#### Signal Decomposition

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A signal's complexity is not related to how wiggly it is. Rather, a signal expert looks for ways of decomposing a given signal into a **sum of simpler signals**, which we term the **signal decomposition**. Though we will never compute a signal's complexity, it essentially equals the number of terms in its decomposition. In writing a signal as a sum of component signals, we can change the component signal's gain by multiplying it by a constant and by delaying it. More complicated decompositions could contain derivatives or integrals of simple signals.



Thus, the pulse is a more complex signal than the step. Be that as it

may, the pulse is very useful to us.

As an example of signal complexity, we can express the pulse **pΔ (*t*)** as

a sum of delayed unit steps.

**Example 2.2**

Express a square wave having period ***T*** and amplitude ***A*** as a superposition of delayed and amplitude-scaled pulses.

**Exercise 2.3.1**

Because the sinusoid is a superposition of two complex exponentials, the sinusoid is more complex. We could not prevent ourselves from the pun in this statement.

Clearly, the word "complex" is used in two diferent ways here. The complex exponential can also be written (using Euler's relation (2.16)) as a sum of a sine and a cosine. We will discover that virtually every signal can be decomposed into a sum of complex exponentials, and that this decomposition is very useful. Thus, the complex exponential is more fundamental, and Euler's relation does not adequately reveal its complexity.

### Discrete-Time Signals

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So far, we have treated what are known as **analog** signals and systems. Mathematically, analog signals are functions having continuous quantities as their independent variables, such as space and time. Discrete-time signals (Section 5.5) are functions defned on the integers; they are sequences. One of the fundamental results of signal theory (Section 5.3) will detail conditions under which an analog signal can be converted into a discrete-time one and retrieved **without error**. This result is