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КАФЕДРА
ТЕЛЕМАТИКА

Семинар по специальности на английском языке
(Workshop in English)

тема
Natural Morphological Computation as Foundation of Learning to Learn Intelligent Machines

занятие 9

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Что обсуждали на прошлой лекции

Фундаментальный вопрос относящийся к взаимодействию между разумом и природой: почему термодинамическое и психологическое (интеллектуальное) направление эволюции (стрелки) совпадают по времени

A fundamental question relating to the interaction between mind and nature: why do the thermodynamic and psychological (intellectual) directions of evolution (arrows) coincide in time

Понимание субъективности (локальности свойств) энтропии проливает свет на основы общей физической теории информации

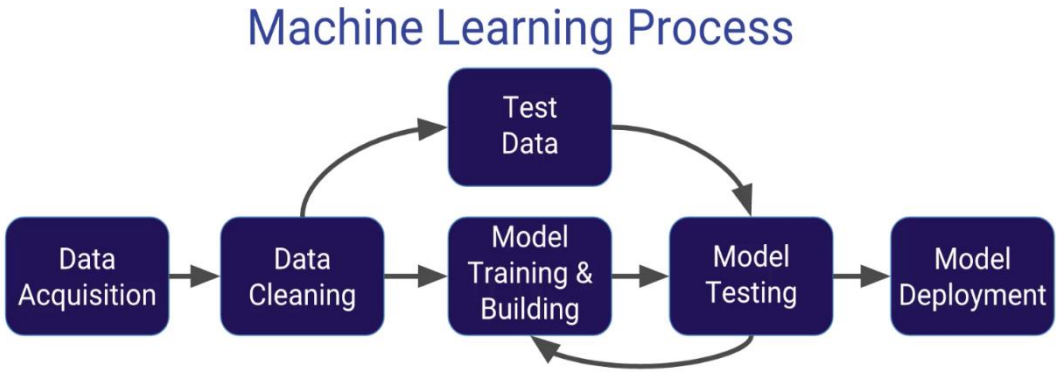
Understanding the subjectivity (local properties) of entropy sheds light on the foundations of the general physical theory of information

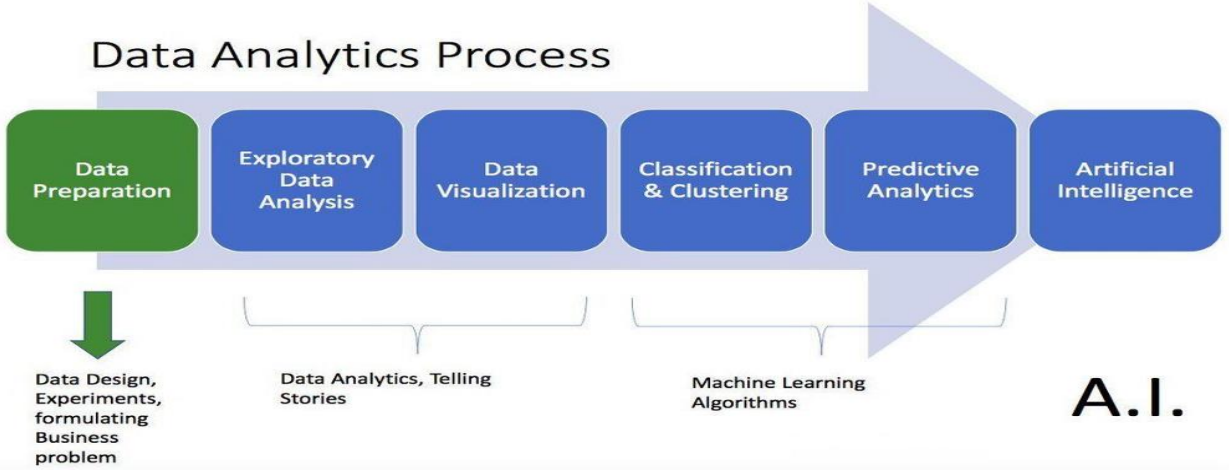
Как энтропийные феномены и особенности природы ограничивают точность и производительность компьютеров - один из приоритетных вызовов науки

How entropic phenomena and features of nature limit the accuracy and performance of computers - one of science's priority challenges

What is Learning Process

Effective Learning Process is central for acquiring, maintaining, and managing knowledge, both theoretical and practical





Example:
There are more small earthquakes than large ones. But there is no apparent cut-off in the possible size of an earthquake; earthquakes of all sizes are possible.
If the probability distribution were of the form exp(-E/E0), then there would be a well defined cut-off at the energy E0 such that the probability for an earthquake of size E much greater than E0 is **exponentially small.**

The goal of a computation is to provide a yes/no – answer to a well-defined problem, given by a binary input string that is completely known at the start of the computation.

• The goal of a control process is the generation of a **continued** stream of signals which are provided as input for some form of actuator. The signals are in general a function of some sensory input.

• Control usually involves some form of computation (and some computers)

Note: This distinction of computation and control neither produces deep insights nor is it generally made, nor is it that strict.

Most control processes are resolved into many short computations.

Computation and Control: Differences

The concept of control differs from that of a computation:

1. Control: Input not completely known at begin of process.

2. Success: A computation is succesful, when it reaches a halting state. There is no comparable concept for control.

3. Output-Input relation:
   - Computation: Output does not influence the input.
   - Control: Output at time t can (should) influence the input that will be gathered at later times.

Our computers are Turing machines: Programs are (in principle) fully portable between two different realizations of a Turing machine.

- The physics of the realization of the TM is of no importance for the outcome (maybe for the speed, but not for the outcome as such).

- If one desires to solve a problem that involves physics, all the necessary physics has to be provided by the program, the physics of the machine must not interfere.

Abstraction: Pros and Cons

Abstraction: Definition of conventional computation is as independent as possible of the nature of the computing device.

• Morphological computation (to be defined in what follows) is inspired by the suspicion that this independency is not for free.

• Already in conventional computation, dedicated hardware speeds up a calculation at the price of loosing portability and scalability

Abstraction vs. Embodiment

To be discussed:
Embodiment and portability are antagonistic and seem to correlate with the pair programmability vs. specific function.
Morphological computation can be regarded as the attempt to explore the space between the extremes.

Abstract Turing machine – dedicated hardware – actual computer

Reconfigurable hardware

• Does not need an OS in the usual sense: The computation is directly realized in hardware.

• Takes profit of the connection topology of individual components. Reconfigurable hardware is a example where morphology facilitates conventional computation.

BTW: Graphic cards, initially designed for 3D geometry only, are used for various types of problems being structurally related to those posed by graphics.

Natural calculation

Natural control