Signals and Samping

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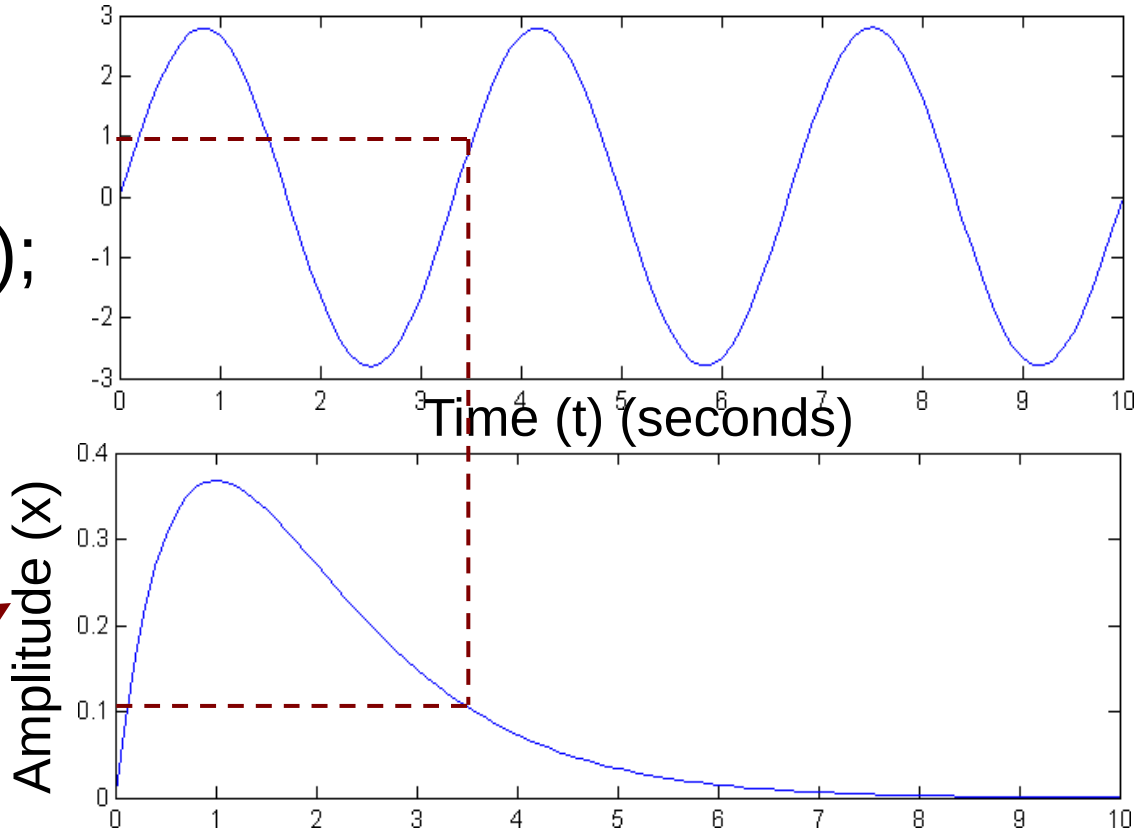
Signal types: Continuous time

Continuous time (C-T) signals has a known value corresponding to every time *t*

Examples:

```
t= 0:0.1:10;
x1= 2.8*sin(2*pi*0.3*t);
plot(t,x1)
```

```
x2 = t.*exp(-t);
plot(t,x2)
```



x has units. Real signal is physical, and sensor converts to volts

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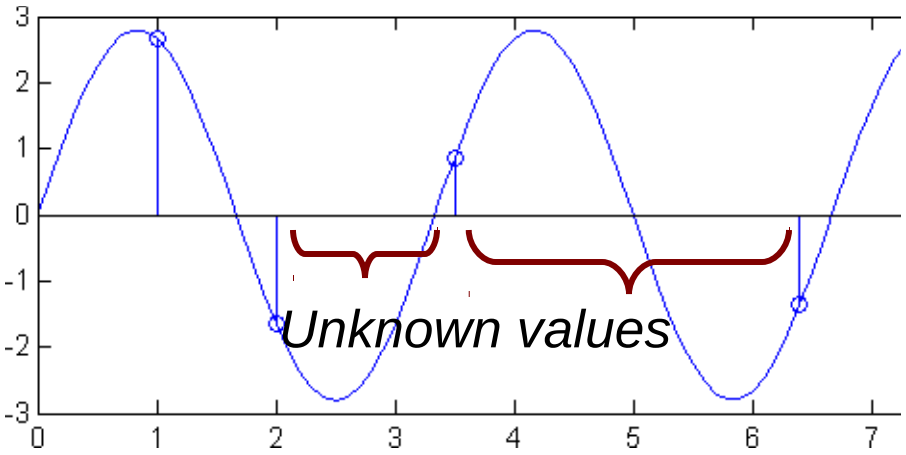
Signal types: Sampled sequence

If we only know the signal value at certain times, the signal is discrete time (D-T)

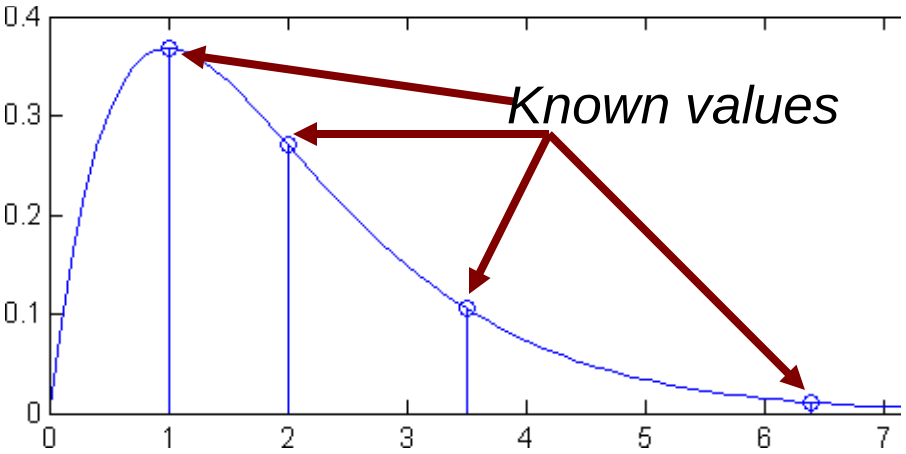
We know the value at 1.0s, 2.0s, etc

Example:

```
td = (t==1.0) | (t==2.0) | ...
     (t==3.5) | (t==6.4);
plot(t,x1);
hold on; stem(t(td), x1(td))
```




```
plot(t,x2)
hold on; stem(t(td), x2(td))
```



DT is not digital. Amplitude is continuous

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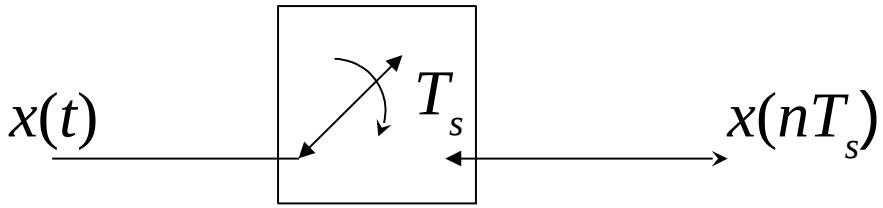
Signal types: Sampled sequence

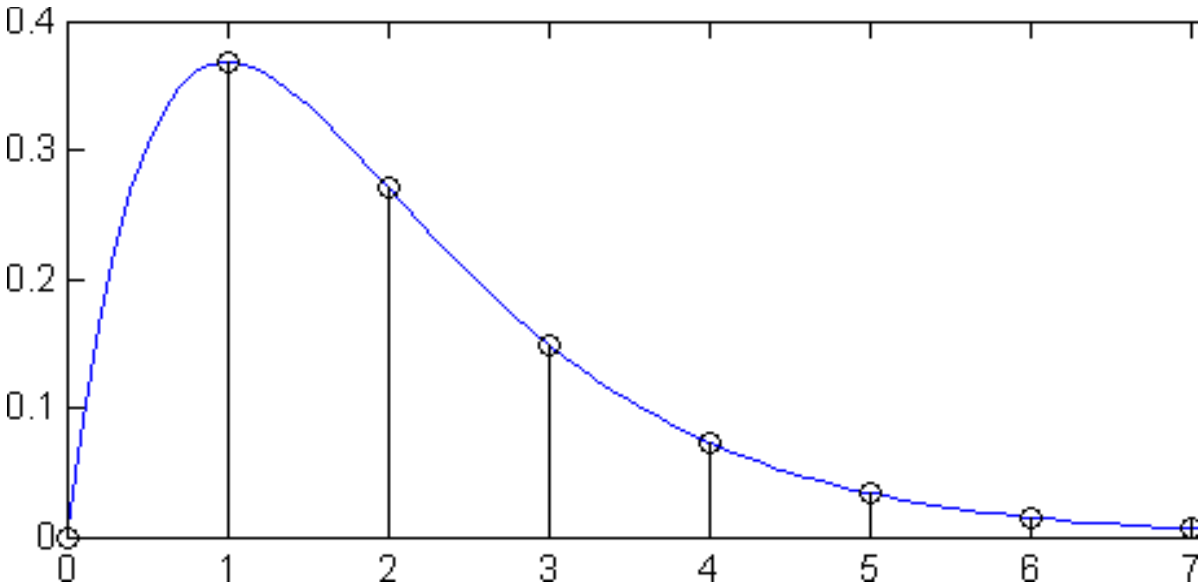
Most D-T signals obtained by sampling C-T signals at a regular interval T_s.



ON/OFF Switch

Switch closes every T_s.

We know value of signal at $t=nT_s$ for integer n.



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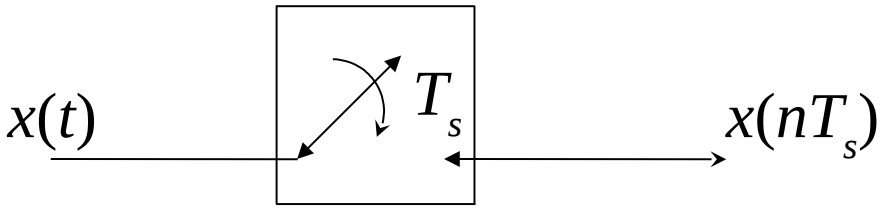
Signal Types
Sampled sequence



ON/OFF Switch

Most D-T signals obtained by sampling C-T signals at a regular interval T.

- **Sample:** Discrete points where signal is known
- Signal value between adjacent samples *undefined*.
  - We will assume *uniform sampling*, where samples are taken every T_s seconds.
  - non-uniform sampling is a tricky problem
- **Samping period** = T_s (example 1 µs)
- **Samping rate** = $1/T_s = f_s$ (example 1 Msample/s)

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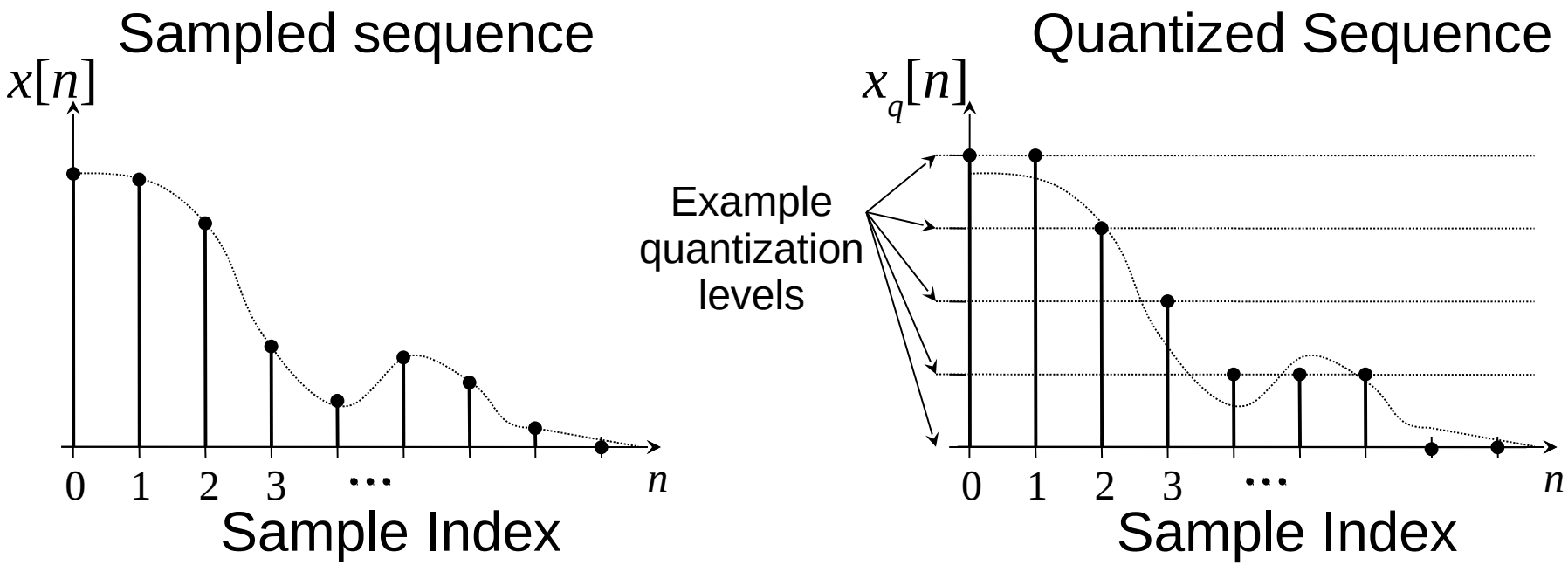
Signal Types
Sample Quantization

A D-T signal is turned into a *digital sequence* suitable for storage in finite precision registers by quantizing each sample.



Note: Sample values are approximated at the closest quantization level.

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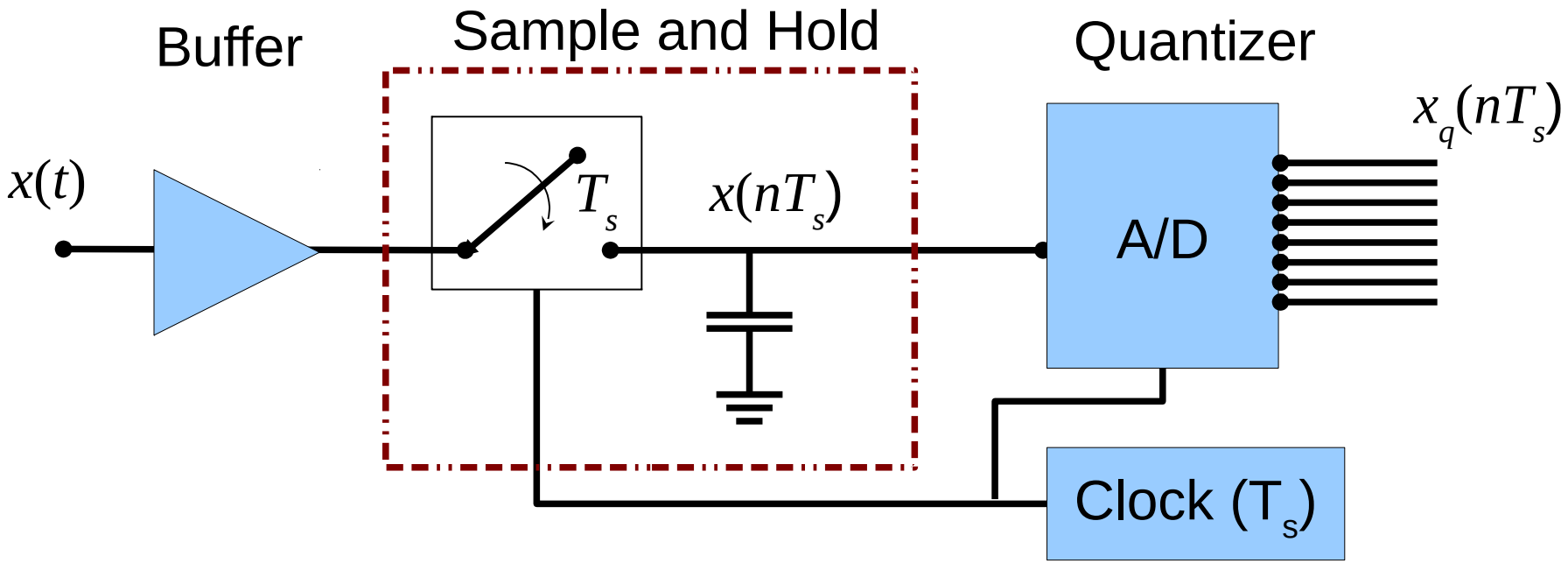
Converter implementation



Two circuits driven by clock

- Sample and Hold
- Quantizer

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Questions

- What is a
  - Continuous signal
  - Discrete-time signal
  - Digital signal?
- What is the difference between *sampling* and *quantization?*
- Exam (2014) Q4. In order to record the measured data, an analog-to-digital (ADC) converter is used. As shown in the block diagram, it is consists of a S/H (sample and hold), a quantizer and an encoder.
  - (a) What is the function of a S/H circuit?
  - (b) What is the function of the clock? Why is it required to feed into both the ADC and S/H circuit?

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