Introduction to programming – Activity 9

Getting started

☐ Double-click on the file *Activity9.R*

☐ Make sure your working directory is set to Activity9

Main exercise

In the last two weeks, we measured characteristics of a wave and used these characteristics in an equation to simulate our own theoretical wave. This week, we will see if the theoretical equation represents our actual wave well.

☐ Go back to **Activity 7** and recopy your wave's information and characteristics in table 1. I hope someone in your group took good notes! For the crest, remember to use the area of the image that is most in focus (left area near near x = 250).

Table 1: Wave information and characteristics

	In graphing units
Wave #	
Frame #	
Amplitude (`A`)	
Wavelength (`L`)	
Water depth (`D`)	
X-position of one crest (`x_crest`)	

☐ At the top of the R Script, change the line below to match your wave. Use **frame1** to start.

```
wave_file <- "wave#_frame1.png"
```

☐ Change the value for wavelength (`L`), amplitude (`A`), water depth (`D`), and the x-position of a crest (`x_crest`) to match the ones you calculated for your wave in Activity 7 (use graphing units). Hint: don't use the wave from Activity 8, we want the wave on the picture.

☐ In the R console, type `source("Activity9.R")`.

☐ You should see a theoretical wave plotted on top of your image. If the theoretical line looks like it could fit the actual wave better, you can try to adjust the other wave properties a bit. Remember Activity 8 and how each parameter moves the wave. If values are very different though, make sure you are using the right image. Update table 1 if necessary. Do not erase your old values, simply write the new ones and circle them.

- ☐ **Except for the x-position of the crest, do not modify the wave characteristics for the rest of the activity, unless you start over.**

- ☐ Type `source("Activity9.R")` one last time so that the values of `A`, `L`, `D`, and `x_crest` are set to the ones for your wave.

- ☐ Find the lines below and uncomment them (remove the # at the beginning).

```
# geom_vline(xintercept = x[Icrest], colour = "cyan", lwd = 1, lty =
'dotted') +

# annotate("text", x = x[Icrest]+30, y = D/2, label = x[Icrest],
#          color = "cyan") +
```

- ☐ Run the script. You should see the crests of your waves labeled with the **x value** corresponding to their location. Record the **x value** for the first crest in table 3, under Frame 1.

Table 3: First crest position in each frame.

	x
Frame 1	
Frame 2	
Frame 3	
Frame 4	
Frame 5	

- ☐ At the top of the R Script, change the line below to match your wave. Use frame 2 this time. **Do not change the value of the wave characteristics.**

```
wave_file <- "wave#_frame2.png"
```

- ☐ Type `source("Activity9.R")`.

- ☐ The theoretical wave is now offset from the actual wave because the picture is later than the first and the wave has traveled. **Adjust the value of `x_crest` and run the code.** Repeat until the waves are aligned. Record the **x value** for the crest you are following in table 3, under Frame 2.

- ☐ Each student can repeat the steps above for one frame until all 5 frames are completed.

- ☐ While other students are completing their turn, try to think about how the computer knows how to label the crests automatically. Hint: you can look at the code when no one is at the computer. The locations of the crests are found and stored in `Icrest`. Write down your idea.

  The crests are the ____ values of the equation.

- ☐ Calculate the distance (in graphing units) that the wave has moved between each frame and enter it in table 4. Show your calculations.

☐ **Table 4:** First crest position in each frame.

	Calculations (xend – xstart)	Distance traveled
Frame 1 to Frame 2		
Frame 2 to Frame 3		
Frame 3 to Frame 4		
Average		

☐ Knowing that each frame is 1/10 of a second apart and using the average distance traveled by the wave, calculate its speed (distance/time). You can use a calculator, but show the numbers you divided.

Speed of the wave: ______________________________

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: ______________________________