Experiment No. 1

Introduction about signals:

Signals convey information. Systems transform signals. This book is about developing an understanding of both. We gain this understanding by dissecting their structure and by examining their interpretation. For systems, we look at the relationship between the input and output signals (this relationship is a **declarative** description of the system) and the procedure for converting an input signal into an output signal (this procedure is an **imperative** description of the system). A sound is a signal. We leave a description of the physics of sound to texts on physics and instead show how a sound can be usefully decomposed into components that themselves have meaning. For example, a musical chord can be decomposed into a set of notes. An image is a signal. We do not discuss the biophysics of visual perception; instead we show that an image can be usefully decomposed. We can use such decomposition, for instance, to examine what it means for an image to be sharp or blurred and thus to determine how to blur or sharpen an image.

Signals can be more abstract (less physical) than sound or images. A signal can be, for example, a sequence of commands or a list of names. We develop models for such signals and the systems that operate on them, such as a system that interprets a sequence of commands from a musician and produces a sound. One way to get a deeper understanding of a subject is to formalize it by developing mathematical models. Such models admit manipulation with a level of confidence not achievable with less formal models. We know that if we follow the rules of mathematics, a transformed model still relates strongly to the original model. There is a sense in which mathematical manipulation preserves “truth” in a way that is elusive with almost any other intellectual manipulation of a subject. We can leverage this truth preservation to gain confidence in the design of a system, to extract hidden information from a signal, or simply to gain insight. Mathematically, we model both signals and systems as functions. A **signal** is a function that maps a domain, often time or space, into a range, often a physical measure such as air pressure or light intensity. A **system** is a function that maps signals from its domain—its input signals—into signals in its range—its output signals. Both the domain and the range are sets of signals (**signal spaces**). Thus, systems are functions that operate on functions.