EE229: Signal Processing - I

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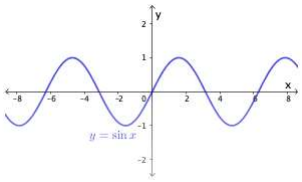
Signals

- A signal is a pattern of some form of *variation.*
- Signals carry 'information'
- Signals are processed for extracting the information or for signal modification.
- Mathematically, a signal is a function of one or more independent variables. The function has a domain and a range.

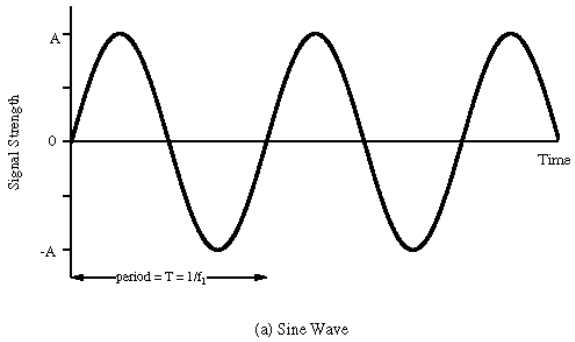
Signal: sine function



$$y = \sin x$$

$$y(t) = A\sin(2\pi f_1 t)$$

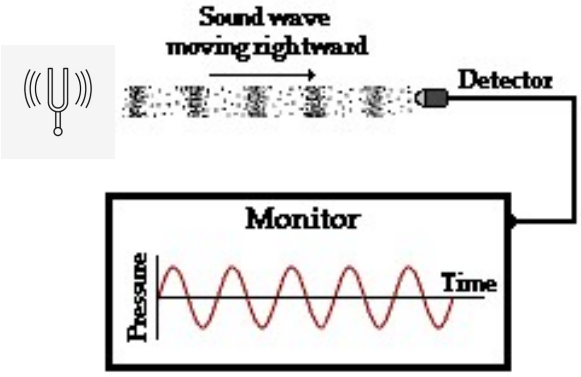
"Waveform"



(a) Sine Wave

- What is the information contained in a signal?
- How is the information embedded in the signal?

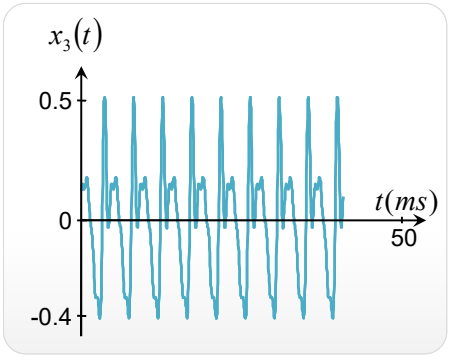
Sound waveforms



Tuning fork: 440 Hz resonance

**The Physics Classroom:http://www.glenbrook.k12.il.us/gbssci/phys/Class/sound/u1l1l2a.html*

Another sound (and waveform pattern)



Musical sounds are typically periodic

Audio waveform -→ Function of time

- Speech: see the signal “waveform”
- Music

Classification of Signals

- Continuous-time and discrete-time
  - more generally: continuous/discrete in “domain”
- Analog and digital
  - continuous/discrete in “range”

ECG signal

time --->

“Dow Jones Industrial Average” measured annually
Discrete-time signal

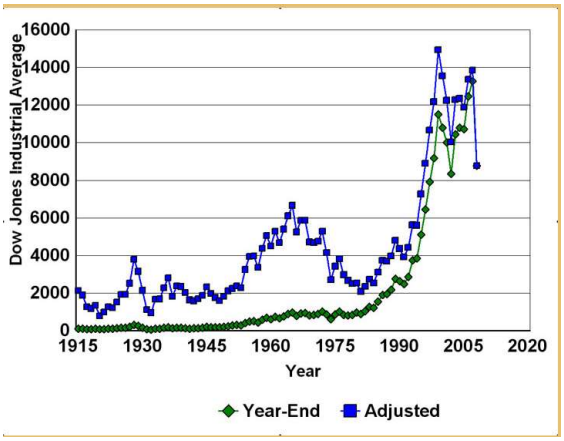
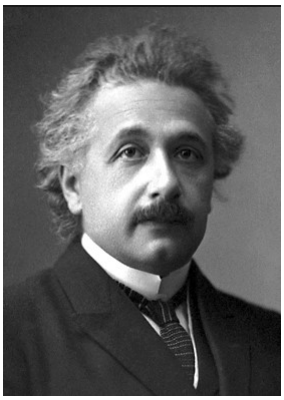


Image: a “multidimensional” signal



“Brightness” as a function of the spatial domain (x,y).

Colour photo

How about Video signals?

Text: a discrete-valued signal

THE ADVENTURE OF THE ENGINEER'S THUMB

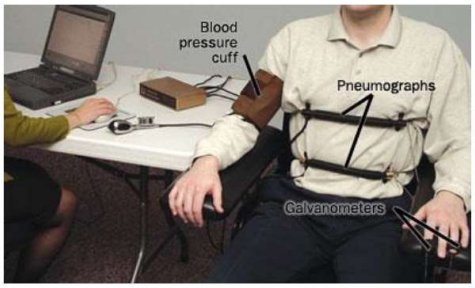
OF ALL the problems which have been submitted to my friend, Mr. Sherlock Holmes, for solution during the years of our intimacy, there were only two which I was the means of introducing to his notice—that of Mr. Hatherley's thumb, and that of Colonel Warburton's madness. Of these the latter may have afforded a finer field for an acute and original observer, but the other was so strange in its inception and so dramatic in its details that it may be the more worthy of being placed upon record, even if it gave my friend fewer openings for those deductive methods of reasoning by which he achieved such remarkable results. The story has, I believe, been told more than once in the newspapers, but, like all such narratives, its effect is much less striking when set forth *en bloc* in a single half-column of print than when the facts slowly evolve before your own eyes, and the mystery clears gradually

Signals & Systems…

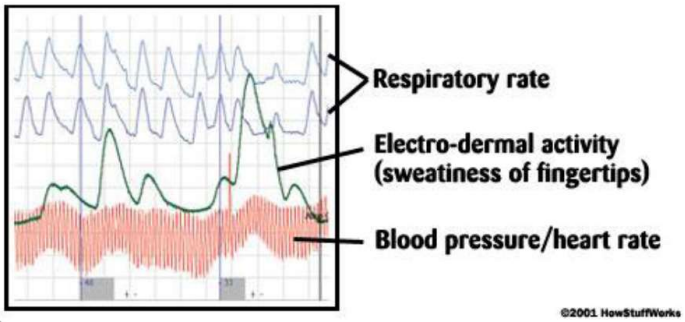
- Signals convey information
- Systems process signals to transform them

The polygraph: how does it work?

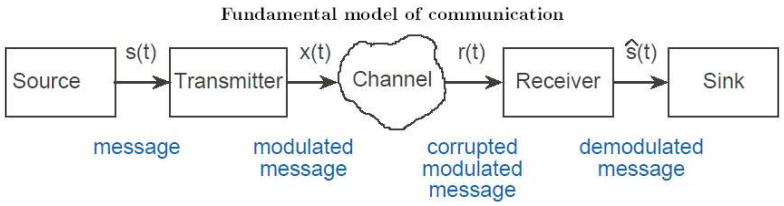
- A polygraph instrument is basically a combination of medical devices that are used to monitor changes occurring in the body (heart rate, blood pressure, respiratory rate and electro-dermal activity)



Polygraph measures



Communicating information

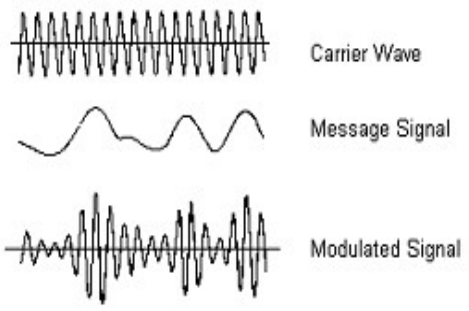


A signal is a function (with a domain and a range).

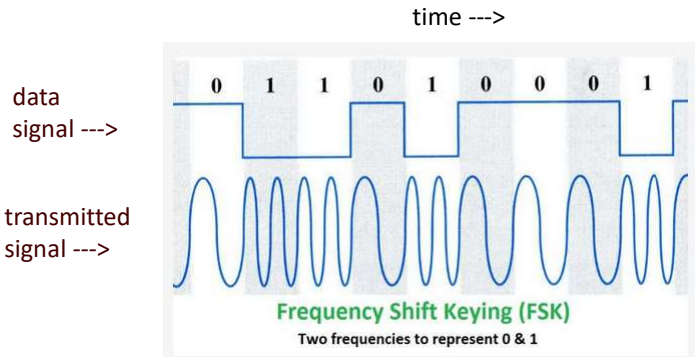
In the above block diagram, the signal is a function of time.

A system operates on an input signal to produce an output signal.

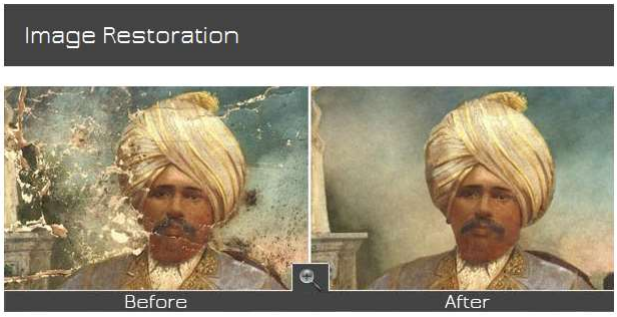
Radio transmission of signals



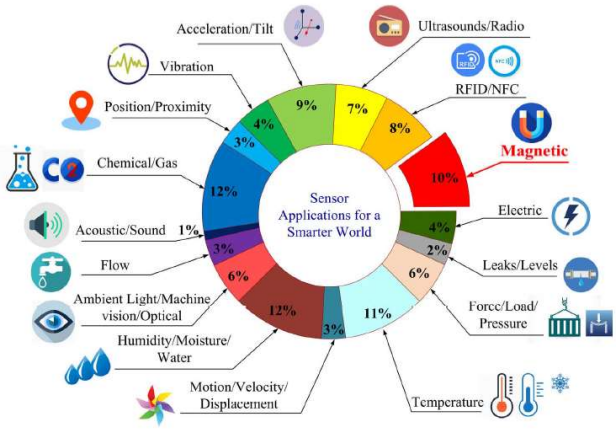
Modem: data transmission over telephone line



Images: Multidimensional signal

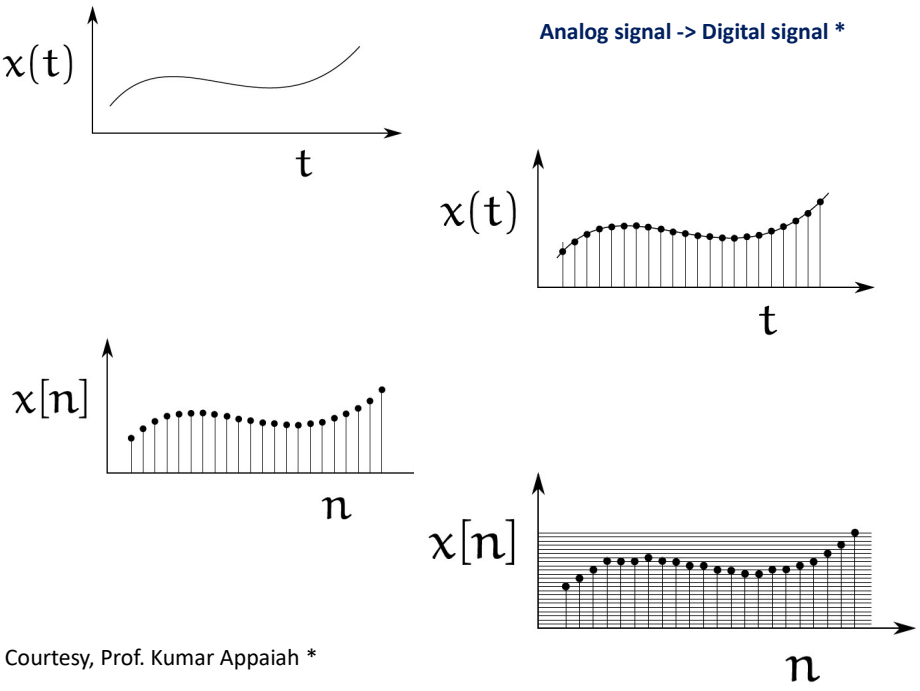


Signal processing: Applications to IOT



How do we process analog signals digitally?

Analog signal -> Digital signal *



Courtesy, Prof. Kumar Appaiah *

Conclusion

- Signals, signals everywhere…
- We need to model and design systems to achieve useful transformations of signals such as enhancement, transmission, information extraction.

Course Outline

- Signals and their properties, simple operations
- Description and properties of LTI systems
- Fourier series representation of periodic signals
- Fourier transform: continuous and discrete time
- Sampling and Analog to Digital Conversion
- Laplace transform

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Sounds too abstract?

- Where does this course fit in?

Signals Processing-I (EE229)

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Digital Signal Processing (EE338)

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Digital Signal Processing (EE338)

+ Probability and Random Processes

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Speech Processing, Image Processing, Adaptive Signal Proc.