

# ex04: Sketching graphs

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## 1 Overview

Think of a situation where you write your thesis, a paper, slides, weekly reports to your boss or to future you. You may have an idea for the proof of your conjecture. You may want to discuss why the mechanism you describe in the article/note/journal works as you expect.

You can demonstrate your idea unambiguously with mathematical expressions. To reveal the economic intuition behind your theory, you must elaborate on the mechanism in words. Often times, drawing a graphical sketch of your theory is the most effective way to convey your idea to the reader.

Since sketching graphs is an important skill for academic communication, I would recommend all of you to build your own routine to draw nice graphs on a computer.

### Purpose

To learn

- how to draw a sketch of a graph on computers and
- how to embed it in an R Markdown document.

Here, in this `problem.pdf`, I show you my routine. Imitate and extend it if you don't have yours already or if you think yours is not as good as mine.

If you think you have a better way, you don't need to learn from me. Just follow your routine to create a picture file and embed it in the document with the function I show you later in this document.

## Instructions

In this assignment, you will

- clone the assignment repository and make a working branch (eg. `solution` branch);
- draw graphs and put the file in `figure` folder (see Section 3);
- write the solutions in `solution.Rmd`;
- commit `solution.Rmd` and `solution.pdf` together with the picture file(s); and
- open a Pull Request.

## 2 My routine

### Draw

I use Keynote, a presentation application for Mac, to draw graphs. If you work on Windows, PowerPoint is an alternative. As a sample I attach the presentation file I used for a class. Uncompress `asset/images/solow_model.key.zip` and open `solow_model.key` with Keynote for Mac to see how I draw the graphs and set fonts for mathematical expressions.<sup>1</sup>

### Export

Export the presentation file to a single PDF or multiple image files (JPEG or PNG). Put them somewhere close to the R Markdown file. I usually put the original file and the exported together under a folder named `figures` or `images`.

The resulting PDF file is stored in `asset/images/solow_model.pdf` as a sample.

### Embed

Now that we have the graphs, let's move to RStudio and to an R Markdown file.

Set global knit options at the beginning of the document with a code chunk similar to below. This set the default figure width to 14cm and default alignment to center.

Your `solution.Rmd` already has this chunk.

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<sup>1</sup>My favorite choice is Palatino fonts in bold italics, which go well with `mathpazo` package of LaTeX. To embed more complex mathematical expressions in a presentation file, I use LaTeXIt, which converts a LaTeX code snippet into an image of the rendered math expressions.

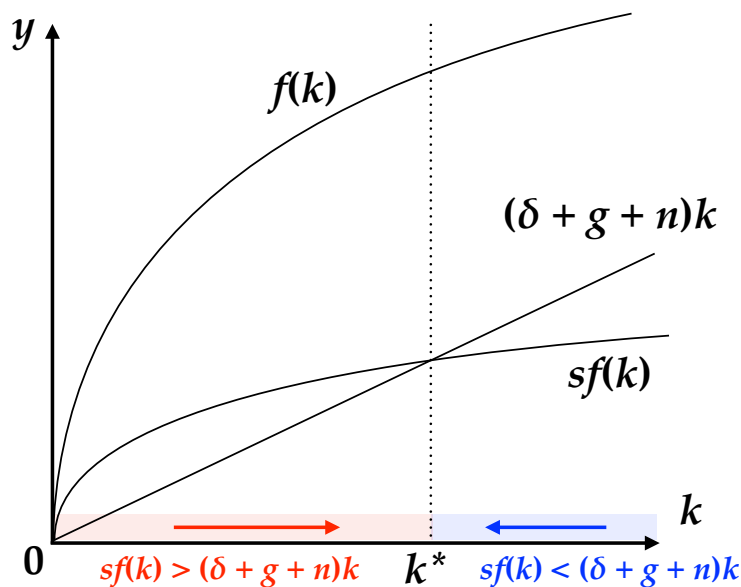


Figure 1: Solow Model

```
```{r, include=FALSE}
knitr::opts_chunk$set(fig.align = 'center', out.width = "12cm")
```
```

To embed the first page of the PDF, You can use a code chunk as follows:

```
```{r solow1, fig.cap="Solow Model", out.extra="page=1", echo=FALSE}
knitr::include_graphics("asset/images/solow_model.pdf")
```
```

This R code chunk produces Figure 1. I used cross-reference command `\@ref{fig:solow1}` here. Note that the chunk label (solow1) with prefix fig: is used as a pointer to the figure.

Please have a look at the source file (problem.Rmd) to see how I take advantage of text reference for the caption (fig.cap option).<sup>2</sup> This feature comes in handy when the caption is long.

The chunk option, `out.extra="page=1"`, is a special option used when including a page from a multiple-page PDF file. `out.extra="page=n"` includes n-th page of the PDF file specified as the argument to `knitr::include_graphics()` function.

<sup>2</sup>For more detail, see <https://bookdown.org/yihui/bookdown/markdown-extensions-by-bookdown.html#text-references>

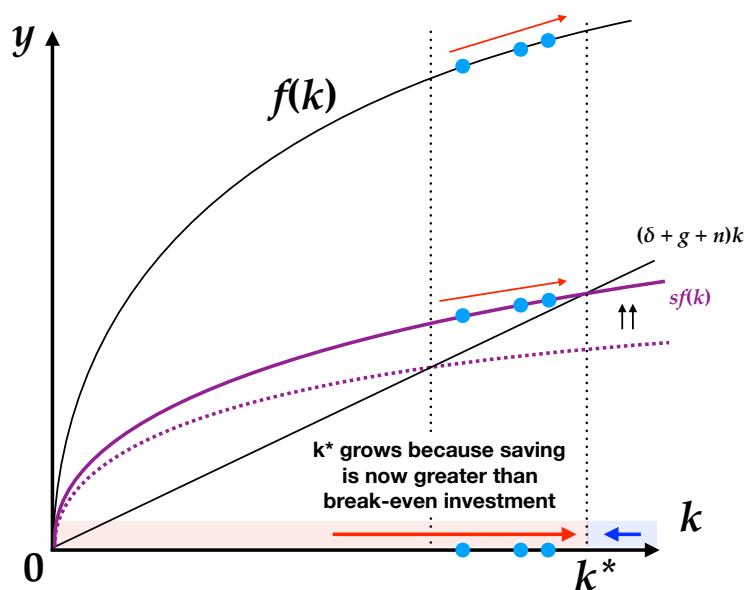


Figure 2: Increase in  $s$

### 3 Problem

Produce a figure similar to Figure 2 but for the case of a sudden decrease of  $s$ . Put the file in figures. In the body of the document, explain what happens to  $k$  after the parameter change.

The document must have all of the following.

- Correct graph
- Reasonable caption and
- Reference to the Figure in the body at least once (If you use more than one figure, all figures must be mentioned once.)