Lecture 1: Motivation, Policies , DSP

Foundations of Digital Signal Processing

Outline

- What is digital signal processing?

- Applications of digital signal processing

- Recent and future advances in digital signal processing

- Syllabus and policies

- Tips for success

- Introduction to digital signal processing

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Foundations of Digital Signal Processing

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- **What is digital signal processing?**

- Applications of digital signal processing

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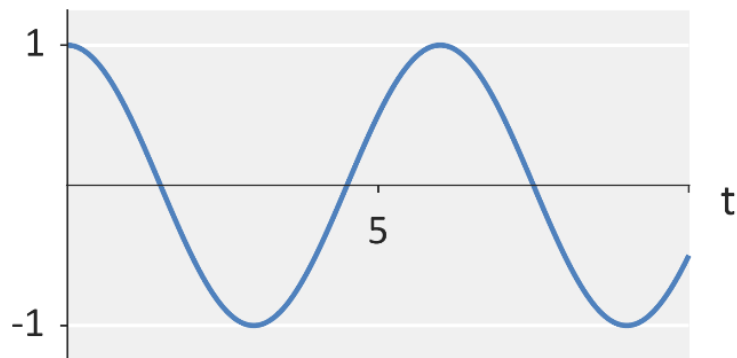- Tips for success

- Introduction to digital signal processing

Digital Signal Processing

■ **Question:** What is a **signal**?
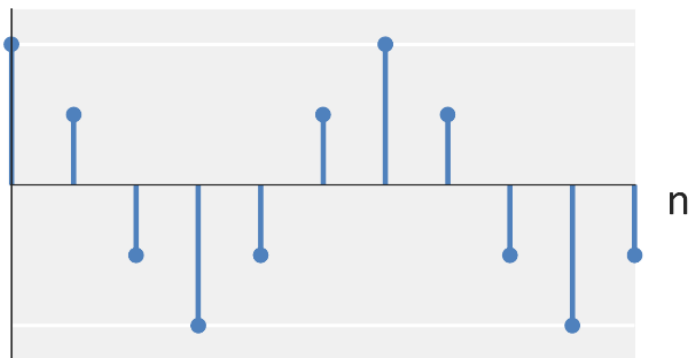
Digital Signal Processing

- **Signals: time signals (1D signals)**

  - Continuous-time signals

$$x(t)$$
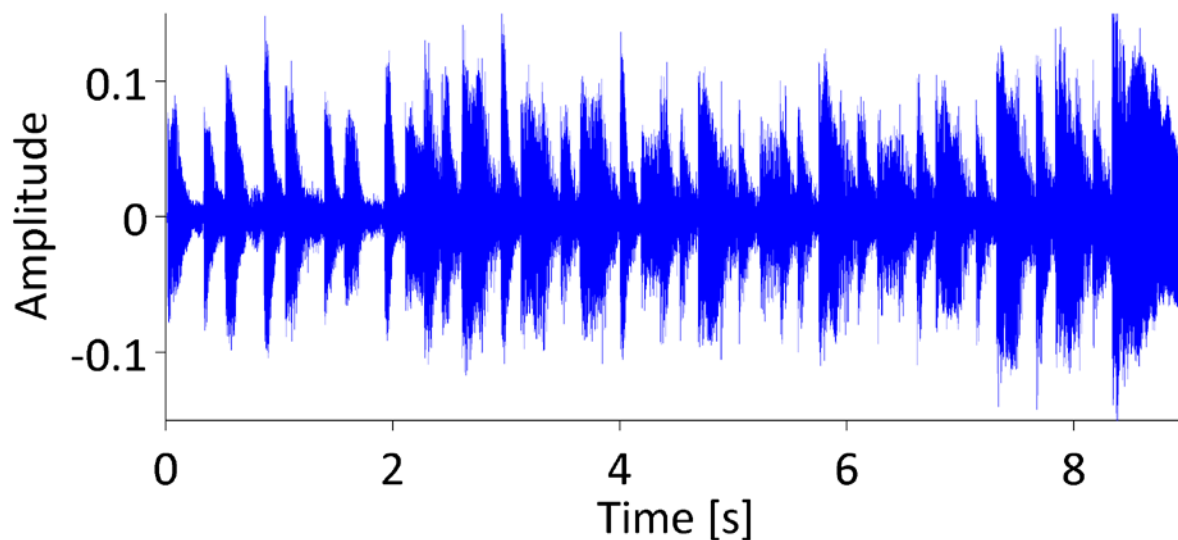
  - Discrete-time signals

$$x[n]$$

Digital Signal Processing

- **Signals: time signals (1D signals)**

  - Music

Physical:	$x(t)$
Digital:	$x[n]$

Digital Signal Processing

■ **Signals: Images (2D spatial signals)**

Photo:	$x(t_1, t_2)$
Digital:	$x[n_1, n_2]$

Digital Signal Processing

- **Signals: Images (2D spatial signals)**
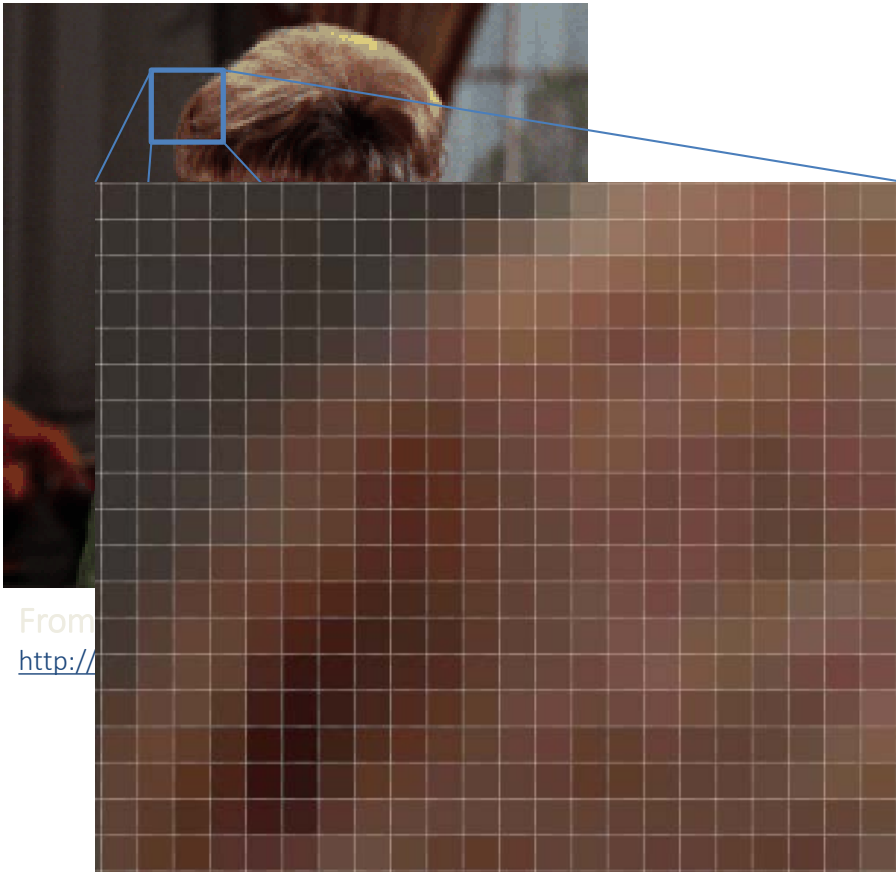

From
http://

Photo:	$x(t_1, t_2)$
Digital:	$x[n_1, n_2]$

Digital Signal Processing

- **Signals: Images (2D spatial signals)**

Photo:	$x(t_1, t_2)$
Digital:	$x[n_1, n_2]$

$$x[n]$$
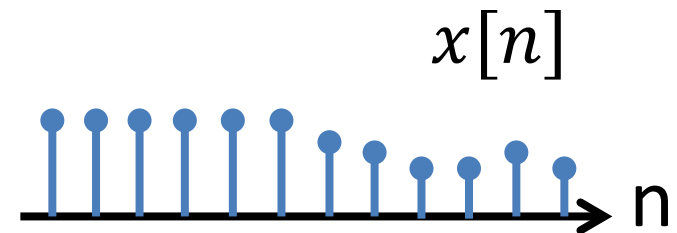
Digital Signal Processing

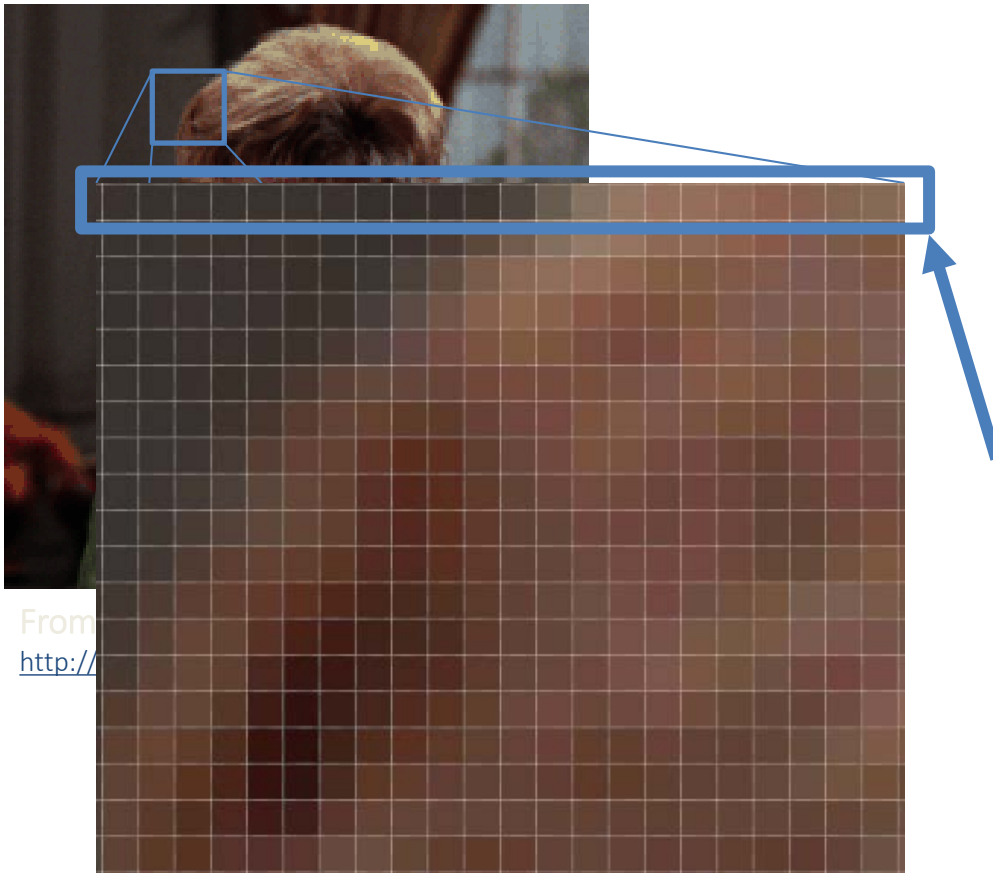■ **Signals: Video (2D spatial + 1D time signals)**

Film: $x(t_1, t_2, n)$

Digital: $x[n_1, n_2, n]$
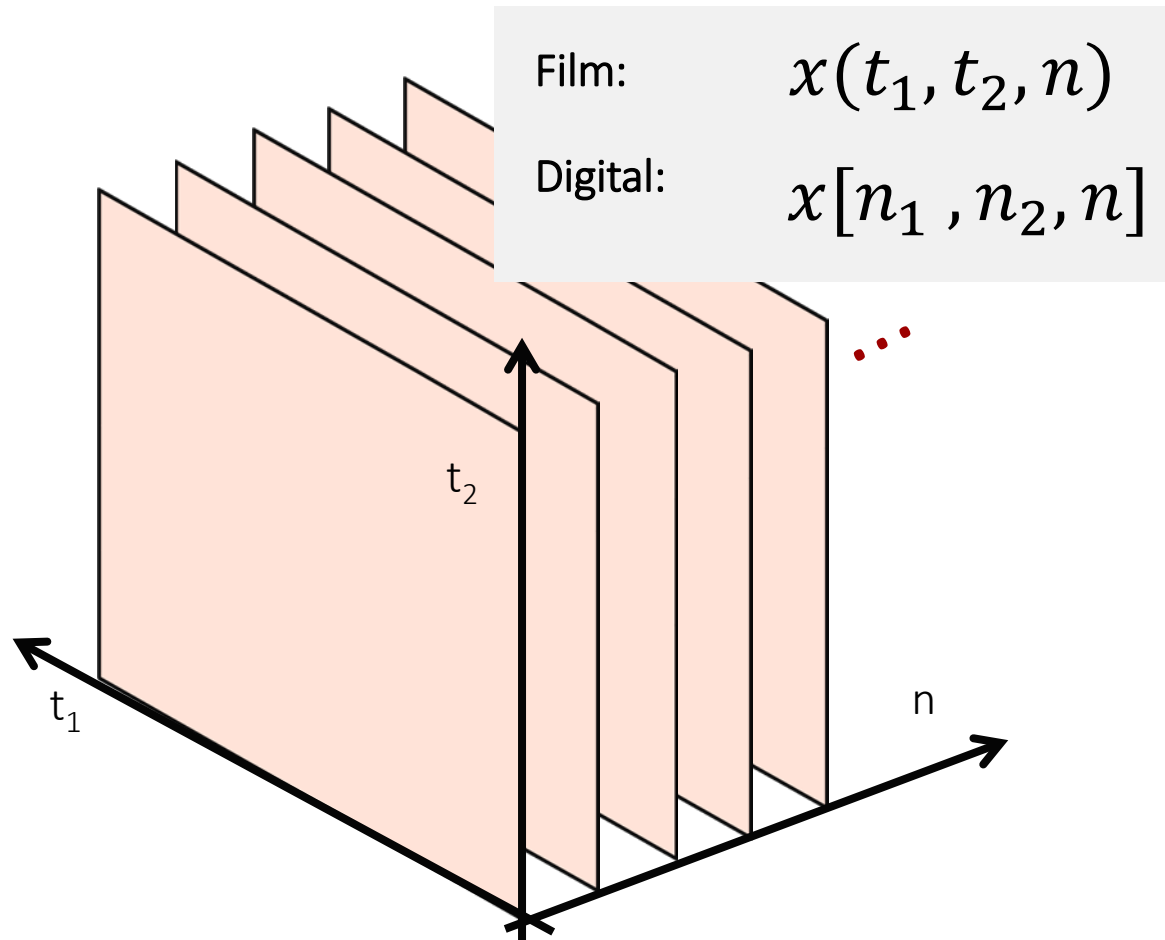
Digital Signal Processing

- **Signals: chromatograms**
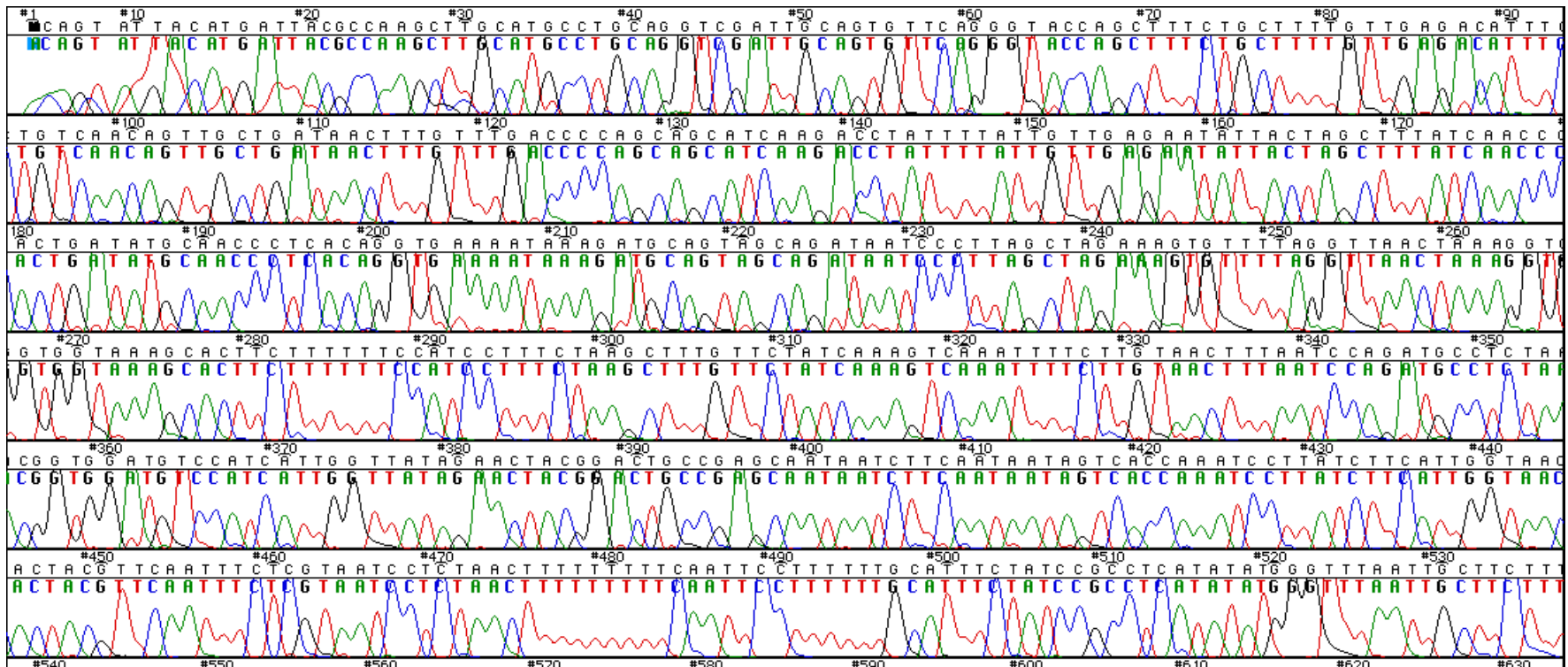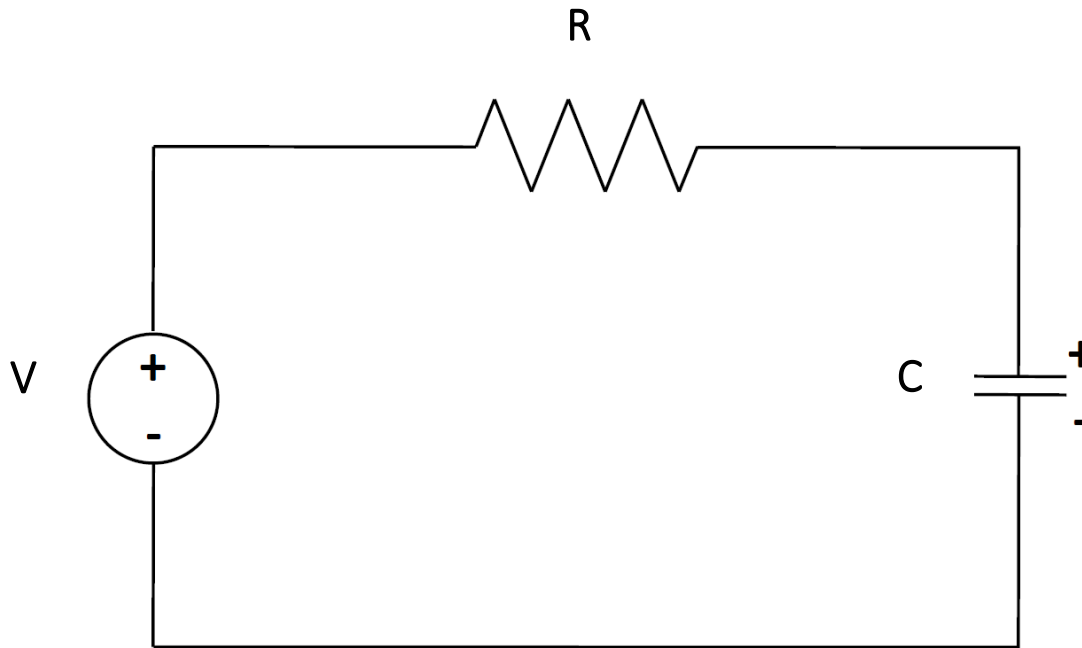

From University of Chicago:
http://cancer-seqbase.uchicago.edu/

Digital Signal Processing

- **Question:** What is a **system**?

Digital Signal Processing

- **System: circuit**

Digital Signal Processing
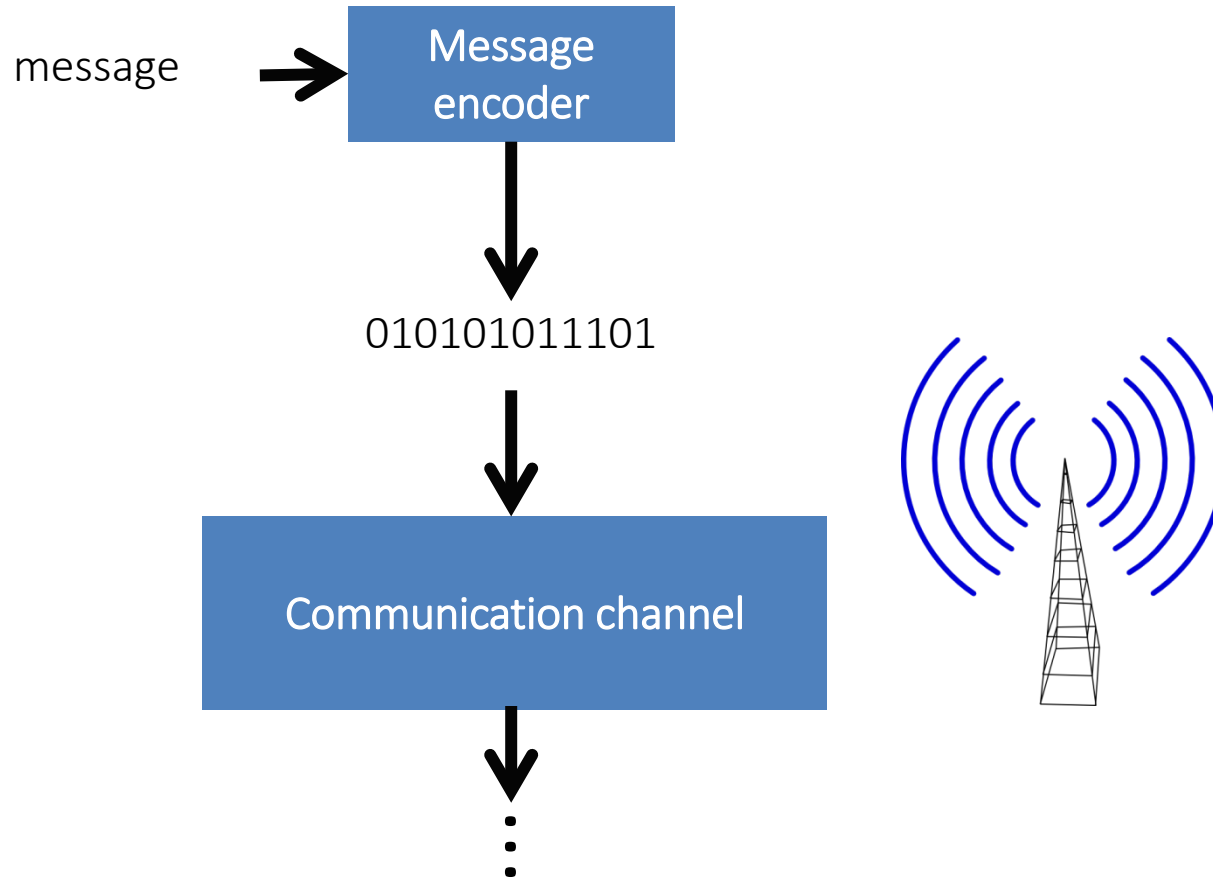
- **System: stock market**

Google
NASDAQ: GOOG - Aug 18 7:24 PM ET

582.16 ↑8.68 (1.51%)
After-hours: 583.58 ↑1.42 (0.24%)

| 1 day | 5 day | 1 month | 3 month | 1 year | 5 year | max |

Open	576.11		Market cap	391.36B
High	584.51		P/E ratio (ttm)	29.51
Low	576.00		Dividend yield	–

Google Finance - Yahoo Finance - MSN Money   Disclaimer

■ **System: communications**

message →

Message encoder

↓

010101011101

↓

Communication channel

⋮

Lecture 1: Motivation,   Policies , DSP

Foundations of Digital Signal Processing

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Digital Signal Processing

- **Question:** Where do we encounter digital signal processing in real life?

Applications of Signals and Systems

- **Signal / Array Processing** (what is the signal? what is the system?)

https://www.youtube.com/watch?v=GQu6_MjDwcU

■ **Speech Processing** (what is the signal? what is the system?)

https://www.youtube.com/watch?v=80Z7zUpB-ig

Lecture 1: Motivation,   Policies , DSP

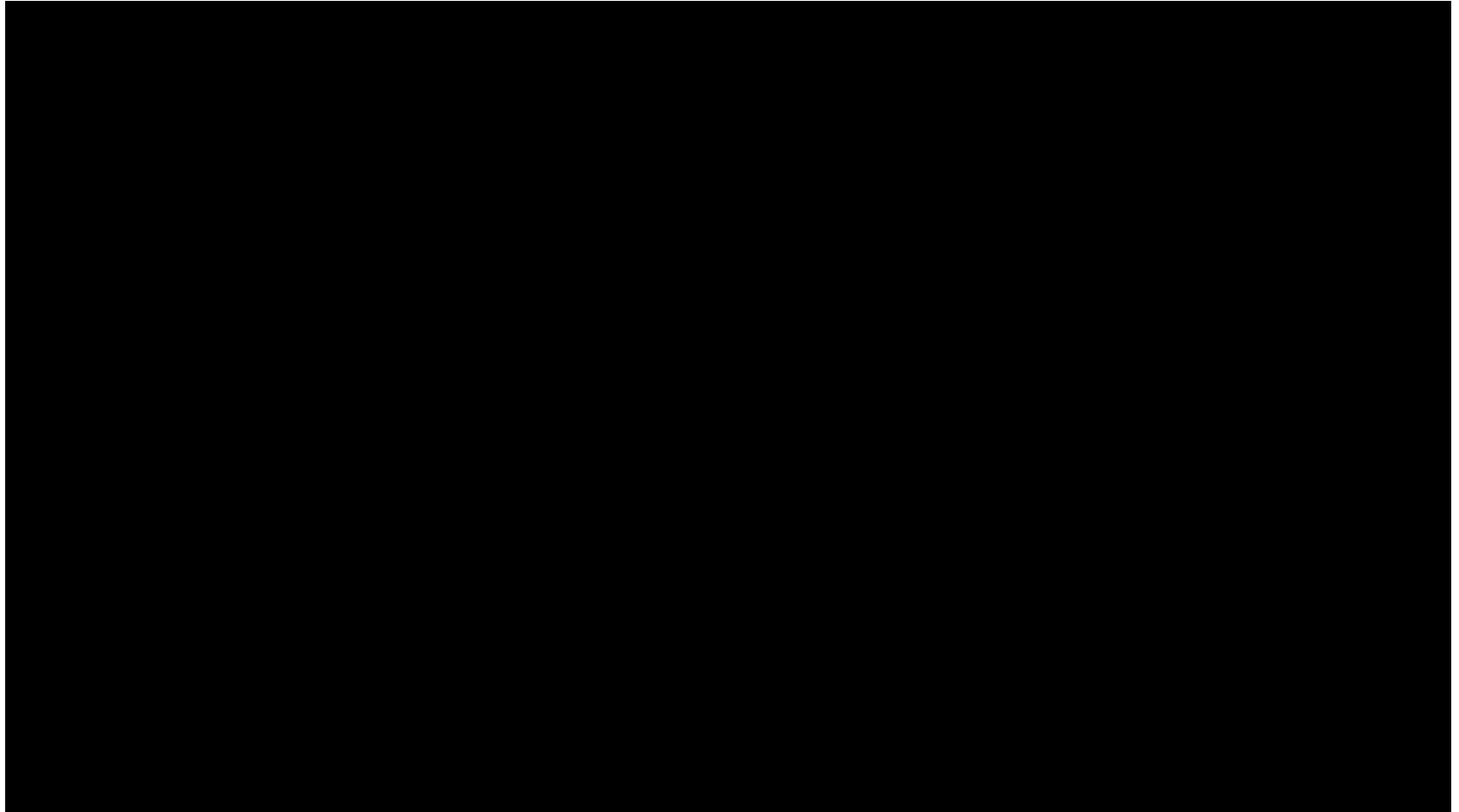Foundations of Digital Signal Processing

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What we learn in EEL 5525

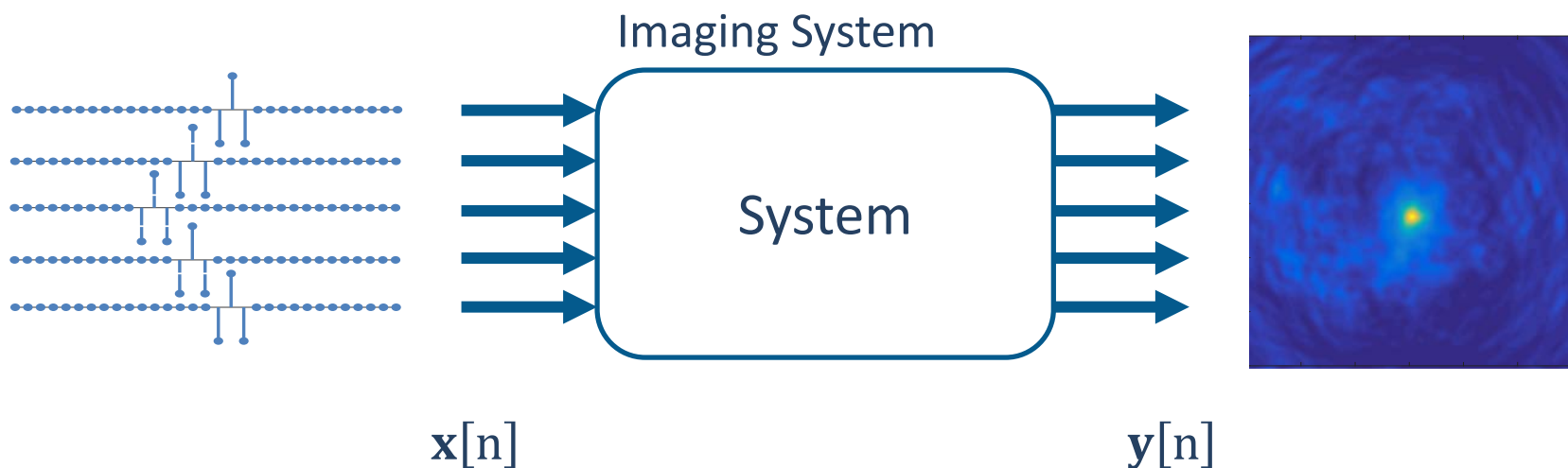- **Foundations of digital signal processing**

  - *Analysis* of signals and systems

  - *Design* of signal processing systems

  - Mostly deterministic signals

  - Mostly single input, single output systems

Edge Detector

System

$x[n]$ $y[n]$
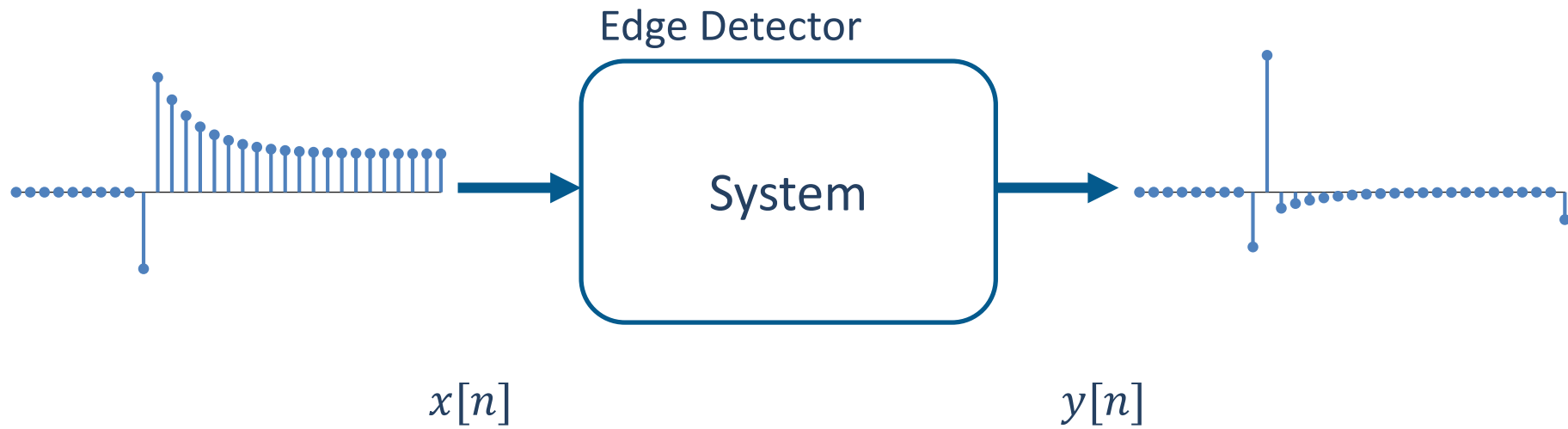
What we learn after EEL 5525

- **What do more complex courses cover?**

  - Advanced signal processing system *design*

  - Random / stochastic signals (noisy – i.e., realistic) [**applied statistics**]

  - Multiple inputs, multiple outputs [**applied linear algebra**]

  - Adaptable / learnable [**machine learning**]

Imaging System

System

$\mathbf{x}[n]$

$\mathbf{y}[n]$

What is related to this course?

EEL3135
Introduction to Signals and Sys.

EEE4511C
Real Time Digital Signal Proc. App.

EEL4516
Noise in Devices and Comm. Sys.

EEL4540
Introduction to Radar

EEL4750
Found. Digital Signal Proc.

EEL4598
Computer Communications

EEL4610
State Var. Methods in Linear Sys.

EEL4657C
Linear Control Systems

EEL5406
Computational Photography

EEE5544
Noise in Linear Systems

EEL5840
Fundamental Machine Learning

EEL5934
Neural Signals, Systems, and Tech.

EEE6504
Mach. Learn. for Time Series Anal.

EEL6507
Queueing Theory / Data Comm.

EEE6512
Image Proc. / Computer Vision

EEL6535
Digital Communication

EEL6617
Multivariable Linear Control

EEL6814
Neural Net. and Deep Learning

EEL6935
Big Data Ecosystems

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Advanced Design   **Applied Statistics**

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Advanced Design   **Applied Statistics**   **Applied Linear Algebra**

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Advanced Design   **Applied Statistics**   **Applied Linear Algebra**   **Machine Learning**

Example Advanced Topics
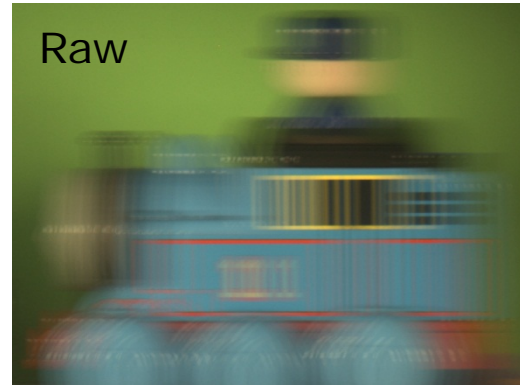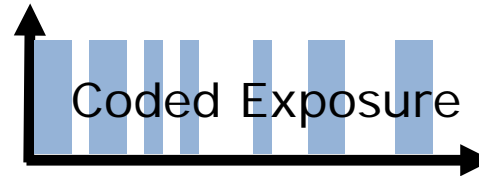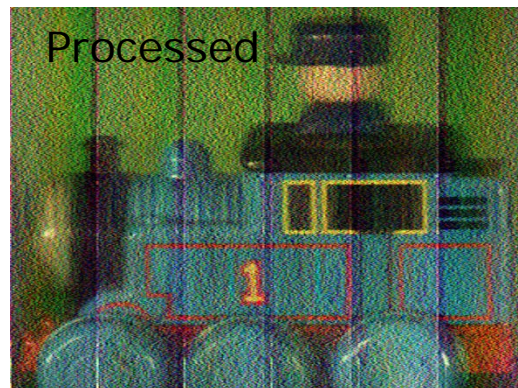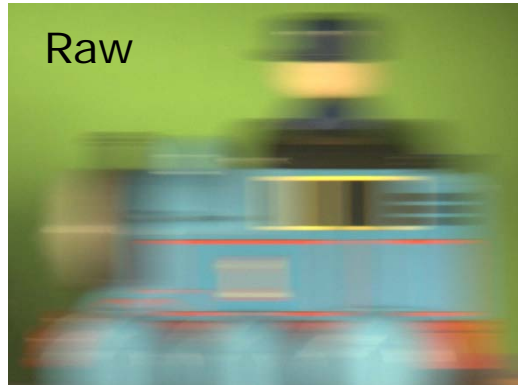
- **Example Advanced Topics**

  - Statistical estimation of quantities and detection of events

Example Advanced Topics

- **Example Advanced Topics**

  - Modern signal processing
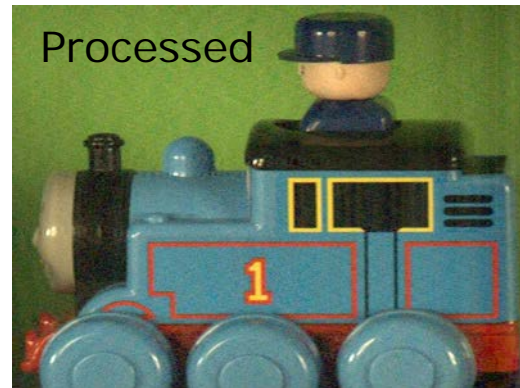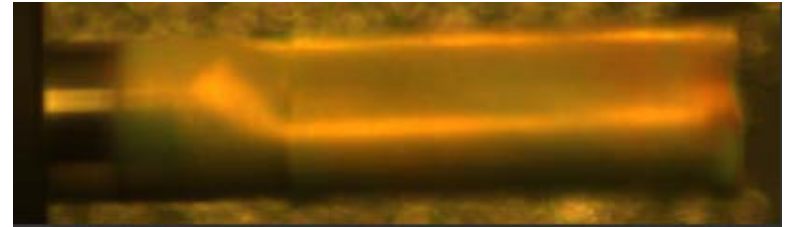
Example Advanced Topics

- **Example Advanced Topics**

  - High speed video from normal speed cameras
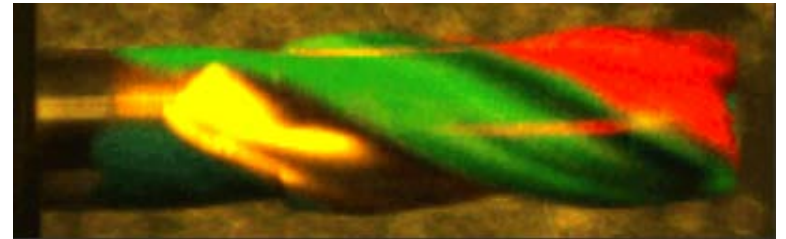
    Normal video at 25fps

    Compressively sampled
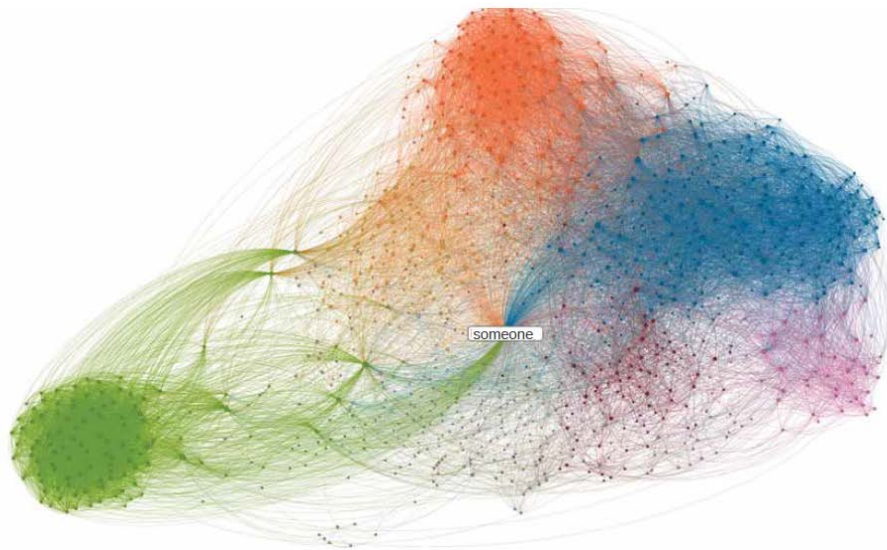   video at 25fps

    Recovered video at 2000fps

From:
A. Veeraraghavan, D. Reddy, and R. Raskar, "Coded strobing photography: compressive sensing of high speed periodic videos," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 33, no. 4, pp. 671–686, Apr. 2011.
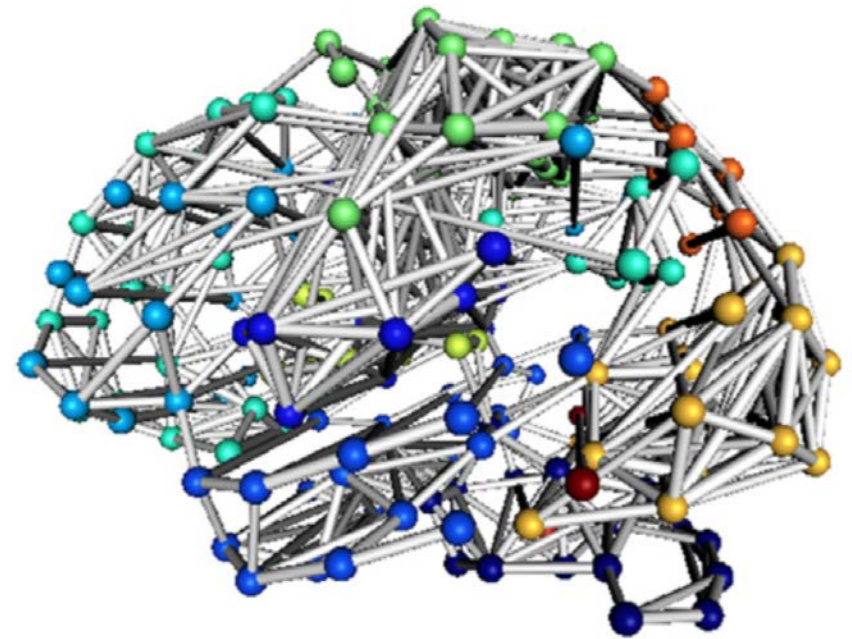
Example Advanced Topics

- **Example Advanced Topics**
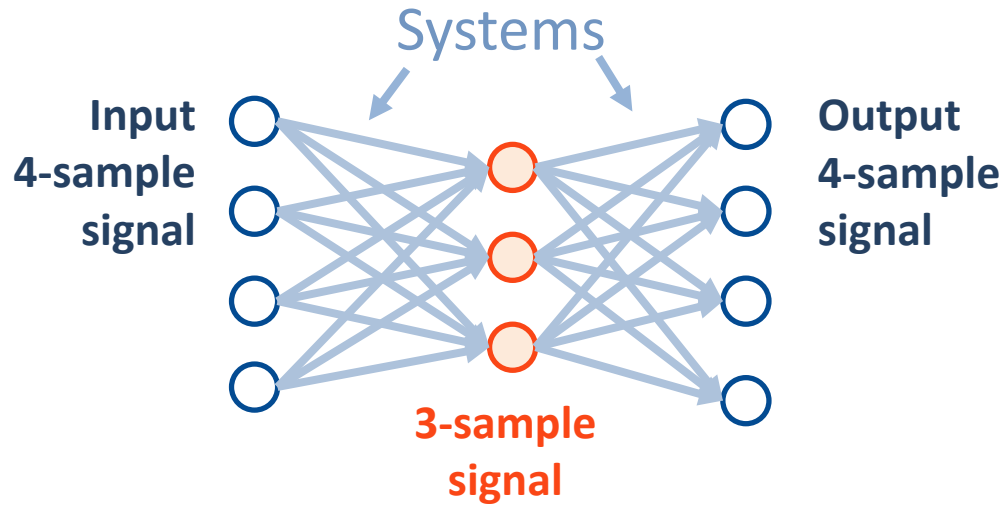 - Modern signal processing
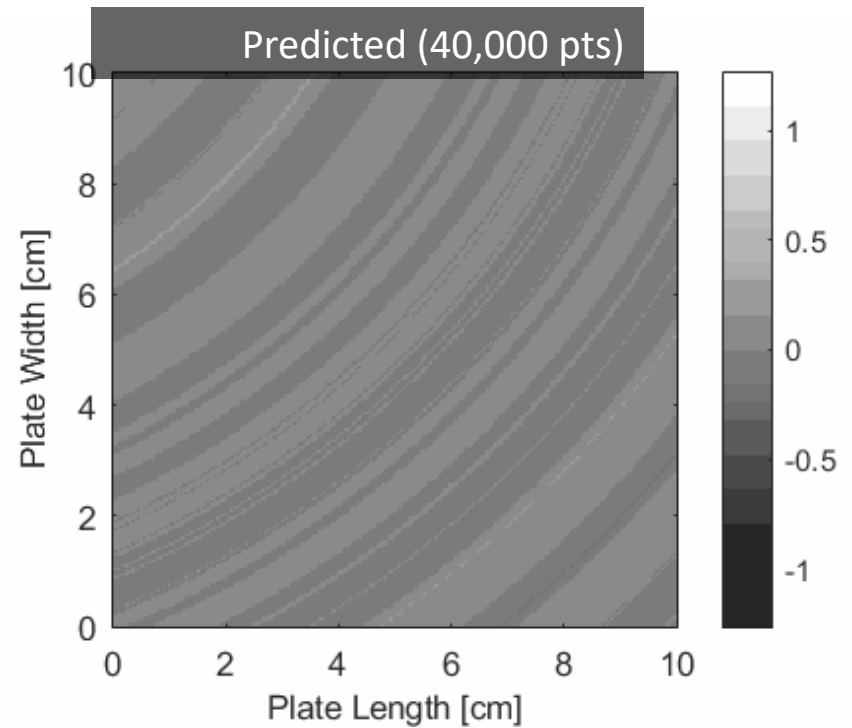

Social Network

The Brain

Example Advanced Topics

- **Example Advanced Topics: Neural Networks**

Systems

Input
4-sample
signal

Output
4-sample
signal

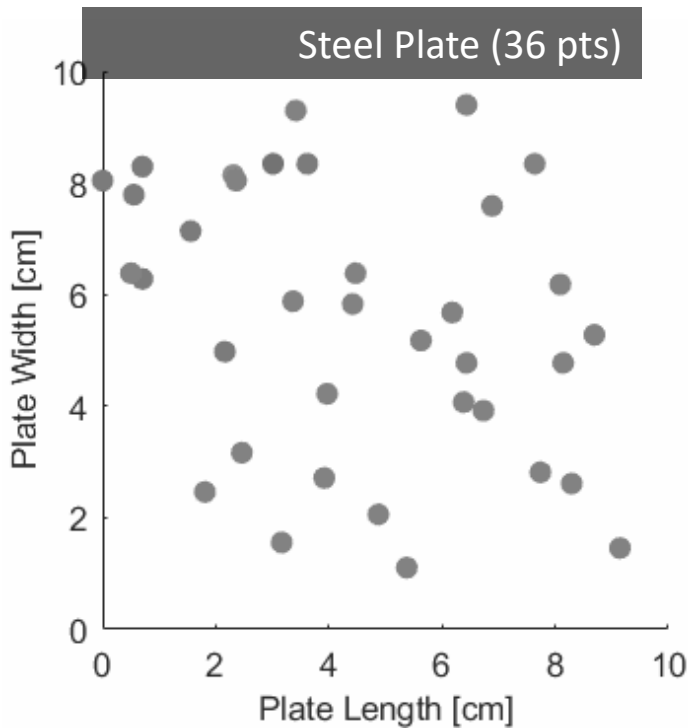**3-sample signal**

R. Zhang, P. Isola, and A. A. Efros, "Colorful Image Colorization," *arXiv [cs.CV]*, 28-Mar-2016.

My Research: Learning About Waves

Lecture 1: Motivation,   Policies , DSP

Foundations of Digital Signal Processing

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Syllabus

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Tips for Success

- **Just keep swimming**

  - *All* exams can be retaken and scores improves

  - Turn in all homework

  - Turn in all coding assignments

  - **Remember:**

    – A score of a 60 is infinitely better than a score of a 0

- **Use your resources intelligently**

  - Examples problems in class

  - Notes will be posted online

When life gets you down, you know what you gotta do? Just keep swimming, just keep swimming.