《数字信号处理》：时域中的离散时间信号与系统

Digital Signal Processing: DT Signal and System in Time-domain

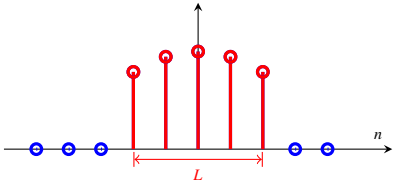
Signal Classes and Basic Operations

DSP MOOC Course

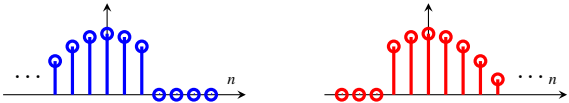
Signal Classes

- **Finite and Infinite-length**
- **Periodic**
- **Symmetric**

- **Length** of a sequence is the number of effective elements

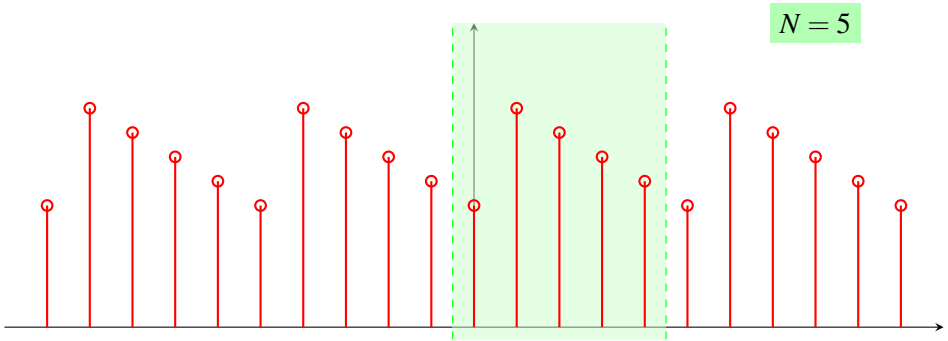


- **Finite** sequence is with finite length
- **Infinite** sequence: left-sided or right-sided



- **Periodic sequence** has repetitive appearance
- mathematically, with periodicity $N < \infty$,

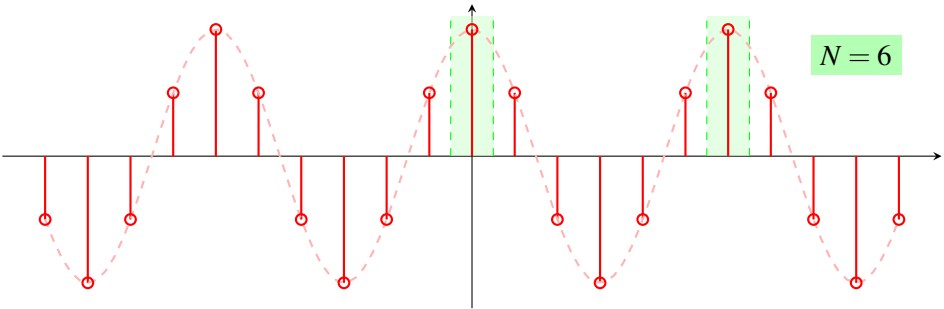
$$x[n] = x[n + kN], \forall n, k \in \mathbb{Z}$$



- **Sinusoid sequence**

$$x[n] = \cos \omega n$$

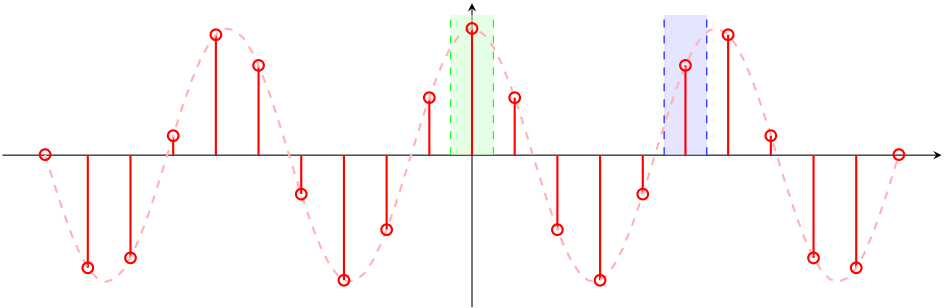
  - when $\omega = \pi/3$, $x[n]$ is periodical



- **Sinusoid sequence**

$$x[n] = \cos \omega n$$

  - when $\omega = \pi/3$, $x[n]$ is periodical
  - when $\omega = 1.1$, $x[n]$ is non-periodical



- **Sinusoid Sequence** is periodic iff ωN is integer times of 2π

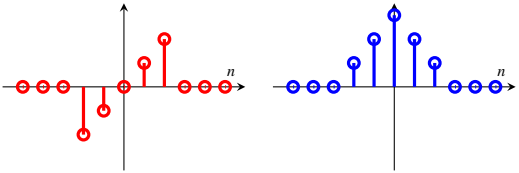
$$x[n] \triangleq \cos(\omega n + \phi) = x[n + Nk], \forall n$$

- the minimum N is its periodicity

- **Symmetry of Real sequence**

Odd sequence: $-x[n] = x[-n]$

Even sequence: $x[n] = x[-n]$



Even component: $x_e[n] = \frac{1}{2}(x[n] + x[-n])$

Odd component: $x_o[n] = \frac{1}{2}(x[n] - x[-n])$

For any: $x[n] = x_e[n] + x_o[n]$

- **Addition:**

$$y[n] = x_1[n] + x_2[n]$$

- **Multiplication (or modulation):**

$$y[n] = x_1[n] \cdot x_2[n]$$

- **Scaling:**

$$y[n] = \alpha x[n]$$

- **Time-shift:**

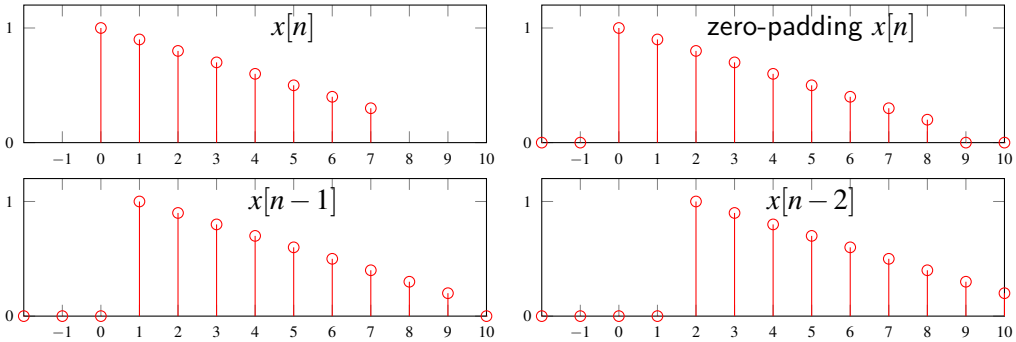
$$y[n] = x[n-k]$$

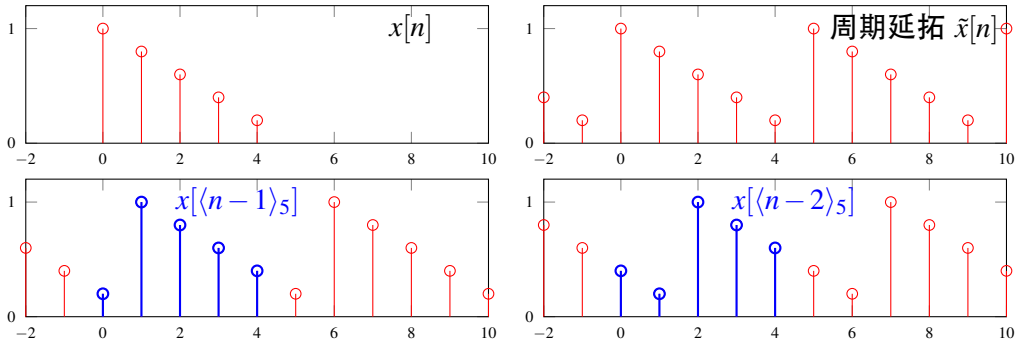
- **Time-reversal:**

$$y[n] = x[-n]$$

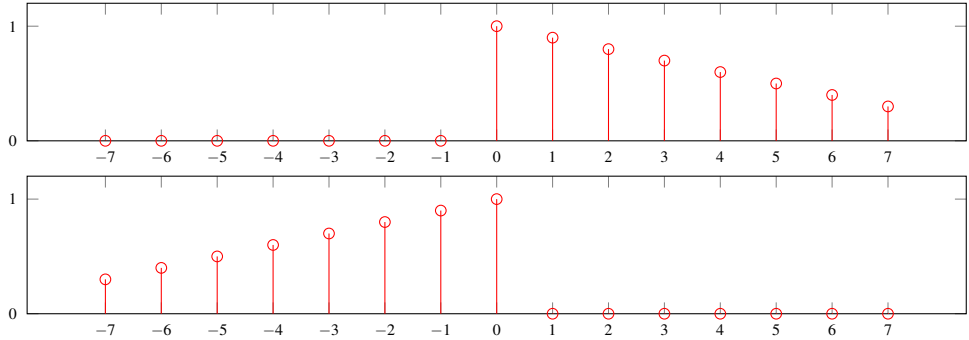
Two different ways to padding ...

- Zero-padding
- Periodic-padding


$x[n]$
zero-padding $x[n]$
$x[n-1]$
$x[n-2]$


$x[n]$
周期延拓 $\tilde{x}[n]$
$x[\langle n-1\rangle_5]$
$x[\langle n-2\rangle_5]$
1
0
−2
0
2
4
6
8
10

$$x[n] \rightarrow y[n] = x[-n]$$



$$y[n] = x[\langle -n \rangle_N], \quad \langle m \rangle_N = m \text{ modulo } N$$