# Decoding ultrasound data

Context

Ultrasound probes are used to image various parts the body (e.g. heart, abdomen), and can play a critical role in diagnosing a wide range of diseases. The goal of this exercise is to reconstruct the acquired image from a probe's raw data.

Ultrasound probes rely on a very intuitive technology. In a simplified model, the probe, placed against the body, sends ultrasound waves and receives reflected ("echoed") signals. The magnitude of the various echoes the probe receives provides the ultrasound machine with the position and density of body elements relative to the probe. By sending several ultrasound waves from different lateral positions in the probe, the ultrasound machine can reconstruct a full 2D image of the area that the probe is aimed at. The resulting image may have a cone shape, as shown below.
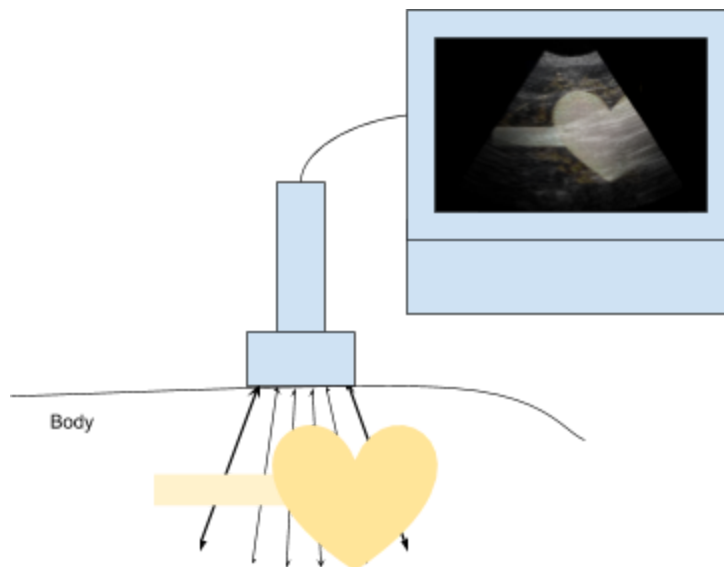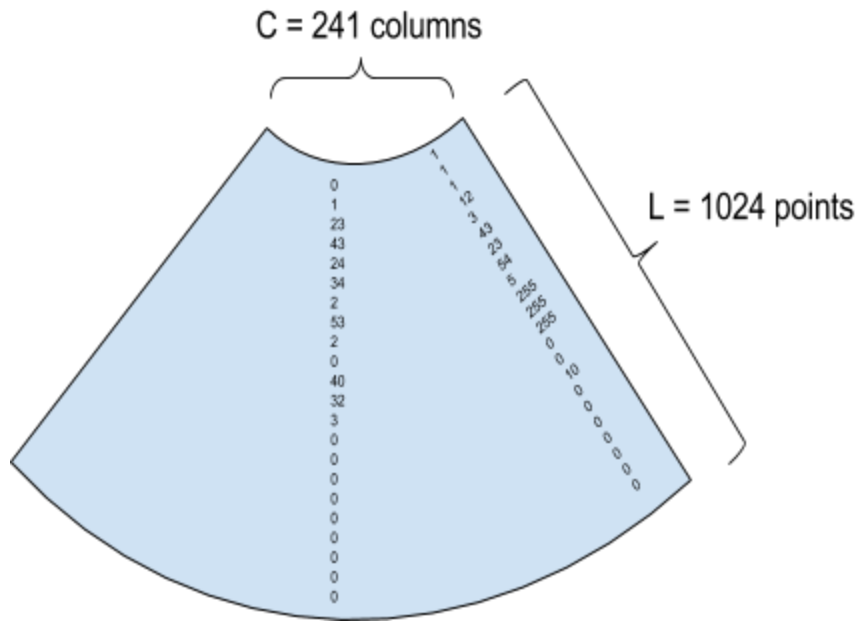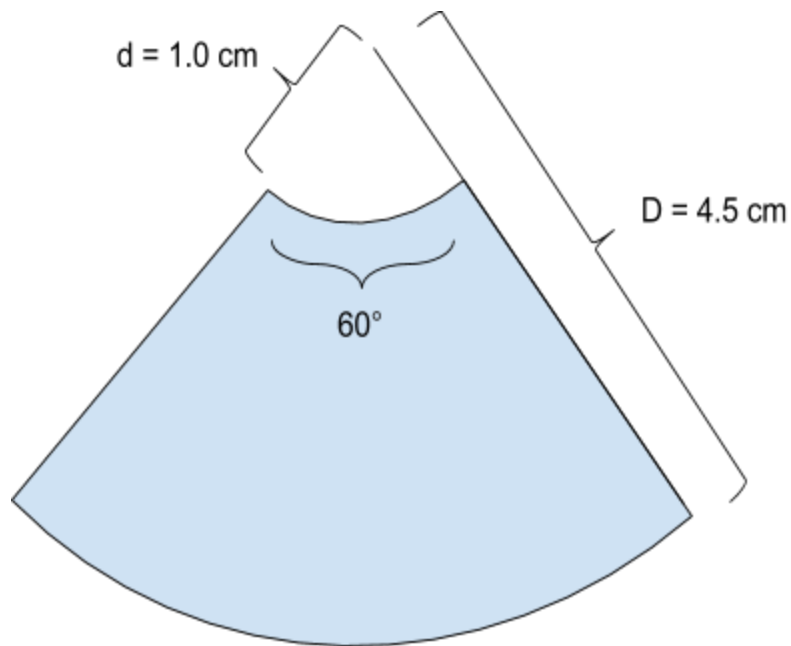

Data format

An ultrasound probe was used to record a video of the carotid artery.

For each frame of the video, the probe sends $C=241$ separate ultrasound waves in different radial directions from the probe. For each of these ultrasound waves the probe records $L=1024$ density points with increasing echo delays and thus increasing distance from the probe. The recorded data are an array of $C \times L$ integers, with integers ranging from 0 to 255, representing the amplitude of the received echo (255 corresponds to the strongest echo, a white point on the image).

The image encoded in this process is a partial cone, as shown below.
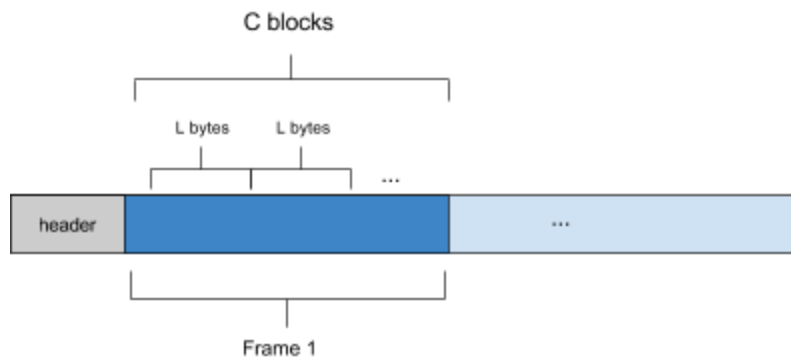

We also provide you with the physical dimensions of the cone.

File format

The file `carotid.cine` contains the data for each frame (one byte per number in the array), stored as consecutive raw bytes after an irrelevant header of 1240 bytes). The video has 32 frames. The first column will correspond to the left side of the cone.

Exercise

The goal of this exercise is to reconstruct from this file the video of the ultrasound cone in 512x512 pixel resolution. You are welcome to place the cone wherever you see fit in that space, on a black background. We would prefer an output in .mp4 format.

As a sanity check, a still frame of the video inside the cone should look like the following image, which is the long-axis view of the carotid artery acquired with an ultrasound probe.

Thank you again for your interest in Bay Labs. We look forward to reading your solution!