Linear Systems and Signals

Signals entering systems

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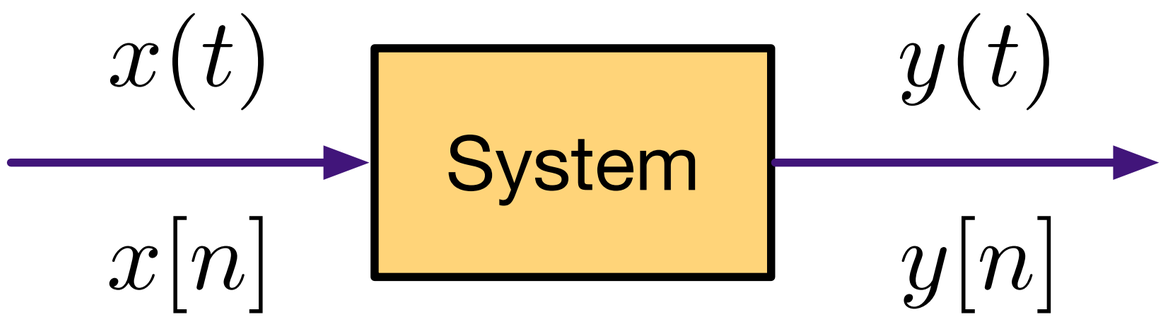
Learning objectives

The learning objectives for this section are:

- explain how signals enter into systems "flipped"

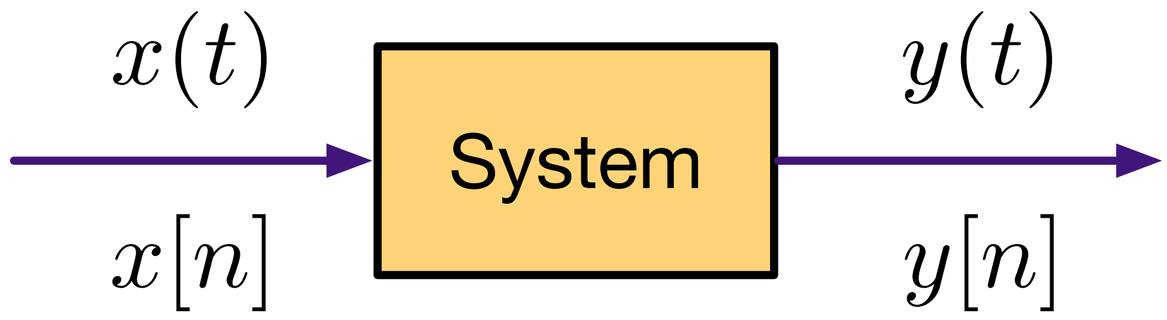
What is a system?



A system is a function that maps an input signal to an output signal.

- Abstracts away the internal operations: systems are equivalent if the have the same I/O behavior.
- Can characterize different system properties in terms of properties of the I/O behavior.

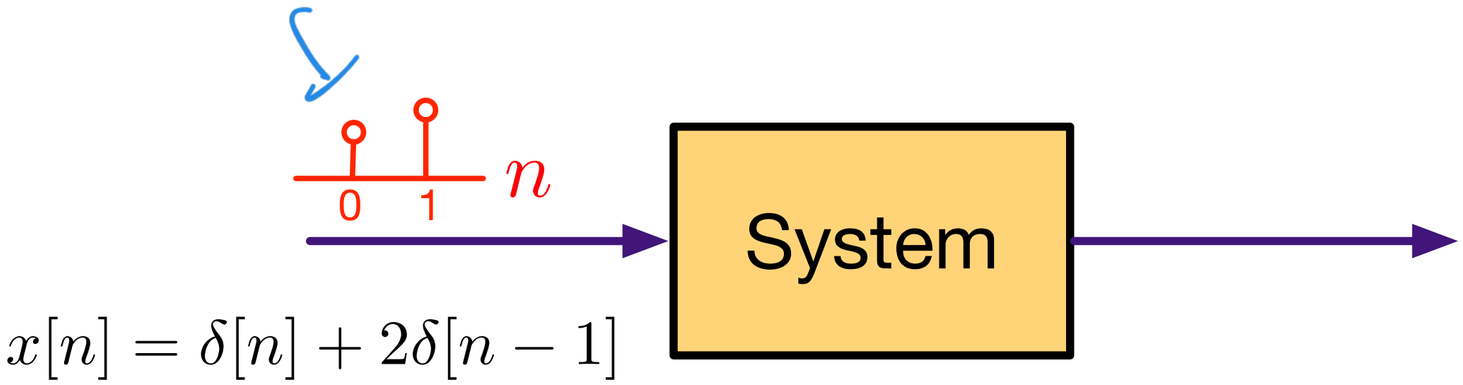
Systems in a block diagram



We represent systems as boxes in our block diagrams. Some examples:

- Delay: $y(t) = x(t - \tau)$.
- Accumulator: $y[n] = \sum_{k=-\infty}^{n} x[k]$
- Rectifier: $y(t) = |x(t)|$
- Squaring: $y[n] = |x[n]|^2$.
- Downsampler: $y[n] = x[nN]$

Signals entering a system

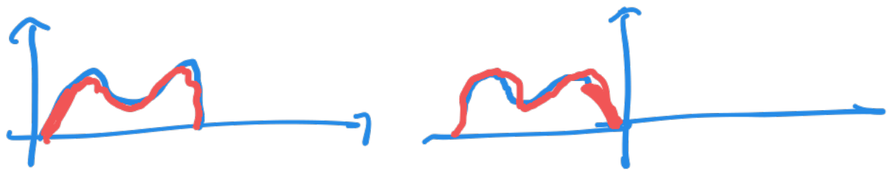


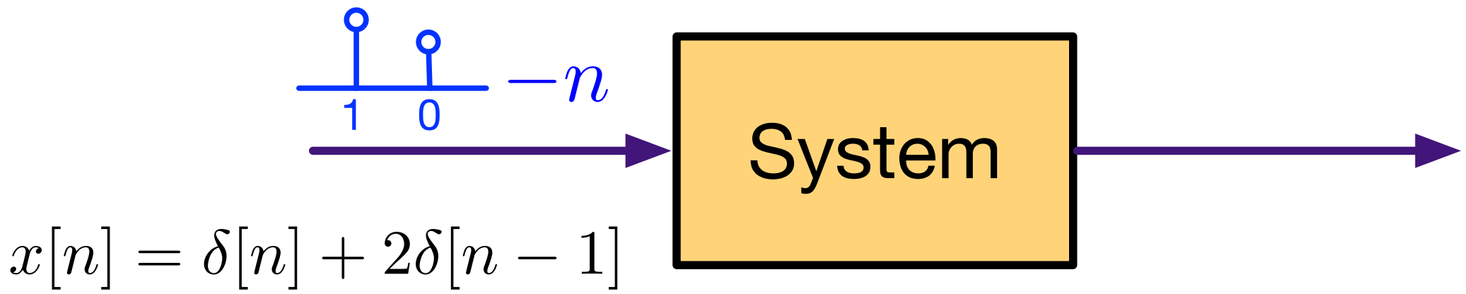
Let's look at a signal going into a system. The signal is

$$x[n] = \delta[n] + 2\delta[n-1] \tag{1}$$

At time 0 the sample $x[0]$ should enter the system. But this isn't physically how it looks!

Signals enter... backwards

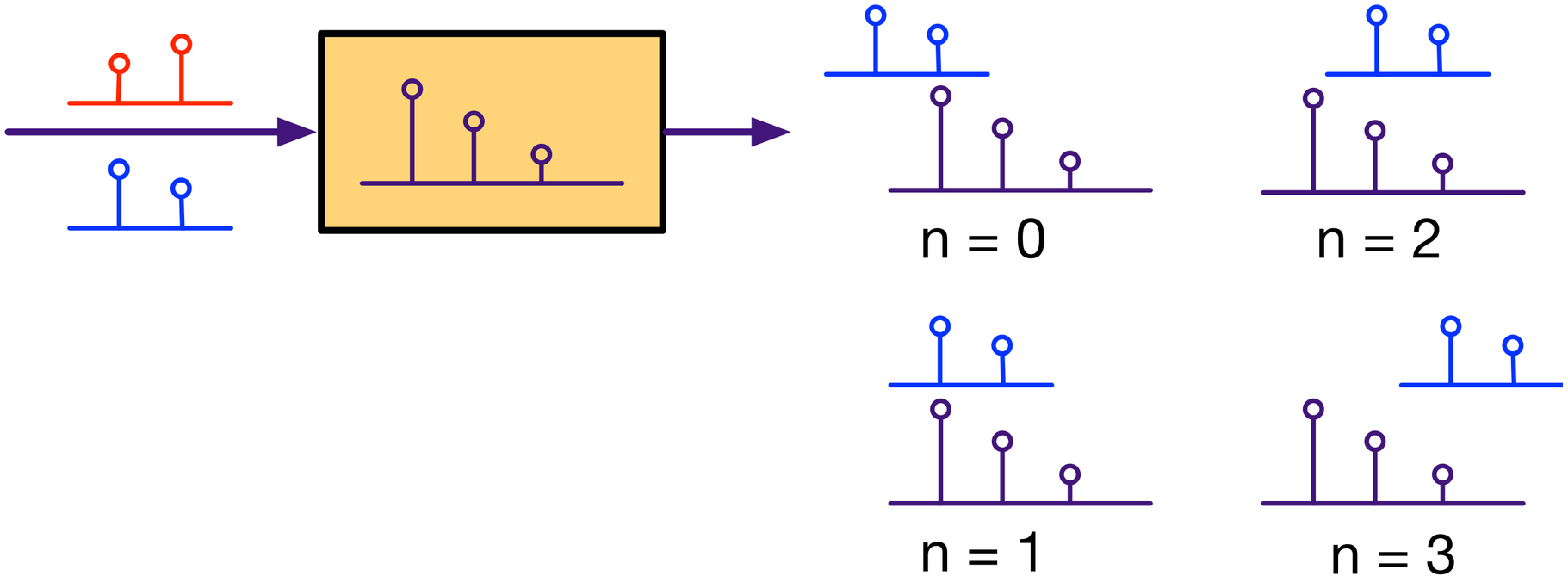




$$x[n] = \delta[n] + 2\delta[n-1]$$

The trick is that the signal enters the system "backwards" or *flipped*. This is an important concept that will come up when we discuss convolution.

Preview of convolution



Suppose

$$y[n] = 3x[n] + 2x[n-1] + x[n-2]. \tag{2}$$

We can see how the input signal enters and leaves the system by sliding the flipped signal into the system.