BYTES AND BEATS
An Introduction to Programming with MATLAB

Instructor Guide

Module 3: Introduction to MATLAB®

Prerequisite Domain Knowledge: None

Expected Completion Time: 50 minutes

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Using MATLAB to Visualize Sounds

Expected Duration: 15 minutes

Learning Objectives

- Visualize a sound signal in MATLAB.
- Understand the effect on a sound by changing the wave's amplitude and frequency; and adding noise to it.
- Start MATLAB and execute a command given by the instructor.

Motivation

Are you ready to start working with MATLAB? Let's open MATLAB up and use it to explore the connection between the shape of a sound wave and the corresponding sound.

Materials

- MATLAB
- Worksheet "Using MATLAB to Visualize Sounds"
- Vocabulary Handout
- MATLAB Functions Handout

Steps

- Ask the students to follow along with you on their computers.
- Have the students open and login to MATLAB Online
- Have them give you thumbs up when they have opened MATLAB.
- The students shouldn't worry right now about what the different boxes and icons in the MATLAB window mean or do. We will cover those soon.
- Ask them to go to the APPS tab and click on "Amplitude and Frequency"
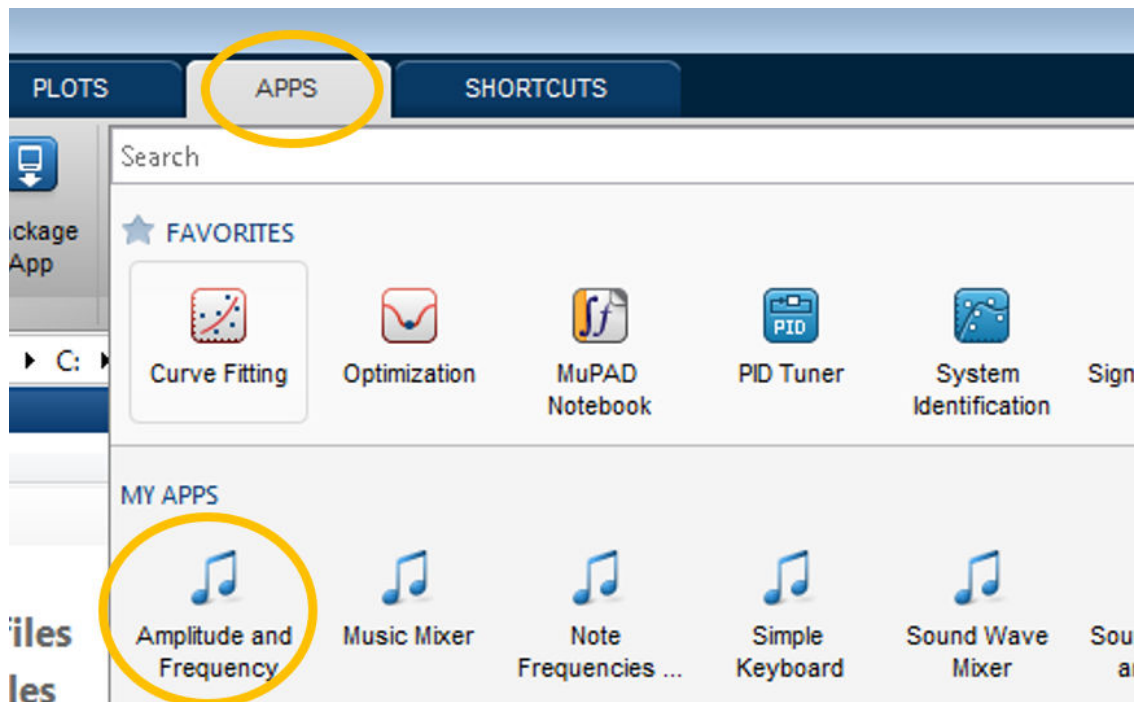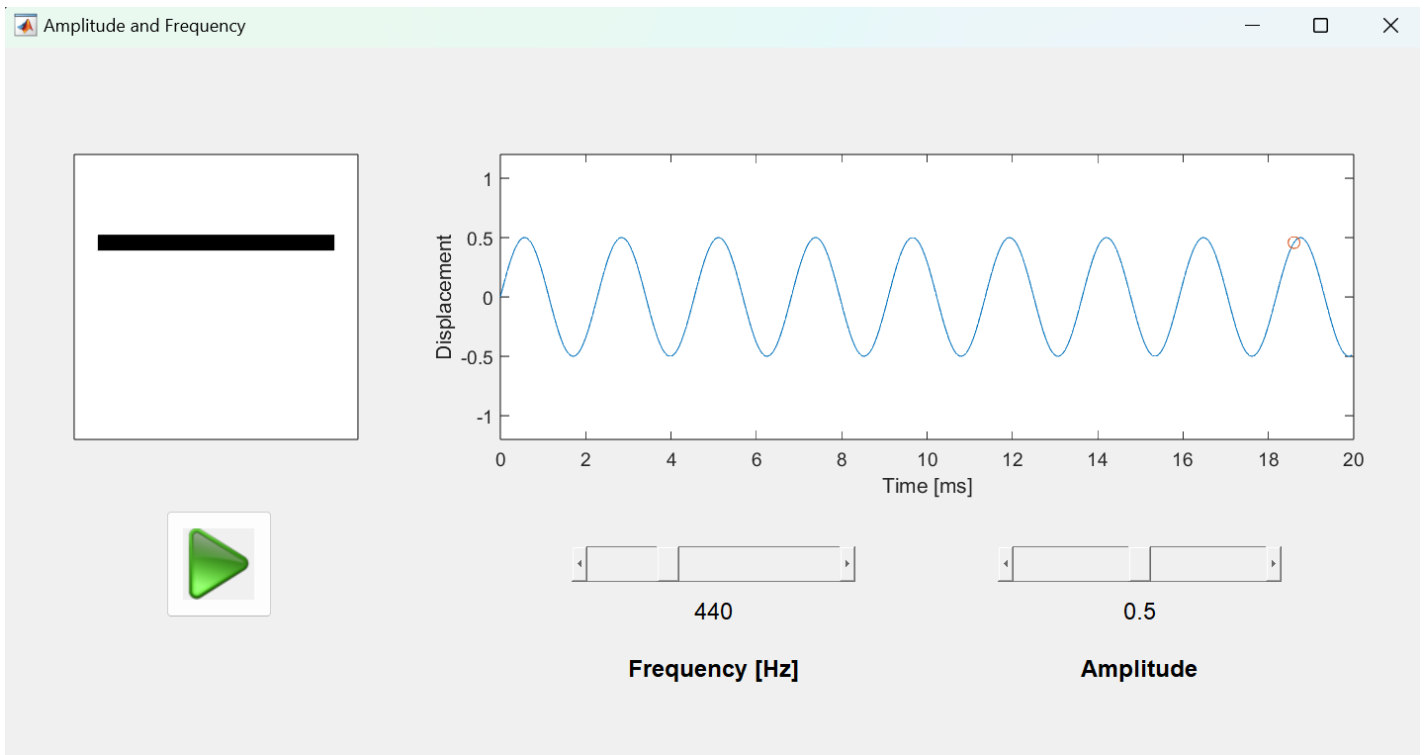
- This will open an app which illustrates vibrations from different frequencies.
- Get the students to change the frequency and amplitude values to see how these affect the vibration of the sound waves.
- What happens when we increase or decrease the frequency?
- Increase the frequency – the vibrations are quicker or *more frequent.*
- Decrease the frequency – the vibrations are slower or *less frequent.*

So, frequency denotes how frequently the vibrations are happening.

- What happens when we increase or decrease the amplitude? The height of the sound wave becomes larger or smaller accordingly.
- Once they have had a few mins to see how vibrations cause sound waves, tell the students that we have another app to visualize and interact with sound waves, and we can bring it up by going to the **APPS** tab again and clicking on "Sound, Music and Noise".
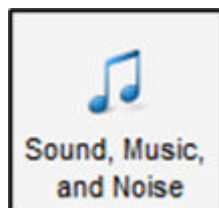
- Explain the purpose and use of the Sound, Music, and Noise app. By pressing Play, the student will play a sound file that has noise in it. This noisy sound can be visualized on the application.
- Get the students to move the Noise to Music slider (bottom) and the Volume control (right) to adjust the noise added and the volume of the sound.

- Hand out the "Using MATLAB to Visualize Sounds" worksheet and ask the students to fill it out by playing with the application.
- This can be found within *worksheets_and_handouts > worksheets*

Ask and discuss the following:

What happens when the noise is increased or decreased? How is the wave affected?

- It increases the noise level – makes the wave messy *because it adds disturbances.*

What happens when the volume is increased or decreased? How does the wave change?

- The height of the wave will change, which corresponds to volume.
- The height, or *amplitude*, of a wave determines how loud it is.
- Students can increase the amplitude with the toggle in the program.

Does music stay recognizable as I add random noise to it?

- Students can increase the amount of noise to the clip and view the effects.
- Optional: Give the students the vocabulary and MATLAB function handouts. These have a list of useful terminology and MATLAB functions that the students have available for use.
- This can be found within *worksheets_and_handouts > handouts*

Fun with MATLAB

Expected Duration: 15 minutes

Learning Objectives

- Execute some fun commands in MATLAB's Command Window
- Get comfortable and familiar with the MATLAB interface

Motivation

Take some time to get comfortable with MATLAB and explore all the fun things it can do.

Materials

- MATLAB

Steps

At the **Command Window** ask to students to try the following commands:

```
>> fifteen %opens a sliding game

>> why %MATLAB answers all questions!

>> knot %see a cool knot shape

>> life %se a demo of conway's game of life
```

```
>> lorenz %see an animation a complex mathematical integration

>> spy %see a plot of a dog

>> xpbombs %play minesweeper

>> xpquad %edit a shape using sliders

>> logo %open an image of the MathWorks membrane
```

Using MATLAB as a Calculator

Expected Duration: 20 minutes

Learning Objectives

- Gain familiarity with the **Command Window**
- Execute simple commands
- Perform basic calculations in MATLAB

Motivation

Computers are exceptionally good at crunching numbers. Let's use MATLAB as a calculator and at the same time get practice interacting with the MATLAB programming language.

Materials

- MATLAB

Steps

- Introduce the topic, which is using MATLAB as a calculator.
- To tell MATLAB what to do, we can type commands at prompt in the **Command Window**:

Type:

```
>> 7 * 8
```

Then press **Enter** to reveal the answer.

- Explain that we have just entered a command on the command line.
- A command is a piece of code or instructions for the computer. The computer reads what you wrote, and then does whatever tasks you told it to do.
- The computer then completed the task when we pressed Enter. When you make the computer do the command by pressing Enter, that is called executing that command. The line where you execute a command in MATLAB is called the command line.
- Go through basic mathematical calculations. The important thing here is the concept of *execution*. You type commands, such as numbers and arithmetic symbols, and when you press **Enter** on the keyboard,

MATLAB will execute the command, or perform a calculation for the line you just typed. This is done at the prompt in the **Command Window**, which is the line with the blinking cursor beginning with the "**>>**" symbols. The overall white window they are typing in is the **Command Window**.

- Ask for some calculations to be performed and type them out if there is a response. Otherwise, perform your own calculations, such as

```
>> 6000000 * 120
```

- Be very explicit when giving the directions for typing in MATLAB
- The +, -, *, / symbols are plus, minus, times, and divided by, respectively. The ^ is to raise to a power, i.e. 3^5 is 3*3*3*3*3.
- Press **Enter** to perform the calculation.
- Students may ask if spaces matter. Tell them they do not (99% of the time they do not).
- Let the students perform their own math calculations. Ask them for example calculations that they performed.
- Congratulate the students on performing their first few calculations and commands in MATLAB!