CGSC 1001: Winter 2016 Midterm Review

Lecture 2: Learning, Memory, Representation

Cognitive System:

- Cognitive System An agent perceives the outside world around that agent
- Perception Phase Turns things from the environment into meaningful internal representations
- Action Phase Turns these perceptions into a physical change on the environment

How the animal and human mind works:

- Human mind: perceiving the outside environment by using their sensory organs (eyes, ears, nose, senses on their skin)
- Once processed these perceptions are turned into actions using our bodies (these actions are meaningful physical changes on the world)

How the "robotic" mind works:

- Similar to the human mind as they still perceive and process information in order to produce and action
- Instead of sensory organs and a body, robots use sensors and actuators
- Perceives the world using sensors to understand the environment around them
- Example: Light sensors to help perceive light inputs
- Using the information taken and perceived by their sensors robots then perform and output using actuators which come in many different forms
- Example: an automated vacuum which uses its sensors to navigate around in order to clean

How a disembodied system works:

- Functions much differently than the other cognitive system as it requires a user input in order to work rather than seeking out information within the outside world
- When a disembodied system is perceiving information it updates its database
- Rather than performing an action it takes the information from the updated database and returns a display back to the user

Distributed Cognition:

- Belief that information is not only embedded within an individual but in both their social and physical environment
- Perception happens through both sensory organs in humans and sensors in robots in agents and artifacts

- Actions happen through using both the body and actuators

Cognition as a manipulation of representations:

- When an animal or robot sees something, it activates neurons/pixels which hold location coordinates much like a grid that help us process the image for what it is

How does the Human memory remember facts & perceptions - NOT skills:

- **Sensory memory:** like a scratchpad where memories can be overwritten with new memories, this scratchpad is re-written every few seconds.
- **Short-term memory:** like a temporary storage of memories, some things from your short-term memory end up in your long-term memory.
- **Long-term memory:** Memories in your long-term memory are stored here forever although we might have difficulty retrieving these memories.

What is Learning and the different kinds of learning:

- **Learning:** Defined as changing memory to prepare a mind for better action in the future
- Example: Studying for my “mysteries of the mind” final at 2:34 am on a Friday night

Learning includes:

- **Habituation:** The reduction in a behavioural response with repeated exposure to a particular stimulation – Example: Someone screaming and you are shocked the first time but as they scream more and more your reaction starts to diminish and you become less shocked as it happens
- **Sensitization:** The increase in a behavioural response with repeated exposure to a particular stimulation – Example: Someone having barbeque sauce for the first time, as they have barbeque sauce more often they become hooked on barbeque sauce
- **Classical conditioning:** Learning from associating two previously unrelated stimuli – you react similarly to “stimuli A” as you would for “stimuli B” – Example: Dog and a leash … the dog starts to associate grabbing the leash with a walk even though they are not definitely related to one another as you could be just moving the leash off the table
- **Practice:** Repeated action of doing something over and over again and learning how to do that particular task better. Practice can use both reinforcement and punishment in order to perfect the skills – Example: Play is theorized to be a form of practice among children for future events such as running, fighting, or caretaking when children play “house”. Motor skills become more efficient over time due to automatization

- **Imprinting:** Time sensitive learning within animals where they believe that a different entity plays the role as their parental figure
- **Observational training:** Watching what other people are doing and copying them – Example: watching how to cook on YouTube
- **Testimony:** Someone telling you something, this can be auditory or read, typically university learning is testimonial
- **Cultural:** 3 types of cultural learning
  1) Conformist Bias: do what everyone else is doing
  2) Prestige Bias: do what the most successful are doing
  3) Content Bias: do what the best idea is

Lecture 3: The Cognitive Level
What are productions and what do they do:
- Little information processing rules that are fired by the mind when it wants to do something
- Example: If you are hungry, and you see food, then you will eat the food
- Productions affect us when something good/bad happens, those productions used to reach that state will be made more/less likely to happen again in the future

Learning at the biological level – synapses and synaptic change:
- **Synapses:** the space between neurons where communication happens
- **Hebbian Theory**: neurons that fire together wire together meaning that synapses becomes more effective with repeated use
- This idea of synapses is how associations are learned since these neurons coactive with one another

Learning at the chemical level: synaptic change in taste receptors:
- At the chemical level some of the learning occurs in the form of synaptic change
- As you age, your taste receptors change too – learning how to tolerate bitter foods which explains why kids are often nauseated by the bitter foods that adults tend to enjoy

Learning at the physical level – a bad level for description:
- The physical level is a poor level for the description of leaning

How to tell if a level is legitimate:
- If we can make successful casual predictions using the ontology of that level
- **Ontology:** a set of things that is said to exist

Why are Scholars dismissive of the levels above the one they work – Reductionism:
- They believe that the regularities found at higher level are or will be deducible from lower-level regularities

- This is a form of reductionism

Why do we need the Sociological Level – Group Behavior Phenomena:

- It helps describe certain group behaviours such as strikes, which otherwise would be difficult to do on an individual basis

Why do we need the Psychological level – Influences of social context:

- In addition to the sociological level to help explain behaviors that are not influenced by their social context
- We need it in addition to the cognitive level since it is a place for non-causal statistical models

Why do we need the Cognitive level – Information Processing Level:

- It acts as an explanation for certain behaviours that need the language of information processing otherwise it would be to vague
- Both mental states and processes are defined functionally not anatomically.

Why do we need the Biological Level:

- Sometimes the biological structure influences behaviours in particular ways that the cognitive level cannot explain.
- Certain brain structures appear to be used in different ways chemically

Why do we need the Chemical Level – The effect of drugs:

- It helps describe certain behaviours particularly with people who are under the effects of drugs
- Physics don’t tell us much about human behaviour

Proximate and Ultimate Description in Cognitive Science – Why do we eat:

- **Proximate:** we eat because we enjoy the taste of food and it satisfies our hunger
- **Ultimate:** we eat because we need the nutrients and it is necessary for survival

The Cognitive level – Information Processing Level:

- Cognitive science prefers descriptions of information and how it is represented and changed
- Example: a theory cognitive scientist has come up with that individual memories have certain “activation levels” that determine how easily that memory can be accessed

Lecture 4: The Fields of Cognitive Science:

- Cognitive science composes of **three (3) different fields**:

1) Historically core fields
2) Contemporary fields
3) Secondary fields

Historically Core fields of Cognitive Science:

- The historically core fields of cognitive science composes of

1) Psychology
2) Computer science
3) Linguistics
4) Philosophy

Historically Core Fields – Psychology:

- Psychology is characterized as the study of natural minds, mostly human
- Psychology is also broadly interested in cognitive functioning, even when it is erroneous (which means it is wrong)
- Methods in studying psychology include laboratory experiments, statistical analysis, and computer cognitive modeling

The subfields of psychology include:

- **Cognitive psychology:** broad field of basic research in human internal mental processes
- **Human factors/human-computer interactions:** how humans interact with human-designed artifacts such as user interfaces
- **Evolutionary psychology:** how our evolutionary history has made our minds what they are
- **Psycholinguistics**: the study of language with experiments
- **Comparative psychology:** compares animal cognition to humans

The critiques of psychology include:

- There isn't enough model building, which means we cannot play 20 questions with nature and win as we don't know the answers
- Dustbowl empiricism: there isn't enough theory in psychology as there are not theoretical psychologists
- Methodologically limited – cognitive science is made possible since psychology refuses to embrace the methods of other fields
- Underestimation of the complexity of language, psychology is naive to the several complexities that are present in language
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Historically Core Fields – Philosophy:

- Psychology is characterized as the study of big questions such as what the concepts in life mean… Aside from this philosophy is quite broad

- Methods in studying philosophy include traditional thinking and writing as well as thought experiments, conceptual analysis, argumentation, and theorizing from evidence from other fields and common sense observations

The subfields of philosophy include:

- **Philosophy of the mind example:** which animals feel pain?
- **Philosophy of science example:** how is science practiced today?
- **Philosophy of language example:** how do words connect to have meaning?

The critiques of psychology include:

- They don't spend enough attention to empirical study, they don't look at studies that have been based on actual and objective observations or experiments
- They believe that the existence of a word implies the existence of its intended referent
- They are too concerned with unimportant issues such as why should we care about how unicorns came to be?

Historically Core Fields – Computer Science:

- Characterized as the study of how mental processes can work on machines and as well as how humans can interact with computers effectively
- Methods involved in computer science are typically building and testing computer programs

The subfields of computer science include:

- **Artificial intelligence:** artificial intelligence is building and understanding mental systems
- **Human-computer interaction(HCI):** HCI is designing computer interfaces that humans can effectively interact with

The critiques of computer science in particular artificial intelligence include:

- Insufficiently concerned with natural intelligence, what this means is that AI researchers don't care about if the programs work the same way that people or animals do
- They are overly optimistic about the future of AI, to mimic the basic human functions like picking up an object is very difficult to mimic on a computer program so it will take many years to even master such a basic function

Historically Core Fields – Linguistics:

- Linguistics is characterized as the study of spoken human language or signed natural language
- This does not include computer, animal or written language
- The methods involved in linguistics include sound analysis, grammar creation and corpus analysis
- Linguistics is strongly characterized by both its subject matter and methods

The subfields of linguistics include:

- Phonology: how sounds are organized and used within language
- Morphology: how sounds morph to interact in words to have different meanings
- Syntax: how words are organized within a sentence
- Semantics: the meaning in language
- Pragmatics: how words interact with sentences to change meaning

The Critiques of linguistics include:

- Linguist build models of language but don't know what to do with them after
- Linguist do not attempt to nor are they familiar with other findings about the mind and how it works
- Linguist are only concerned with their part in cognition

Contemporary Core Fields – Neuroscience:

- Neuroscience is characterized as the study of how the brain processes information and creates cognitive processes
- Neuroscience is the biological functions of mental phenomena
- Methods in the study of neuroscience include neuroimaging, single-cell recording and genetic analysis
- Neuroscience overlaps with biology, physiology and psychology

The critiques of neuroscience are:

- Neuroscience underestimates the complexity of language and other thought processes
- Neuroscience cannot shed light on the subjects that other people are interested in
- In neuroscience they tend to be dismissive of other approaches or reductionist
- They lean too far on the nature side of the nature vs nurture debate

Secondary fields – Education:

- Education is characterized as the study of how people, typically children learn
- Education also looks at how to design education to help people learn effectively
- The methods involved in education are naturalistic observations of case studies and empirical studies

The critiques of education are:

- The case studies that are performed in education are worthless or close to it
- Education is applied and cannot or does not tell us very much about cognitive processes as it is the straight application of these processes
- The control studies in education are very poor, due to extreme difficulty and expense
- Education only deals with a single part of cognition

Secondary Fields – Anthropology:

- Anthropology is characterized as the study of social organization and human culture
- The methods involved in anthropology include performing fieldwork, ethnographic observation and interviewing
- There is a strong emphasis on qualitative study in anthropology which means non-numerical studies
- Anthropology includes archeology and cultural anthropology includes cognitive

The critiques of anthropology are:

- Anthropology tends to lean too far onto the nurture side on the nature vs nurture debate
- Research is too qualitative and expensive
- The research found in anthropology is not general enough to be applicable
- They are “splitters” not “lumpers”: Splitters - they characterize and categorize information into subcategories and Lumpers - they generalize and group information into larger groups

Lecture 5: How Cognitive Science Can Help You Get Through School & Learning Disabilities

Learning Styles:

- There are some interesting theories about learning styles, but scientific evidence that people have different learning styles is very weak

- What this means is that some students and teachers are bad at learning and teaching, but it’s not the learning style that affects their ability to learn

Taking Notes:
- Handwritten notes are better than typing notes because it forces the brain to mentally process what you are writing which invokes a deeper thinking process
- You also get more distracted by the web

Multitasking:
- Multitasking is not real, people cannot do it
- When people attempt to multitask they are reducing their performance in both tasks drastically

Writing:
- Writing is key to thinking clearly
- Writing is one of the most important skills to have in university

Where to Study:
- It is better to study in a variety of places as it increases retention of knowledge when studying in multiple environments

Sleep:
- Sleep is necessary for encoding long-term memories
- When you're awake your brain is active, when you’re asleep your mind strengthens the connections to make your mind more efficient

Adults with Learning Disabilities and Effective Study Habits:
The Working Definition of a Learning Disability
- A learning disability is an unexpected academic underachievement
- These learning disabilities affect specific psychological processes
- Specific impairments are associated with dysfunction of the brain
- It is present with you since birth
- It is not primarily explained by cultural, psychosocial, psychiatric factors or lack of educational opportunity
- It is distinct from global learning intellectual impairments
- There is no sign of academic improvement after intervention

Academic Achievement:
Reading:
- These are learning disabilities that are associated with reading: word recognition/phonology (dyslexia), fluency, and comprehension

Math:
- The learning disabilities that are associated with math: Problem-solving, accuracy (computations) and fluency.

Written Language:

- The learning disabilities that are associated with written language are: handwriting, spelling, fluency, written expression – Example: organizing thoughts and the flow of ideas

Oral Language:

- Expressive or receptive
    - Expressive - Effectively conveying thoughts and ideas
    - Receptive - Able or willing to receive something: especially signals or stimuli

Specific Processing Impairment:

Specific Cognitive Weaknesses:

- Visual Processing: Generating, storing, and retrieving images
- Auditory Processing: Processing sounds
- Working Memory: Manipulating information
- Processing Speed: Performing simple tasks quickly

Pattern of Strengths and Weaknesses:

- Essential Features:
    - **a.** Average to above-average intelligence
    - **b.** a specific academic weakness
    - **c.** a specific cognitive processing weakness
    - **d.** there is a meaningful relationship between the cognitive deficit and the academic deficit.

Lecture 6: Cognitive Architectures

What is a Model?

- Across fields, it is a representation of something that excludes unimportant detail and information
- Some examples include:
    - A scale model of a home made of cardboard
    - A categorization scheme for the students in a lecture
    - A simulation of a hurricane

What is a Cognitive Model?

- Typically, a cognitive model is a computer program that models some aspects of thought – Example: it might model how people do categorization or how a mouse learns to navigate a maze
- The model makes predictions that can be compared to data
- If the predictions match the data, it supports the theory underlying the model

What is a Cognitive Architecture?

- A cognitive architecture is a programming environment or set of tools for making a cognitive model
- Typically, it includes constraints on how cognition works in all people - speed of learning and memory retrieval are some examples ignoring cultural and learned aspects
- Making a model in an architecture is easier in some ways and harder in others

Kinds of Cognitive Architectures:

- **Symbolic:** operates at the level of discrete symbols
- **Sub-symbolic:** operates using numbers representations, which in aggregate constitute symbols
- Hybrid symbolic/sub-symbolic
- **Brain:** model cognition at the level of biology, but speak to cognitive issues.

Symbolic Architecture:

- Symbolic architecture refers to the classical view of the architecture of the mind
- In this approach the mind is viewed as a process in which symbols are manipulated
- Symbols are moved between memory stores such as long term and short term memory and are acted upon by an explicit set of rules in a particular sequence

Typical Characteristics of Symbolic Architectures:

- Declarative/procedural memory distinction
- Justification: Henry Molaison and other damaged patients
- Our inability to consciously retrieve and reflect on procedural memories
- Goals are subsets of declarative memory
- Production compilation models automatization

Lecture 7: Perception

- Perception is the process by which an agent interprets and organizes sensations to produce a meaningful experience of the world around them
- From a cognitive science perspective, it means turning information from one form into new and meaningful representations

Typical Sensory Modalities

Physical Signal	Perceptual Modality
Light	Vision

Air Vibrations (Sound)	Audition (hearing) and echolocation
Physical Pressure	Haptics (touch)
Chemicals	Tase and Olfaction (smell)
Body Position	Kinesthetic and Proprioception
Senses in bowel and stomach	Atypical

Human Vision:

- Extra mission Theory: Rays of light emanating from the eye in combination with the light in the world allow us to see
- Intromission Theory: Rays of light reflected from objects into the eye allow us to see

Rods and Cones on Retina:

- Rod: The lightest sensitive photoreceptor cells in the retina used of night vision and peripheral vision
- Cones: There are (3) types of cones that correspond to colours:
- **Short = Blue**
- **Medium = Green**
- **Long = Red**

Depth Perception:

- Size: The bigger it is, the closer that object is to you
- Perspective: Things are smaller on the fovea as they move away
- Occlusion: When something is in front of something else, example that tree is occluding that house
- Texture, Shading, Saturation: The closer things are the more saturated and texture gradient
- Multiple Images: Includes both motion and binocular vision, when we see things move it helps us determine how big it is

Dorsal and Ventral Stream:

- Dorsal Stream: Runs along the top of the brain like the dorsal fin of a shark, it is the “where” pathway.
- It is associated with motion, representation of object location and the control of both sets of arms and eyes
- Ventral Stream: Runs along the bottom of the brain and is the “what” pathway
- It is associated with form recognition and object representation and it is also associated with the storage of long-term memories

How Does Audition Work?

- Audition works by taking acoustical energy which are sound waves and vibrates the eardrum when in the air

- When underwater, it vibrates through your body so that you can hear
- Localization is like depth perception for your ears, and it works by listening to the differentiation between the sounds in your ears to determine where an object is

What is echolocation?

- Echolocation is determining where something is by using echoes and the information they provide. Echolocation is used by both bats and dolphins

Haptics (Touch):

- Haptics is crucial for the manipulation of objects, particularly in combination with proprioception
- We feel through the sensors in our skin
- There are (2) action perceptions going on all the time
    - **i.** Haptics
    - **ii.** Vision

Olfaction (Smell):

- For smell there is no clear energy continuum like there is for sound and light
- Much of what we experience in taste, actually comes from our smell which is why food taste bland when out noses are stuffy

What is the Smelly T-Shirt studies?

- The smelly t-shirt studies were studies that found that based on smell women could detect immune system compatibility, whereas men were able to detect ovulation

What do Animals use Smell for?

- They use it to establish territory
- Sense fertility
- Ant Pheromones

Proprioception, Kinesthesia and the Vestibular System:

- Proprioception: You know where your body parts are without physically seeing them
- Kinesthesia - Knowing how your body moves

What is Phantom Limb?

- Phantom Limb is believing that a missing limb is still there
- Phantom Limb is needed for an artificial limb to be effective

What is interoception?

- Interoception is the perception of bodily functions such as the perception of hunger, need of digestive elimination and heart rate