

CMPE 489/COGS 500: Intro. to Cognitive Science

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Computer Engineering,
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Slides from



Dr. Albert Ali Salah



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Important Dates

Submission deadline:

~~March 15th, 2017~~

EXTENDED:

April 2nd, 2017 (strict)

Author notification:

~~June 1st, 2017~~

DELAYED:

June 6th, 2017 (sorry!)

Camera ready due:

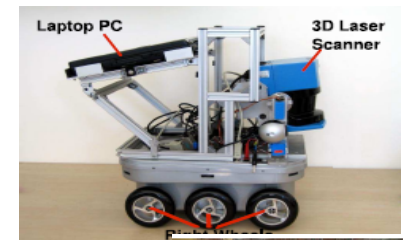
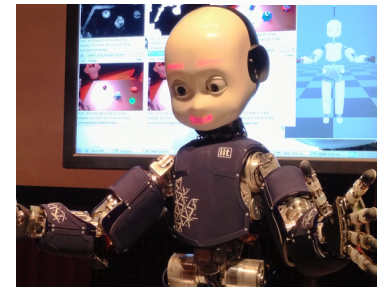
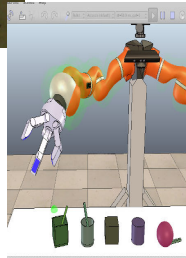
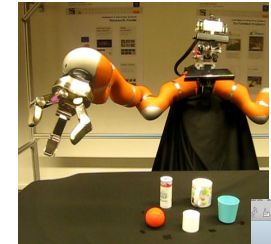
~~July 1st, 2017~~

EXTENDED:

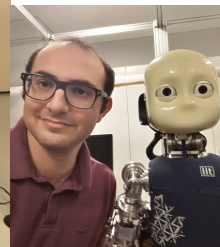
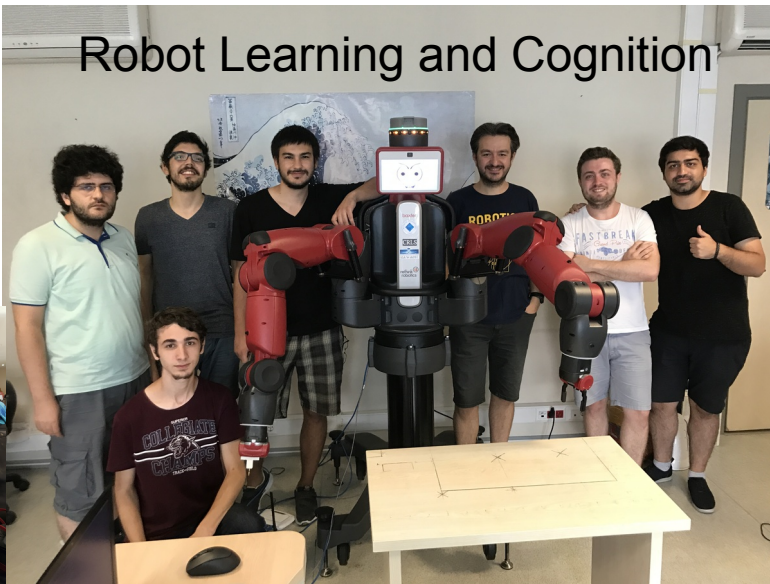
July 7th, 2017 (strict)

learning robot categories environment features over
 through traversability information prediction interactions learned
 relations performance world shape perception hand training
 position distance relevant experts imitation real
 method execution end range studies
 image phase al effects perceptual predicted
 parameters Robotics state entity initial
 system next prov example robots robot's space control
 primit feature aroach development results cm
 computed new action number vector actions
 complex relation interaction human Psychology
 developmental grasp planning affordances
 behavior affordance category

WordItOut



Robot Learning and Cognition



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Basic information

■ Time & Place:

- Tuesday slots 1-2 (09:00-11:00) – BM A3
- Wednesday slot 1 (09:00-10:00) – BM A3

■ Staff:

- Instructor: Emre Ugur
 - E-mail: emre.ugur@boun.edu.tr
 - Office: BM33
 - Office hours: Anytime – drop a line before coming

Basic information

- Format:
 - In-class discussions, no 'main' textbook
 - Quiz every Tuesday in a random time
 - Attendance every Wednesday
 - Assignments every Wednesday
 - A lot of readings

 - Grading:
 - 1 midterm (20)
 - 1 final exam (20)
 - Quizzes/assignments (35)
 - Attendance (5)
 - Term project/paper (20)
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Basic information

- Course materials:

- Will be available in course webpage:

<https://www.cmpe.boun.edu.tr/~emre/courses/cogs500-cmpe489/>

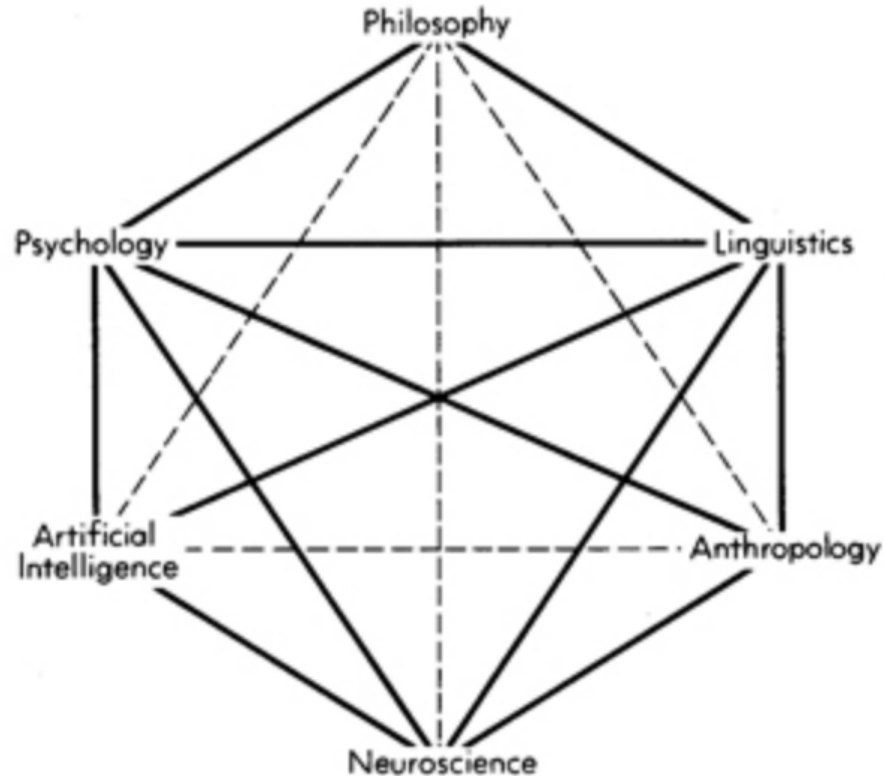
- Course mailing list: TBA

- cogs500-cmpe489@listeci.cmpe.boun.edu.tr

What is cognitive science?

- “The science of the mind” Bermudez
- Cognitive: «perceiving and knowing»
- What does it involve?
- “a contemporary, empirically based effort to answer long-standing epistemological questions – particularly those concerned with the nature of knowledge, its components, its sources, its development and its deployment”
Gardner

Scope of cognitive science

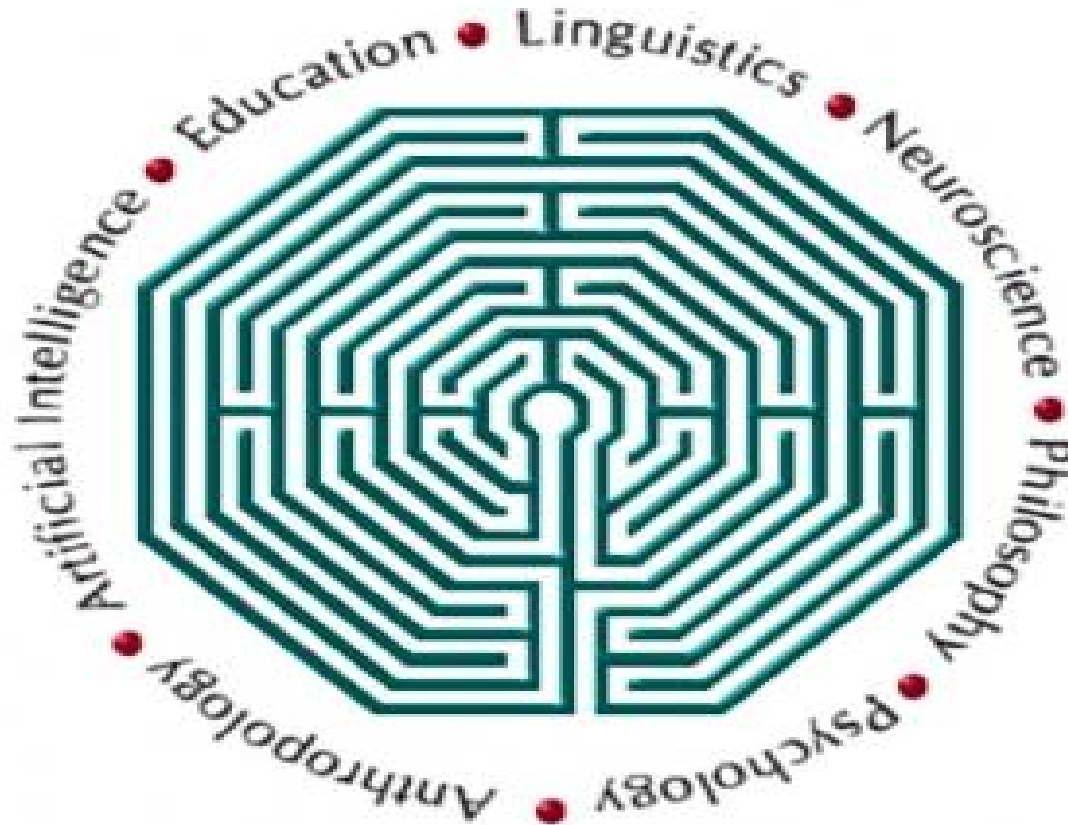


Connections among the Cognitive Sciences

Key: Unbroken lines = strong interdisciplinary ties
Broken lines = weak interdisciplinary ties

Sloan Initiative
SOAP unpublished report,
1978

Scope of cognitive science



Tentative Syllabus

- Week 1: Cognitive Science
 - Methodological concerns
 - Philosophical issues, consciousness
- Week 2: Brain as a System
 - An overview of the brain
 - Parallel, distributed systems
 - Ways of looking at brain signals
 - Computational neuroscience



Cem Say

Syllabus

■ Week 3: Representation of sensory information

- processing of sensory information
- motor and sensory areas
- perceptual fusion in different modalities.
- computer perception



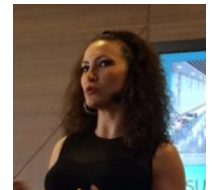
Lale Akarun

■ Week 4: From Sensation to Cognition

- Multisensory integration in cortex
- information fusion
- from sensation to cognition



Erhan Oztop



Hülya Yücel

Syllabus

- Week 5: Roots of cognitive science
 - Cybernetics
 - Artificial intelligence
 - Turing test and the Chinese room



Yağmur Denizhan

Syllabus

■ Week 6: Speech and Language

- Cortical aspects
- Syntax and semantics
- Critical age
- The great past tense debate



Junko Kanero

■ Week 7: Attention

- Principles of attention
- Selective attention
- Top-down and bottom-up processing
- Computational models of attention



İnci Ayhan

Syllabus

- Week 8: Cognitive Development
 - Cognitive development
 - Child
 - Robotic development



Gaye Soley

Syllabus

■ Week 9: Learning

- Categories and concepts
- Concept learning
- Logic
- Machine learning

■ Week 10: Memory

- Constructing explicit memories
 - Information processing model of memory
 - Sensory memory
-

Syllabus

■ Week 11: Reasoning

- Rationality
- Bounded rationality
- Heuristics and biases
- Reasoning in computers

■ Week 12: Social cognition

- Key points in social cognition
 - Context and social judgment
 - Schemas
-

Syllabus

- Caveat: We will probably not be able to cover ALL this material... The subject is too broad, you need to read some on your own.

Any questions???

Cognitive Science in 1950's

- Allen Newell&Herbert Simon: the first complete proof of a theorem ever carried out on a computing machine.
- Noam Chomsky: Three models of language, his own approach to grammar, based on linguistic transformations.
- John von Neumann's book The Computer and the Brain.
- Warren MuCulloch: recorded from the retina of frog
- David Hubel and Torsten Wiesel, record from cells in the visual cortex of the cat.
- Mid-50's, antropologists, contrasts abilities of people in remote cultures.
- 1956: Dartmouth College birth of AI, John McCarty, Marvin Minsky, Newell&Simon
- 1960, Hilary Putnam, solution to mind-body problem:
- 1967: Cognitive Psychology by Ulric Neisser
 - Highly constructive view of human activity.
- 1969: Herbert Simon:
 - both the computer and the human mind should be thought of as “symbol systems” - physical entities that process, transform, elaborate, and in other ways, manipulate symbols of various sorts.

Overview

- Philosophical issues:
 - What are the relevant questions of philosophy pertaining to cognitive science?
 - Methodological concerns:
 - How to ask cognitive scientific questions?
 - What is the methodology of its disciplines?
 - How do we bring things together?
-

Overview

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PART I - PHILOSOPHY

Some fundamental questions

- “How to reach knowledge and truth?”
- “How does the human mind work?”
- “Will it be possible one day to design a machine that thinks?”
- “Do people perceive reality correctly?”
- “What is consciousness?”
- “Are people inherently rational/irrational?”
- “Are people capable of free choice?”

Methodology of philosophy

- Deductive reasoning:
 - Socrates is a man
 - All man are mortal
 - Therefore, Socrates is mortal
 - Inductive reasoning:
 - Socrates is a man
 - Socrates is mortal
 - All man are mortal
-

Methodology of philosophy

- Deductive reasoning
 - Conclusions are certain
 - They are derived from syntax/forms, via logic
 - Objective reasoning
- Inductive reasoning
 - Conclusions are probabilistic/intuitive
 - Evaluation is subjective
 - Depending on prior knowledge, we can sometimes perform huge inductive leaps!

Methodology of philosophy

■ Abductive reasoning

- a form of logical inference which goes from an observation to a theory which accounts for the observation, ideally seeking to find the simplest and most likely explanation.
 - Charles Sanders Pierce introduced it.
 - It is reasoning from incomplete evidence (guessing), and has a probabilistic nature
 - Example: The lawn is wet -> It might have rained last night.
-

Greek philosophers

- “Where does human knowledge come from?”
- “What is the purest form of knowledge?”
- Plato: Idealized forms, innate in human soul
- “What is a form, an image, a concept, a word? How do these representations relate to each other?”
- “What is the influence of language over thoughts and beliefs?”

Schools of thought

- Descartes attributed all thought and creativity to mind, and devalued senses.
- He was a “rationalist”, as opposed to “empiricists” (like Locke) who were more interested in external sensory impressions.
- The British empiricists: Locke, Hume, Berkeley



René Descartes' illustration of mind/body dualism.
Source: wikipedia



Wikipedia

Schools of thought

- Rationalist: Impose powers of reasoning upon the world of sensory experience
- Empricist: Mental processes either reflect or are structured on the basis of external sensors

Locke and Empiricism

- John Locke:

Let us then suppose the mind to be, as we say, white Paper, void of all Characters, without any *Ideas*: How comes it to be furnished? Whence comes it by that vast store, which the busy and boundless Fancy of Man has painted on it, with an almost endless variety? Whence has it all the materials of Reason and Knowledge? To this I answer, in one word, From *Experience*. (Quoted in Herrnstein and Boring 1965, p. 584)

Logical empiricism

- George Berkeley: no material world
- David Hume: It is impossible to attribute causality reliably, and there is no observing or controlling soul behind the processes of thought
 - The nature of sensory experience
 - The classification of objects
 - The role of language
 - The status of individual conscious self

Kant and foundational philosophy

- Later (1781) Kant tried to bring these together.
- Kant: Some knowledge is a-priori, this is the ground on which everything else rests. The everything else, that is sensation. The a-priori part is the rationalist grounding.

Early 20th century

- Unmodifiable rules of logic, impossibility of psychology
- Dramatic advancements in mathematics and physics
- Alfred North Whitehead and Bertrand Russell
 - All mathematics from basic laws of logic
 - Make sense of external world through logical construction from sensory data
- Ludwig Wittgenstein
 - Logical structure implicit to language
 - Propositions of language, perceptual expressions of thoughts, logical pictures of facts
 - Objects in the world, thoughts in the mind, words in language

Fresh approaches to epistemology

- Hilary Putnam (1973): nature of computers and their implications for thinking.
 - Processes attributed part of “thinking” can now be performed by computers
 - Idea of functional organization
 - Shows the importance of abstraction
 - Mind-body problem:
 - Thought can indeed occur in a physical apparatus and can be correlated with certain behavior and yet not have to be identifies with the precise class of activities that happen to be produced.

PART II - ARTIFICIAL INTELLIGENCE

Cybernetics Perspective

- Thinking is a form of computation. The computation involved is not the mental operation of a human being who manipulates symbols in applying rules, such as those of addition or multiplication; instead it is what a particular class of machines do-machines technically referred to as “algorithms”
- Physical laws can explain why and how nature appears to us to contain meaning, finality, directionality, and intentionality

J.P. Dupuy, On the Origins of Cognitive Science

Artificial Intelligence

- Modest definition: “Making computers that outperform **humans** in tasks which humans currently excel.” (Rich & Knight)
- Ambitious definition: “Making computers that **think**.”
 - (strong AI?)
- Relation to cognitive science:
 - Human is the yardstick of AI
 - The human brain is an exceptional system
- The Turing test



“Artificial **Intelligence** is the ability to adapt to change in artificial agents”

Artificial Intelligence

- Problem solving
- Natural language processing
- Machine learning
- Pattern recognition
- Expert systems
- Reasoning
- Embodied systems and robotics
-

AI vs. Cognitive Science

- **CogSci** asks questions of cognitive psychology
 - Tries to explain an aspect of cognition
 - Works in a primarily reductionist mode
 - Uses **computational techniques** from AI
 - Information processing is the prevalent metaphor for brain activity
 - Uses **empirical data** in constructing and validating its hypotheses
 - Linked strongly to medical and biological sciences
-

Quiz

What is the relation between Cognitive Science and Artificial Intelligence. In 3 sentences

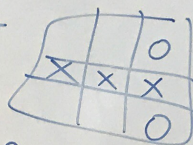
Starts: 09:00

Ends: 09:06

1997: Deep Blue beats Kasparov

Alan Turing

1950



GOF AI

Artificial Intelligence

1956

Partmouth

↑ Imitate the
brain's
architecture

↑ "Let the machine
learn (discover) itself,"
AlphaGo

