# Manual Statistical Application - Proefcentrum Hoogstraten

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## Introduction

Proefcentrum Hoogstraten vzw. (Belgium) is a research company specialized in greenhouse field trials and practical research for three crops: strawberry, sweet pepper and tomato. In order to ensure the quality of the research conclusions and repeatability a standardised statistical analysis tool was developed as a R-Shiny web application. With this Shiny application researchers of Proefcentrum Hoogstraten are able to perform frequently used analysis on their data.

This manual helps researchers to use the application as intended. For further questions or inquiries please contact me directly dieterbaets(at)gmail(dot)com or dieter(dot)baets(at)proefcentrum(dot)be.

## Installation requirements

Before running the Shiny application on your own machine please ensure following prerequisites:

- at least R-version 4.0.0 (Arbor Day) or higher
- at least RStudio 1.2.5033 (Orange Blossom) or higher

First install the correct R-version on your own machine befor installing R-Studio. This ensures that alle R-related documents are recognised by RStudio as an IDE. After installing the software download the code on the github repo ( github.com/dbaets/PCH_StatisticalApplicaton ). Unzip the code in a folder of your own choosing, best to keep it on your own c:// harddrive for example under documents. Look for install folder and open the *install.Rproj* file. In this R project open the *R_installpackages.R* file and run the script by selecting the entire code and clicking on *Run* in the right top corner of the scripts pane. Wait untill all necessairy applicatons are installed.

## Running Shiny application

After installing all the required packages you can now run the shiny application. Open the *statisticalapp* folder and open the *PCH_statisticalApplication.Rproj* file. By doing so you are ensuring that all necessairy scripts for the application are located in the right place so the app can run smoothly. Open the *app.R* file and click on **Run App** in the right upper corner of the scripting pane. If all goes well you are now officially running the *PCH - Statistical application* and you can perform the necessary statistial analasys.

## Performing statistical analysis using statistical application

### Preparing data

In order to perform any analys using the *PCH - statistical application* you need to put the data in to the correct format and on the correct named sheet otherwise the shiny app cannot load the data and will throw an error. Please download the correct template beforehand.

## Loading data

First select a input file using the **Select file** button and select an input type using the radiobuttons on the *Input* pane before loading the file using the **Load file** button.

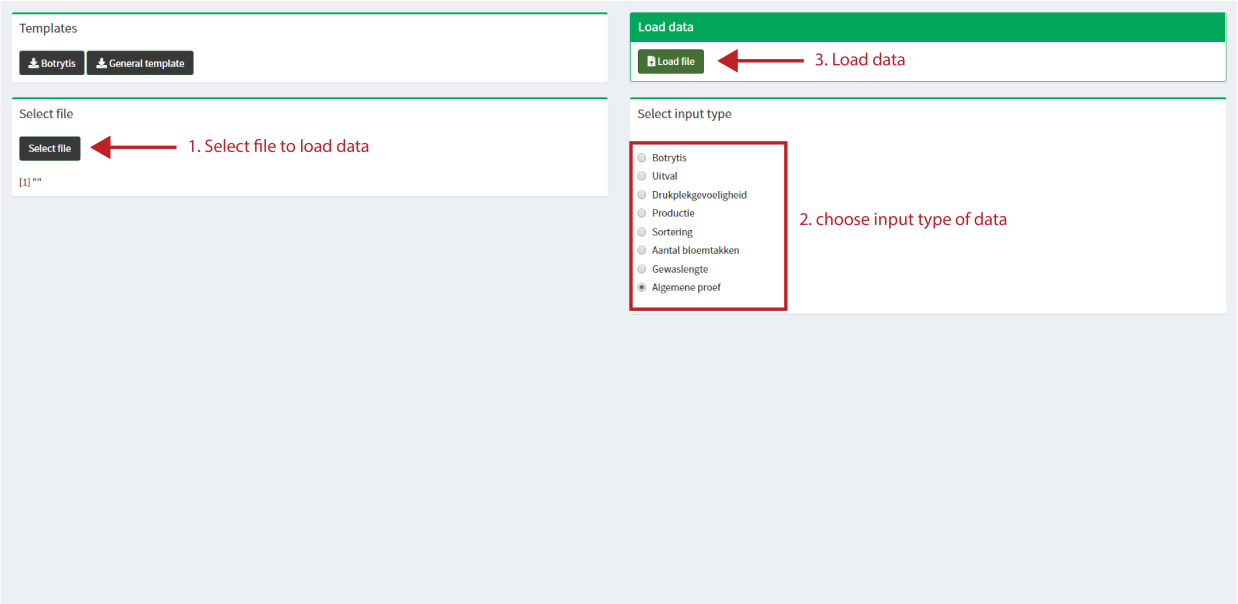



Figure 1: Input pane to load data for analysis

## Running analysis

When de data is loaded correctly in to the application you are automatically taken to the next pane called *statistics*. On this pane you only have to press the green button *Run Statistics*. If everything goes well you are redirected to the *output* pane where you can download the results using the green *Output Results button*. The output excel is redirected to the same folder were you loaded the inputdata from.

If the app jumps automatically to the next pane the analysis went without errors.

# Interpreting output

## output file

following tabs are generated in the outputfile:

- **inputdata**: the inputdata used to perform the analysis
- **teststatistic**: summary of the test statistic used to differentiate between different objects. The app chooses automatically between parametric and non parametric tests according to the prerequisites for each tests.
- **sigletters**: if the p-value of the test statistic is $<0.05$ you can interpret the results using a post-hoc test. For each object a letter or p-value is placed in a table with the summary statistics. If the letters are different from each other the different objects are different from each other.
- **summary**: table with a summary of the data. This summary is ideal as a starting point to make graphs.

## reporting results

When writing a report please include following text under the title *statistical analysis*:

All results were statistically confirmed by the statistical software R (version 4.0.0, 24/04/2020) (R Core Team, 2019), with RStudio (RStudio Team, 2016) as an integrated development environment (IDE). In order to analyse the results following packages were used: tidyverse (Wickham, 2017), multcomp (Hothorn et al., 2008) lsmeans (Lenth, 2016), rcompanion (Mangiafico, 2019) and car (Fox and Weisberg, 2019). The statistical tests have the goal to evaluate the difference between the different objects. When the data and residues were normally distributed an analysis of variance (ANOVA) was used. In the case both assumptions were not fulfilled a Kruskall-Wallis test was used as a non-parametric test. With each result it is clearly mentioned which test is used for the analysis. When a significant difference occurred a Tukey post-hoc test between the different objects was performed. A significant result is shown by the use of different letters.

with following references:


Fox, J. en Weisberg, S., 2019. An {R} companion to applied regression, Third Edition. Thousand Oaks.

Hothorn, T., Bretz, F. en Westfall, P., 2008. Simultaneous inference in general parametric models. Biometrical Journal 50(3)

Lenth, R., 2016. Least-squares means: the R package lsmeans. Journal of statistical software, 69(1)

Mangiafico, S., 2020. Rcompanion: functions to support extension education program evaluation. Package version: 2.3.0 R Core Team, 2019. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL: www.R-project.org

RStudio Team, 2016. RStudio: Integrated Development for R. RStudio Inc., USA, Boston. URL: wwww.rstudio.com Wickham, H., 2017. Tidyverse: easily install and load the 'Tidyverse'. Package version: 1.2.1


The results of an anova can be best reported in the following format:

$$F(5, 18) = 1.288, p = 0.312$$

- **5**: DF object, degrees of freedom at the level of the objects
- **18**: DF residuals, degrees of freedom of the residuals
- **1.288**: F-value in *TestStatistic* table
- **0.312**: p-value in *TestStatistic* table

The results of an Kruskal-Wallis should be reported in following format:

$$\chi^2(3) = 5.889, p = 0.117$$

- **3**: DF, degrees of freedom
- **5.889**: F-value in *TestStatistic* table
- **0117**: p-value in *TestStatistic* table

# Types of inputdata

## Botrytis

excelsheetname: *statistiek*

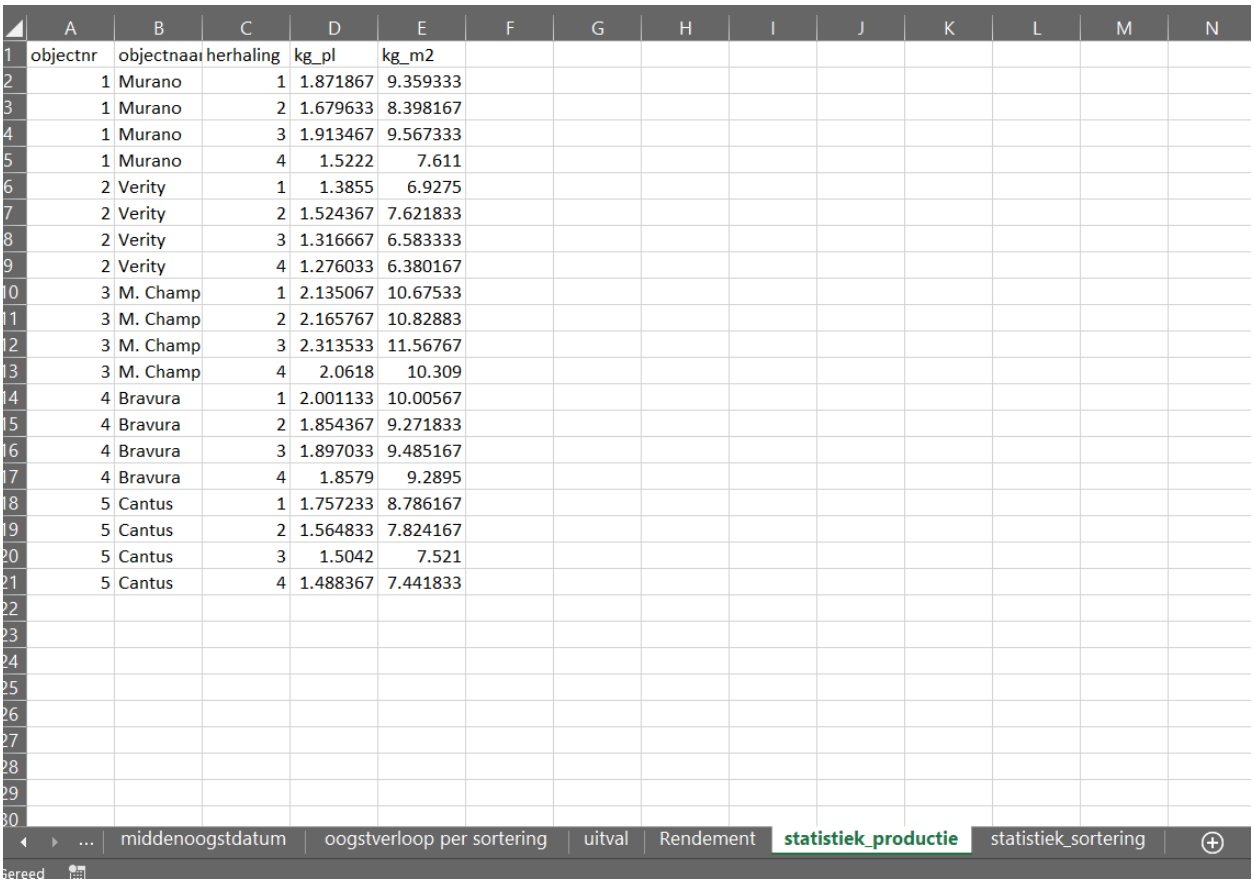
## productie

excelsheetname: *statistiek_productie*

| | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | datum | objectnr | objectnaam | herhaling | aantal_stuks | aantasting_geen | aantasting_25 | aantasting_50 | aantasting_75 | aantasting_100 | |
| 2 | datum1 | 1 | Murano | 1 | 52 | 49 | 2 | 0 | 0 | 1 | |
| 3 | datum1 | 1 | Murano | 2 | 52 | 50 | 1 | 0 | 0 | 1 | |
| 4 | datum1 | 1 | Murano | 3 | 52 | 47 | 2 | 1 | 1 | 1 | |
| 5 | datum1 | 1 | Murano | 4 | 52 | 48 | 2 | 2 | 0 | 0 | |
| 6 | datum1 | 2 | Verity | 1 | 49 | 45 | 4 | 0 | 0 | 0 | |
| 7 | datum1 | 2 | Verity | 2 | 51 | 45 | 3 | 2 | 1 | 0 | |
| 8 | datum1 | 2 | Verity | 3 | 39 | 37 | 2 | 0 | 0 | 0 | |
| 9 | datum1 | 2 | Verity | 4 | 52 | 50 | 1 | 0 | 1 | 0 | |
| 10 | datum1 | 3 | M. Champio | 1 | 34 | 31 | 1 | 1 | 1 | 0 | |
| 11 | datum1 | 3 | M. Champio | 2 | 23 | 21 | 0 | 0 | 1 | 1 | |
| 12 | datum1 | 3 | M. Champio | 3 | 10 | 8 | 2 | 0 | 0 | 0 | |
| 13 | datum1 | 3 | M. Champio | 4 | 35 | 34 | 0 | 0 | 1 | 0 | |
| 14 | datum1 | 4 | 08-06-10 | 1 | 52 | 48 | 1 | 0 | 3 | 0 | |
| 15 | datum1 | 4 | 08-06-10 | 2 | 52 | 49 | 2 | 0 | 0 | 1 | |
| 16 | datum1 | 4 | 08-06-10 | 3 | 52 | 51 | 1 | 0 | 0 | 0 | |
| 17 | datum1 | 4 | 08-06-10 | 4 | 52 | 50 | 1 | 0 | 1 | 0 | |
| 18 | datum1 | 5 | CIV 621 | 1 | 52 | 47 | 1 | 2 | 2 | 0 | |
| 19 | datum1 | 5 | CIV 621 | 2 | 52 | 51 | 1 | 0 | 0 | 0 | |
| 20 | datum1 | 5 | CIV 621 | 3 | 52 | 46 | 3 | 1 | 1 | 1 | |
| 21 | datum1 | 5 | CIV 621 | 4 | 52 | 49 | 1 | 1 | 1 | 0 | |
| 22 | datum2 | 1 | Murano | 1 | 52 | 43 | 8 | 0 | 1 | 0 | |
| 23 | datum3 | 1 | Murano | 2 | 52 | 42 | 7 | 2 | 1 | 0 | |
| 24 | datum4 | 1 | Murano | 3 | 52 | 47 | 4 | 0 | 1 | 0 | |
| 25 | datum5 | 1 | Murano | 4 | 52 | 44 | 4 | 2 | 2 | 0 | |
| 26 | datum6 | 2 | Verity | 1 | 52 | 45 | 3 | 2 | 2 | 0 | |
| 27 | datum7 | 2 | Verity | 2 | 52 | 48 | 3 | 1 | 0 | 0 | |
| 28 | datum8 | 2 | Verity | 3 | 52 | 48 | 2 | 1 | 1 | 0 | |
| 29 | datum9 | 2 | Verity | 4 | 52 | 47 | 4 | 1 | 0 | 0 | |
| 30 | datum10 | 3 | M. Champio | 1 | 52 | 51 | 1 | 0 | 0 | 0 | |
| 31 | datum11 | 3 | M. Champio | 2 | 52 | 46 | 4 | 1 | 1 | 0 | |
| 32 | datum12 | 3 | M. Champio | 3 | 52 | 48 | 0 | 2 | 2 | 0 | |
| 33 | datum13 | 3 | M. Champio | 4 | 52 | 44 | 5 | 0 | 3 | 0 | |

FAB_4 | samenvatting | Datum 1 | Datum 2 | Datum 3 | Totaal | Blad1 | statistiek

Figure 2: botrytis



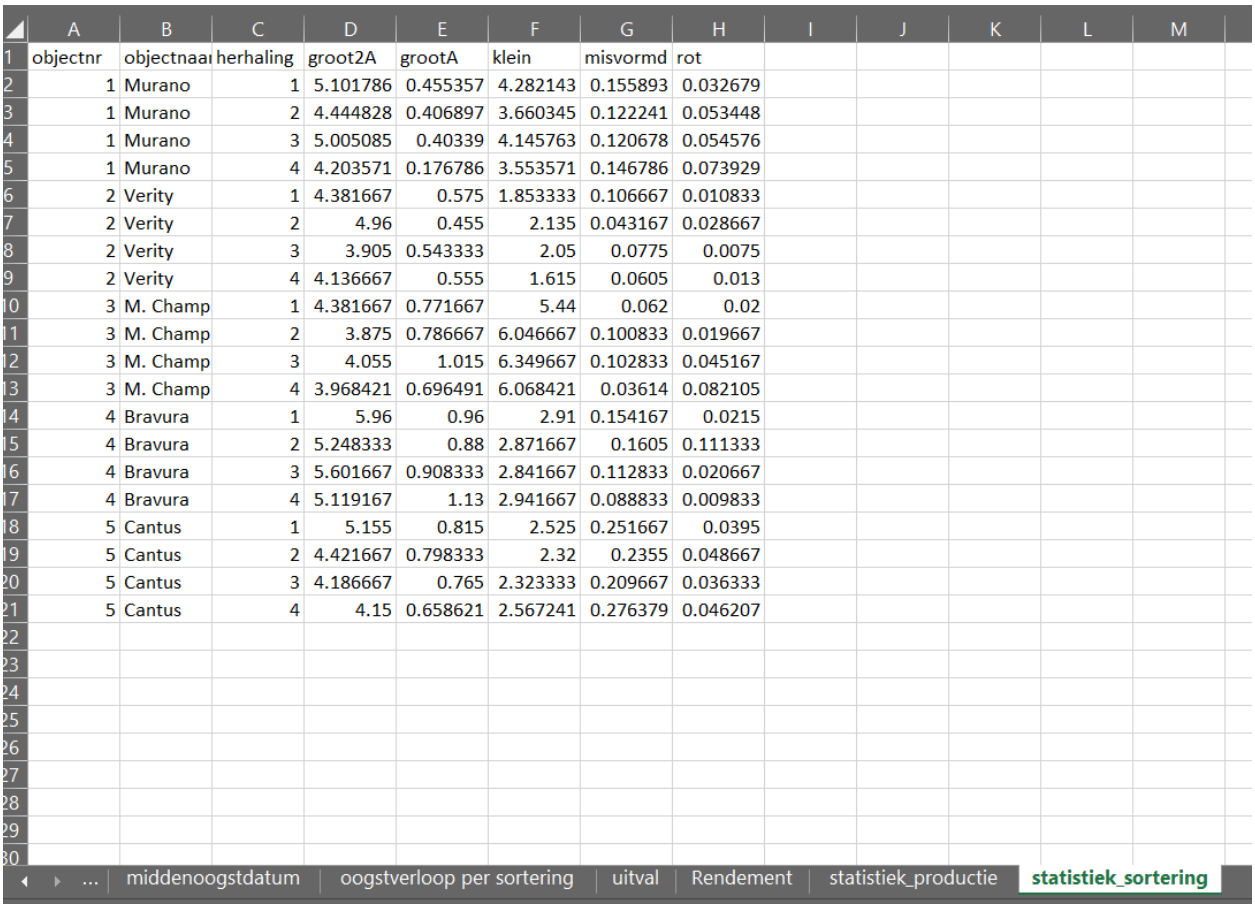
| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | objectnr | objectnaa | herhaling | kg_pl | kg_m2 |
| 2 | 1 | Murano | 1 | 1.871867 | 9.359333 |
| 3 | 1 | Murano | 2 | 1.679633 | 8.398167 |
| 4 | 1 | Murano | 3 | 1.913467 | 9.567333 |
| 5 | 1 | Murano | 4 | 1.5222 | 7.611 |
| 6 | 2 | Verity | 1 | 1.3855 | 6.9275 |
| 7 | 2 | Verity | 2 | 1.524367 | 7.621833 |
| 8 | 2 | Verity | 3 | 1.316667 | 6.583333 |
| 9 | 2 | Verity | 4 | 1.276033 | 6.380167 |
| 10 | 3 | M. Champ | 1 | 2.135067 | 10.67533 |
| 11 | 3 | M. Champ | 2 | 2.165767 | 10.82883 |
| 12 | 3 | M. Champ | 3 | 2.313533 | 11.56767 |
| 13 | 3 | M. Champ | 4 | 2.0618 | 10.309 |
| 14 | 4 | Bravura | 1 | 2.001133 | 10.00567 |
| 15 | 4 | Bravura | 2 | 1.854367 | 9.271833 |
| 16 | 4 | Bravura | 3 | 1.897033 | 9.485167 |
| 17 | 4 | Bravura | 4 | 1.8579 | 9.2895 |
| 18 | 5 | Cantus | 1 | 1.757233 | 8.786167 |
| 19 | 5 | Cantus | 2 | 1.564833 | 7.824167 |
| 20 | 5 | Cantus | 3 | 1.5042 | 7.521 |
| 21 | 5 | Cantus | 4 | 1.488367 | 7.441833 |



Figure 3: productie

## sortering

excelsheetname: *statistiek_sortering*



| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | objectnr | objectnaa | herhaling | groot2A | grootA | klein | misvormd | rot |
| 2 | 1 | Murano | 1 | 5.101786 | 0.455357 | 4.282143 | 0.155893 | 0.032679 |
| 3 | 1 | Murano | 2 | 4.444828 | 0.406897 | 3.660345 | 0.122241 | 0.053448 |
| 4 | 1 | Murano | 3 | 5.005085 | 0.40339 | 4.145763 | 0.120678 | 0.054576 |
| 5 | 1 | Murano | 4 | 4.203571 | 0.176786 | 3.553571 | 0.146786 | 0.073929 |
| 6 | 2 | Verity | 1 | 4.381667 | 0.575 | 1.853333 | 0.106667 | 0.010833 |
| 7 | 2 | Verity | 2 | 4.96 | 0.455 | 2.135 | 0.043167 | 0.028667 |
| 8 | 2 | Verity | 3 | 3.905 | 0.543333 | 2.05 | 0.0775 | 0.0075 |
| 9 | 2 | Verity | 4 | 4.136667 | 0.555 | 1.615 | 0.0605 | 0.013 |
| 10 | 3 | M. Champ | 1 | 4.381667 | 0.771667 | 5.44 | 0.062 | 0.02 |
| 11 | 3 | M. Champ | 2 | 3.875 | 0.786667 | 6.046667 | 0.100833 | 0.019667 |
| 12 | 3 | M. Champ | 3 | 4.055 | 1.015 | 6.349667 | 0.102833 | 0.045167 |
| 13 | 3 | M. Champ | 4 | 3.968421 | 0.696491 | 6.068421 | 0.03614 | 0.082105 |
| 14 | 4 | Bravura | 1 | 5.96 | 0.96 | 2.91 | 0.154167 | 0.0215 |
| 15 | 4 | Bravura | 2 | 5.248333 | 0.88 | 2.871667 | 0.1605 | 0.111333 |
| 16 | 4 | Bravura | 3 | 5.601667 | 0.908333 | 2.841667 | 0.112833 | 0.020667 |
| 17 | 4 | Bravura | 4 | 5.119167 | 1.13 | 2.941667 | 0.088833 | 0.009833 |
| 18 | 5 | Cantus | 1 | 5.155 | 0.815 | 2.525 | 0.251667 | 0.0395 |
| 19 | 5 | Cantus | 2 | 4.421667 | 0.798333 | 2.32 | 0.2355 | 0.048667 |
| 20 | 5 | Cantus | 3 | 4.186667 | 0.765 | 2.323333 | 0.209667 | 0.036333 |
| 21 | 5 | Cantus | 4 | 4.15 | 0.658621 | 2.567241 | 0.276379 | 0.046207 |



Figure 4: sortering

## algemene proef

exelsheetname: *statistiek*

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | objectnr | objectnaam | herhaling | meting | | | | |
| 2 | 1 | a | 1 | 10 | | | | |
| 3 | 1 | a | 2 | 2 | | | | |
| 4 | 1 | a | 3 | 3 | | | | |
| 5 | 1 | a | 4 | 4 | | | | |
| 6 | 2 | b | 1 | 4.1 | | | | |
| 7 | 2 | b | 2 | 8 | | | | |
| 8 | 2 | b | 3 | 2.1 | | | | |
| 9 | 2 | b | 4 | 3.1 | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |

Figure 5: sortering