# Distances for Sequences and Text

- symbol distance: $\rho(x,y) = \begin{cases} 0 & \text{if } x = y \\ 1 & \text{otherwise} \end{cases}$

- Hamming distance:

$$H((x^{(1)},\ldots,x^{(p)}),(y^{(1)},\ldots,y^{(p)})) = \sum_{i=1}^{p} \rho(x^{(i)},y^{(i)})$$

- edit/Levenshtein distance:

$$L((x^{(1)},\ldots,x^{(p)}),(y^{(1)},\ldots,y^{(q)})) =$$

$$\begin{cases} p & q = 0 \\ q & p = 0 \\ \min\{L((x^{(1)},\ldots,x^{(p-1)}),(y^{(1)},\ldots,y^{(q)})) + 1, & \text{other-} \\ \quad L((x^{(1)},\ldots,x^{(p)}),(y^{(1)},\ldots,y^{(q-1)})) + 1, & \text{wise} \\ \quad L((x^{(1)},\ldots,x^{(p-1)}),(y^{(1)},\ldots,y^{(q-1)})) + \rho(x^{(p)},y^{(q)})\} & \end{cases}$$

# Example Edit/Levenshtein Distance

| | | C | L | E | O | P | A | T | R | A |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| C | 1 | **0** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| A | 2 | 1 | 1 | 2 | 3 | 4 | **4** | 5 | 6 | **7** |
| E | 3 | 2 | 2 | **1** | 2 | 3 | 4 | 5 | 6 | 7 |
| S | 4 | 3 | 3 | 2 | 2 | 3 | 4 | 5 | 6 | 7 |
| A | 5 | 4 | 4 | 3 | 3 | 3 | **3** | 4 | 5 | **6** |
| R | 6 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | **4** | 5 |

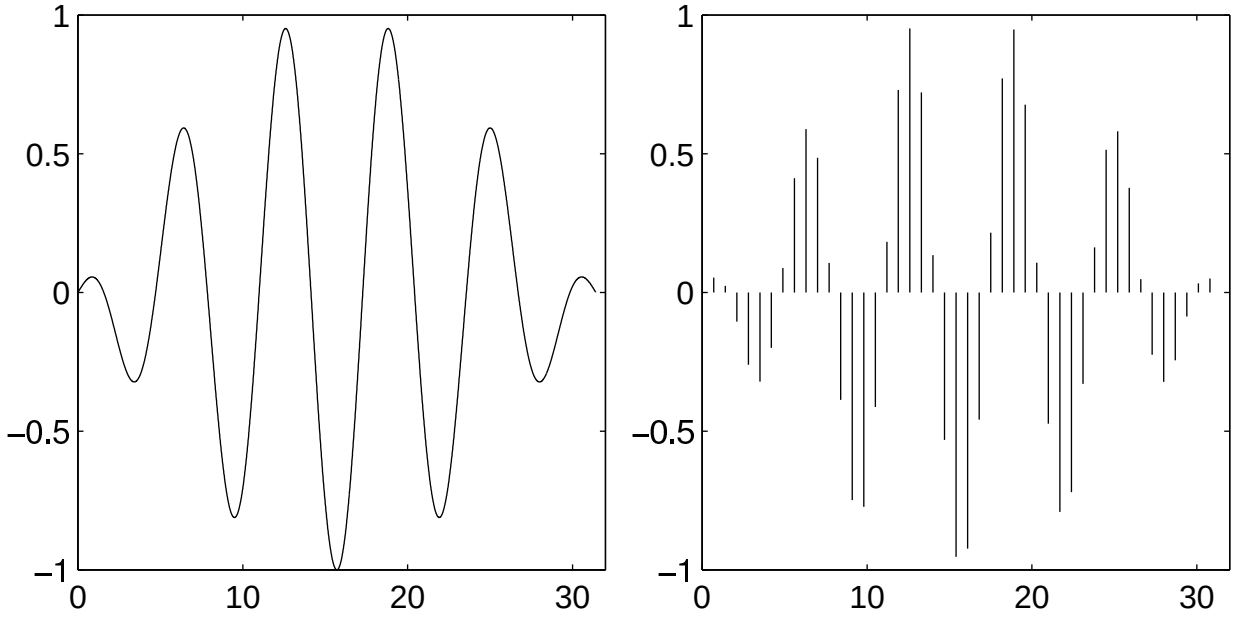
| C | A | E | S | | A | | R | |
|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |
| C | L | E | O | P | A | T | R | A |

$\Rightarrow 5$

# Sampling Continuous Signals

original signal
$s(t)$

sampled signal
$s_n = s(n \cdot T)$

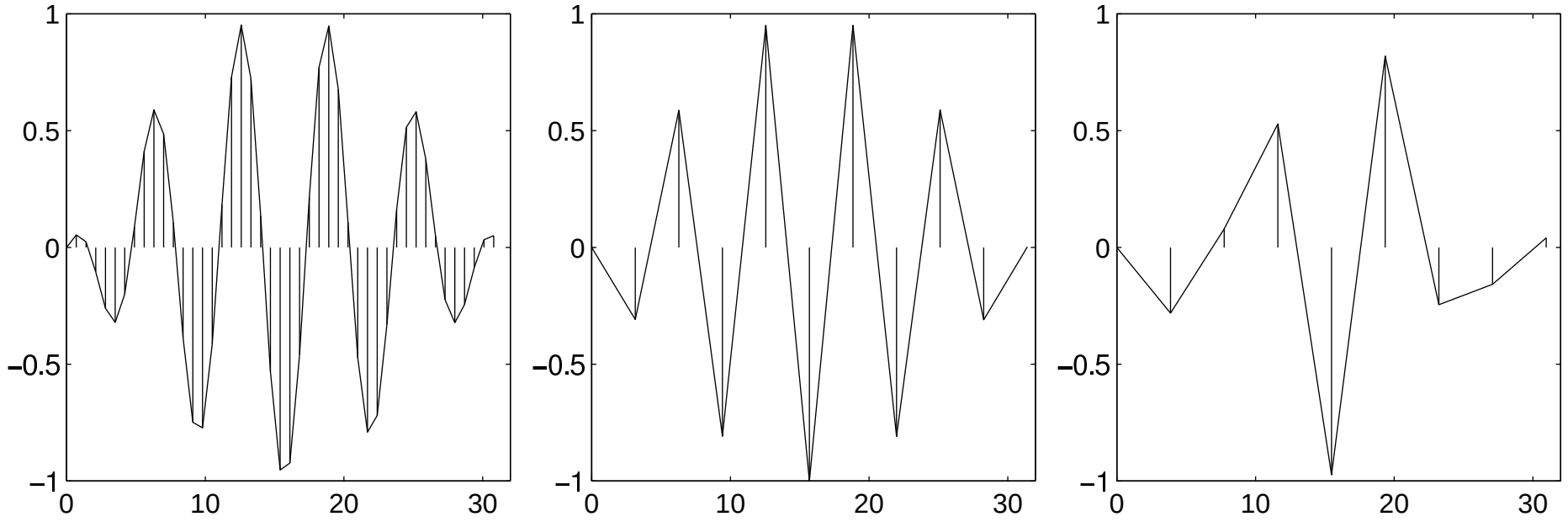


# Shannon's Sampling Theorem

1. $s(t)$ band limited: Fourier spectrum $|s(j2\pi f)| = 0$ for $|f| > f_{\text{max}}$
2. $T_s < \frac{1}{2 \cdot f_{\text{max}}}$ (Nyquist condition)

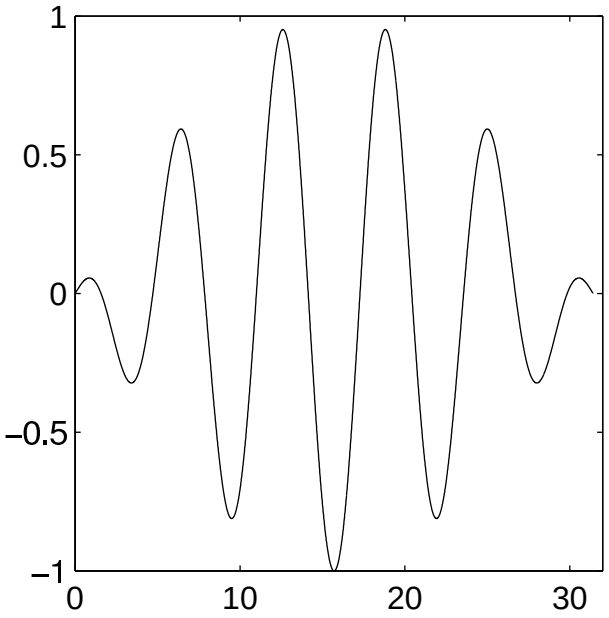
$\Rightarrow$ $s(t)$ can be completely reconstructed from $s_n$

$T < \frac{1}{2 \cdot f_{\text{max}}}$ $T = \frac{1}{2 \cdot f_{\text{max}}}$ $T > \frac{1}{2 \cdot f_{\text{max}}}$

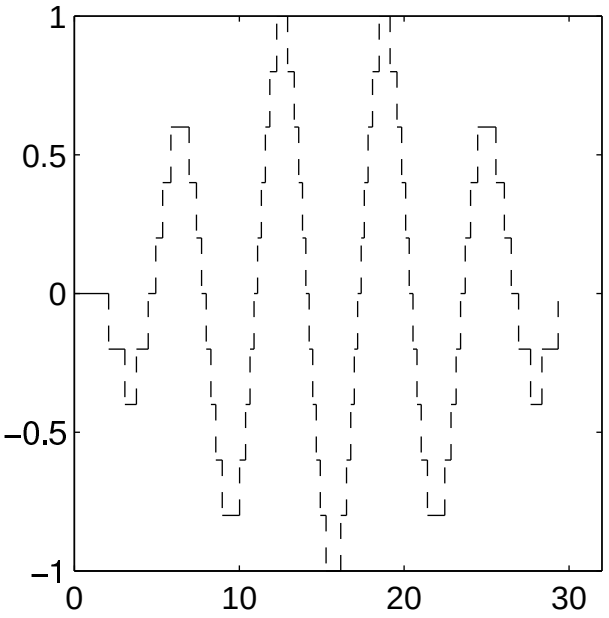


# Quantization

original signal
$s(t)$

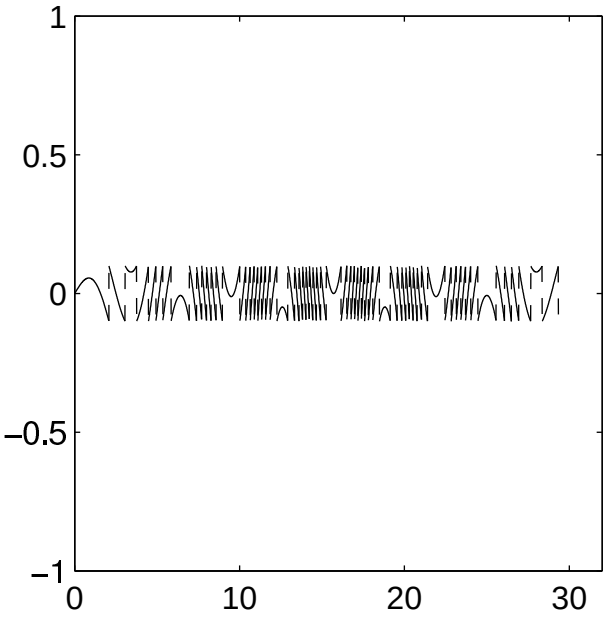



quantized signal
$s_q(t)$




quantization
$d = 0.2$

quantization error
$s(t) - s_q(t)$




max. abs. error
$\max\{|s(t) - s_q(t)|\}$
$= \frac{d}{2} = 0.1$

# Chapter 3: Data Preprocessing

1. Error Types and Handling
2. Filtering
3. Standardization and Transformation
4. Data Merging