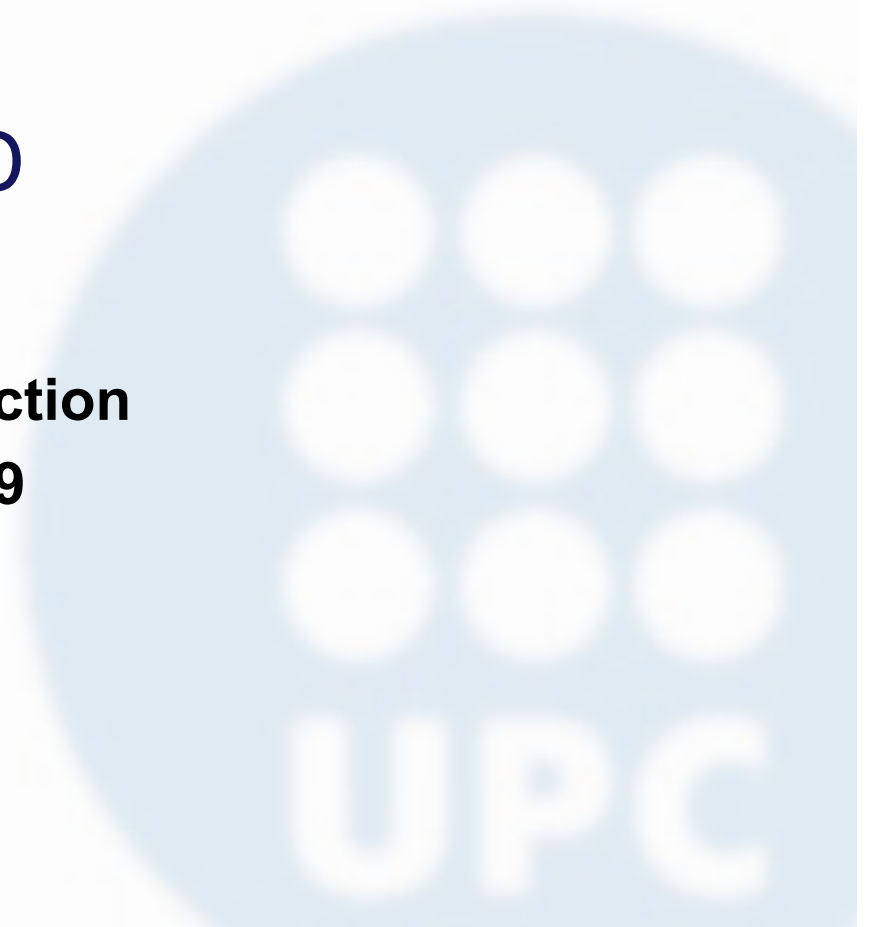


Sistemas Inteligentes Distribuidos

Distributed Intelligent Systems

SID

**Introduction
2019**



Who am I

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The Team

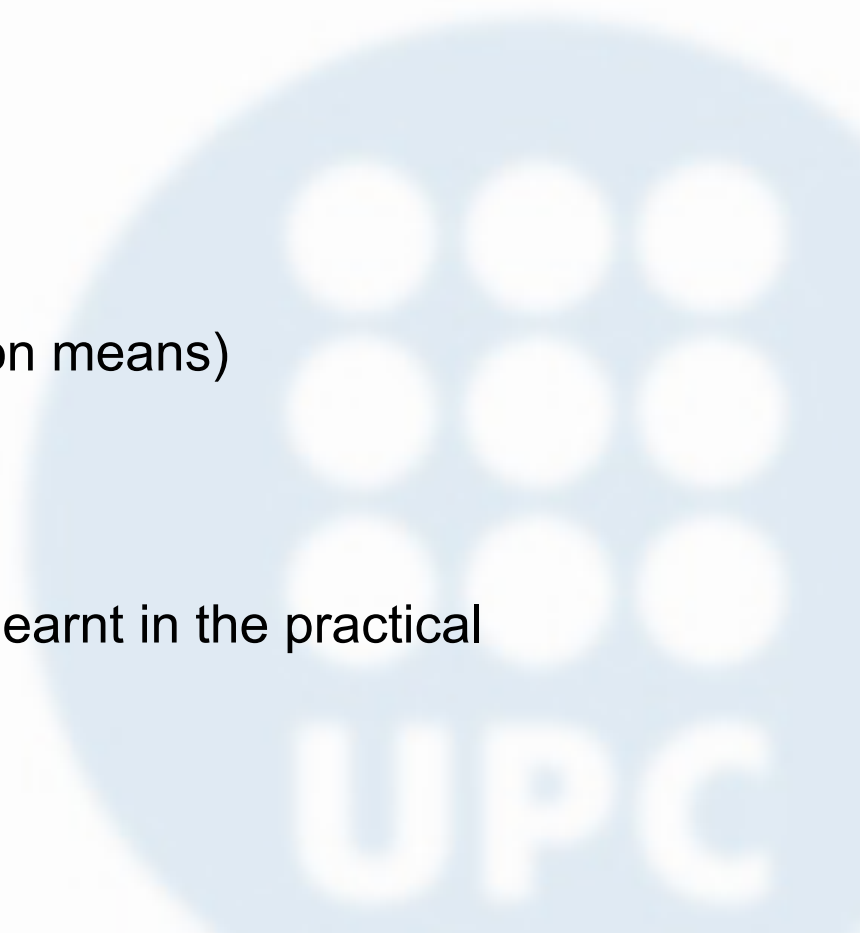
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Organization

- Theory
 - Slides and readings
- Practical Assignment
 - Programming assignments
- Communication
 - Racó (official communication means)
 - E-mail (fastest way)
- Varia
 - Exam (Theory + Concepts learnt in the practical assignments)

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Organization (2)

- Reading
 - See Raco (3 in average)
- Slides
 - See Raco
- Practical Assignment
 - Programming assignments
 - A single problem, many situations
 - Group assignment

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Week	M	T	Topic
1	11/2 T	14/2 T	Introduction
2	18/2 T	21/2 T	Agents
3	25/2 T	28/2 T	Agents
4	4/3	7/3 P/L	Agents
5	11/3	14/3 P/L	
6	18/3	21/3 P/L	
7	25/3	28/3 P/L	
8	01/4	4/4 P/L	
9	8/4	11/4 P/L	
10			Semana Santa
11		25/4	
12	29/4	2/4	
13	6/5	9/5	
14	13/5	16/5	
15	20/5 P/L	24/5 P/L	
16	27/5 P/L	31/5 P/L	

Cognitive Architectures

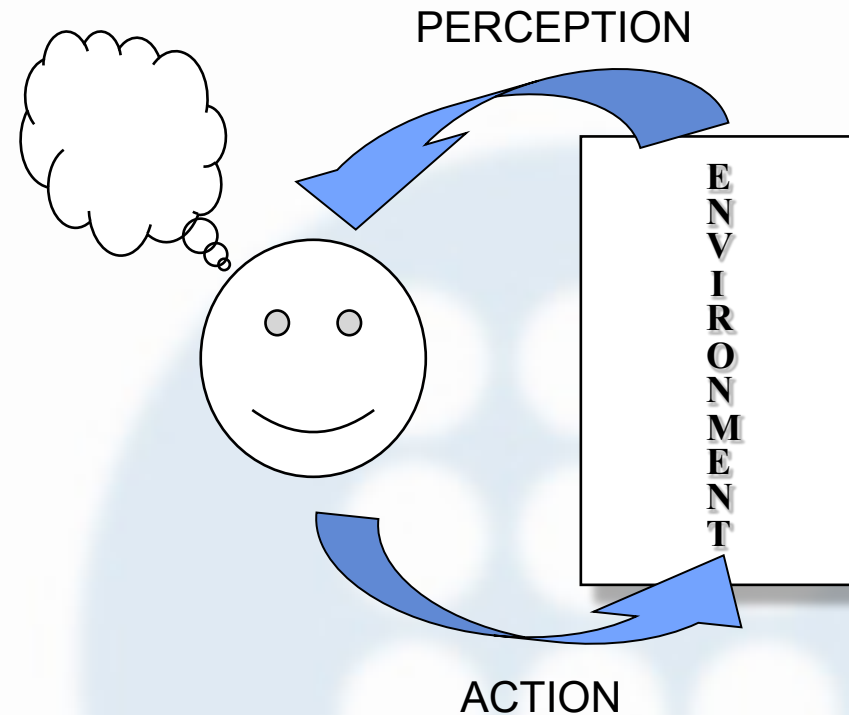
- In this course we aim to have a **holistic view** of Artificial Intelligence: its methods, techniques, and how to combine them into intelligent systems.
- But... what is an **intelligent system**?
- One way to characterize the behaviour we *think* as **intelligence** is through the study of the architectures providing such behaviour.
- We call **Cognitive Architectures** the ones that use **symbols** to represent the environment.

Cognitive Architectures

- Architectures are described by the description of their foundations and the methods used to achieve an *intelligent behaviour*.
- Cognitive architectures are based on computational entities, but this does not imply that intelligence should come always from the computer.
- A metaphor typically used in Cognitive Architectures to cover both human and machine intelligence is the one of the *Intelligent Agent*.

Intelligent Agent

- *An agent is a computer system capable of autonomous action in some environment in order to meet its design objectives*
- An agent should be able to perceive and act in the environment
- Usually the environment is *complex* and *dynamic*, and agents should interact with it in real time.



Cognitive AI Paradigms

- In AI, paradigmas can be characterized by the metaphor used to model intelligence:
 - **Logics**
 - **Search in a State Space**
 - **Knowledge-Based**
(rules, patterns, experiences)
 - **Evolutionary**
 - **Social**

Cognitive AI Foundations

- **PHILOSOPHY**

- Can rules be used to extract valid conclusions?
- How mind emerges from the physical brain?
- Where does Knowledge come from?
- How can Knowledge lead to action?

Cognitive AI Foundations

- **MATHEMATICS/LOGICS**
 - Which are the formal rules to extract valid conclusions?
 - Which things are computable?
 - How to reason with Knowledge that is uncertain and/or vague and/or incomplete?

Cognitive AI Foundations

- **NEUROSCIENCES**

- How is information processed by the brain?

- **PSICOLOGY**

- How do animals and humans think and act?

- **SOCIOLOGY/ETOLOGY/ECONOMICS**

- How collective (social/organizational) behaviour can be generated from individual (animal/human) behaviour?

- **CONTROL THEORY**

- How can self-controlled artifacts behave/act?

George Herbert Mead (1863-1931)

Mind, Self, and Society

- The self is an object to itself.
- The self is a social structure.
- Self arises from social experience.
- Self arises from language and interaction with others.
- The conversation of gestures is the beginning of communication.
- The inner conversation is the beginning of self (self-realization).

George Herbert Mead (1863-1931)

Mind, Self, and Society

- One inevitably seeks communication with others.
- Communication requires planning.
- **Thinking** becomes preparatory to social action.
- The process of **thinking is an inner conversation.**
- **Symbols are essential for communication and the development of the self.**

George Herbert Mead (1863-1931)

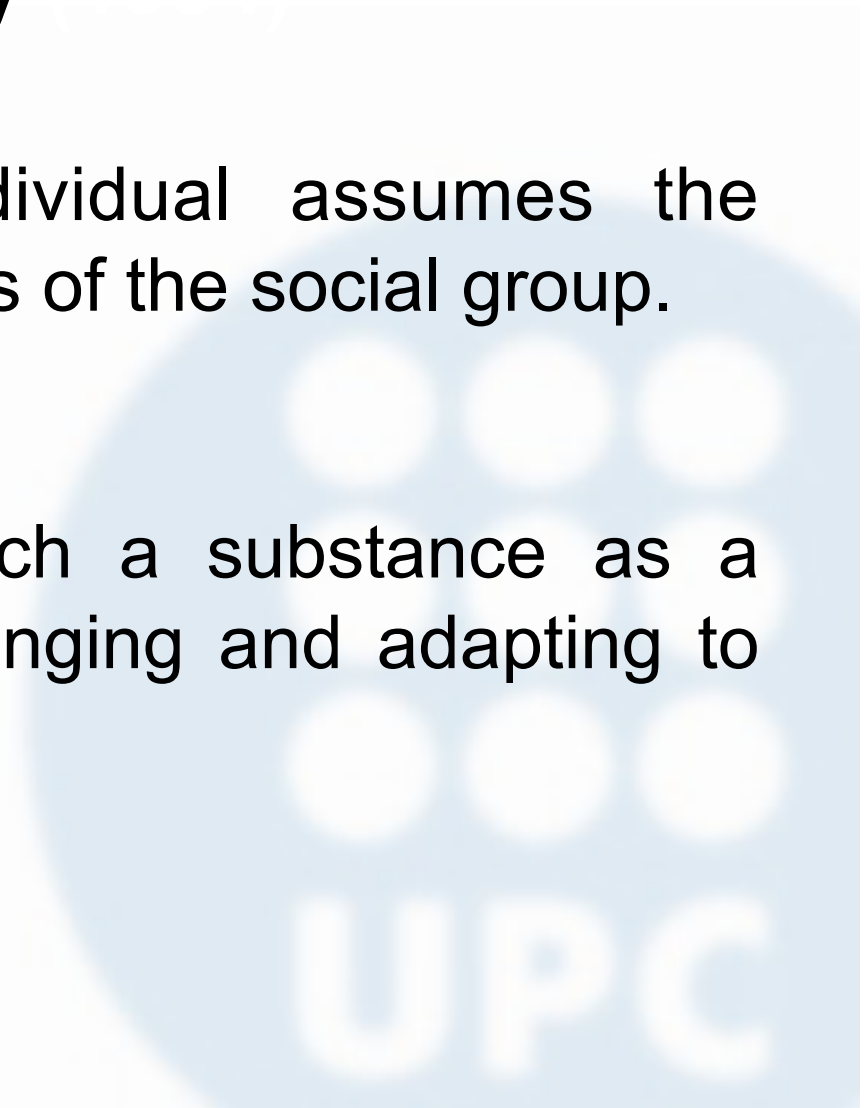
Mind, Self, and Society

- The *complete self* reflects the unity of the social process; and each of the *elementary selves* reflects the complete social process of self-reflection and interaction with others.
- Stages of the development of the self:
 1. Play stage: dyadic relationships.
 2. Game stage: multiple relationships.
- *Game playing* requires a realization of the *generalized other*: assuming the statuses and roles of all involved.

George Herbert Mead (1863-1931)

Mind, Self, and Society

- The self-conscious individual assumes the organized social attitudes of the social group.
- The self is not so much a substance as a process, continually changing and adapting to social processes.



George Herbert Mead (1863-1931)

Mind, Self, and Society

- The "**me**" is the accumulated awareness of "*the generalized other*."
- The "**I**" is the more personal. It is the reflector or observer.
- *The human mind arises solely through social experience*. It represents the thinking process of internalized communication.

The Society of Mind (Marvin Minsky)

- **Background:**

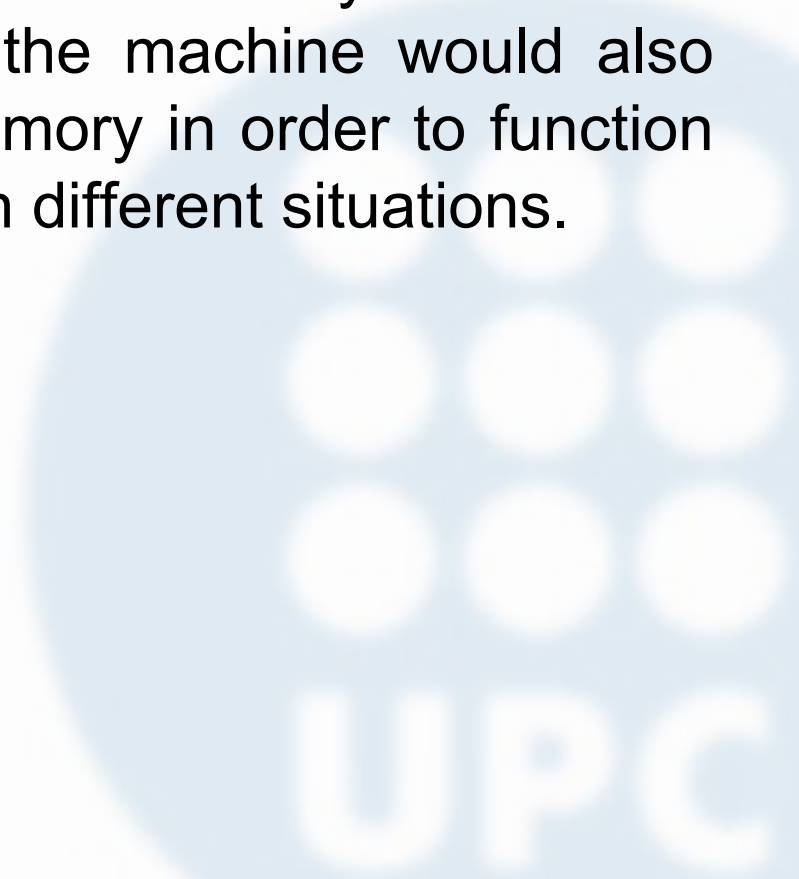
*The functions performed by the brain are the products of the work of thousands of different, specialized sub-systems, the intricate product of hundreds of millions of years of biological evolution. We cannot hope to understand such an organization by emulating the techniques of those particle physicists who search for the simplest possible unifying conceptions. **Constructing a mind is simply a different kind of problem**—of how to synthesize organizational systems that can support a large enough diversity of different schemes, yet enable them to work together to exploit one another's abilities.*

[Minsky, M.: Logical vs. Analogical or Symbolic vs. Connectionist or Neat vs. Scruffy.]

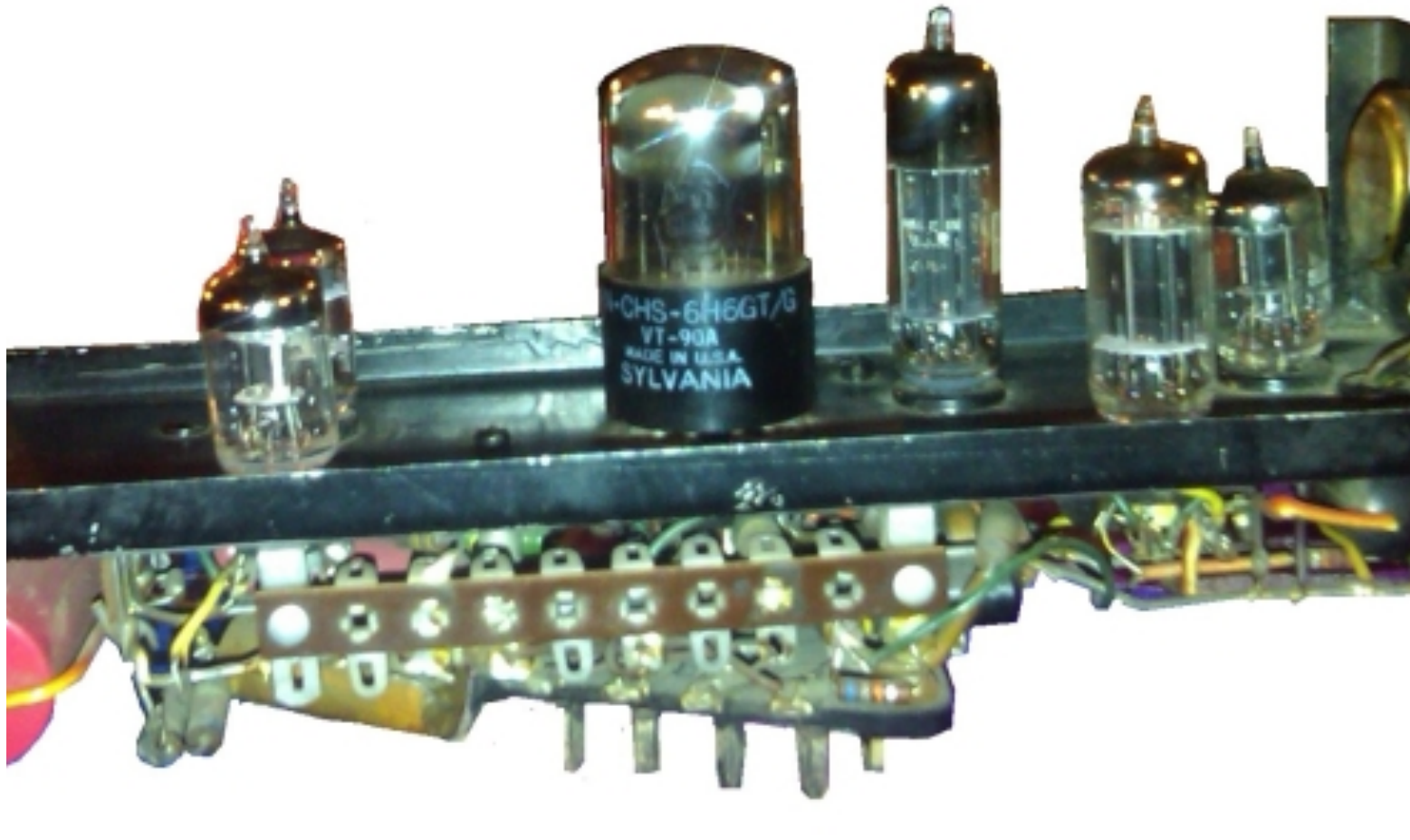
- **Aim: to create a theory of human cognition**

Stochastic Neural Analog Reinforcement Computer (SNARC, 1951)

- **Key idea:** producing machines which could learn by providing them with memory *neurones* connected to *synapses*; the machine would also have to possess past memory in order to function efficiently when faced with different situations.



Stochastic Neural Analog Reinforcement Computer (SNARC, 1951)

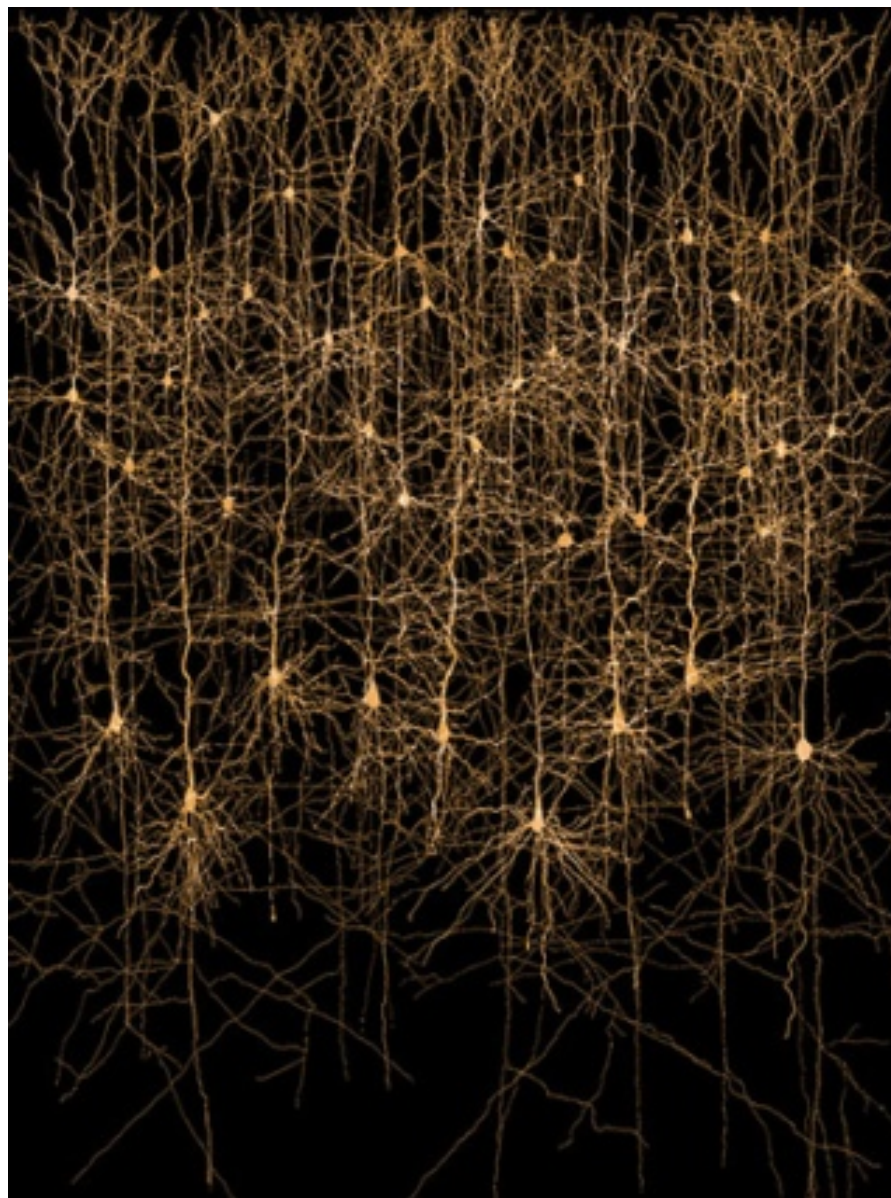


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24/02/2018

The Society of Mind (Marvin Minsky)

- **Approach:** A Cognitive Architecture composed by thousands of individual agents.
- **Idea:** Human intelligence is built layer by layer from the interactions of simple parts called **agents**, which are themselves mindless.
- Theory covers processes such as **language**, **memory**, **learning**, **consciousness**, **the sense of self**, and **free-will**
- Very flexible. Based on integration. Scalable.
- **Point of view:** constructivist and organicist.
- **Technical perspective:** Parallelism, different types of Knowledge bases, compatibility between the symbolic and sub-symbolic levels.



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12/02/13



The Society of Mind: a revolutionary proposal

- It takes into account and tries to explain cognitive development.
- It takes into account evolution
- It takes into account emotions
- Flexible behaviour depending on the environment
- Exhibiting some rationality
- Operating in real time

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Which kind of Cognitive Architectures are we looking for?

- Capable to operate in rich and complex environments
- Capable of using symbols and abstractions
- Use of *natural* and *artificial* languages
- Learn from the environment and the experience

What about the nature of the brain?

- **Human minds are not perfect decision-makers, but by and large they are *very* good.**
- **Brains are not as modular as software**
- **Brains may be to *intelligence* as wings to *flying*.**
Mimesis is not always the best idea
- **Lessons learned: memory and simulation (planning) are good to decision making**

Which kind of Cognitive Architectures are we looking for?

- **Get capabilities during execution time (adaptation)**
- **Operate in an autonomous way, but being social**
- **Be self-conscious**
- **Be built from (artificial) neurons**
- **Emerge from evolution**

Cognitive Architectures : Parameters

- **Generality**
- **Versatility**
- **Rationality**
- **Learning**
- **Psychological
Validation**

- **Applicability**
- **Scalability**
- **Reactivity**
- **Efficiency**

Cognitive Architectures: Open issues

- Which is the *best* of all Architectures?
- Will we ever get complete architectures?
- Which kind of intelligence will we get?

Cognitive Architectures: Functional aspects

- **Engineering methodology (*how to develop them*)**
- **Capability to tackle a wide range of complex tasks**
- **Efficiency when acting on the environment**
- **Autonomy**

Course objectives

- **Understand the basic roles of...**
 - Knowledge representation
 - Machine learning methods
 - Problem solving
 - Distributed solutions (?)**... when building intelligent systems.**
- **To be able to build an *intelligent system* to solve some kind of problem.**

What kind of AI?

Think like people	Think rationally
Act like people	Act rationally

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Rational Decisions

- Rational: maximally achieving pre-defined goals
- Rationality only concerns what decisions are made
- Goals are expressed in terms of utility (of outcomes)

Distributed Intelligent Systems– Intro



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