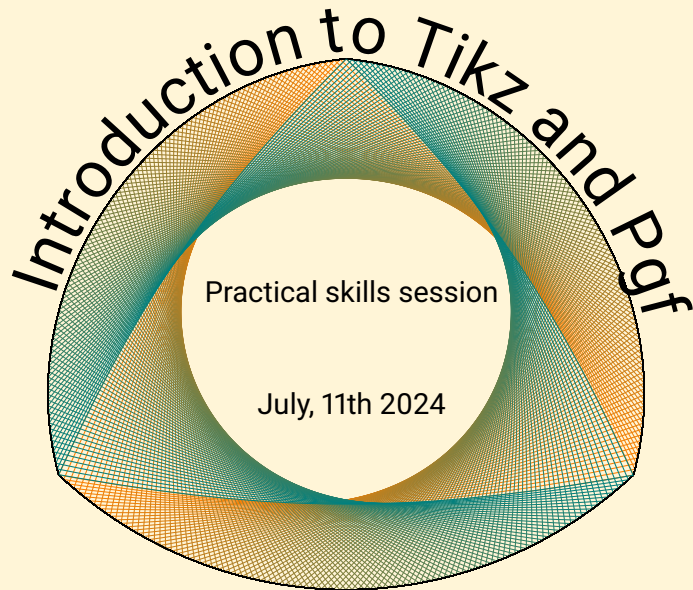




Plan for this session

- ▶ (If needed) Short presentation on the basics of Tikz ($\approx$ 10 minutes)
- ▶ Practice ($\approx$ 1 hour):
 - make your own drawing;
 - look at the repository with examples.
 - Ask questions.

Overleaf repository:



What is Tikz?

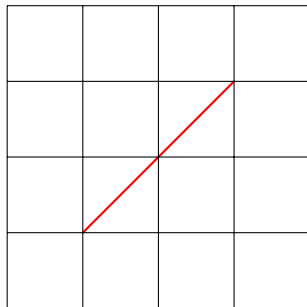
- ▶ Tikz is the recursive acronym of *"Tikz Ist Kein Zeichenprogramm"*.
- ▶ It is a graphics library (script-based) for $\text{\LaTeX}$.
- ▶ Usage: drawings, beamer and poster templates,...

Disclaimer

Not necessarily better than the graphical interface alternatives: e.g. Inkscape, Blender, Geogebra...

How to communicate with Tikz?

```
\usepackage{tikz}  
...  
  
\begin{tikzpicture}  
  
\draw[red] (-1,-1) to (1,1);  
\draw (-2,-2) grid (2,2);  
  
\end{tikzpicture}
```



Basic commands

There are four basic commands:

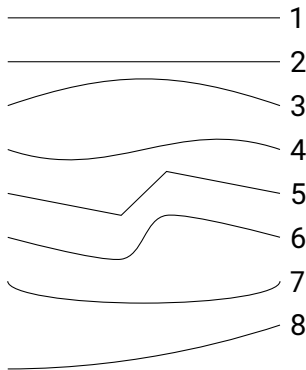
1. **Draw:** to draw lines, cycles and curves.
2. **Fill:** to color regions.
3. **Node:** to add text or other inputs.
4. **Coordinate:** to find/save specific coordinates that are recurrent.

Draw command (curves)

```
\begin{tikzpicture}

\draw (-6,9) to (6,9);
\draw (-6,8)--(6,8);
\draw (-6, 7) to [bend left=10] (6,7);
\draw (-6, 6) to [out=-10, in=170] (6,6);
\draw plot coordinates
      {(-6,5) (-1,4.5) (1, 5.5) (6,5)};
\draw plot [smooth] coordinates
      { (-6,4) (-1,3.5) (1, 4.5) (6,4)};
\draw (-6,3) arc (180:360:6 and 0.5);
\draw (-6,1) parabola (6,2);

\end{tikzpicture}
```



Draw command options

```
\begin{tikzpicture}
```

```
\draw[dashed] (-6,9) to (6,9);
```

```
\draw[dotted] (-6,8)--(6,8);
```

```
\draw[dashdotted](-6, 7) to [bend left=10](6,7);
```

```
\draw[thin] (-6, 6) to [out=-10, in=170] (6,6);
```

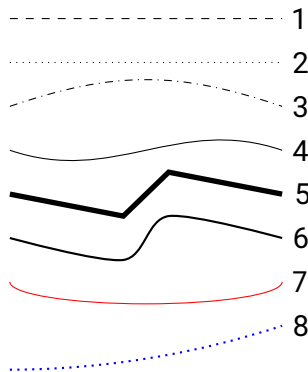
```
\draw[line width=2] plot coordinates  
{(-6,5) (-1,4.5) (1, 5.5) (6,5)};
```

```
\draw[thick] plot [smooth] coordinates  
{ (-6,4) (-1,3.5) (1, 4.5) (6,4)};
```

```
\draw[red] (-6,3) arc (180:360:6 and 0.5);
```

```
\draw[blue, thick, dotted] (-6,1) parabola (6,2);
```

```
\end{tikzpicture}
```



Fill command

```
\begin{tikzpicture}
```

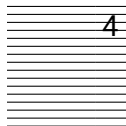
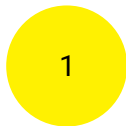
```
\fill[yellow] (-1,3) circle (1cm);
```

```
\filldraw[yellow!30, draw=black]  
  (2,3) ellipse (0.5cm and 1cm);
```

```
\fill[yellow!70!red] (-2, -1) rectangle (0,1);
```

```
\fill[pattern= {horizontal lines}]  
  (1, -1) rectangle +(2,2);
```

```
\end{tikzpicture}
```



Node command

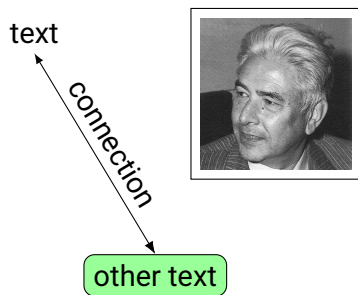
```
\begin{tikzpicture}

\node (A) at (0,2) {text};
\node[draw, fill=green!40, rounded corners]
  (B) at (2,-2) {other text};

\draw[<->] (A.south) to
  node[above, sloped]{connection} (B.north);

\node[draw] at (4,1) {\includegraphics{god.png}}

\end{tikzpicture}
```



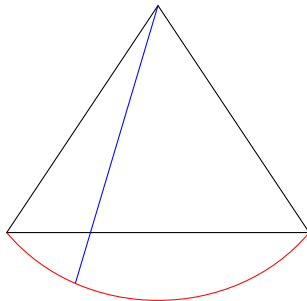
Coordinate command

```
\begin{tikzpicture}

\coordinate (A) at (0,0);
\coordinate (B) at (8,0);
\coordinate (C) at (4,6);

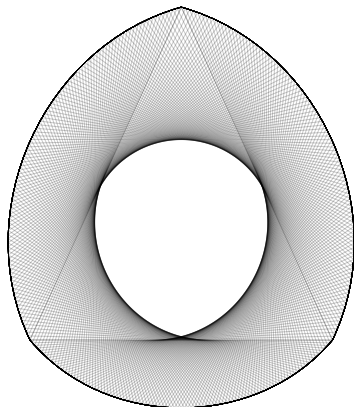
\draw (A)--(B)--(C)--cycle;
\draw[red] (A) to [bend right=50]
    coordinate[pos=0.25] (p) (B);
\draw[blue] (C)--(p);

\end{tikzpicture}
```

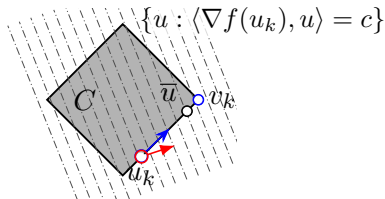
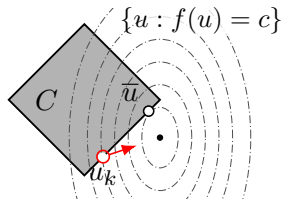


Loops

```
\coordinate (A) at (0,0);  
\coordinate (B) at (8,0);  
\coordinate (C) at (4,6.4);  
\foreach \x [evaluate=\x as \k using (\x*0.01)]  
  in {0,...,100}{  
  \draw (A) to [bend right=50]  
    coordinate[pos=\k] (p) (B);  
  \draw (C) to [bend right=50]  
    coordinate[pos=\k] (q) (A);  
  \draw (B) to [bend right=50]  
    coordinate[pos=\k] (w)(C);  
  \draw[thin] (p)to (q) to (w)to cycle;  
}
```



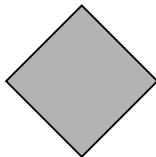
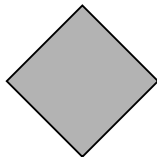
Example: Frank-Wolfe



```
\coordinate (min) at (1,0.5);
\coordinate (a) at (0,0);
\coordinate (b) at (1,1);
\coordinate (minC) at ($(a)!0.85!(b)$);
\coordinate (uk) at ($(a)!0.24!(b)$);
\coordinate (dist) at (7,0);
```

```
\coordinate (min2) at ($ (min)+(dist) $);
\coordinate (b2) at ($ (b)+(dist) $);
\coordinate (uk2) at ($ (uk)+(dist) $);
```

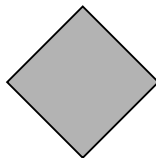
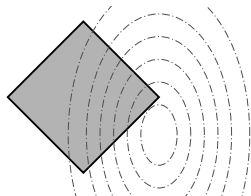
Example: Frank-Wolfe



```
\filldraw[fill=black!30, line width=0.7]  
  (a)-- (b)--++(-1,1)--+(-1,-1)--cycle;
```

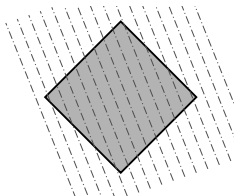
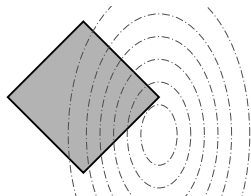
```
\filldraw[fill=black!30, line width=0.7]  
  ($ (a)+(dist)$)--($ (b)+(dist)$)--++(-1,1)--+(-1,-1)--cycle;
```

Example: Frank-Wolfe



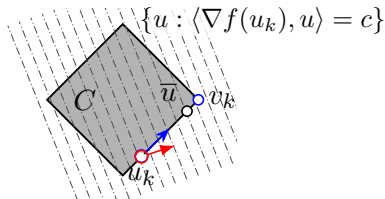
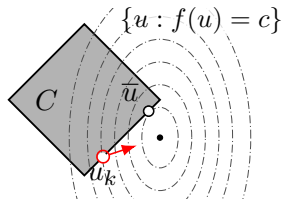
```
\begin{scope}
\clip (-1.5,-0.3) rectangle +($(3,2.5)+(dist)$);
\foreach \y [evaluate=\y as \x using (\y*0.6)]
in {0.4,0.7,1.0,1.3,1.6,2}{
\draw[densely dashdotted, very thin, black!70]
(min) ellipse (\x cm and \y cm);}
}
```

Example: Frank-Wolfe



```
\foreach \k in {-1,-0.8,...,2}{  
  \draw[densely dashdotted, very thin, black!70]  
    ($(\uk2)!\k!(min2) + (0,-0.5)$)-- ++(-1,2.5);  
}  
\end{scope}
```

Example: Frank-Wolfe



[...Names and points...]

```
\draw[o-Latex, line width=0.6, red]
  ($ (uk) - (0.08,0.02)$ ) -- ($ (uk) !0.6! (min)$ );
\draw[o-Stealth, line width=0.6, blue]
  ($ (uk) - (0.06,0.05) + (dist)$ ) -- ($ (uk) !0.5! (b) + (dist)$ );
\draw[o-Latex, line width=0.6, red]
  ($ (uk) - (0.08,0.02) + (dist)$ ) -- ($ (uk) !0.6! (min) + (dist)$ );
```

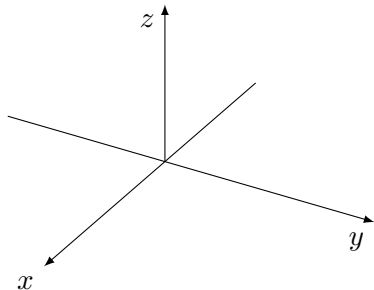

Finale: 3D drawings

```
\usepackage{tikz, tikz-3dplot}
\tdplotsetmaincoords{60}{120}

\begin{tikzpicture}[tdplot_main_coords]

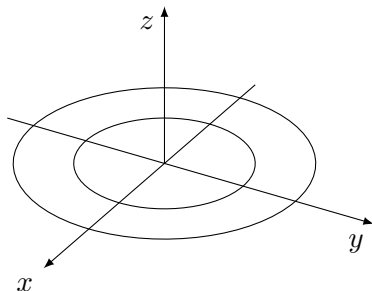
\draw[-latex] (-3,0,0)--(4,0,0)
    node[below left]{$x$};
\draw[-latex] (0,-3,0)--(0,4,0)
    node[below left]{$y$};
\draw[-latex] (0,0,0)--(0,0,3)
    node[below left]{$z$};

\end{tikzpicture}
```



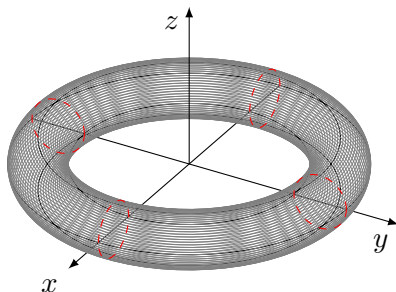
Finale: 3D drawings

```
\usepackage{tikz, tikz-3dplot}  
\tdplotsetmaincoords{60}{120}  
  
\begin{tikzpicture}[tdplot_main_coords]  
  
\begin{scope}[canvas is xy plane at z=0]  
    \draw (0,0) circle (2);  
    \draw (0,0) circle (3);  
\end{scope}  
  
\end{tikzpicture}
```



Finale: 3D drawings

with a few more lines of code and trigonometry....



Second part

- ▶ Try to make a drawing for your own research.
- ▶ Check the examples in the repository
- ▶ Good luck!

