

# SPEEDING UP MICROSOFT® EXCEL®

A space shuttle is shown launching, ascending vertically against a dark sky. A large, bright plume of white and yellow smoke and fire trails behind it, creating a dramatic, high-contrast scene.

30 Methods for Improving  
Calculation Performance

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**Bonus:**  
Five ways  
to speed up  
opening Excel  
workbooks

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## Introduction

You are holding a book about improving the speed of Excel calculations, so it's fair to assume that you're struggling with Excel's performance.

Excel is an excellent tool for performing calculations. Just a few years ago, many of the complex calculations you can do today were not even possible or required significant simplifications. You probably won't agree with this while in your current situation, but Microsoft has made some powerful improvements to Excel over the years. These improvements over the last decade have improved data handling and calculation performance. To a certain degree, you can now throw all your raw data into Excel and conduct a large analysis. It is now possible to create very intricate models and conduct complex calculations.

If you've used Excel for a long time—for example, before Excel 2007—then you'll know what I'm talking about. Today, you can solve problems in Excel that were simply impossible because of previous “hard” restrictions, such as only being able to use 65,536 rows.

Because of these improvements in Excel's limitations and calculation capabilities, users often no longer have to worry about performance and calculation times. That's fine, until they really experience Excel slowing down.

Figure 1 shows calculation times and the Excel user's feelings according to those times. Everything below 1/10 of a second for one

round of calculation feels instantaneous, and there's no noticeable delay. Between 1/10 of a second and 1 second, the delay is noticeable but still acceptable. It gets annoying for the user when Excel takes longer than 1 second but under 10 seconds; in these cases, the user can still concentrate on the current work stream. For calculation times in excess of 10 seconds, the user usually loses track and shifts his or her concentration to other tasks (1).

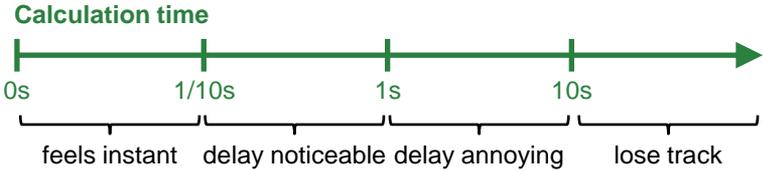


Figure 1: Calculation time and the feeling for an Excel user

The intention of this book is to provide you with quick help when you need it. You will not get a lengthy theoretical discourse here (although the first chapter does start with the theoretical background of Excel's calculation processes) but rather a hands-on recipe for what to do when things slow down.

The problem with improving calculation performance is that every Excel model is different. Therefore, the methods you'll learn in this book will have a different impact depending on your situation. Some of the methods may work very well and help a lot, while others might not help at all. For example, one piece of advice is to switch your computer to an English language region. If your computer is already set to English—for example, "English (United States)"—then you can't gain anything from that tip. If your computer is set to any other language region than English, however, then your calculation time will instantly be reduced by at least 70 percent.

Another annoyance with large Excel files is the long time required to open them. Besides reducing actual calculation times, you'll also get to know a few methods for reducing the time it takes to open an Excel workbook.

In conclusion, this book includes a variety of ways to save you time when working with sophisticated Excel files. Some might work for you, while others might not. But the following pages should provide you with simple guidelines on how to immediately increase the calculation speed and improve the opening performance of your Excel files.

## **Chapter 1: Theoretical background of Excel's calculation process**

With the 2007 version of Excel, Microsoft fixed many workbook and worksheet limitations, for example by increasing the number of rows and columns in a worksheet. Now that these changes have been made, it is necessary to optimize the workbook and the environment for the best possible performance. Fortunately, the newer Excel versions have already become a lot smarter under the hood. The whole calculation process has improved.

It helps a lot to understand what Excel is doing in the background. Although the methods for improving calculation performance discussed later concentrate on specific actions, it is worth spending a little time on the theory first.

- The methods within group 4 usually require a lot of effort, and the performance improvement is at most 15 percent. In other words, you don't get much bang for your buck. This is the "Last resort" group.

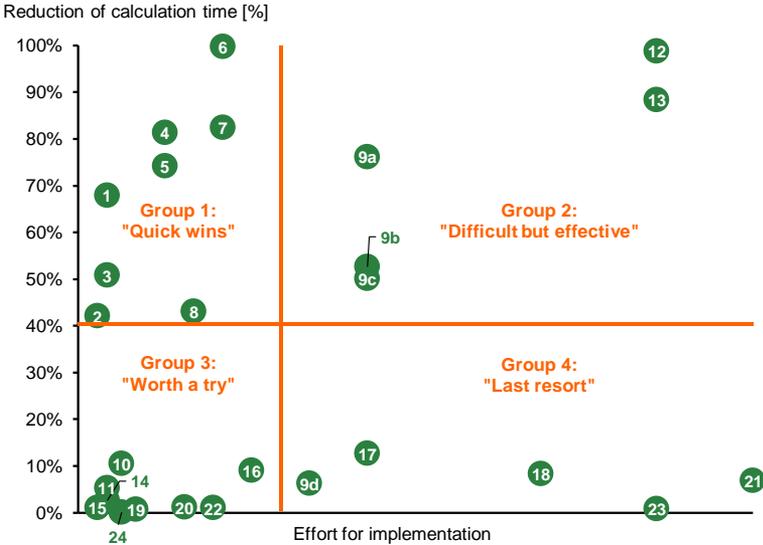


Figure 8: Overview of the various methods for speeding up Excel calculations<sup>6</sup>

As described on page 21, the reduction of calculation time (on the vertical y-axis shown in figure 8) was measured with a VBA macro. The effort for the implementation of a method (the horizontal x-axis)

<sup>6</sup> Methods 25 through 30 are not included in the overview due to their negative (or not measurable) impact.

is based on experience and a rough estimation; there is no scientific background to that number.

The 30 methods in this chapter are arranged in the following order: by the reduction of calculation time (in percentages) divided by estimated effort (in seconds). For example, because hypothetical method A reduces the calculation time by 50 percent and requires 200 seconds for implementation, while method B reduces the calculation time by 40 percent but only requires 100 seconds, method B will be listed ahead of method A.

## 01. Avoid links to other workbooks, or keep linked workbooks open

### Idea

Links to other Excel workbooks (also called external references) are sometimes unavoidable but often come with more disadvantages than advantages: they are slow and difficult to find, they break easily, and they are often simply annoying. (You've probably experienced the error message when opening a workbook with external links in which Excel asks you if you'd like to refresh the linked data.)

### Implementation

You have various options for handling external links in Excel. The easiest method is to break all links. Please note that all formula cells with references to other workbooks will be replaced by values.

1. Click on "Edit Links" on the "Data" ribbon. If the button is grayed out and you can't click on it, then your workbook does not have external links, and you can stop here.
2. Select the link that you want to break. Again, a word of caution: please be aware that your calculation might be damaged and may not work as it did before. Also, links can't be restored once they're broken.
3. Click on "Break Link."

Avoid links to other workbooks, or keep linked workbooks open

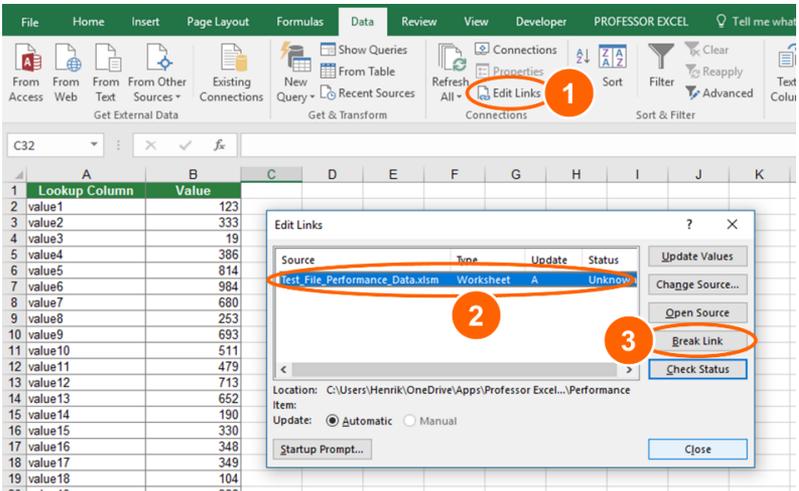


Figure 9: Steps for breaking workbook links

You also have a few other options. If you want to maintain references to other workbooks instead of breaking them, please consider the following options.

- Keeping the linked workbook open when Excel performs calculations can significantly speed the calculation process (as long as your source workbook does not require calculations to be performed).
- Use direct cell links, for example  
`=[Source_WB.xlsx]Sheet1!A1` instead of formulas that refer to ranges in the other file, such as  
`=VLOOKUP(A1, [Source_WB.xlsx]Sheet1!A:B, 2, FALSE)`.
- Consider alternative methods, for example using queries to retrieve data from the other workbook.

**Impact**

The impact of this method will differ, depending on whether the source workbook is open at the time of calculation. If the source workbook is open, then the calculation will be 0.7 percent faster if the data is in the same workbook instead of linking to another open workbook.

Reduction of calculation time:  
**68%**

If the source workbook is closed, then the calculation will take 3.1 times longer than if you had no external links at all. In other words, opening a linked workbook reduces the calculation time by 68 percent.

## 02. Use all available processors for calculations

### Idea

Modern computers usually have more than one processor. Excel can use this situation to split calculations across several processors and calculate (for example) one thread on each processor.<sup>7</sup>

There are some restrictions, though:

- You will only experience improvements in calculation performance if your workbook has more than one independent calculation tree. A workbook with more than one calculation tree “will show gains close to the number of processors available,” according to Williams, Bokone, and Rothschiller (4).
- Some features do not support multithreaded calculations, including
  - data-table calculations
  - user-defined functions
  - XLM functions
  - the INDIRECT, CELL, and GETPIVOTDATA formulas
  - the VBA functions `Range.Calculate` and `Range.CalculateRowMajorOrder`
  - circular-reference loops

The default setting is that Excel will use all available processors, but once your workbook has been calculated and saved with fewer processors, Excel usually stays with the lower number of processors.

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<sup>7</sup> A thread is the “smallest sequence of programmed instructions that can be managed independently,” according to *Wikipedia* (10).

### Implementation

The implementation is quite simple (see figure 10):

1. Click on “Home” and then “Options.”
2. Click on “Advanced” on the left-hand side.
3. Scroll down until you reach the “Formulas” section.
4. Make sure “Enable multi-threaded calculation” is checked.
5. Now you have two options:<sup>8</sup>
  - a. “Use all processors on this computer” (recommended) or
  - b. Set the number of threads manually.
6. Confirm with “OK.”

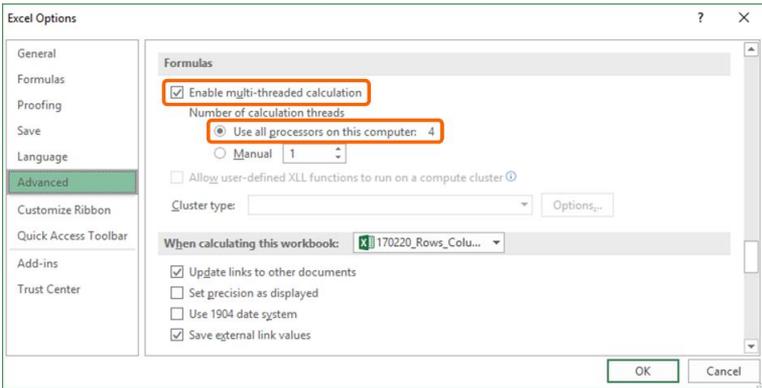


Figure 10: Enable multi-threaded calculations

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<sup>8</sup> For step 5 above, you must differentiate between the number of threads and the number of processors. The number of processors is equal to the number of cores of your computer, while a thread is just a virtual sequence; one processor can host more than one thread. You can set the number of threads manually to a maximum of 1,024 threads in Excel. *Recommendation:* The option “Use all processors on this computer” is usually a safe choice, but you can—and you are encouraged to—test what happens if you manually change the number of threads.

## Impact

The effect with a test workbook is quite clear: changing the number of processors from four processors to one processor increases the calculation time between 62 and 94 percent. Alternatively, switching from one processor to four processors reduces the calculation time by from 39 to 49 percent.<sup>9</sup>

Reduction of  
calculation time:

**39% to  
49%**

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<sup>9</sup> The test was done under three different environments and settings, which led to this range of performance increases (3).

## 04. Switch the Windows region to “English (United States)”

### Idea

Modern hardware and software environments (your computer and the operating system, Windows) are built for the English language system. They can of course handle other languages, but they are optimized for English input, processing, and output.

A member of the Microsoft Excel team has explained it this rather technical way: “The reason is that we can short-circuit English to byte comparison. More complex scripts require involving more heavy Unicode machinery” (5).

The concept is to set your computer’s language region to English: for example, to “English (United States).”

### Implementation

Probably the fastest way to implement this is to follow these steps.

1. In Windows 8 or 10, press the Windows key and start typing “region.”
2. If your search result shows the “Region” settings within the Control Panel, as shown in figure 11, then press Enter.
3. Change “Format” to “English (United States).” Any other English region, such as “English (United Kingdom),” is also fine.
4. Optional: Adjust the date and time settings per your own language and preferences.
5. Confirm with “OK.”

Switch the Windows region to “English (United States)”

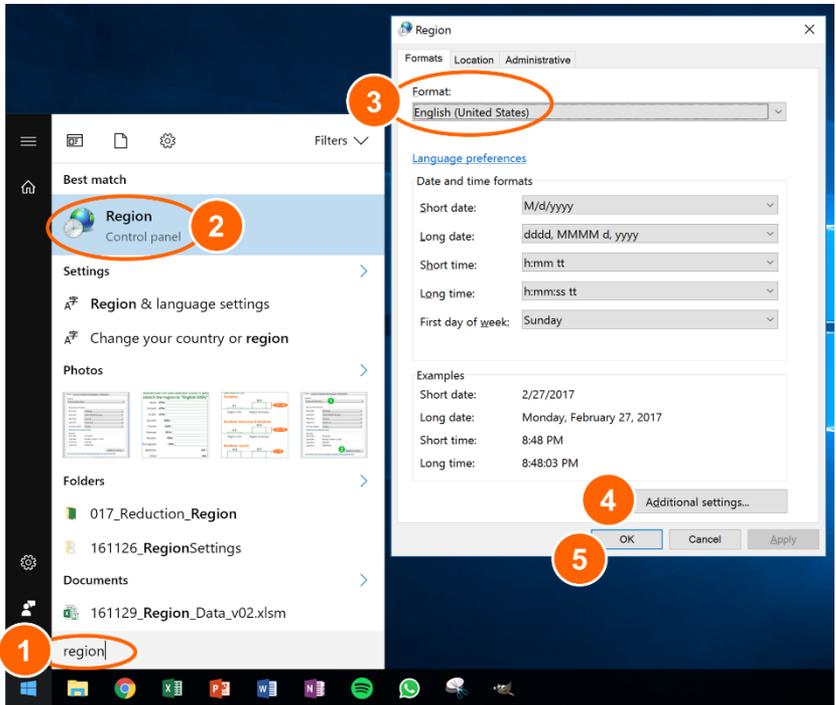


Figure 11: Steps for changing the computer's region (first method)

Another way to change the region settings is to open the Control Panel.

1. Right-click on the Start button in the bottom left corner of the screen (in Windows 8 or 10). In Windows 7, click on “Start” and then on “Control Panel.”
2. Open the Control Panel.
3. If the view of the Control Panel is set to “Small icons” or “Large icons” (as shown in figure 12), then just click on “Region.” If your Control Panel is organized by “Category,”

then click on the “Change date, time, or number formats” option within the “Clock, Language, and Region” group.

4. Change “Format” to “English (United States).” As mentioned earlier, you can also select any other region that starts with “English.”
5. If you want to return to your local settings (for example for dates), then you can further modify the settings by clicking the “Additional settings...” button.
6. Confirm with “OK.”

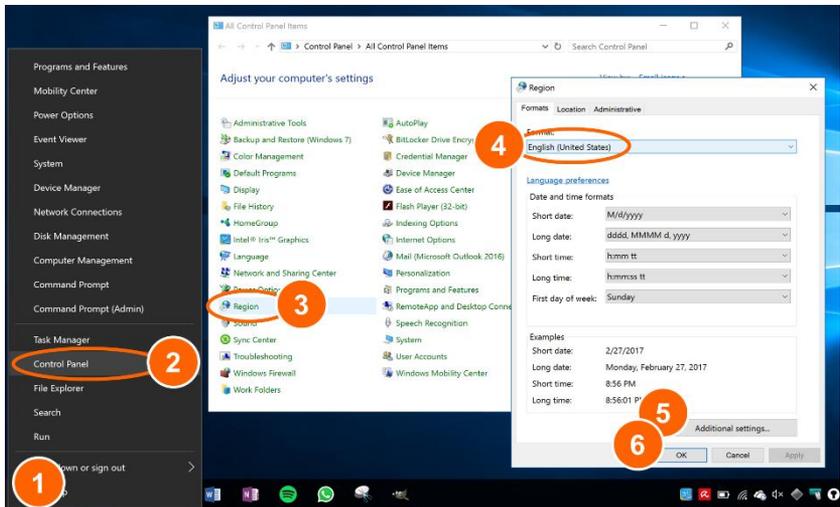


Figure 12: Steps for changing the computer’s region (second method)

Please note that you should not change the *language* of your computer or of Excel. Only the *language region* as shown before of the computer matters.

## Impact

If you change the language region of your computer to any “English” language region, then the impact will be very high. With a simple test file containing 50,000 VLOOKUP formulas, the effect was significant, as shown in figure 13. The results ranged from an 82 to 99 percent reduction of calculation times.

Reduction of  
calculation time:

**82% to  
99%**

The different language regions can be summarized in four different groups:

1. The first group is the reference region, “English.”
2. The second group contains a group of highly heterogeneous regions with markedly different languages, including Chinese, Greek, Korean, German, Japanese, and Russian. By changing the region from one of these languages to English, you can reduce calculation times by at least 82 percent.
3. The third group required 12 to 23 times the amount of time to calculate a test file compared to using English, which means that you can reduce calculation times by from 92 to 96 percent by making this switch. Somewhat surprisingly, this group contains “Spanish,” but “Portuguese” is listed in group 2.
4. The fourth group required from 44 to 70 times the calculation time than was the case with English. In terms of reduction, this means that you can reduce calculation times by almost 99 percent if you switch from one of these languages (Hindi, Punjabi, or Bangla, for instance) to English (6).

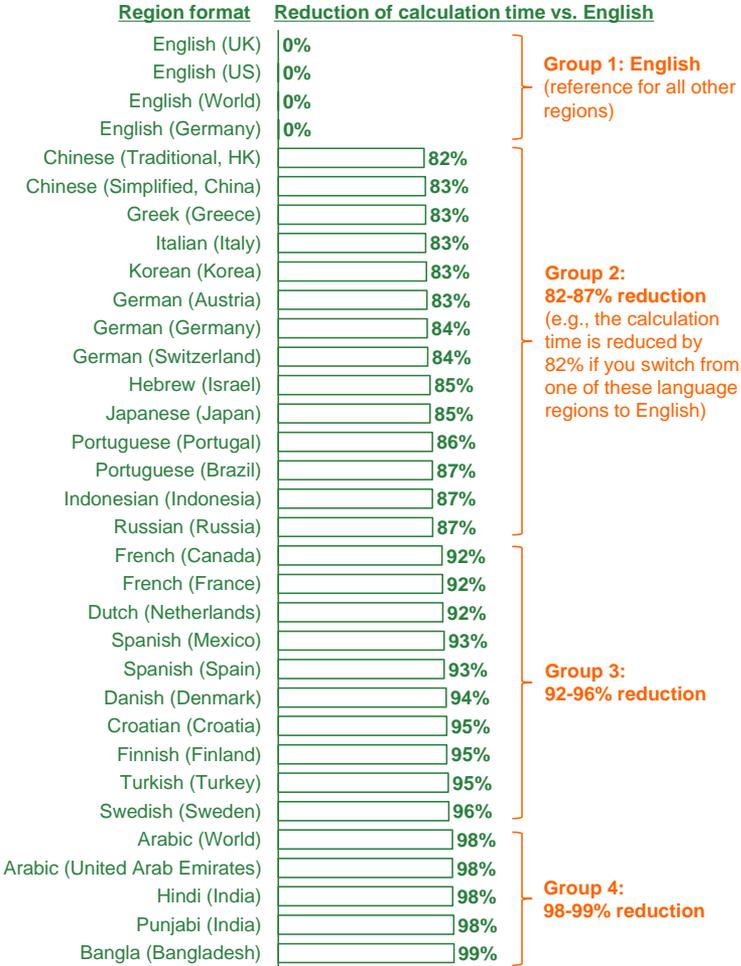


Figure 13: Reduction in calculation times for a simple test file after changing the computer's language region settings<sup>10</sup>

<sup>10</sup> The values represent the reduction of the calculation time (in percentages) compared to the English reference region (group 1). Your

## **Chapter 3: Improve opening performance**

Another important aspect of speeding up Excel besides the actual calculation performance is the performance of opening Excel files. You might object that once you've opened a file, you no longer want to be bothered. But waiting for one minute for a file to open—even if it's just once—is still annoying.

This chapter introduces five simple methods that speed up the process of opening Excel files. As we did previously, each method is outlined by the three “I”s: idea, implementation, and impact. As before, the impact is measured with a simple VBA macro designed for a test workbook. Although the actual effects you'll experience might differ according to your own situation, the numbers should provide a rough idea of what to expect when you apply these methods.

## 01. The XLSB file type

### Idea

The XLSB file type was designed to keep file sizes and load times low. The file format is a binary format, which means the source code of your Excel file can only be read by computers, not by humans. In addition, other Office programs might experience problems opening them. Please refer to page 59 for more information on the XLSB file format.

### Implementation

This is one of the easiest methods of reducing the load time of Excel workbooks. You can save your Excel file in XLSB file format by going to “File” and clicking on “Save as.” Alternatively, press F12 on the keyboard to open the “Save as” window. Choose the file format XLSB in the lower part of the “Save as” window, as shown in figure 23 on page 61.

### Impact

Again, the impact will depend on your file. Most importantly, the impact will depend on the original file size in the XLSX format.

Figure 45 shows the relationship between the size of an XLSX file and opening times (in the solid line). The dotted line indicates the opening times if you change the XLSX file to XLSB. When you change the file type, the size of the Excel file decreases. The dotted line shows the speed of the corresponding XLSX file for comparison.

Reduction of  
opening time:

**69%**

As you can see in figure 45, the opening time for a 5 MB XLSX file took approximately 3.0 seconds. After changing the file type to XLSB (the file size reduced to 3.5 MB), the opening time was reduced to 1.5 seconds. That's a reduction of 50 percent, but in terms of absolute number, it's "just" 1.5 seconds.

With a 10 MB workbook, the opening time decreased from 5.4 to 2.5 seconds; the reduction in this case was 54 percent, or 2.9 seconds. At the same time, you've shrunk the file size from 10 MB to 5 MB.

With a file size of 78 MB, switching the file type from XLSX to XLSB will reduce the file size to 55 MB, and the time for opening the file will change from 46 seconds to 14 seconds. You save 69 percent of the time, or 32 seconds.

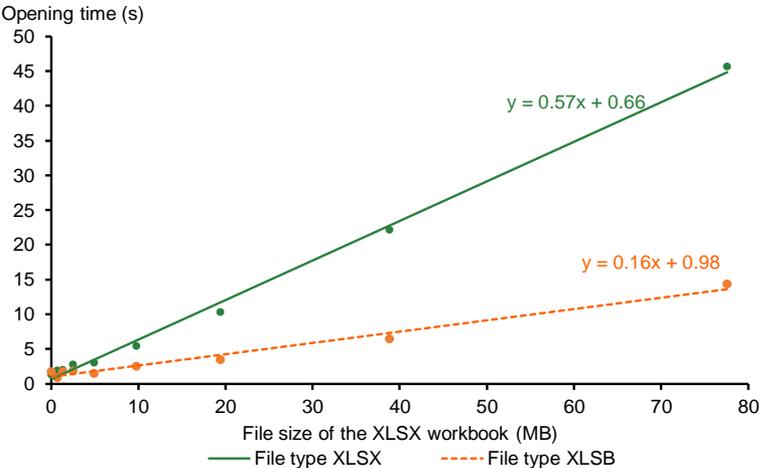


Figure 45: Opening times for an Excel workbook in the XLSX and XLSB formats

*Recommendation:* Because the XLSB file format comes with a few disadvantages (see page 60), you should only use the XLSB format when it's worth it; this is usually the case when the file size exceeds 10 MB.

# SPEEDING UP MICROSOFT EXCEL

Tired of waiting for Excel? Use the 30 best methods described in this book to speed up Excel calculations!

- Learn how Microsoft Excel performs calculations
- Use the simple and effective step-by-step guide to master each method
- Get to know the impact each method will have on performance

The goal of the book is to provide you with quick and easy-to-access help. Once you learn these tips, you'll be able to improve Excel's calculation performance with just a few clicks of the mouse.

The book also includes five ways to open Excel workbooks more quickly.

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