Review for MIDTERM 3
Week 7.
Dr. Gary Cottrell -
The introduction to Neural Networks we all need!

Neural Networks
Week 6 - Lecture 16 - Dr. Mary ET Boyle
I Think Therefore, I AI

Neural Network Models
Week 7 - Lecture 17 - Dr. Gary Cottrell
Visual Procension and Neural Nets

lecture notes
BIOLGICAL INSPIRATION

Neuromorphic technology is based on neurons and neural circuits in the brain. Like the brain, it uses much less power than standard computer chips.

**Synapses**
Each neuron has about **10,000** of these tiny junctions, which receive signals in the form of voltage spikes coming in from other neurons.

**Connections**
Each emulated neuron receives signals through **several thousand** of these links, which are often much simpler than biological synapses.

**Neuron cell body**
In both real neurons and neuromorphic versions, voltages and currents vary smoothly rather than jump in digital fashion from one discrete value to another.

**Emulated neuron**
Both real and emulated neurons add up, or integrate, incoming signals until they pass a threshold and 'fire', producing an outgoing series of voltage spikes.

**Axon**
This fibre, which can be up to 1 metre long, transmits the voltage spikes to other neurons.

**Wire**
This mimics the axon, and carries the voltage spikes to other emulated neurons.
2. What is a ‘theory’? What is the relationship between “models” and “theories”?

- Theories are high level descriptions of behaviors
  - Not explicit about the underlying processes involved
  - Difficult to reason about them
  - Hard to make quantitative predictions using them
- Using machine learning methods, people can build models without theories and algorithms
• In Natural Neural Networks:
  ○ Input signal from dendrites (weighted) - Soma integration - Output signal to axons
• In Synthetic Neural Networks:
  ○ Weighted Input -> integrated -> output
  ○ Use of the sigmoid function to integrate input potentials.
3. What are the three types of learning presented in lecture?
   - Habituation, sensitization and conditional learning
   - Donald Hebb’s Hebbian law: “Cells that fire together, Wire together”

4. What is the limitation of Perceptrons?
   - The perceptron can only divide inputs into two categories, those that are above threshold and those that are not
   - Cannot be applied to linearly non-separable data
     - Boolean XOR problem
Week 8.
Dr. Gert Cauwenberghs - Neuromorphic Microchips

Neuromorphic Engineering
Week 8 - Lecture 19 - Dr. Mary ET Boyle
Primer on Neuromorphic Engineering

Reverse Engineering in Silica
Week 8 - Lecture 20 - Dr. Gert Cauwenberghs
Reverse Engineering the Cognitive Brain

read
2. In the videos that Dr. Boyle played in class, how could those robots achieve such a level of robustness?

"Our long-term goal is to make robots that have mobility, dexterity, perception and intelligence comparable to humans and animals, or perhaps exceeding them; this robot is step along the way."

-Marc Raibert, Boston Dynamics
3. What is von Neumann architecture? What units does it have?

- Control unit
- Logic unit
- Memory unit
- Input/output mechanism

4. Understand how a biological brain differs from von Neumann architecture from different levels.

The brain ≠ von Neumann architecture.

<table>
<thead>
<tr>
<th>Logic core (CPU)</th>
<th>Biological systems are completely different!</th>
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</thead>
<tbody>
<tr>
<td>Sequential operations on stored data</td>
<td>Distribute computation and memory</td>
</tr>
<tr>
<td>Data and instructions are represented in binary.</td>
<td>Use 'noisy' processing units (neurons) – using spikes</td>
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<td></td>
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<tr>
<td>VS.</td>
<td>Highly interconnected with thousands of synapses</td>
</tr>
<tr>
<td></td>
<td>Organized hierarchically, modularly and functionally</td>
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</table>
4. Processing unit

Is there a limit to how small the transistors can get?

Gordon Moore predicted that you would get more and more transistors on a processing chip—an exponential relationship every two years.

Reduce the size of transistors!
9. How semiconductors work?

- Most semiconductors are made of Silicon
- Silicon is a very common element, but very unique.
- Look silicon up in the periodic table:
  - It sits next to aluminum, below carbon and above germanium.

- **N-type** - In N-type doping, phosphorus or arsenic is added to the silicon in small quantities. Phosphorus and arsenic each have five outer electrons, so they're out of place when they get into the silicon lattice. The fifth electron has nothing to bond to, so it's free to move around. It takes only a very small quantity of the impurity to create enough free electrons to allow an electric current to flow through the silicon. N-type silicon is a good conductor. Electrons have a negative charge, hence the name N-type.

- **P-type** - In P-type doping, boron or gallium is the dopant. Boron and gallium each have only three outer electrons. When mixed into the silicon lattice, they form "holes" in the lattice where a silicon electron has nothing to bond to. The absence of an electron creates the effect of a positive charge, hence the name P-type. Holes can conduct current. A hole happily accepts an electron from a neighbor, moving the hole over a space. P-type silicon is a good conductor.
Week 9.
Dr. Jim Hollan-
Activity Enriched Computing.
1. According to Dr. Hollan, what differentiates those that make significant contributions from those that don’t?

- Expectations
- Neglect unimportant things
- Do what you love and love what you do
- Be careful about your commitment but when you do commit \textit{really} commit
- Be intentional about the people you spend time with
  - “You’re the average of the 5 people with whom you spend the most time”
    - Jim Roan (some motivational speaker)
- Think important thoughts
2. According to Dr. Hollan, for what does computation provide the most plastic medium?

Computation provides the most plastic meta-medium for representation, interaction, and communication we have ever known. It can be used to:

- Create new media and modify the form of existing media
- Mimic existing media
- Model
- Provide virtual worlds
- Combine the real and the virtual

“The computer is the first meta-medium, and as such it has degrees of freedom for representation and expression never before encountered and as yet barely investigated.” — Alan Kay
2. What are the processes of human centered design? What is the meaning of each step?

- Needfinding
- Storyboarding
- Paper Prototyping
- Mockups: Visual Design
- Interactive Prototypes
- User Testing
- Online Experiments
- Final Web/Mobile App
3. How should one build a good design portfolio?

**Basic:**
- Personal Website
- Class projects
- Willing to help!
- Part-time job
- Intern

**Advance:**
- Have a compelling and fresh point-of-view
- Justify and critique your own process
- It's ok to show how you improved a product, not necessary to create one
- Emphasize most relevant projects
Week 9.
Dr. Benjamin Bergen -
What Profanity Teaches Us
About Ourselves

Profanity
Week 9 - Lecture 23 - Dr. Ben Bergen
Profanity and the Brain

lecture notes
1. The most offensive word in English language belongs to what category? Where did the ranking/data came from (or; how was the ranking/data obtained)?

(W)estern
(E)ducated
(I)ndustrialized
(R)ich
(D)emocratic

WEIRD

(Henrich, Heine and Norenzayan, 2010)
2. What’s the relationship between profanity and word length?

**English Orthographic Word Length**

Four-letter word acts as a substitution of profane
5. Know the described cross-cultural differences with regards to profane words.

Cultural differences
- Profane words are related to cultural relevant taboos
- Can be copulation, social minority, body parts, and religion
- Japanese don't really have a profane word e.g. "Baka" means fool

バカ野郎!!
7. Know the theories of speech errors described by Dr. Bergen.

- Freudian slip: Errors may reflect otherwise unstated and repressed thought
- If this is true, speech errors should be more likely to result in taboo language than not.

![Graph showing number of errors]

9. What is Automatic Aphasia? What is Coprolalia? Know the symptoms of these deficits.

**Automatic aphasia**
“could not provide the correct expletive for situations described to him nor could he complete a curse”

Speedie et al., 1993

**Coprolalia**
Characteristic, attested phrases (Lanscher & Cummings, 1999)

fuck, shit, cunt, mother-fucker, prick, dick, cocksucker, nigger, cockey, bitch, pregnant-mother, bastard, tits, whore, fu . . ., doody, penis, queer, pussy, coitus, cock, ass, shi . . ., bowel movement, homosexual, screw, fag, faggot, schmuck, blow-me, wop, God damn it, damn fool, fuck my your, fucking, fucking, cunts, fuck, shit, ass, bitch, cock, fart, suck, you fucking idiot, asshole, fuck you, shit on you, fucka, fu . . .
Week 10.
Dr. Brad Voytek -
The Unreasonable Effectiveness of Data.

Data Science
Week 10 - Lecture 24 - Dr. Brad Voytek
Introduction to Data Science

read

lecture notes
What is data science?
What is cognitive science?
What is “cognition”?
What is the link between data science and cognitive science?
Why did Voytek create branScanR? What did he do?
How does UBER make use of data? What predictions can be derived from data collected? How does that impact and inform their business model?

Discuss the merits associated with Google Translate? What makes it work well? What are the weak points?
Discuss the scale and quantity of data gathered on Facebook and other social media.
What are n-grams?
What is the Semantic Web? What are ontologies?
Compare and contrast the Brown Corpus with the Google Corpus. Why is “big data” so powerful?
THANK YOU FOR A GREAT QUARTER.

* Some final thoughts:
MIDTERM3 - FRIDAY MARCH 16, 2018

• 10:00 -- 10:50am
• Sleep well and study hard.