**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: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_