turn]\Ang:1cm)([turn]\Ang:1cm);
  <--cycle>
\end{tikzpicture}
```



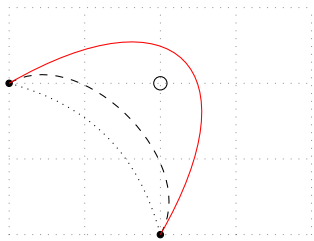
```
% \tztos
\begin{tikzpicture}
\tzhelplines(4,3)
\tzdots(1,2)(2,1)(3,3);(3pt)
\tztos(0,0)[out=80,in=180]{start}[b,sloped,near start]
      (1,2)[out=0,in=180]
      (2,1)[out=0,in=180]
      (3,3)[out=0,in=100]
      (4,1);
\end{tikzpicture}
```



```
% \tztos: tangent to a line
\begin{tikzpicture}
\tzhelplines*(4,3)
\tzcoors(0,0)(O)(3,0)(X)(0,2)(Y);
\tzline(X)(Y)

\pgfmathsetmacro{\xx}{atan(2/3)}
\tzanglemark(O)(X)(Y){\xx}[l,pos=1.1,scale=.6]

\tzcoors(.5,2.5)(A)(1.5,1)(B)(3.5,.5)(C);
\tztos[red,thick](A)[out=-70,in=180-\xx]
                    (B)[out=-\xx,in=175](C);
\end{tikzpicture}
```

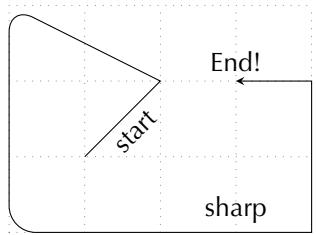



```
% \tztos: looseness
\begin{tikzpicture}
\tzhelplines*(4,3)
\tzcoors*(0,2)(A)(2,0)(B);
\tzdot(2,2)(5pt)
\tztos[dotted](A)[bend left=30]                (B);
\tztos[dashed](A)[out=30,in=60]                (B);
\tztos[red]    (A)[out=30,in=60,looseness=2.3](B); %%
\end{tikzpicture}
```

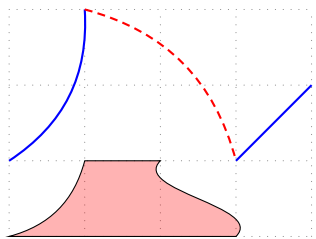


11.5 \tzlinks

```
% \tzlinks
\begin{tikzpicture}
\tzhelplines(4,3)
\tzlinks[->](1,1){start}[b,sloped]
            (2,2)[[rounded corners=10pt]--]
            (0,3)
            (0,0)[[sharp corners]--]{sharp}[a,near end]
            (4,0)[|-]<++>
            (-1,2){End!}[a];
\end{tikzpicture}
```




```
% \tzlinks(*)
\begin{tikzpicture}
\tzhelplines(4,3)
\tzlinks[blue,thick](0,1)[to[bend right]]
   (1,3)[edge[red,bend left,densely dashed](3,1)]
   (3,1)(4,2);
\tzlinks*[fill=red] (0,0)[to[bend right]]
      (1,1)(2,1)[to[out=-135,in=45]](3,0); <--cycle>
\end{tikzpicture}
```

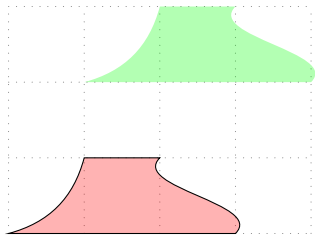


11.6 Filling: `\tzpath*`

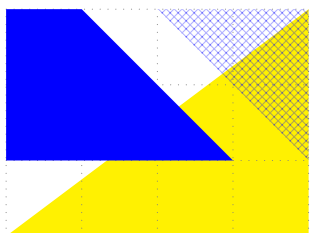
Roughly,

- `\tzpath(*)`: `<--cycle>` version of `\tzlinks(*)[draw=none]`

```
% \tzlinks*, \tzpath*
\begin{tikzpicture}
\tzhelplines(4,3)
\tzlinks*[fill=red] (0,0)[to[bend right]]
      (1,1)(2,1)[to[out=-135,in=45]](3,0); <--cycle>
\tzpath*[green]<1,2>(0,0)[to[bend right]]
      (1,1)(2,1)[to[out=-135,in=45]](3,0);
\end{tikzpicture}
```



```
% \settzpathlayer{behind}: default: main
\begin{tikzpicture}
\tzhelplines(4,3)
\tzpath[fill=blue](0,1)(0,3)(1,3)(3,1);
\tzpath*+[pattern=crosshatch,pattern color=blue]
         (2,3)[-|](2,-2);
\settzpathlayer{behind}  %%
\tzpath[fill=yellow](0,0)(4,3)(4,0);
\end{tikzpicture}
```

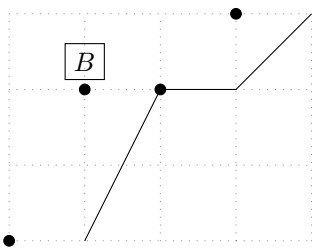


11.7 plot coordinates: \tzplot and \tzplotcurve

```
\tzplot*(0,0)(1,2)(2,2)(3,3); % works like:
  \draw [draw=none,mark=*] plot coordinates { (0,0)(1,1)(2,2)(3,3) } ;
```

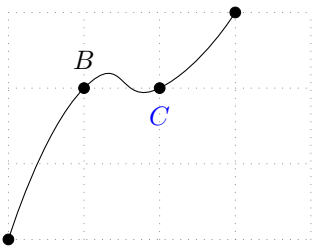
```
\tzplot (0,0)(1,2)(2,2)(3,3); % works like:
  \draw [tension=0] plot [smooth] coordinates { (0,0)(1,1)(2,2)(3,3) } ;
```

```
% \tzplot(*): all coordinates
\begin{tikzpicture}
\tzhelplines(4,3)
\tzplot*(0,0)(1,2){$B$}[[draw]90](2,2)(3,3);
\tzplot<1,0>(0,0)(1,2)(2,2)(3,3);
\end{tikzpicture}
```

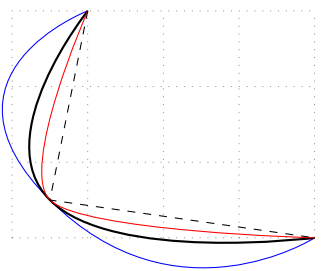


```
\tzplotcurve[blue,smooth cycle]{1}(0,0)(1,2)(2,2)(3,3); % works like:
  \draw [blue,tension=1] plot [smooth cycle] coordinates { (0,0)(1,1)(2,2)(3,3) } ;
```

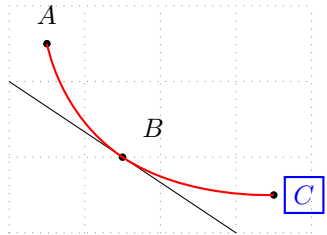
```
% \tzplotcurve: plot coordinates
\begin{tikzpicture}
\tzhelplines(4,3)
\tzplot*(0,0)(1,2){$B$}[90](2,2)(3,3);
\tzplotcurve(0,0)(1,2)(2,2){$C$}[[blue]-90](3,3);
\end{tikzpicture}
```



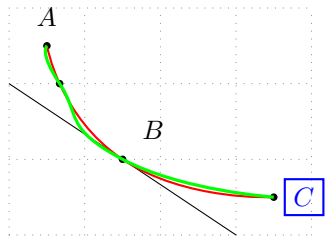

```
% \tzplotcurve: {tension}
\begin{tikzpicture}
\tzhelplines*(4,3)
\tzcoor(.5,.5)(A)
\tzplotcurve[blue]{2}(1,3)(A)(4,0);
\tzplotcurve[thick](1,3)(A)(4,0); % default: tension=1
\tzplotcurve[red]{.5}(1,3)(A)(4,0);
\tzplotcurve[dashed]{0}(1,3)(A)(4,0);
\end{tikzpicture}
```



```
% \tzplotcurve: tangent to a line
\begin{tikzpicture}
\tzhelplines*(4,3)
\tzline(0,2)(3,0)
\tzcoors*(.5,2.5)(A)(1.5,1)(B)(3.5,.5)(C);
\tzplotcurve[red,thick,text=black]
   (A){$A$}[90](B){$B$}[45](C){$C$}[[blue,draw]0];
\end{tikzpicture}
```



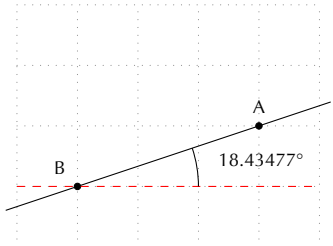

```
% \tzplotcurve: connecting 4 coordinates
\begin{tikzpicture}
\tzhelplines*(4,3)
\tzline(0,2)(3,0)
\tzcoors*(.5,2.5)(A)(1.5,1)(B)(3.5,.5)(C);
\tzplotcurve[red,thick,text=black]"curve"
   (A){$A$}[90](B){$B$}[45](C){$C$}[[blue,draw]0];
\tzhXpointat*{curve}{2}(K)
\tzplotcurve[green,very thick](A)(K)(B)(C);
\end{tikzpicture}
```



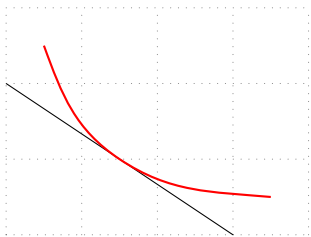
12 Angles and angle marks

12.1 \tzpointangle

```
% \tzpointangle
\begin{tikzpicture}[scale=.8,font=\scriptsize]
\tzhelplines(5,4)
\tzcoors*(4,2)(A){A}(1,1)(B){B}[135];
\tzline[red,dashed](0,1)(5,1)
\tzline[tzextend={1cm}{1cm}](B)(A) % (B): center
\tzpointangle(B)(A){\myAngA}
\tznode(3,1){\myAngA\textdegree}[ar=2mm,absolute]
\tzarc(1,1)(0:\myAngA:2cm)
\end{tikzpicture}
```

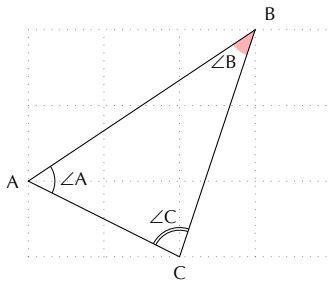



```
% \tzpointangle: tangent to a line
\begin{tikzpicture}
\tzhelplines*(4,3)
\tzcoors(0,0)(O)(3,0)(X)(0,2)(Y);
\tzline(X)(Y)
\tzpointangle(X)(Y){\xx} %%
\tzcoors(.5,2.5)(A)(1.5,1)(B)(3.5,.5)(C);
\tztos[red,thick](A)[out=-70,in=\xx]
                    (B)[out=\xx-180,in=175](C);
\end{tikzpicture}
```

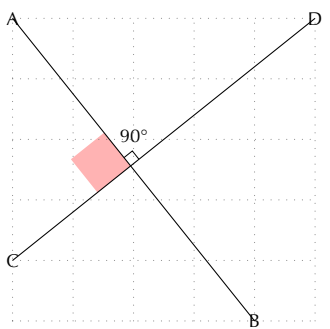


12.2 Angle marks

```
% \tzanglemark*(')
\begin{tikzpicture}[font=\scriptsize]
\tzhelplines(4,3)
\tzcoors(0,1)(A){A}[180](3,3)(B){B}[45]
        (2,0)(C){C}[-90];
\tzpolygon(A)(B)(C);
\tzanglemark'(C)(A)(B){$\angle$A}[pos=1.7] % swap
\tzanglemark*[red](A)(B)(C){$\angle$B}[xshift=-1mm]
\tzanglemark(A)(C)(B){$\angle$C}(11pt) % radius=11pt
\tzanglemark(A)(C)(B)
\end{tikzpicture}
```




```
% \tzrightanglemark(*)
\begin{tikzpicture}[scale=.8,font=\scriptsize]
\tzhelplines(5,5)
\tzcoorsquick(0,5)(A)(4,0)(B)(0,1)(C)(5,5)(D);
\tzline"AB"(A)(B)
\tzline"CD"(C)(D)
\tzXpoint{AB}{CD}(E)
\tzrightanglemark(A)(E)(D){90\textdegree}
\tzrightanglemark*[red](A)(E)(C)(20pt)
\end{tikzpicture}
```



13 References

- The Ti*k*Z and PGF Package: Manual for version 3.1.9a (`https://github.com/pgf-tikz/pgf`).
- `tzplot.sty`: Plot Graphs with Ti*k*Z Abbreviations, version 2.0 (`https://www.ctan.org/pkg/tzplot`).
- 경제학자를 위한 Ti*k*Z (`http://wiki.ktug.org/wiki/wiki.php/LaTeXWorkshop/2017`).
- `tzplot`: Basics (`http://wiki.ktug.org/wiki/wiki.php/LaTeXWorkshop/2021`)
- `tzplot`: How to Plot Graphs (`http://wiki.ktug.org/wiki/wiki.php/LaTeXWorkshop/2021`)