1.1.1 Example: Communication Systems

Communication systems play a central role in our lives. Everyday, we use our cell phones, access the internet, use our TV remote controls, and so on. Each of these systems relies on transferring information from one place to another. For example, when you talk on the phone, what you say is converted to a sequence of 0's or 1's called *information bits*. These information bits are then transmitted by your cell phone antenna to a nearby cell tower as shown in Figure 1.1.

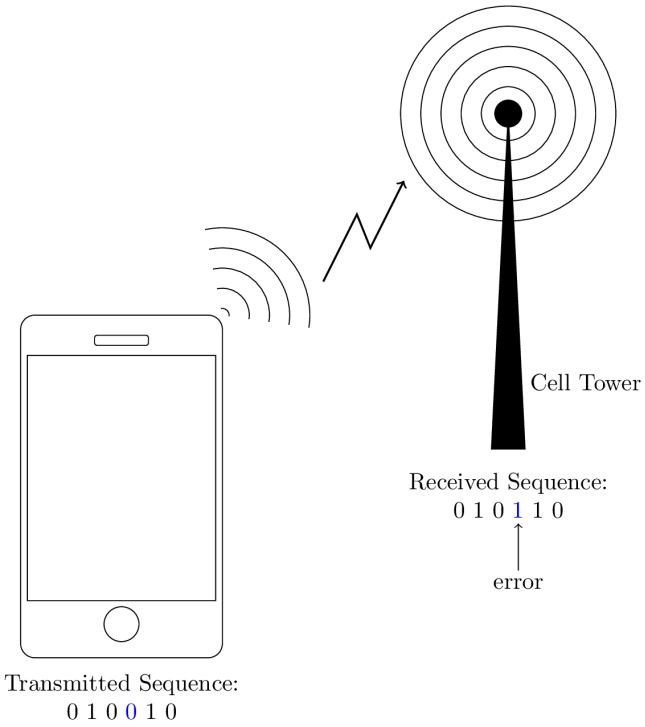

Fig.1.1 - Transmission of data from a cell phone to a cell tower.

The problem that communication engineers must consider is that the transmission is always affected by **noise**. That is, some of the bits received at the cell tower are incorrect. For example, your cell phone may transmit the sequence "$010\mathbf{0}10\cdots$," while the sequence "$010\mathbf{1}10\cdots$" might be received at the cell tower. In this case, the fourth bit is incorrect. Errors like this could affect the quality of the audio in your phone conversation.

The noise in the transmission is a random phenomenon. Before sending the transmission we do not know which bits will be affected. It is as if someone tosses a (biased) coin for each bit and decides whether or not that bit will be received in error. Probability theory is used extensively in the design of modern communication systems in order to understand the behavior of noise in these systems and take measures to correct the errors.

This example shows just one application of probability. You can pick almost any discipline and find many applications in which probability is used as a major tool. Randomness is prevalent everywhere, and probability theory has proven to be a powerful way to understand and manage its effects.
