# Excel Programming and Automation

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# Introduction

Welcome to the course ELE 3915 Excel Programming and Automation. You're about to get your hands dirty! This course is about being able to do cool things Excel and TypeScript. It should give you the confidence to assert that you can program in Excel. And it gives you an introduction to TypeScript, a popular general-purpose programming language used in Microsoft Office on the web. The slides can be found on Github, in the `slides` directory.

If you need to get in contact with me, please send an e-mail to `jonas.moss@bi.no`. I do not check It's learning often.

⚠ Warning

This webpage is being continuously updated during. Most of the chapters are not finished.

## Rough structure

The course is split into into four parts.

1. **Lecture 1–3**. Basic Excel usage, including formulas such as `SUM` ,`COUNTIFS`, `INDEX`, and `MATCH`. We focus on general mathematical formulas and data manipulation, in addition to simple formatting. Roughly speaking, these lectures cover the sort of Excel you should expect to see in lecacy Excel sheets. Most of the curriculum is covered on the excellent webpage ExcelJet.
2. **Lecture 4–6**. These lectures covers modern Excel formulas using dynamic arrays, `LAMBDA` and `LET`. Many of these features are just a couple of years old (as of 2023). I would not expect most employers to know about them. These features can do quite a bit of what Visual Basic for Applications (VBA) did in legacy worksheets. Programming using `LAMBDA` and `LET` is difficult, so make sure you take the exercises seriously. Again, most of the curriculum is covered on ExcelJet.
3. **Lecture 7–9**. Covers power query, power pivot, and DAX. These are modern tools for data visualization, data cleaning, and data manipulation. These tools are likely to form the core of your automation in Excel. They are widely regarded as the most important tools in the Excel analysts toolbox.

4. **Lecture 10–14**. These lectures contain an introduction to TypeScript and its application in Excel. Take note that we assume no previous exposure to programming in this course. TypeScript is a *typed* modification of JavaScript, the dominant language in web development, and has application far beyond Excel. The lectures will focus on programming in TypeScript in general, and the emphasis is on exercises.

## A note on difficulty

Most of the course is about programming. Students often find programming hard. **Don't expect to be able solve every exercise in 5 minutes!** Solving programming exercises often take a long time, and you need to persevere.

Be aware that the difficulty of this course is uneven. For instance, lectures on `LAMBDA` and `LET` are harder than the first three lectures, and the lectures on power query are likely to be easier. Do not think this course will be a walk in the park.

To become a decent programmer it's a good idea to

1. Do a lot of exercises.
2. Spend at least 20 minutes on each exercise before you give up. You need to think really hard. Don't expect to be able to solve the problem without making an effort.
3. Do the exercise yourself after you have looked at the solution! Close the window and do it from memory. It's also a good idea to revisit the same exercise later on, e.g. the next day, to make sure you're able to do it.
4. Tinker around, either modifying exercises yourself, or with your own ideas. If your tinkering leads to something cool, tell me! Use Kaggle to download data sets to tinker with and Mockaroo to generate fake but plausible-looking data sets.

Do not to spend an inordinate amount of time on an exercise before you check the solution. If you have spent 1 hour on an exercise and haven't gotten anywhere, it might be smart save yourself some time and look at the solution.

Moreover, be aware that programming is often *extremely frustrating*. It's like talking to someone who just simply refuses to understand what you're saying, no matter how many times you repeat yourself. **It's normal and expected to feel frustrated**!

There are many tips online about learning to program, e.g., this collection of tips. But it mostly boils down to spending a lot of time solving problems.

## About this site

Curious how this site was made? It is written using Quarto books.

# 1 Excel basics (i): Introduction to formulas

⚠ Warning

This page is not finished yet.

## 1.1 Curriculum

- Basics of Excel, including cells, active cells, and ranges. Worksheets, basic formatting, data types and blank cells.
- Understanding what formulas and functions are, including copying of formulas using relative references.
- Using flash fill.
- Using the operators `+`,`-`,`/`, and `*`.
- Three shortcuts.
  - Press F2 to edit a cell and see its dependencies.
  - Press escape to exit editing a formula.
  - Press tab to auto-complete a formula.
- Simple use of the Excel IF function, not including nested IFs.

Basic functions using one range as argument.

| Name | Description |
|---|---|
| `SUM` | Sum all numbers in a range. |
| `PRODUCT` | The product of all numbers in a range. |
| `MAX` | The maximum of numbers in a range. |
| `MIN` | The minimum of numbers in a range. |
| `COUNT`/`COUNTA`/`COUNTBLANK` | Count the number of cells in a range that contain numbers (`COUNT`), are non-empty (`COUNTA`), or empty (`COUNTBLANK`). |

| Name | Description |
|---|---|
| `AVERAGE` | The average of the numbers in a range. Empty cells are ignored. |
| `MEDIAN` | The median of the numbers in a range. |
| `STDEV` | The standard deviation of the numbers in a range. Empty cells are ignored. |

## 1.2 Exercises

Remember to look at the solutions only after giving the exercises a serious attempt. Solve the exercises yourself after looking at the solution.

### 1.2.1 Exercises without solutions

### 1.2.2 Exercises with solutions

## 1.3 Recommended resources

There are many excellent video resources for Excel online. The content of this lecture is pretty standard stuff, and there are probably 100s of Youtube videoes covering essentially the same content. For instance, the formulas covered in this lecture are also covered by Kevin Stratvert here, but he goes a little further, covering harder formulas too. Leila Gharani introduces formulas here.

# 2 Excel basics (ii): More formulas; conditional formatting

! Important

This page is ***not finished***, but might contain notes from the course developers. The curriculum, exercises, and recommended resources listed on this page is subject to change.

## 2.1 Curriculum

## 2.2 Exercises

## 2.3 Recommended resources

# 3 Excel basics (iii): Look-up functions and tables

! Important

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## 3.1 Curriculum

## 3.2 Exercises

## 3.3 Recommended resources

# 4 Dynamic arrays

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## 4.1 Curriculum

## 4.2 Exercises

## 4.3 Recommended resources

# 5 User-made functions with `LAMBDA`

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## 5.1 Curriculum

Here is an example of a complex function.

```
=LET(
    tab; FILTER(vgsales; (vgsales[Genre] = genre) * (vgsales[Platform] = platform));
    rows; {7; 8; 9; 10};
    regions; {"NA"; "EU"; "JP"; "Other"};
    VSTACK(
        HSTACK(""; TRANSPOSE(Years));
        HSTACK(
            regions;
            MAKEARRAY(
                ROWS(rows);
                ROWS(Years);
                LAMBDA(row_index; year_index;
                LET(
                    row;index(rows;row_index);
                    year;index(Years;year_index);
                    IFERROR(SUM(FILTER(CHOOSECOLS(tab; row); CHOOSECOLS(tab; 4) = year));
                )
            )
        )
    )
)
```

## 5.2 Exercises

## 5.3 Recommended resources

# 6 `LET`, `LAMBDA`, and dynamic arrays

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## 6.1 Curriculum

Excel is equipped with many functions for handling dynamic arrays and `LAMBDA` functions. The most important are `FILTER`, `MAP` (and its cousins `BYCOL`, `BYROW`, and `MAKEARRAY`), and `REDUCE`.

To use `FILTER`, `MAP`, and `reduce`, we will need convenience functions such as

## 6.2 Exercises

### 6.2.1 Utility functions

We have discussed

Recall that `FILTER` does not take the same sort of arguments as e.g. `MAP`. Its second argument is an array of truth values, not a `LAMBDA` function. That is OK, but it's inconsistent with most ofther functions of dynamic arrays. Make a function

- `FILTER_(array; lambda)` Returns the array consisting of elements from `array` where `lambda(x)` is `TRUE`.
- `TAKEWHILE(array; lambda)` Takes elements from `array` until the `LAMBDA` function `lambda` returns false.
- `MAPWHILE(array;mapper;predicate)` Maps `mapper` onto array untile the `predicate` function returns `FALSE`.
- `FILTERBY(out;filter_array;lambda)` Returns the array consisting of elements from `out` where `lambda(x)` evaluates to `TRUE`.
- `ENUMERATE(array)` Takes a one-dimensional array (a column) merges it with `SEQUENCE(R)`, yielding a two-dimensional array.

## 6.3 Recommended resources

# 7 Power query (i)

! Important

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## 7.1 Curriculum

## 7.2 Exercises

## 7.3 Recommended resources

# 8 Power query (ii)

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## 8.1 Curriculum

## 8.2 Exercises

## 8.3 Recommended resources

# 9 Power pivot and DAX

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## 9.1 Curriculum

## 9.2 Exercises

## 9.3 Recommended resources

# 10 Typescript (i)

! Important

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## 10.1 Curriculum

## 10.2 Exercises

## 10.3 Recommended resources

# 11 Typescript (ii)

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## 11.1 Curriculum

## 11.2 Exercises

## 11.3 Recommended resources

# 12 Typescript (iii)

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## 12.1 Curriculum

## 12.2 Exercises

## 12.3 Recommended resources

# 13 Typescript (iv)

**!** Important

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## 13.1 Curriculum

## 13.2 Exercises

## 13.3 Recommended resources

# 14 TypeScript in Excel

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## 14.1 Curriculum

## 14.2 Exercises

## 14.3 Solutions to exercises

## 14.4 Recommended resources