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КАФЕДРА
ТЕЛЕМАТИКА

Семинар по специальности на английском языке
(Workshop in English)

тема

Computational theory of mind: does consciousness can used "numbers“

занятие 7

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Просил прочитать и постараться понять

АКАДЕМИЯ НАУК СССР

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ГОМОМОРФИЗМЫ И МОДЕЛИ

Логико-алгебраические аспекты моделирования

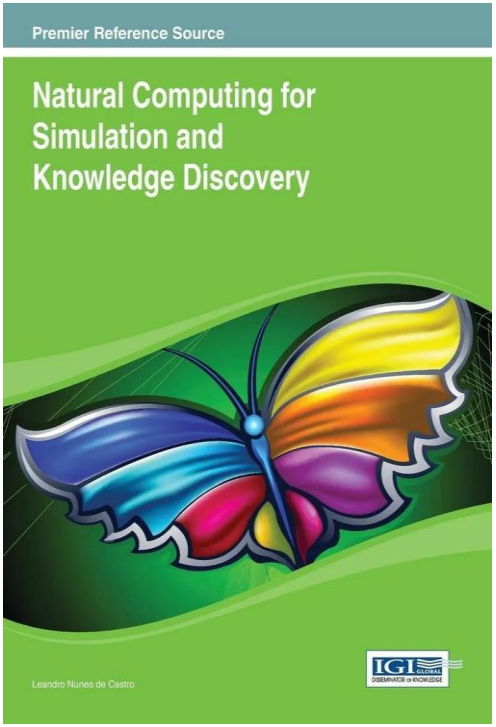
ИЗДАТЕЛЬСТВО «НАУКА»

Москва 1975

Под интуицией я подразумеваю **понимание**, настолько отчетливое, что не остается никакого сомнения относительно того, что мы разумеем.

Р. Декарт
(1596 – 1650)

Что обсуждали на прошлой лекции



Компьютерное моделирование Природы опирается на ряд положений:

- абстрагирование или семантическая фильтрация сущностей - путь представления физических явлений через процессы вычислений.
- применение вычислительных технологий не должно нарушать «презумпцию непрерывности» физических явлений.
- использование человеческого сознания, чтобы формировать классы эквивалентности мыслимых сущностей, суть которых заключена в сентенции «Computo ergo sum» - **существует то, что можно вычислить.**

Question: if cognition a real property of living organisms does it has computational nature ?

1. **Is Mind fundamentally a computational phenomenon? What "number" are involved in these calculations**

2. Why Mind can not control transition from an ensemble of molecules to an ensemble of organisms? How the mind solves problems of combinatorial and NP (non-deterministic polynomial) complexity.

3. Whether the phenomenon of life is a necessary condition for the appearance of Mind

What we already think:

- Mind (Consciousness) is a phenomenon in which information is integrated in the brain in a way that …. cannot be broken down
  - information ? (difference that make the difference…- log P…
  - integrated ? (+, *, ….)
  - broken down ? ($S=\Delta Q/T$, ….$Q= -kT\ln 2 * (I_{in}-I_{out})$

- Consciousness is saved information experience….
  - saved – where, how, whwn, volume….

What we need to know:

Is whether the processes of consciousness can be modeled mathematically using **numbers** of modern methods of physics, algorithm theory, and computer science ?

Consciousness is not pure computable ?!

1. Conscious experience **is integrated with everything** one knows about reality (what has actually seen, touched, heard, or studied theoretically).
2. Therefore, the nature of the "experience of consciousness" is radically different from the methods of automatic pattern recognition implemented in modern computer technology.
3. The **essence of the difference** is that conscious experience is not reduced to the identification of a “mathematical” object – formal set of predetermined parameters or properties.

Если вы чему то научились, то полученный опыт (знания) будет интегрирован со всеми видами других знаний и переживаний, хотя доступ к конкретным «знаниям» может быть со временем затруднен

Можно ли такие свойства описать МАТЕМАТИЧЕСКИ ?

Пример

«Сознательный опыт» можно рассматривать как своего рода процесс сжатия информации. «Сознательное» сжатие информации позволяет сформировать «семантический базис» …. топологического пространства понятий, в которое отображаются воспринимаемые (опытные) данные.

В памяти интеллектуального субъекта сохраняется не вся информация, которую первоначально содержал входной сигнал, полученный с помощью сенсорных или иных каналов связи, а только «базисная» ее часть.

Так,
рассмотрим последовательность чисел:
4, 6, 8, 12, 14, 18, 20, 24.... Это бесконечный ряд, определяемый как: нечетные простые числа
3, 5, 7, 11, 17, 19, 23…..
плюс 1.
Такое объяснение не содержит все множество простых чисел, но оно позволяет точно воспроизводить ряд, поэтому может рассматриваться как смысловое сжатие информации, полученной в предъявленной последовательности данных .

Psychologists.... argue that the behavior of an intellectual subject in a particular situation cannot be modeled independently of his entire conscious experience.

This means that something happens in the subject's brain that cannot be represented as a "fixed" algorithm. Formal difference between

truth, consciousness, and computation

are that computation can be mapped to a certain algorithm, while consciousness cannot.

Итак, сознательный опыт должен позволить **реконструкцию** полученных ранее данных (данные опыта), но без явного хранения всех частей.

Такая форма представления задачи математически формулируется как «обратная» и допускает «множество решений».

Вопрос: можно ли такие процессы смоделировать «вычислительно» ?

Вопрос: Почему законы физики вычислимы, насколько нам известно, а законы сознания – нет
При этом Question: Why are the laws of physics, as far as we know, computable, but the laws of consciousness are not?
We should assume that consciousness is not "objectively" computable, but is computable only "subjectively," i.e., directly computable by the "bearer of a particular consciousness

P=NP=....=P local complexity

Заметим, что в математике идея вычислимости не зависит от наблюдателя, но …. так же как в квантовой механике, в теории сознания аналогично нельзя избавиться от «наблюдателя».

Current artificial intelligence speculation.

- Almost all of human intelligence can be deemed to be some form of computation or data input/output/storage.
- Human intelligence doesn't just come only from the brain. Actually, almost every part of the human body plays a role in human intelligence.
- Intelligence has synergetic nature - the whole is much greater than the sum of its parts….so, each cell has limited intelligence by itself, but together, great intelligence can be achieved.
- Intellectual Computation is **distributed, parallel at multiple levels and decentralized** - there is no centralized program framework, analogue of a CPU that controlling a whole computation processes and behavior of brain
- Recursion or self-improvement process at multiple levels main Attention and abstraction mechanisms features that greatly decrease the amount of computation intelligence required.
- Intelligence use of both machine learning (statistics) approach and logical (formal) reasoning (symbolic computation etc.)

… has body and its microbiome significant affects on the brain and human behavior ?

Facts:

- Even a single cell has the computational resource to solve specific computer science problems, such as choosing a path in a maze.

- As a result of imbedding computing, cells choose directions, secrete chemicals, and replicate, following the program of DNA , which is similar to that of digital computers.
- In this case, it does not matter that the cells do not possess what is called **developed consciousness**, but each cell contributes to the **overall human intelligence.**

- ant colony is collectively much more intelligent than the sum of each constituent ant's intelligence

- The concept of "crowd wisdom" and the concept of computer science have much in common. Thus a set of transistors or multilayer neural networks can be more "intelligent" than a single transistor or a single layer network of neurons.

If we assume that **most cells of a human body have some computational capabilities**, it means that the "body" as a living structure can simultaneously (in parallel) perform tens of trillions of coordinated computations.
At that, a traditional processor can process only one command per allocated time interval, a modern multithreaded processor can process n<64 different streams of operations simultaneously, a multi-core graphics (vector) processor can simultaneously process tens of thousands of identical operations, and a supercomputer can perform millions of heterogeneous computational operations.
Can we estimate the performance of brain ?

Distributed and decentralized computation

- Parallel computations allow to react quickly to the occurring events, forming the result of computations "not by separate parts of it, but considering it as a whole.... ", although this "whole" may include many components. Such capabilities exist **not for arbitrary computations**, but for certain types of tasks that are oriented toward processing pre-prepared and pre-trained abstract data.

- The paralleling of computation for the body in general and the brain in particular allows each computational unit (e.g., cell, organ, part of the brain) to be considered a separate agent that both competes and cooperates with each other.
- For example, a gut can compete with a part of the brain to decide on the next action, and one part of the brain can cooperate with another part to form a more accurate thought. Exactly, such mechanisms are the basis of synergy, which **allows the whole to be greater than the sum of its parts**.

There are at least two ways to apply this concept.

- The brain **seems set up to perform tasks** that require recursive logic
- And the brain is capable of self-enhancement, i.e. neuroplasticity capabilities are realized through the brain changing itself. the appearance of certain FEELINGS can lead to the release of certain enzymes, which then cause changes in the number of synapses and synaptic connections.

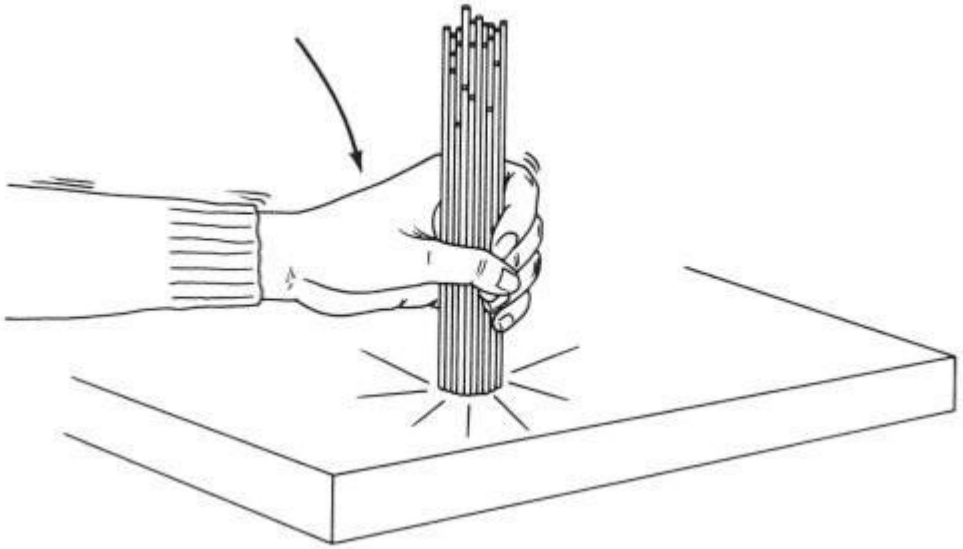
So, similarly, self-improving computers with AI is the key to new computer technologies

People know how to minimize useless calculations. So there may be 10 objects and 10 details about each of them in a person's field of vision. But a person, naturally,
1. will limit his attention to only one of these objects (for example, a dangerous rock flying toward him) and
2. will make a simple abstraction of the object, ignoring the details (e.g., for a dangerous, fast-moving object, there is no need to think about the exact shape or patterns on the rock).

Attention and abstraction mechanisms can sometimes have flaws (e.g., people sometimes draw premature conclusions or miss important details), but in most cases they contribute positively to human intelligence.

Computers can take similar approaches. "Attention is All You Need," this ides led to huge advances in natural language processing and describes advances in using neural networks to create abstract models of the worldthat are computable, and combining them with other **natural phenomena** to successfully complete tasks.

Taking advantage from physics or biology



The advantages of DNA-computing are due to its ability to perform the same operation simultaneously over a given code chain without additional synchronization costs.

"Spaghetti Sort algorithm" can be easily implemented by a human but not by a computer without a physical body.

A human can sort the rods by length with O(n) time complexity. In contrast, the fastest computer algorithm for sorting a list of numbers is O(n log n), which is worse. So, the computer is not able to take advantage of gravity which constantly acts on all the rods at the same time (in parallel). Гипотеза P/NP», по-прежнему имеет большое значение

Computation is a process that implements a mapping between some **symbolic structures** (domains). The implemented mapping can take the form of a

function,
operator,
Algorithms
Understanding
or
relationship.

Any symbolic structure may be

- **numbers**: 3 + 2 equals 5,
  or may not.

All depends from mind!!!

the ear amplifies certain sound frequencies, and then acts as a multiband filter to separate sounds into their components.
The visual cortex performs multilayer convolutions (sort of putting pixels together),
such phenomena can be seen as mathematical algorithm-inspired approaches," or, as "mathematical models that describe the organism's functionality.
The main idea is that the organism can perform cool computations that contribute to human intelligence.

Machine learning algorithms and symbolic reasoning

There are 2 major approaches to AI:
statistical machine learning (learning from the data, e.g. learning to differentiate cats from dogs by looking at the pixels of many labeled photos)
symbolic AI / logical reasoning / computer algebra (e.g. manipulate 2y=x into y=0.5x or deduce from “all men are mortal” and “John is a man” that “John is mortal.”)
I think that humans use some form of both of the above. Only using one of the above would be insufficient to explain the intelligence humans have demonstrated. Statistical machine learning is nowadays often implemented via neural networks which are inspired by the human brain. As for symbolic AI, I guess humans must also be able to use something similar to that, since humans are apparently able to do algebraic manipulations and make logical deductions pretty quickly.
The question is, how exactly do we combine #1 and #2 ? There are many possible approaches.

Intelligent phenomena of Living systems

The are no **hard problems for Living systems**, but only problems that are hard to certain level of there intelligence ….and Mind

theses.

- Intelligent computation-just as digital computation is the manipulation not of physical entities whose properties are related to energy and matter, but of abstract symbols.
- "Inputs" of mind computing come in the form of symbols or representations of other entities, and the output can be either a symbol or an action.
- Computational theory of mind, like the classical digital case, is based on a specific language describing the process of reducing the entropy of environments and situations. In the case of computational intelligence, a language is used to describe thought processes.
- The language of thinking consists of categories, which consciousness uses to constantly "program" the environment and calculate different representations, using the "power of semantics" for this purpose.

What “mental number" are involved in natural calculations

Humans develop a mental model of the world based on what they are able to perceive with their limited senses. Understanding the nature of knowledge representation in the brain is perhaps the most fundamental challenge for cognitive and computer scientists. The domain of numerical knowledge has grate universality and practical relevance.
Mental model is :
The image of the world around us, which we carry in our head, is just a model. Nobody in his head imagines all the world, government or country. He has only selected concepts, and relationships between them, and uses those to represent the real system

Spatial representation of numbers
нейронные цепи , используемые для представления и обработки чисел, тесно связанной с чувством пространства и направленинм движения