Digital signals/Sampling

Sampling

- **continuous signal** (normalized magnitude, length L in seconds)

$$x(t) \in [-1, 1] \quad \text{with} \quad t \in [0, L]$$

```
>> x = @( t ) sin( 2*pi*f * t ); % continuous sine with frequency f
```

- **sampling rate** f_S, quantization of time

$$t \to t_i = \frac{i-1}{f_S} \quad \text{with} \quad i \in \{1, \ldots, N\} \quad \text{and} \quad N = \lfloor L f_S \rfloor$$

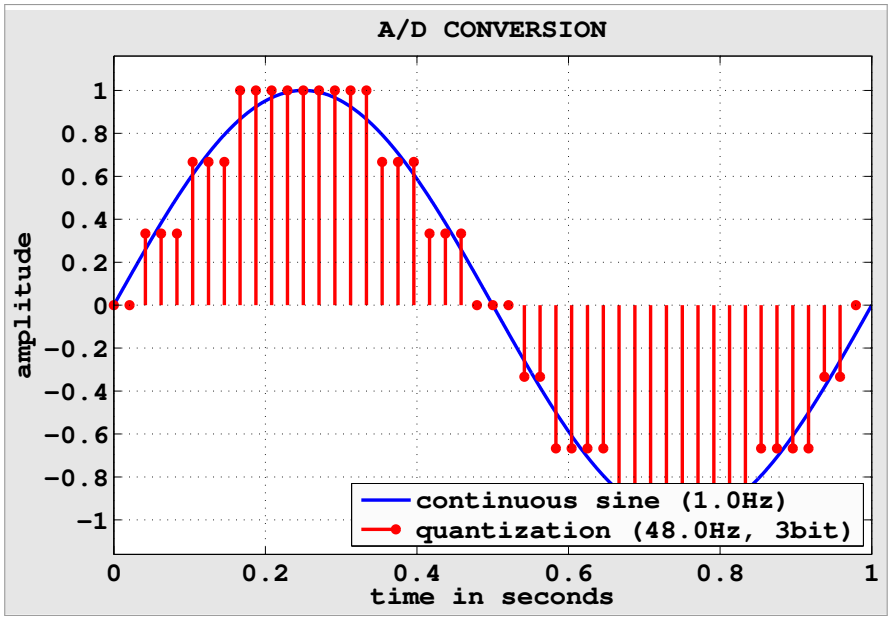
```
>> N = floor( L * fS ); % number of samples
>> ti = (0:N-1) / fS; % quantized time values
```

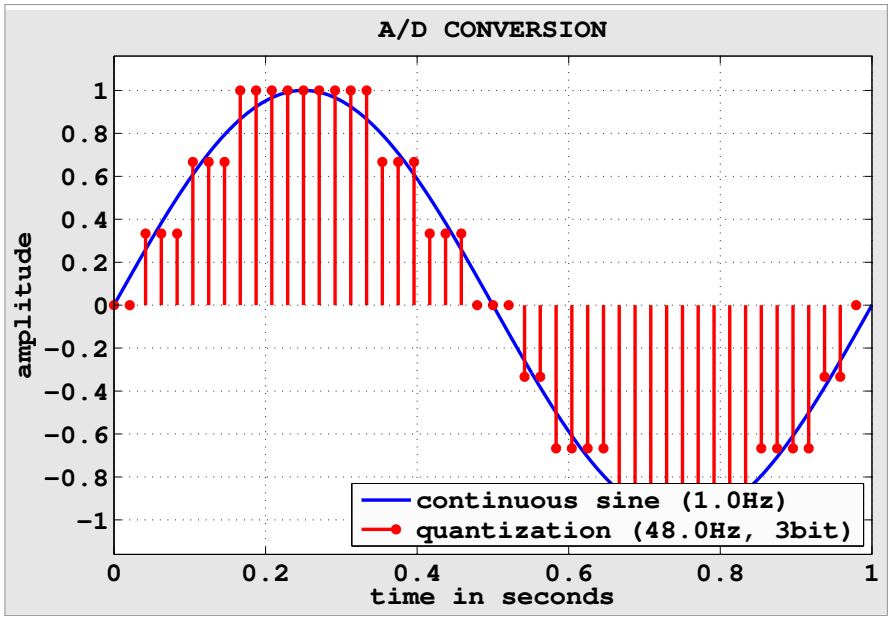
- **bits per sample** n_S, quantization of amplitude

$$x(t) \to x_i = \frac{\lfloor (2^{(n_S-1} - 1) x(t_i) \rceil}{2^{n_S-1} - 1}$$

```
>> xi = round( (2^(nS-1)-1) * x( ti ) ) / (2^(nS-1)-1); % quantized amplitudes
```

- **example:** `matlab/sampling.m`





- **exercise:**
  - verify from reconstruction that **Nyquist frequency** holds

$$f_{\mathrm{Ny}} = \frac{f_{\mathrm{S}}}{2}$$

  - compare commonly used **sampling standards** (telephony, Audio-CD, professional audio equipment, …)