EE-125:
Digital Signal Processing
Lecture 1

Professor Tracey
Fall 2017

Tufts

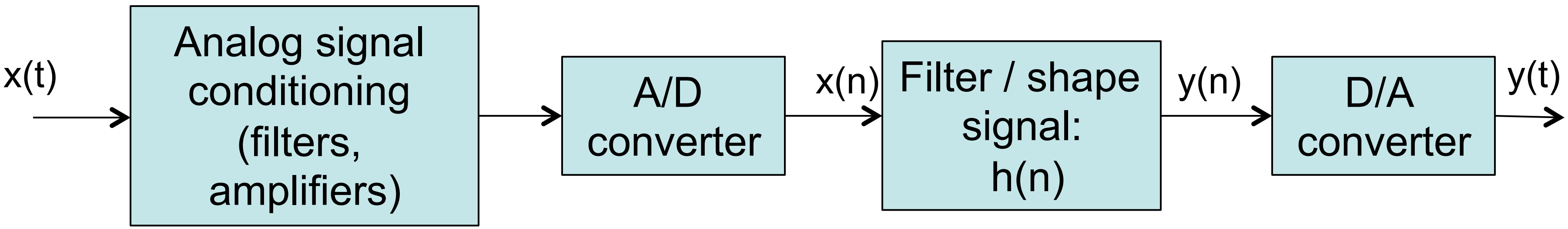
Today's Outline

- Welcome to EE-125!
- Class goals and overall structure
- "Mechanics" of the class
- Preassessment (ungraded, 20 min quiz)
- Start review of LTI systems

Introductions

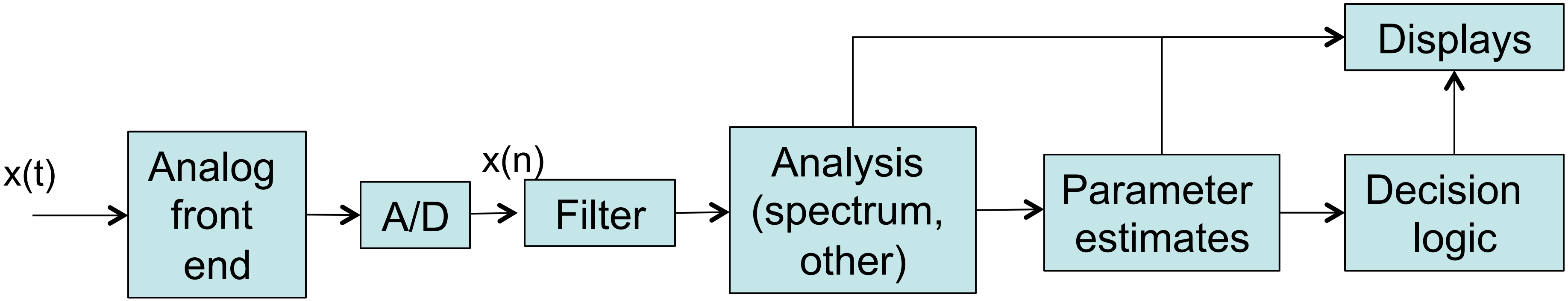
- My background:
  - ECE Professor of the Practice, joined Tufts in February 2011
  - Physics BA, grad school in acoustics / signal processing
  - Industry background: acoustics consultancy, Lincoln Lab, medical device DSP, pharma/startups consulting
- Yun Miao (ECE PhD student) will be TA

DSP applications: modifying a signal



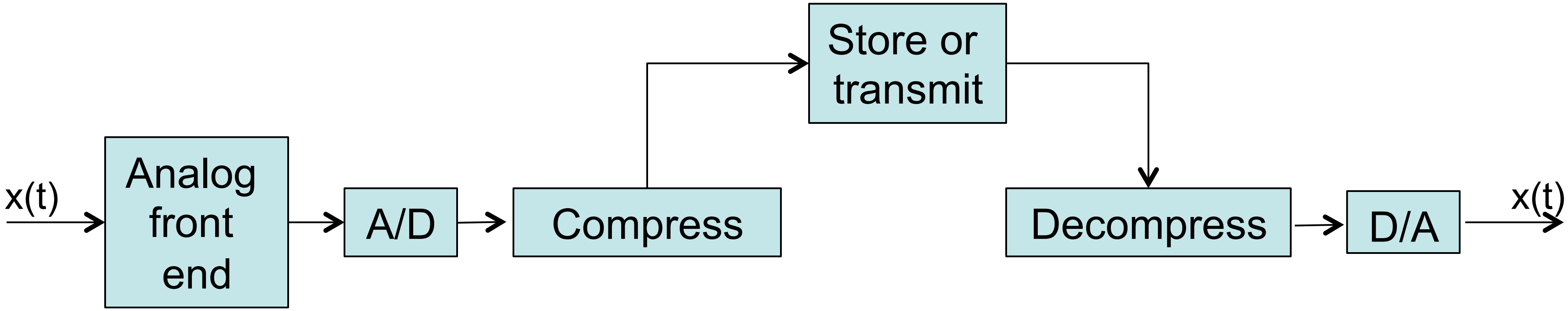
- Examples: a) audio effects, b) selectable filters for med devices
  - DSP can never replace good analog systems, but it can add flexibility and/or reduce cost
- For this type of application, our **course goals** are to understand:
  - How systems (analog or digital) can distort the signal, and how to compensate for distortion
  - What types of filters it is possible to create
  - How to correctly do sampling (A/D) and reconstruction (D/A)
  - Computational complexity, especially for real-time uses

DSP applications: signal analysis (no D/A!)



- Here, the output is either a display (for analysis by human), an automated decision/measurement, or often both
- Examples: a) patient monitors, b) airport screening systems, c) data analysis for scientific research
- For this type of application, our **course goals** are to understand: Everything from the last slide, + spectrum estimation
- A lot of analysis is application-specific
- Uses tools (detection theory, classification) from other courses

DSP applications: data compression



- Data compression / reconstruction has a huge impact on our daily (digital) lives: mp3, jpeg, jpeg2000, mpeg, streaming video…
- In this class we will develop the foundations for digital compression – we'll do a Matlab (or Python!) project on this

Class structure

- Detailed syllabus and schedule on Trunk site
- Topics and goals
  - Solidify / review fundamental concepts (2 weeks)
  - Detailed study of linear systems, including phase response and distortion (2.5 weeks)
  - DFT, FFT, related transforms, and their application to fast filtering (1.5 weeks)
  - Spectrum analysis (2.5 weeks)
  - Digital filter design (2.5 weeks)
  - Some advanced topics as time allows

Our main goals

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Today's Outline

- Welcome to EE-125!
- Class goals and overall structure
- "Mechanics" of the class
  - Stuff I'll talk about today
  - Things you can read later
- Preassessment
- Start review of LTI systems

Assumed background knowledge

- No firm pre-requisite – but EE-23 or equivalent (I need to make this clearer on SIS)

- I assume that you:

a) can write Matlab code (Python OK – let's talk)

b) have had a linear systems class like EE-23

– Assume you have seen convolution, Fourier transforms of various flavors, ideally sampling and reconstruction

– Talk to me if you are concerned

Textbook and other references

- Textbook: Proakis & Manolakis
  - Copy on hold at Tisch
- The other classic book: Oppenheim and Schafer. Very good, especially for spectrum analysis.
- There is a nice set of DSP videos by Barry Van Veen (UW– Madison) at https://www.youtube.com/user/allsignalprocessing with ***mostly*** the same notation, etc. as EE-125
- Several other references are listed in the syllabus.
  - www.dspguide.com
  - For Matlab help / insight, look at Computer Explorations (~$20 used)

Class and Office Hours

- *Proposed* prof office hours: ideally not Thurs / Friday
  - Monday 11-12 am, Halligan 202C
  - Tuesday afternoon? 12-2 pm, Halligan 202C

- TA office hours TBD

- Please make an appointment ahead of time if you'd like to talk privately (for example, about grades)

- I'll answer emails / Piazza outside of office hours

Assignments and grading (see Trunk syllabus for details)

- Details are on syllabus…. See Trunk, esp. academic integrity
- Homework (10% of grade)
  - Due next lecture (except when there is a test)
  - Solutions available before next quiz or test
  - 1 late homework pass/semester
- Matlab projects (6 projects, 35% of grade)
- Quizzes (2 total, 15% of grade)
- Exams (3 total, 40% of grade). Note – no final.
- Late Matlab projects will be penalized at instructor's discretion, up to 100%

Option: design your own final Matlab project

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Matlab / implementation projects

- Please submit electronically
  - PDF on Trunk on Turnitin (details to follow)
  - Perhaps some auto-grading.. TBD
  - Some homework may include a little Matlab work. For those, we'll decide electronic vs printout case-by-case
- Carefully read the syllabus on Matlab projects
  - Well labeled plots
  - Writing matters! Clear discussions
- List your collaborators – collaboration means discussion/troubleshooting. Each student should write his/her own code. See Trunk for discussion

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Complex numbers review

- See info under Lecture 1 on Trunk – sample problems (not required, but take a look)

- Lots of helpful review info on-line

https://youtu.be/a_zReGTxdlQ (Khan Academy, sadly)

https://youtu.be/UAn9uah7puU (van Veen, complex #'s)

https://youtu.be/GhhRIjMywu0 (van Veen, complex sinusoids)

DT system properties and concepts

- The big two: "LTI" systems are **L**inear and **T**ime-**I**nvariant (also called *shift-invariant*)
- Causal: current output depends on past and current inputs
- BIBO stable (bounded input gives bound ed output)
- Concept: the impulse response h(n) is the response of the system when the input is an impulse, d(n)