Introduction to programming – Activity 8

Getting started

☐ Double-click on the file *Activity8.R*

☐ Make sure your working directory is set to Activity8

Main exercise

In this exercise, we will draw a wave using R to see how programming can help us understand equations and solve them faster. We will work with graphing units only.

☐ At the top of the R Script, change the value for wavelength (**L**), amplitude (**A**) and water depth (**D**) to match the ones you calculated for your wave in Activity 7 (use graphing units). Choose the phase shift (**p**) you want.

☐ In the R console, type `source("Activity8.R")`.

☐ Now that there is a wave on the plot, each student can take turns changing one parameter (amplitude, wavelength, water depth and phase shift). First increase the value and run the code. Then, decrease the value and run the code. Everyone should sketch in their notebooks what changes. Note how easy it is to make changes.

☐ Your group should decide on a wave you like and record its characteristics in table 1.

Table 1: Wave characteristics

	In graphing units
Amplitude (A)	
Wavelength (L)	
Water depth (D)	
Phase shift (p)	

☐ Type `source("Activity8.R")` to run the script one last time so that the values of **A**, **L**, **H**, and **p** are set to the ones for your wave.

☐ The equation we used to find the y values of this wave is $y = A \cdot \sin(k \cdot x + p) + H$. Knowing that $k = 2 \cdot \pi/L$, calculate k for your wave and write down the equation for your wave using numbers.

Value of k : _____

Equation: _____

☐ Using **x = 0**, **x = 50**, **x = 750**, and one value of **x** that you select, calculate what **y** should be. You can use a calculator, but **make sure it is set to radians**. Record the value calculated (up to 2 digits after the dot) in table 2. Does the value you calculated correspond to the value you see on your team's R wave?

Table 2: Calculations for the y-values associated with the wave created.

x	y (with calculator)	Same as on graph? (yes/no)	y (using R)	Same as with calculator?
0				
50				
750				

☐ Now, let's try to find this equation in the R Script. It will look a bit different because multiplications are shown with an asterisk (*) in R. In the R Console, type `x <- 0` and press enter. Now, type `x` and press enter. Do you see that the value of `x` is now set to 0?

☐ Using the equation you found, copy paste the part of the equation that is on the **right-hand side** of the arrow (`<-`). Press enter. This will perform the calculation with the value you entered for **x**. Record the value displayed (up to 2 digits after the dot) in table 2. Is the value similar to the one you calculated?

☐ Each student can repeat the step above by setting **x** to 50, 750, and their chosen values (one value per student). Hint: once you have a command that works, you can look for it in the R Console by using the up arrow on the keyboard. Record the values in table 2.

☐ You can already see that doing these calculations in R was much faster than by hand once you had an equation that worked. You could even change the value of **A**, **L**, **H**, and **p** easily, which is what we do in the R Script. The true beauty of programming though is that you can calculate multiple values at once! This is how we plotted the wave so quickly. Try typing `x <- c(0, 50, 750)` (you can add your own numbers), then run the equation. Do you see many answers for y? Are they all the same as before?

☐ It's still a lot of work to type so many numbers and there is no way that's what Jessica did for the entire wave. Try typing `seq(0, 1000, by = 5)`. What do you see?

☐ Now, assign this sequence to **x** by typing `x <- seq(0, 100, by = 5)` and run the equation for **y** again, this time by assigning the result to **y** using `y <- equation`. Replace the word `equation` by the equation you have been using.

☐ For a quick plot of what you just calculated, type:

```
plot(x, y)
lines(x, y, type = 'l')
```

Advanced activities – if your group is done early

☐ **Make new sequences and plots.** Use new sequences of **x**, new equations (you can use something as simple as `y <- x + 2`), or change the colors of your plot.

☐ **Begin converting units.** Go to the *UnitConversion* folder and double-click on the file *UnitConversion.R*. Modify the values of `scale_xstart`, `scale_xend`, and `scale_y` until the red ruler just covers the sheet we taped to the tank. Try not to include the laminated edge. Record the values below:

`scale_xstart`: _____ `scale_xend`: _____

☐ **Calculate the length of the scale bar in graphing units.** Write down your calculations not to forget.

Length of scale bar (graphing units): _____

☐ **Calculate the conversion factor.** The piece of paper is 28 cm or 0.28 m. Calculate how many graphing units are in one cm (graphing unit/cm) and how many cm are in one graphing unit (cm/graphing unit). If this is confusing, skip to the next advanced activity. If this is confusing, go back to another advanced activity and wait until this material is covered in class.

graphing units per cm: _____

cm per graphing unit: _____