

Growth of Dutch Children

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In this task you use the data from the Dutch growth study in 1997 and the Coach program to study the average height and increase in height for boys and girls. The goal is to find points in common and differences in growth of boys and girls. We formulate the research questions as follows:

Research Questions

How does the height of Dutch boys and girls change from 1 to 21 years of age?

What are the points in common and what are the differences?

Because this could well be your first acquaintance with Coach, the first part of the task is mainly meant to get started with the software and especially to learn how to work with tables and diagrams. Hereafter are some questions and that deal with the above research questions. Instructions to learn working with Coach are typeset in Courier font.

Task 2. Mean Height Growth

1. Start Coach and select the project *Growth of Dutch Boys and Girls*.
2. Select activity 2: *Mean Height Growth*.
3. Carry out the tasks in this activity and answer the questions.

You need data to answer the above research questions. Below are the growth data of the 4th nationwide Dutch growth study in 1997.

Growth Data

Age is in years, height is in centimetres (and is of course a mean value).

<i>Age</i>	<i>Height</i>	<i>Height</i>	<i>Age</i>	<i>Height</i>	<i>Height</i>	<i>Age</i>	<i>Height</i>	<i>Height</i>
	<i>boys</i>	<i>girls</i>		<i>boys</i>	<i>girls</i>		<i>boys</i>	<i>girls</i>
1	76.6	75.1	8	132.8	131.5	15	174.4	167.1
2	88.9	87.5	9	138.3	137.5	16	178.7	168.6
3	98.1	96.7	10	143.2	143.3	17	181.3	169.3
4	105.8	104.5	11	148.2	149.2	18	182.6	169.8
5	113.1	111.8	12	154.0	155.3	19	183.2	170.2
6	120.1	118.7	13	160.9	160.8	20	183.6	170.5
7	126.6	125.2	14	168.2	164.7	21	184.0	170.6

These data have been placed in a text window inside the Coach activity. The first task is to construct from this listing a Coach table with which you can really compute and that you can display as a data plot. The table window is already present to be filled. After filling the table, you can display it as a diagram.

Filling the Table in the Coach Activity

Filling a table can be done in various ways: the first method is to type the data entries row by row. In the second method you make use of copy and paste. This goes faster. The third method of filling a table we shall not use for the moment: importing data from a file, for example, from a text file or an Excel sheet. If something goes wrong, you can clear the table via 'Erase all values'.

Method 1: manually

- Press the green 'Start' button
- Press the green button containing "1" to add one data point.
- Enter the data of the first row.
- Press 'OK'
- Press again the green button labelled "1" and repeat the previous steps until the table has been filled completely.
- Finally press the red 'Stop' button to finish the filling of the table.

Method 2: copy and paste

Select all growth data in the text window, copy them, place the cursor in the upper left entry point of the table window, and paste the data into the table. For copying and pasting you can use the menu 'Text edit' that resides in both windows under the tool button or you can bring up the menu by right-clicking in each window. Alternatively, you can use the short-cuts Ctrl-C and Ctrl-V.

Creating the Data Plot of the Table

You can create a diagram of the data in the table as follows:

- Put the diagram on the screen that corresponds with the table (Press the yellow button 'Display Diagram', select '4. Growth table' [the shape of the mouse cursor changes into a diagram symbol], and click in a window to place your diagram. You can also make in the table window the menu choice 'Display as a diagram' and then click in a window to place the diagram).
- Select 'Create/edit diagram...' (tool button or right clicking). Click successively on C1,..., C8. Change the diagram style by using various colours, symbols, and line styles for the graphs.
- Display the grid in the diagram window.
- 'Zoom to fit' so that the graphs fit inside the window.

Exercises

1. Up to what age (after birth) are boys usually 1-1.5 cm taller than girls?
2. What is the largest mean height of boys? And of girls?
3. When (at what ages) are girls usually somewhat taller than boys?
4. Draw the graph of the difference of height of boys and girls (with its own vertical axis). You do this as follows:
 - Select 'Create/edit diagram...'
 - Click on the 4th column (C4)
 - Choose 'Connection: Formula'
 - Choose 'Axis: second vertical'
 - Click in the formula text region:
 - Press the 'Wizard' button
 - Click successively on 'boys height', on the arithmetic operation, and on 'girls height',
 - Take quantity: difference and unit: cm
 - Press 'OK'.
 - Zoom to fit the graphs

Do you understand the diagram and especially the use of two vertical axes?

Creating the Increase Diagram in Coach

Growth is a process of change. That is why doctors are not only interested in the height of a boy or girl, but also in the increase in height in successive periods of time. The *growth rate* is the change of height per time unit. The heights of two moments of measurement are subtracted from each other and divided by the time interval. In our case, the time unit is one year and the height is expressed in centimetres; so, the growth rate is expressed in cm/yr. Its value is equal to the annual increase in height. The growth rate is not constant during child development and it turns out to be different

between boys and girls. You are going to investigate this. Let us first compute the annual change in height and plot it in an increase diagram. You do this by extending the Coach diagram (and the table).

Increase Diagram of Mean Height

5. Change the diagram by adding the increase diagram of mean height (with its own vertical axis).

A change of a quantity X can be defined in Coach as the formula $\text{Delta}(X)$.

For those who find it difficult, we give once more step-by-step instructions:

- Select 'Create/edit diagram...'
- Click on the 5th column (C5)
- Choose 'Connection: Formula'
- Choose 'Axis: second vertical'
- Click in the formula text region:
- Press the 'Wizard' button
- Click successively on the arithmetic operation ' $\text{Delta}()$ ' and on 'boys height'.
- Take quantity: height increase and unit: cm
- Press 'OK'.

Look at the result. Notice that Coach places the height increase in the 5th column one entry higher in the table than the authors of the mathematics textbooks do in an increase table. Hence, the graph of $\text{Delta}(X)$ is not exactly the same as the increase diagram of X in the textbook. (An increase is associated in Coach with the left-hand side of a segment, and not with the right-hand side. *)

Continue to work with the table window and the diagram window.

- Make the first two graphs invisible and afterwards visible again.
- Investigate what happens when you zoom in and out.
- Also add the increase diagram of height for girls by extending the table.

The table window and the diagram window are rather messy now, but you already know how to make columns temporarily invisible or how to remove them. The rest you can figure out yourself.

More Exercises

6. In the beginning the annual increase of height decreases.
In what age period do boys grow faster each year? And girls?
7. At what age do boys usually stop growing in height? And girls?
8. When (at what ages) are differences in growth rate between boys and girls noticeable?
9. In what age period do girls grow faster than boys?
10. At what age do teenage boys and girls usually reach their peak growth rate? Who grows fastest then?

Closure

11. Give a short general description of height growth of boys and girls. Distinguish several phases of growth and mention points in common as well as differences in body growth of boys and girls.

* In other words, Delta is the forward difference operator. Coach has no built-in backward difference operator, which would lead to the increase diagram as defined in mathematics textbooks.