

Software Day TikZ & PGFPlots

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Why we like L^AT_EX:

- 1.
- 2.
- 3.

Why we like TikZ:

- 1.
- 2.
- 3.

Contents

1	Simple Figures for Research & Teaching	2
2	Drawing Pictures	12
3	Plotting from Data	15

1 Simple Figures for Research & Teaching

Getting Started

- Add the TikZ package to your preamble:

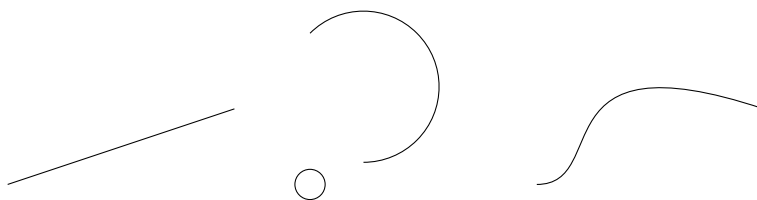
```
1 \documentclass{article}
2 \usepackage{tikz}
3
4 \begin{document}
5 ...
6 \end{document}
```

- Every TikZ picture occurs within the `tikzpicture` environment

```
1 \begin{tikzpicture}
2 ..
3 \end{tikzpicture}
```

- Many TikZ commands begin with `draw` and end with `;`

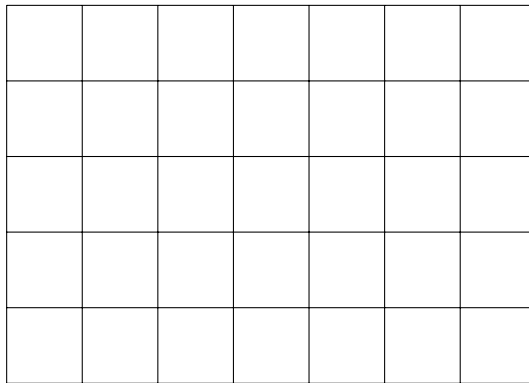
```
1 ...
2 \draw(0,0) — (3,1);
3 \draw(4,0) circle (.2);
4 \draw (4,2) arc(135:–90: 1);
5 \draw (7, 0) .. controls (8, 0) and (7,2).. (10, 1);
6 ...
```



Basic Drawing

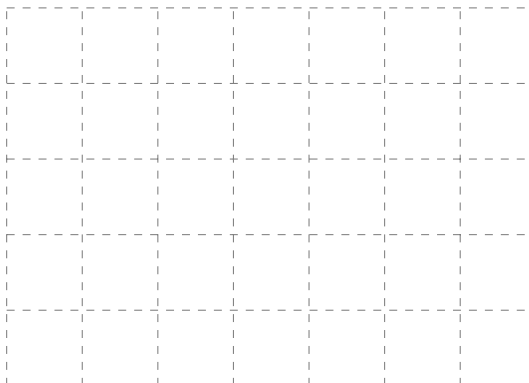
- The `grid` command helps you know where you are:

```
1 ...  
2 \draw (-3,-2) grid (4,3);  
3 ...
```



- Let's add some properties to our previous shapes [...]

```
1 ...  
2 \draw[dashed, gray](-3,-2) grid (4,3);  
3 ...
```

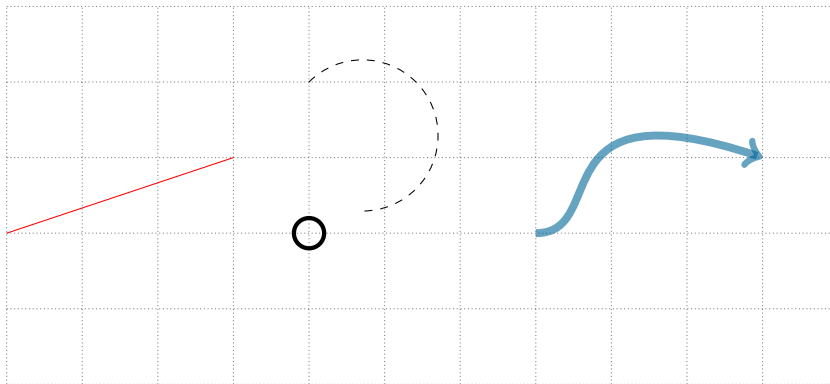


- Add some fun to our previous sketch.
 - Change the color of the line to red.
 - Change the thickness of the circle to 3pt.
 - Make the arc dashed.
 - Make the squiggle thick, blue-green, slightly transparent and add an arrow.

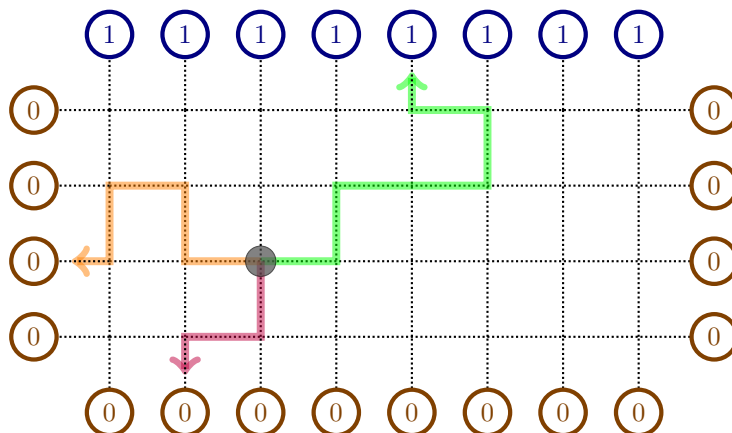
```

1 ...
2 \draw[red](0,0) — (3,1);
3 \draw[ultra thick] (4,0) circle (.2);
4 \draw[dashed] (4,2) arc(135:-90: 1);
5 \draw[line width = 3, ->,blue!60!green, opacity = .6] (7, 0)
  .. controls (8, 0) and (7,2).. (10, 1);
6 ...

```



- Draw a sketch that illustrates a random walk on a lattice.

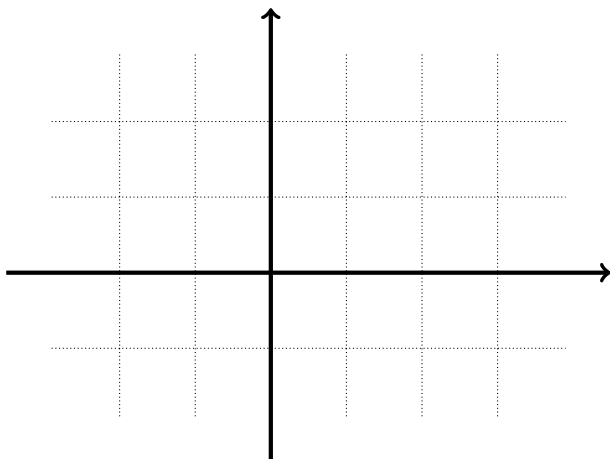


- Draw x - and y - axes.

```

1 ...
2 \draw[ultra thick,->](-3.5,0) — (4.5,0);
3 \draw[ultra thick,->](0,-2.5) — (0,3.5);
4 ...

```

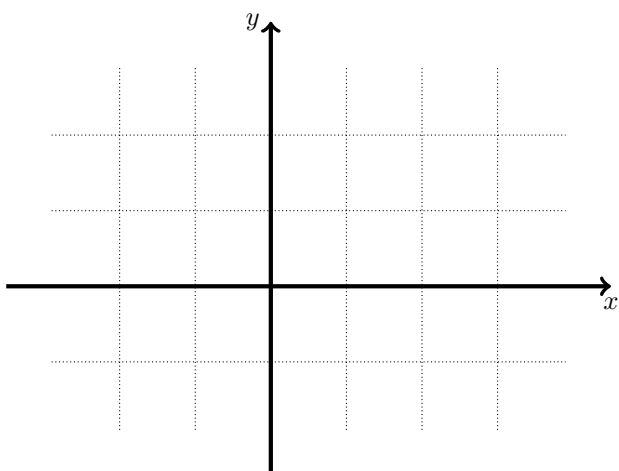


- Add text with the `node[]{ text }` command.

```

1 ...
2 \draw[ultra thick,->](-3.5,0) — (4.5,0) node[below] { $x$ };
3 \draw[ultra thick,->](0,-2.5) — (0,3.5) node[left] { $y$ };
4 ...

```

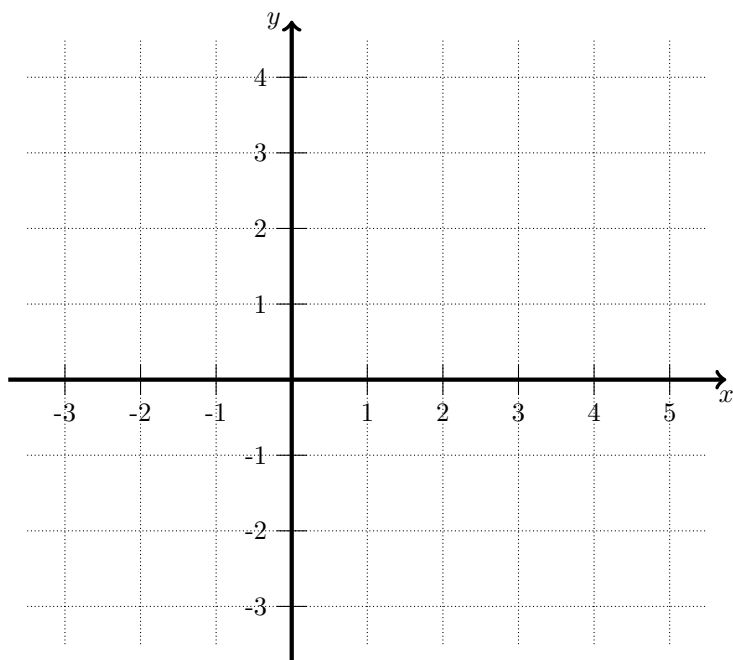


- Add ticks and labels by looping with the **foreach** command

```

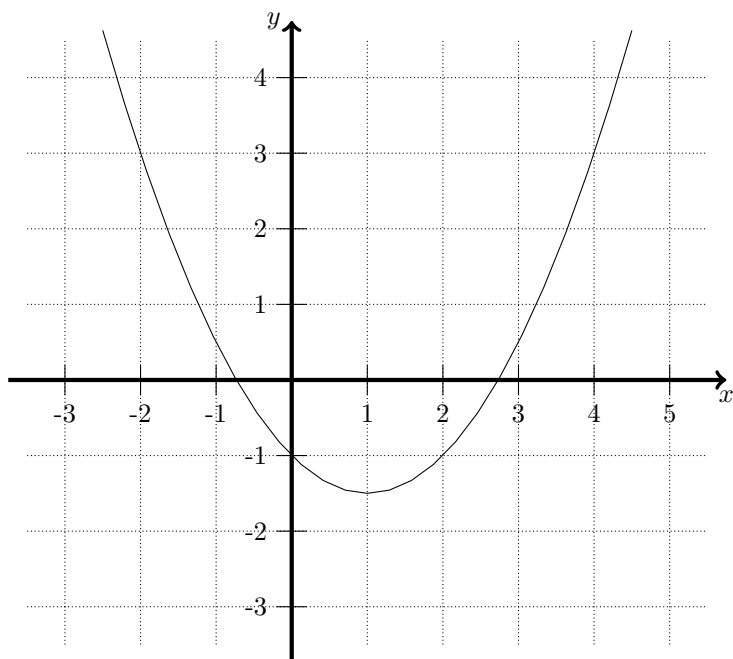
1  ...
2  \foreach \i in {-3,-2,-1,1,2,3,4,5}
3  {
4      \draw (\i,.2) — (\i,-.2) node[below]{\i};
5  }
6  \foreach \j in {-3,...,-1,1,2,...,4}
7  {
8      \draw (.2,\j) — (-.2,\j) node[left]{\j};
9  }
10 ...

```



- Plot functions with `plot`

```
1 ...  
2 \draw[domain = -2.5:4.5] plot (\x, {.5*\x*\x - \x - 1});  
3 ...
```

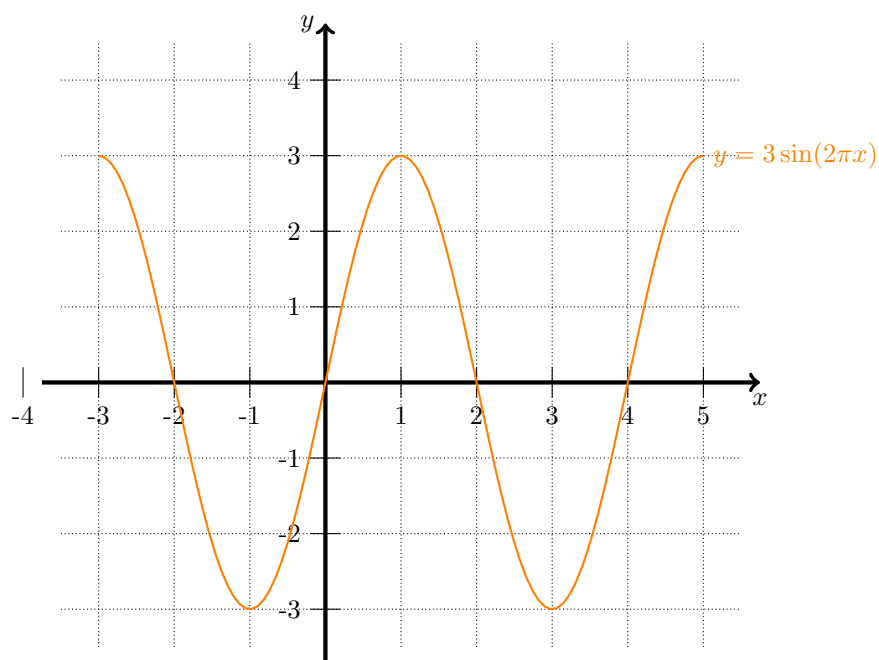


- There are many optional arguments for plotting.

```

1 ...
2 \draw[thick, orange, domain=-3:5, samples=100 ]
   plot (\x, {3*sin(deg(2*pi*\x/4))})
   node[right]{$y = 3 \sin(2 \pi x)$};
3 ...

```

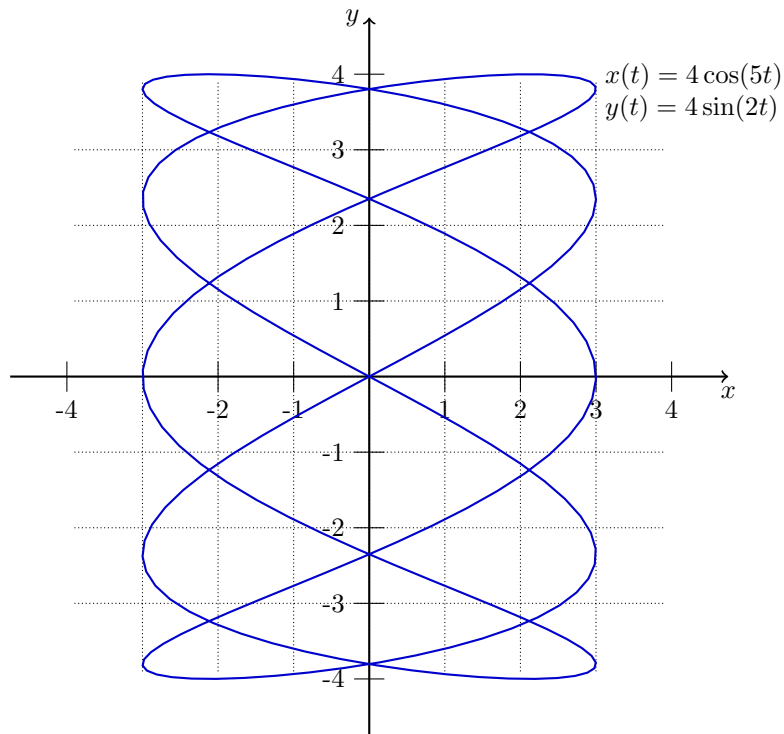


- You can draw parametric equations:

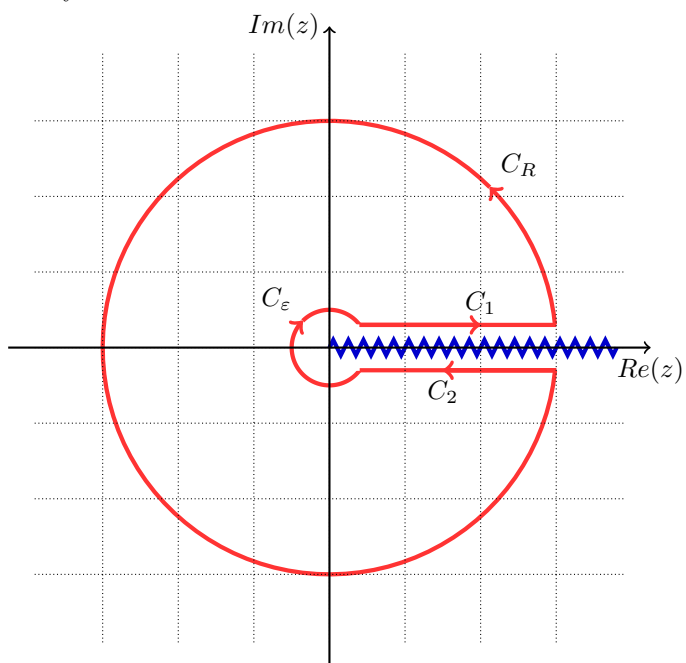
```

1 ...
2 \draw[blue!80!black, domain=0:360, samples=200, variable=\t]
  plot ({3*cos(5*\t)}, {4*sin(2*\t)})
  node[right, black, text width=3cm] {{$x(t)=4\cos(5t)$} \\\
  {$y(t)=4\sin(2t)$}};
3 ...

```



- Can you draw this sketch?



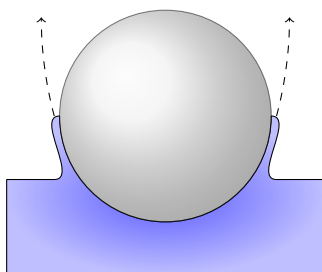
2 Drawing Pictures

- Illustrate the displacement when a ball is dropped in water.

```

1 \shadedraw [inner color = blue!65!white, outer color = blue
   !25!white] (-3,-1.2) to (-2.1,-1.2) to [out = 0, in = 180]
   (-2, 0) arc (180:360:2) to [out = 0, in = 180] (2.1,-1.2)
   to (3, -1.2) to (3,-3) to (-3,-3) to (-3, -1.2);
2 \draw [ball color = gray!20!white, semitransparent] (0,0)
   circle (2);

```

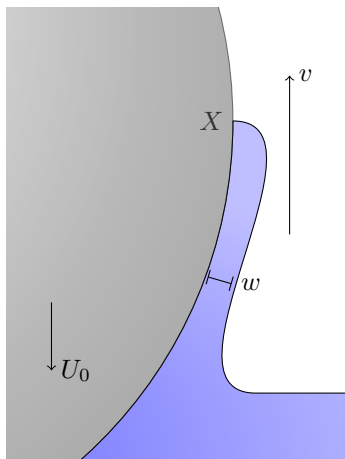


- Zoom and Clip

```

1 \path [clip] (1,.5) to (1,-1.5) to (2.5,-1.5) to (2.5,.5);
2 ...

```

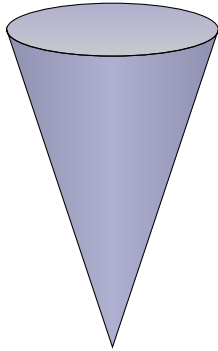


- Draw and shade a cone.

```

1   ...
2   \fill[ top color= blue!50,bottom color = blue!10, shading =
      axis, opacity = .25] (0,0) circle (2cm and 0.5cm);
3   \draw (0,0) circle (2cm and 0.5cm);
4   ...
5   \fill[left color= blue!50!black, right color = blue!50!black
      , middle color = blue!50!white, shading = axis, opacity
      = .25] (2,0) — (0,-6) — (-2,0) arc (180:360:2cm and
      0.5cm);
6   \draw (-2,0) arc (180:360:2cm and 0.5cm) — (0,-6) — cycle;
7   ...

```

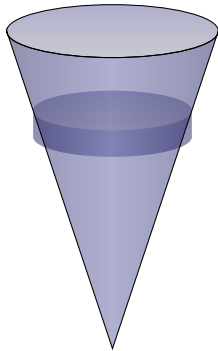


- Draw an infinitesimally small disk

```

1   \fill[ top color= blue!50,bottom color = blue!10, shading =
      axis, opacity = .25](0,-1.5) circle (1.5cm and 0.375cm);
2   \fill[left color= blue!50!black, right color = blue!50!black
      , middle color = blue!50!white, shading = axis, opacity
      = .25](1.5,-1.5) arc (360:180:1.5cm and .375cm)
      (-1.5,-1.5)— (-1.5,-2) arc (180:360:1.5cm and 0.375cm)
      — (1.5,-1.5);

```

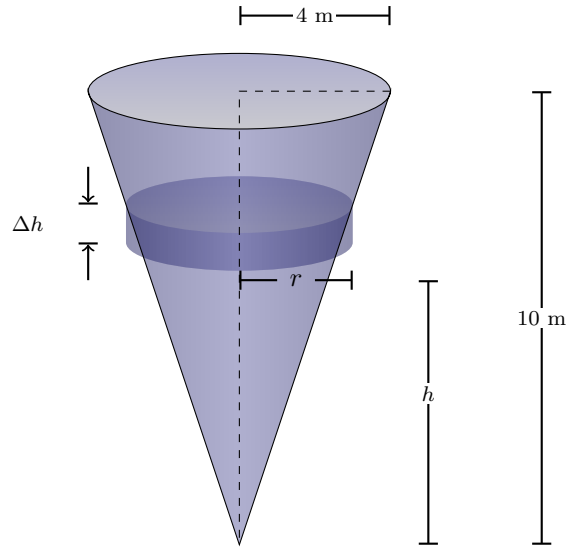


- Add a whole bunch of labels

```

1      ...
2      \tikzstyle{ann} = [ fill=white,font=\footnotesize,inner sep=1
      pt]
3      \draw[dashed] (2,0) — (0,0) — (0,-6);
4      \draw[thick,|-|] (2.5,-2.5) — (2.5,-6);
5      \draw[thick,|-|] (4,-6) — (4,0);
6      \draw[thick,|-|] (0,1) — (2,1);
7      \draw[thick,|-] (0,-2.5) — (.5,-2.5);
8      \draw[thick,-|] (1,-2.5) — (1.5,-2.5);
9      \draw[thick,->|] (-2,-2.5) — (-2,-2);
10     \draw[thick,|<-] (-2,-1.5) — (-2,-1);
11     \node[ann] at (-2.8,-1.75) {\Delta h};
12     \node[ann] at (2.5,-4) {$h$};
13     \node[ann] at (.75,-2.5) {$r$};
14     \node[ann] at (4,-3) {$10$ m};
15     \node[ann] at (1,1) {$4$ m};
16     ...

```



3 Plotting from Data

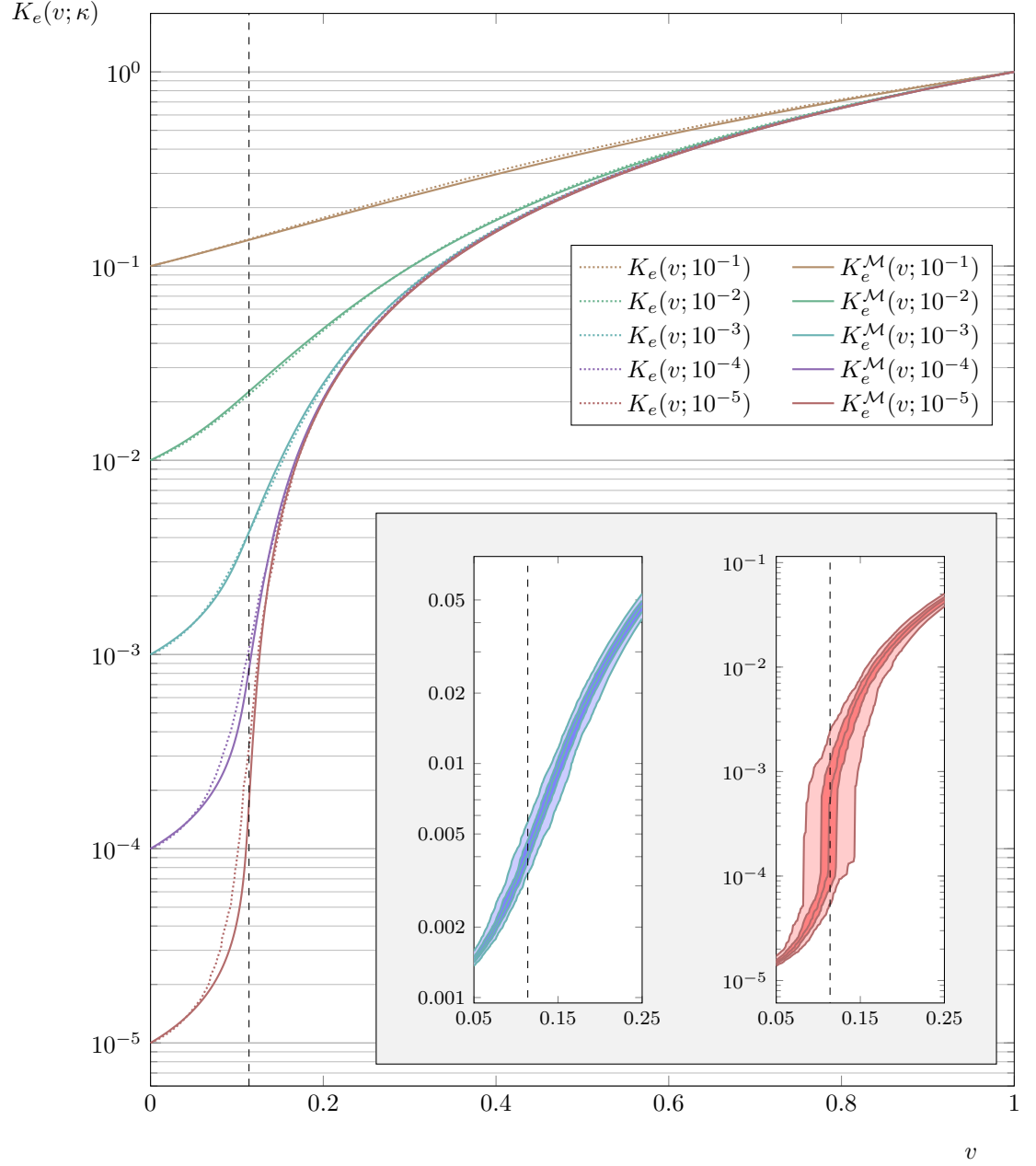


Figure 1: Effective conductivity $K(v; \kappa)$ (dots), as a function of v , the relative volume allocated to M_1 , the more conductive material, for $K_1 = 1$ and select K_0 . Effective conductivity of the model $K^{\mathcal{M}}(v; \kappa)$ (solid curves). Inset: Quantiles of $K_e(v)$ for $K_0 = 10^{-3}$ (left) and for $K_0 = 10^{-5}$ (right). Quantiles shown are 0.05, 0.25, 0.50, 0.75 and 0.95 for 100 realizations. Black dashed lines show percolation threshold $v_c = 0.1135$

https://www.overleaf.com/learn/latex/TikZ_package