

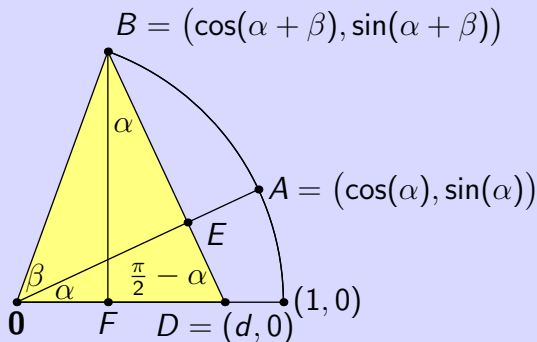
Using animations within \LaTeX documents

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Static graphics



Graphic by Asymptote

And hence

- ▶ $\sin(\alpha + \beta) = \sin(\alpha) \cos(\beta) + \cos(\alpha) \sin(\beta)$
- ▶ $\cos(\alpha + \beta) = \cos(\alpha) \cos(\beta) - \sin(\alpha) \sin(\beta)$

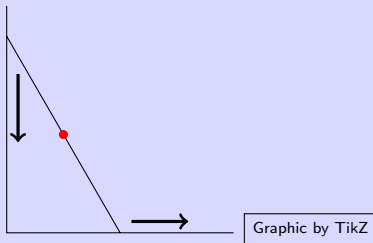
Extreme cases

How it's done

1. Generate each frame
2. Stitch frames together and include in pdf file
3. Stitch frames together for other formats (animated gifs)

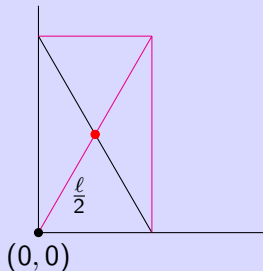
The falling ladder problem

A ladder leans against a wall. The bottom of the ladder is pulled away from the wall causing top to drop down. What path does the midpoint of the ladder take?



- ▶ Concave up
- ▶ Straight line
- ▶ Concave down

Solution to the falling ladder problem



Graphic by TikZ

 $\ell = \text{length of the ladder}$

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Animations of falling ladders

Graphics by PostScript

How it's done

1. Master PostScript file with a parameter
2. Generate individual PS files (sed in this case)
3. Convert each PS file to png format (ImageMagick in this case)
4. Use `\animategraphics` (from animate package with pdfL^AT_EX)
`\animategraphics[loop,width=4.5cm]{16}{ladder}{239}{200}`
5. Convert each PS file to gif format (ImageMagick)
6. Create animated gif from these files (ImageMagick)

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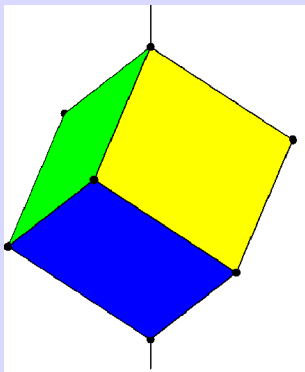
Envelope of lines joining $(0, t)$ to $(\sqrt{1-t^2}, 0)$
for $0 \leq t \leq 1$

How it's done

1. Sage generates single file of pdf graphics pages with one command
2. `\animategraphics` stitches pages into an animation
`\animategraphics[width=5.5cm]{12}{envelope}{}{}`

Slicing the cube

A cube is sliced perpendicular at the midpoint of the axis joining antipodal points. What is the cross-section?



Slicing the cube solution

How it's done

1. Create asymptote file for 3d image with up/down parameter
2. Generate eps file
3. Convert to png
4. Use `\multiframe` with `animateinline` from the `animate` package
`\multiframe{32}{iFnum=100+1}{\includegraphics{cube\iFnum.png}}`

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Graphic by Sage-generated frames

How it's done

1. Use sage to generate the \LaTeX code for individual frames
2. Use `\include` to insert it in the proper place
3. Run with `\animateinline` environment
`\begin{frame} ... \end{frame}`

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Graphic by Asymptote and animategraphics

How it's done

1. Use `asymptote` to make pdf of partial path
2. Use `\shipout` in `asymptote` to make pdf frames
3. Run with `\animategraphics`

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Graphic by Asymptote and animategraphics

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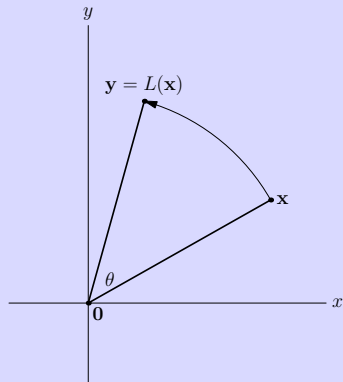
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Graphic by Asymptote and animategraphics

How it's done

1. Use loop within asymptote to make a pdf file of one frame per page
2. Run with `\animategraphics`
`\animategraphics[loop,height=5cm]{16}{circle-rot}{0}{99}`

Rotations in the plane



$$\mathbf{y} = \begin{bmatrix} \cos(\theta) & -\sin(\theta) \\ \sin(\theta) & \cos(\theta) \end{bmatrix} \mathbf{x}$$

Apply $\begin{bmatrix} \cos(\theta) & -\sin(\theta) \\ \sin(\theta) & \cos(\theta) \end{bmatrix}^k$ to each point:

How it's done

1. \LaTeX def with one parameter to make one TikZ figure
2. while/do loop within animateinline