POLITECNICO MILANO 1863	051483 Musical Acoustics Module 1: Modeling of musical instruments Academic Year 2023/2024	Homework Laboratory III Musical Instruments modeling

Assignment: Modeling Techniques

Implement the piano string FD model considering the hammer interaction.
The problem is analyzed on the slides:

- 06_modeling_of_musical_instrument
- Pages 23-35
- A detailed description is provided in the references (page 36)

Complete the code template homework_piano.m.

- Compute the simulation of a C2 piano string with correct CFL condition (0.5 pt)
- Implement FD scheme correctly (0.5 pt)
- The total signal length is 8s (0.1 pt)
- Approximate the sound by averaging the string displacement over a small portion of the string (12 spatial samples). (0.3 pt)
  - The center of the average portion will be specular with respect to the hammer striking position.
- After the FD computation:
  - Plot the whole string diplacement at each time instant (0.2 pt)
  - Plot the estimated sound signal (0.2 pt)
  - Play the sound (0.1 pt)
  - Save the estimated sound signal in a file named: (0.1 pt)
    - yourIDnumber_surname_piano.wav

Suggested parameters:

- $f_1 = 65.4$[Hz] C2 fundamental frequency
- $b_1 = 0.5$
- $b_2 = 6.25 \times 10^{-9}$
- $w = 0.2$ width of the hammer spatial window g
- $Vh_0 = 2.5$[m/s] initial hammer velocity
- $\kappa = \epsilon$ is the string stiffness coefficient
- Other parameters can be found on the slides and articles or derived from the given ones.

Hint:

- Refer to Chaigne et. Al. for
  - The condition on maximum spatial step X
  - Hammer-string contact duration

Exercise 2:
Provide the solution of exercise 6 from the modeling of musical instrument exercise session, which is the refined model of the acoustic guitar.

- Model 20 resonances without string model (0.25 pt)
- Include the guitar string model (0.25 pt)
- Write a Matlab script that: (0.5pt)

  - Execute the model
  - Plot the signal
  - Play the signal
  - Save it on disk
- Comment results.

Please provide the **answers in a report as a PDF file** which explains **how** the FD scheme and the guitar model are implemented and your choices. In addition, you must provide the **source codes** and the output audio files.
All the files **must be included in a .zip file** named:

yourIDnumber_surname_homework_piano.zip

Upload the required file using the WeBeep platform in the "Assignment HL3" delivery folder. **One file for each student must be uploaded**. If more than one student participated to the assignment, write on the cover page of the assignment the name, surname and ID of the participating students.