LaTeXTutorial Project: Graphing

August 17, 2020

Required packages: `tikz`, `pgfplots`, `tikz-3dplot`

Exercises adapted from [1], [3], and [2].

Instructions: Starting with the sources listed in the **References** section, create a `tikzpicture` for each figure described or shown. Note that, if desired, you can place your `tikzpicture` environment inside of a `figure` environment, e.g. to add a placement option, caption, or label (for referencing).

Pure TikZ

Exercise 1. Basic shapes – Create the shapes, but also experiment with the options (e.g. colors, line thickness, dashed) for the `\draw` and `\filldraw` commands.

(a) A line segment from $(-2, -2)$ to $(2, 2)$

(b) A filled equilateral triangle

(c) An ellipse with horizontal major axis (wide and short)

Exercise 2. System of equations (linear) – Consider the system below:

$$\begin{aligned} x + y &= 6, \\ -3x + y &= 2. \end{aligned}$$

(a) Solve the system. For extra mathematical typesetting practice, you can type the solution, as well.

(b) Draw a light-gray grid and system of axes large enough to depict the system.

(c) Sketch the lines from the system.

(d) Plot the solution point (as a filled circle, see [3]).

Exercise 3. System of equations (nonlinear) – Consider the system below:

$$\begin{aligned} y &= 4 - x^2, \\ y &= 3. \end{aligned}$$

(a) Solve the system. For extra mathematical typesetting practice, you can type the solution, as well.

(b) Draw a light-gray grid and system of axes large enough to depict the system.

(c) Sketch the curves from the system.

(d) Plot the solution points.

Using pgfplots

Exercise 4. Plotting functions – Use the `tikzpicture` and `axis` environments, along with the `\addplot` command, to plot the graphs of $y = \sin(x)$ and $y = \cos(x)$, in different colors, for $x \in [-\pi, \pi]$.

Exercise 5. Plotting data

(a) Create five or more coordinates (e.g. could be arbitrary, could create by adding noise to a function).

(b) Use `addplot coordinates` to plot the coordinates and piecewise-linear interpolation.

Exercise 6. Three dimensions – Plot the graph of $z = f(x, y)$ with f defined as below:

$$f(x, y) \;=\; \exp[-(x^2 + y^2)] \sin(x^2 + y^2).$$

Challenge Problems

Exercise 7. Compartmental diagram – Recreate the diagram depicted below, reproduced from [5]. Focus on representing the relevant compartments and arrows.

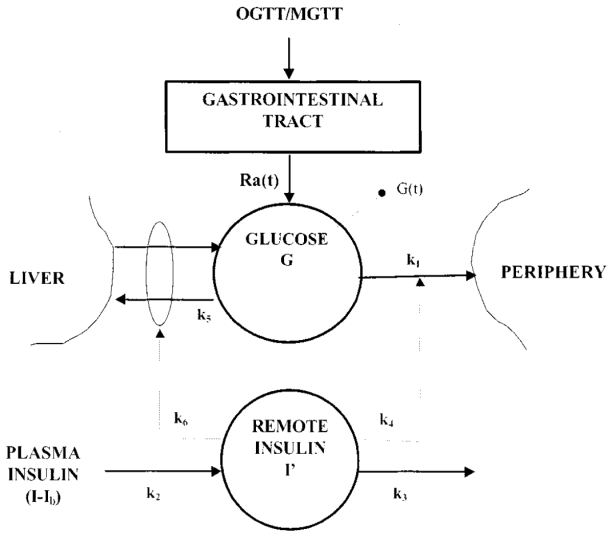

Figure 1: Diagram of the "oral minimal model," used to quantify insulin sensitivity from glucose and insulin data following an oral glucose test.

Exercise 8. Three dimensions – Recreate the diagram depicted below. See [4] for details about `tikz-3dplot`

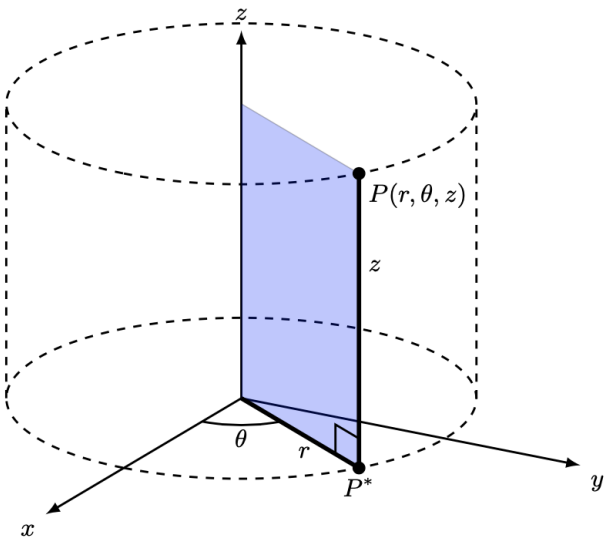

Figure 2: Relationship between rectangular coordinates and cylindrical coordinates in $\mathbb{R}^3$.

References

[1] Latex graphics using tikz. Available at `https://www.overleaf.com/learn/latex/LaTeX_Graphics_using_TikZ:_A_Tutorial_for_Beginners_(Part_1)Basic_Drawing`.

[2] Pgfplots package. Available at `https://www.overleaf.com/learn/latex/pgfplots_package`.

[3] Tikz package. Available at `https://www.overleaf.com/learn/latex/TikZ_package`.

[4] J. Hein. Latex graphics using tikz. Available at `http://www.bakoma-tex.com/doc/latex/tikz-3dplot/tikz-3dplot_documentation.pdf`.

[5] C. D. Man, A. Caumo, and C. Cobelli. The oral glucose minimal model: Estimation of insulin sensitivity from a meal test. *IEEE Transactions on Biomedical Engineering*, 49:419–429, 2002.