Introduction to programming – Activity 7

Getting started

☐ Double-click on the file *Activity7.R*

☐ Make sure your working directory is set to Activity7

Main exercise

When scientists generate waves in a tank, it is difficult for them to measure wave properties, such as wavelength and speed, while the waves are moving. Fortunately, they can take some pictures. In the next 4 activities, you will use the programming skills you learned to analyze some wave data.

☐ In this exercise, we will calculate water depth, as well as the wavelength and amplitude of the wave. We need students to label the bottom of the tank (1), the water level (1), the top of the crests (1), and the distance between two crests (1 or 2).

   Write down your task: _____

☐ Wave properties can be measured on any of the frames provided (**wave#_frame#.png**). Write down the information assigned to your group:

   Wave number: _____   Frame number: _____

☐ In the R Script, find and change the line below to reflect the wave and frame number you will be working with:
   ```
   wave_file <- "wave#_frame#.png"
   ```

☐ In the R console, type `source("Activity7.R")`.

☐ **Bottom of the tank (yellow).** Change the value of `bottom_y` until the yellow ruler is aligned with the bottom **at the front of the tank**, not by the paper at the back. Focus on the part of the wave close to x = 250 because of lens distortion. Hint: You can move the other lines out of the way or comment (`#`) the lines of code that start with `geom_hline(…)` or `geom_vline(…)` that you are not using. **Record the value in table 1.**

☐ **Water level (blue).** Change the value of `water_y` until the blue ruler is aligned with the water level as if it were at rest, i.e. if there were no waves, which is between the crests and troughs of your waves. Focus on the part of the wave close to x = 250 because of lens distortion. Hint: You can move the other lines out of the way or comment (`#`) the lines of code that start with `geom_hline(…)` or `geom_vline(…)` that you are not using. **Record the value in table 1.**

☐ **Top of crests (white).** Change the value of `crests_y` until the white ruler is aligned with the crests of your wave. Focus on the part of the wave close to x = 250 because of lens distortion. Hint: You can move the other lines out of the way or comment (`#`) the lines of code that start with `geom_hline(…)` or `geom_vline(…)` that you are not using. **Record the value in table 1.**

☐ **Crest positions (red).** Change the value of `crest1_x` and `crest2_x` until one red ruler is over the top of one crest and the other red ruler is on top of the crest next to it. Focus on the part of the wave close to x = 250 because of lens distortion. Hint: You can move the other lines out of the way or comment (`#`) the lines of code that start with `geom_hline(…)` or `geom_vline(…)` that you are not using. **Record the value in table 1.**

Table 1: Coordinates of wave characteristics

	x-coordinate	y-coordinate
`bottom_y`		
`water_y`		
`crests_y`		
`crest1_x`		
`crest2_x`		

☐ While other students are taking their turns, draw a diagram of the wave in your notebook and label water depth (D), wavelength (L), and amplitude (A).

☐ Use the position of your rulers to calculate the wave's amplitude and wavelength, as well as the water depth and record the values in table 2. Note that we are not working with real measurement (in physical units, such as meters), we are working with the coordinates of our graph. For now, we will say these measurements are in graphing units and will convert them later.

Table 2: Wave characteristics

	In graphing units	Calculations
Amplitude		
Wavelength		
Water depth		

Advanced activities – if your group is done early

☐ **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 is over the sheet we taped to the tank. 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, go back to another advanced activity and wait until this material is covered in class.

graphing units per cm: _____

cm per graphing unit: _____

☐ **Repeat Activity 7 with the other wave.**