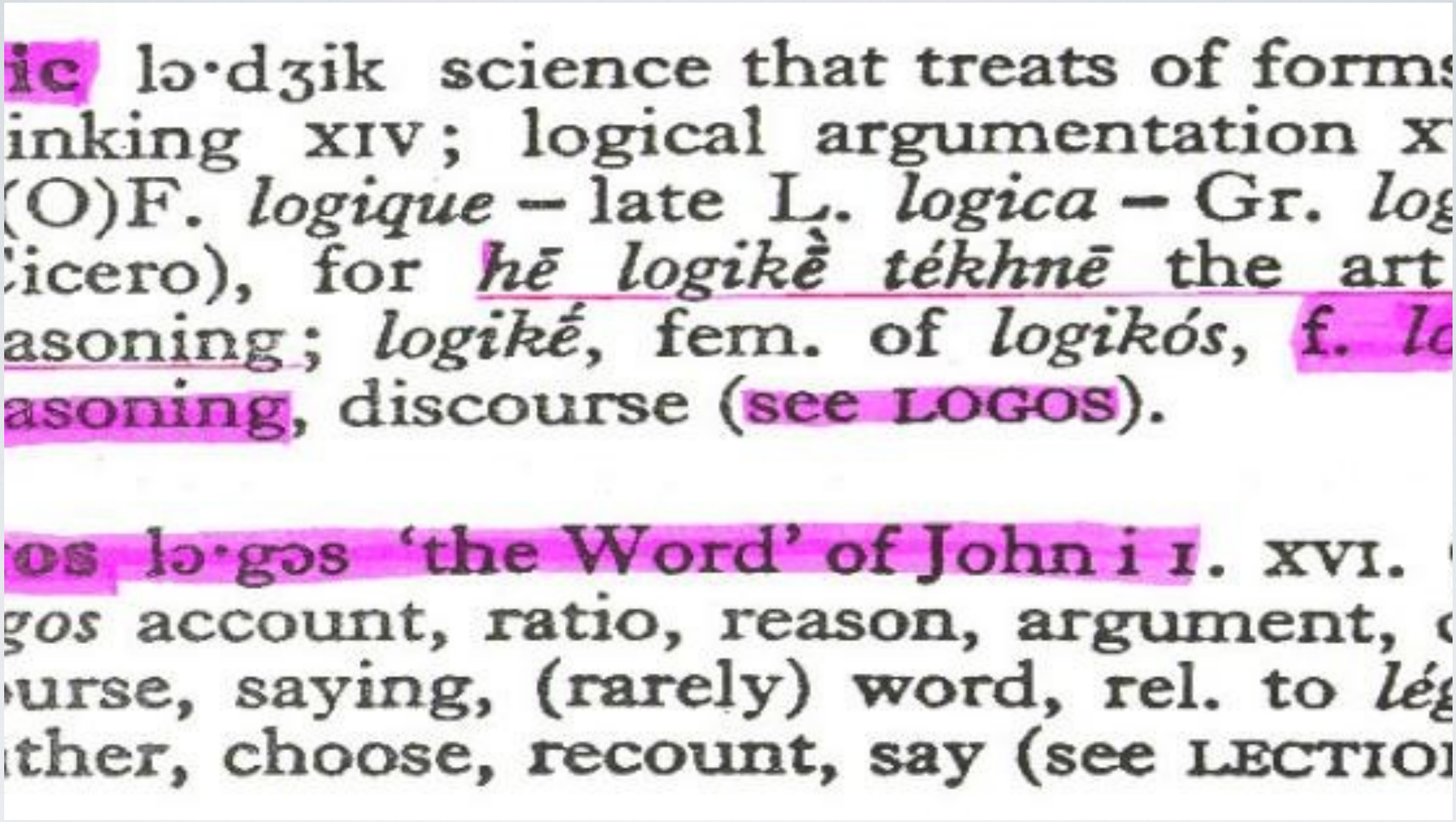
ic lɔ·dʒik science that treats of forms
inking XIV; logical argumentation X
(O)F. *logique* – late L. *logica* – Gr. *log*
Cicero), for *hē logikḕ tékhnē* the art
asoning; *logikḗ*, fem. of *logikós*, f. *lo*
asoning, discourse (see LOGOS).

os lɔ·gɔs 'the Word' of John i 1. XVI.
gos account, ratio, reason, argument,
urse, saying, (rarely) word, rel. to *lég*
ther, choose, recount, say (see LECTIO

IF.05.22 THEORETICAL INFORMATICS

Peter Bauer

UNIT 01

Overview and Administrivia

TODAY

- Overview
  - Motivation
  - Why to study theoretical informatics
- Administrivia
  - Grading
  - Communication
  - Working

CONTENT OUTLINE

- Formal Logic
- Production Systems
- Formal Languages
- Compiler Construction

WHY TO STUDY THEORETICAL INFORMATICS? – PART I

- One base of computer science

VERY EARLY HISTORY

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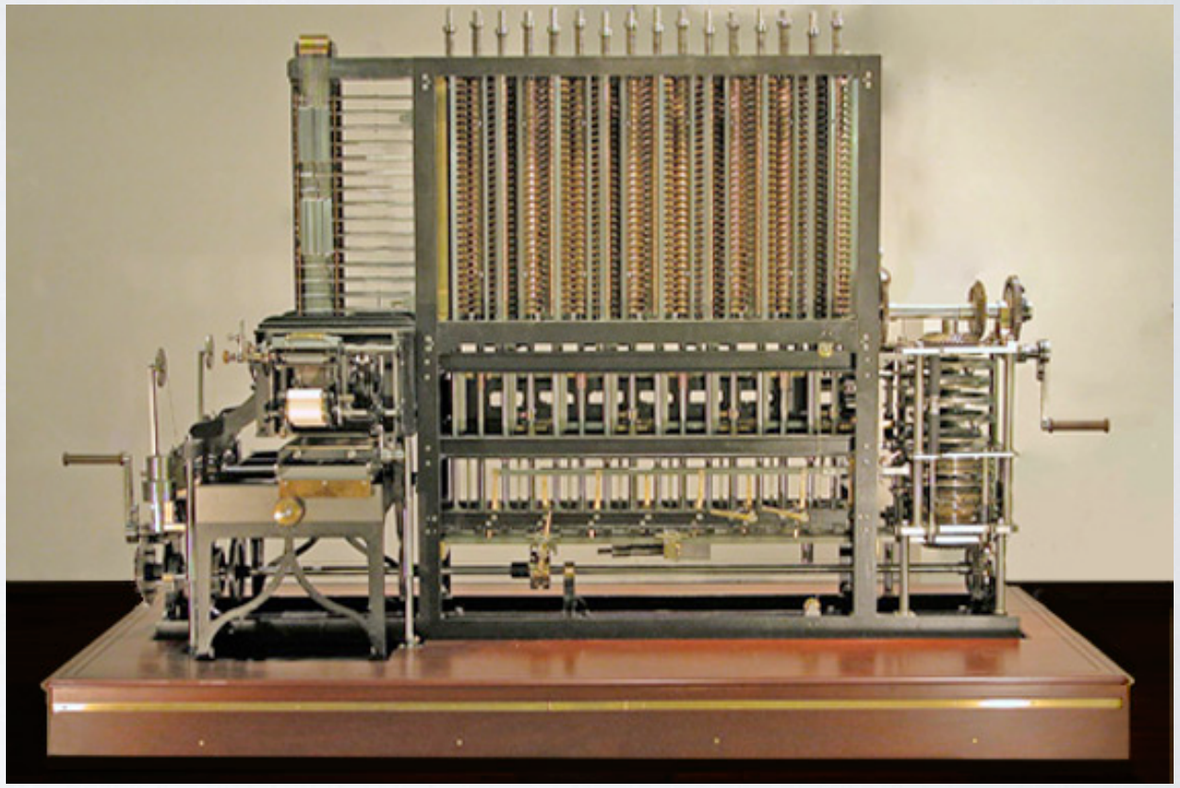

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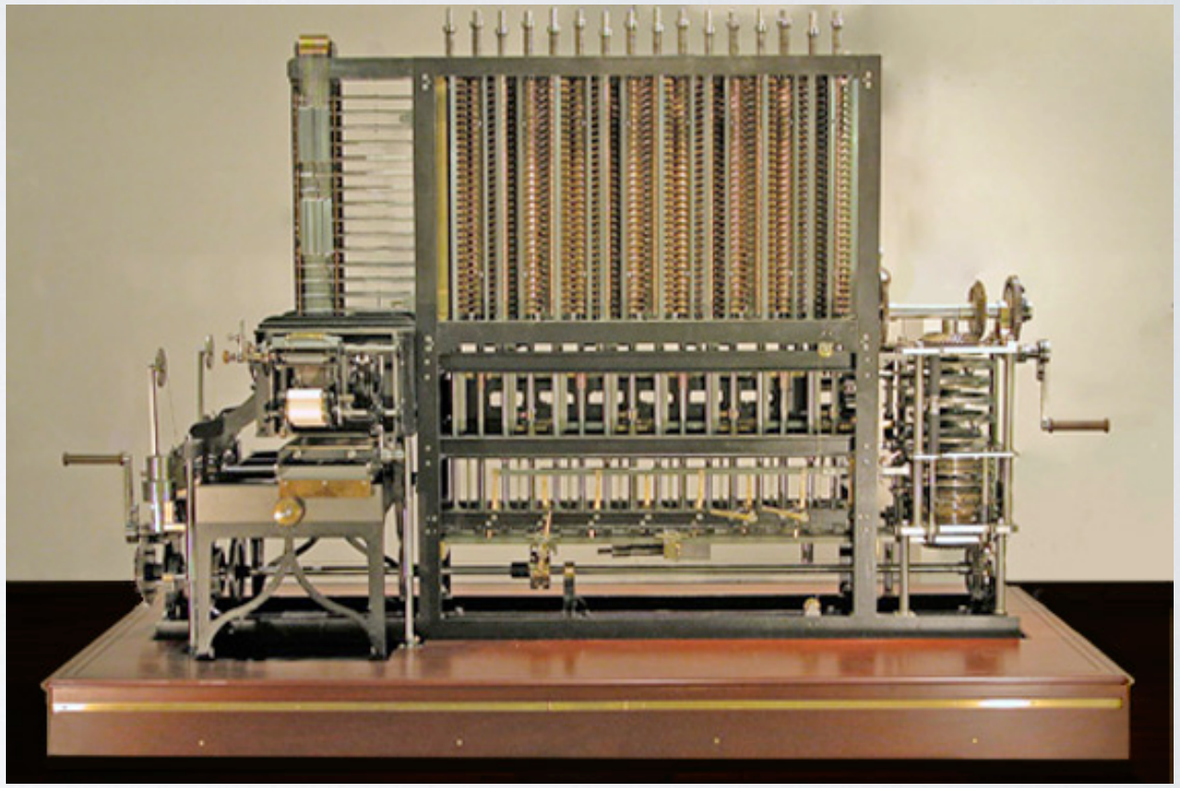

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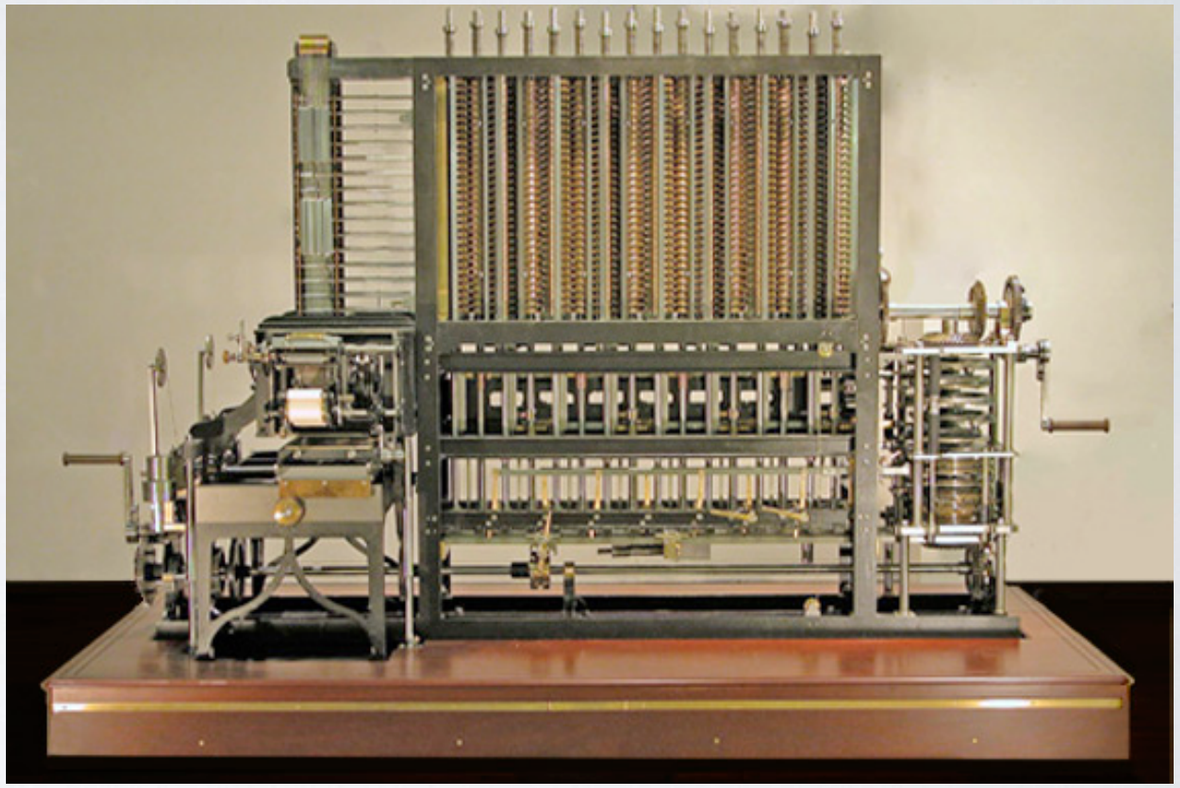

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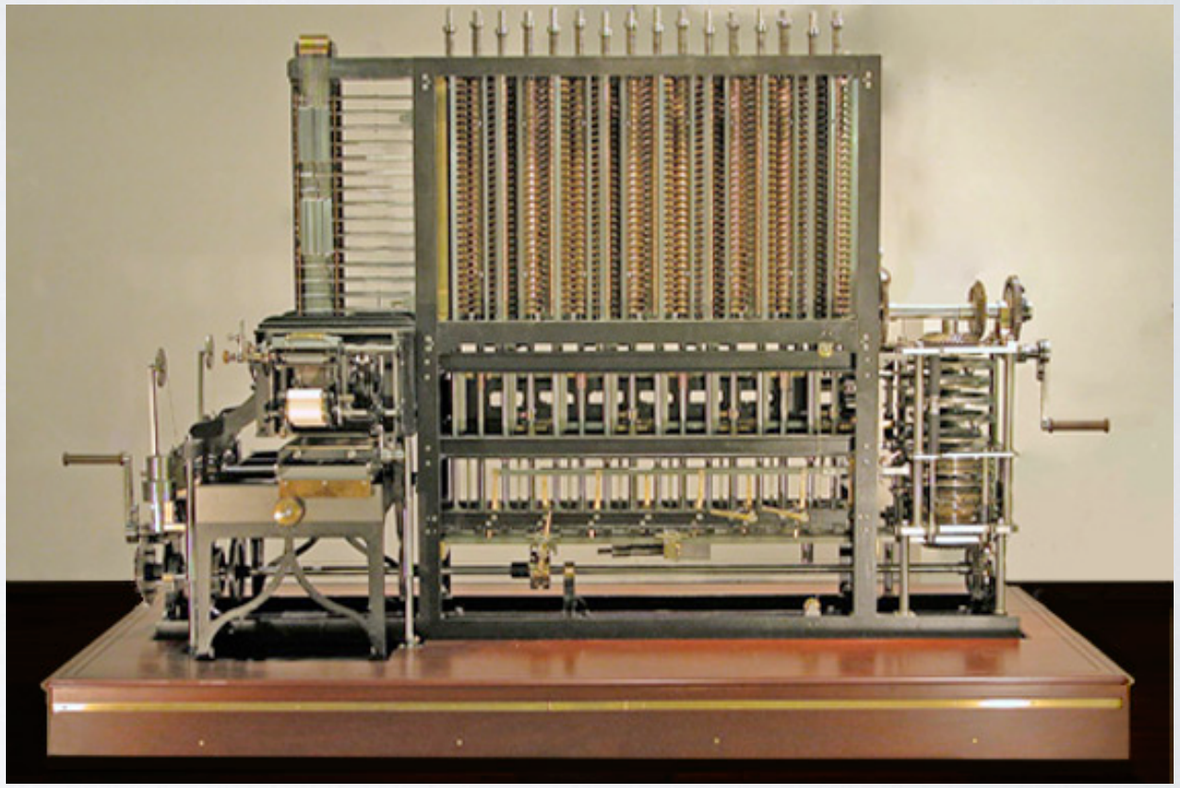

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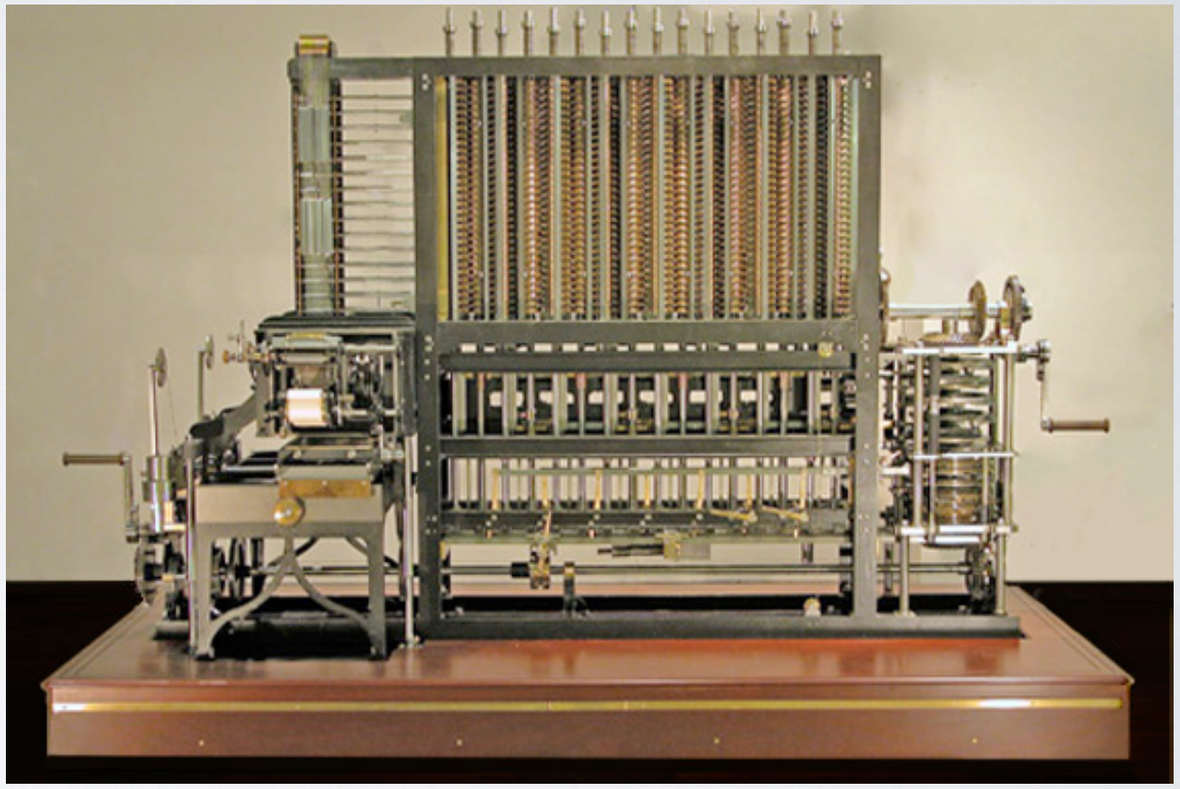

EXCURSUS – A GLANCE ON THE INCOMPLETENESS THEOREM

- "Any formal system either is inconsistent or incomplete."

- Inconsistent: A false sentence can be proven.

- Incomplete: There is no proof for some sentence in the system.

EXAMPLE?

- Difficult, because all "easy understandable" examples do not really catch it

- Try: Barber paradox
  - Village with just one barber, all men clean-shaven.
  - Barber announces: "I shave all those men and only those who do not shave themselves."
  - Question: "Who shaves the barber?"

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Either answer leads to a contradiction, therefore the question cannot be answered

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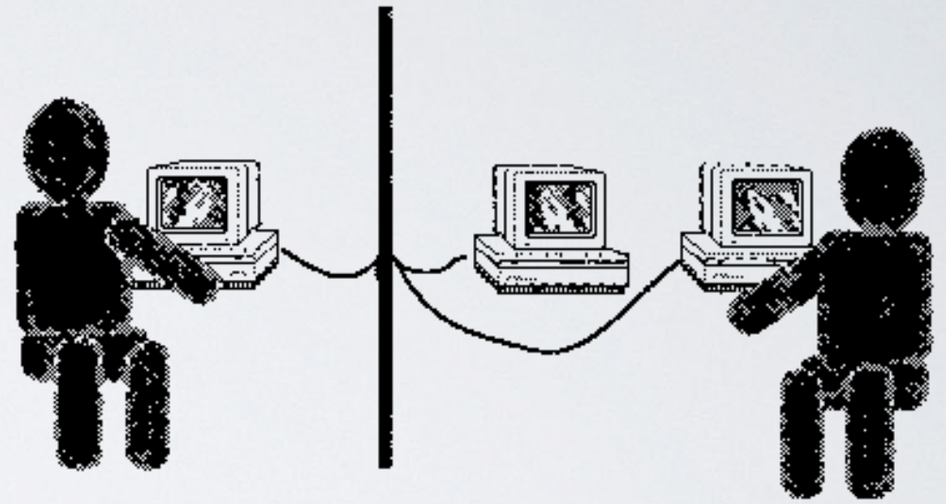

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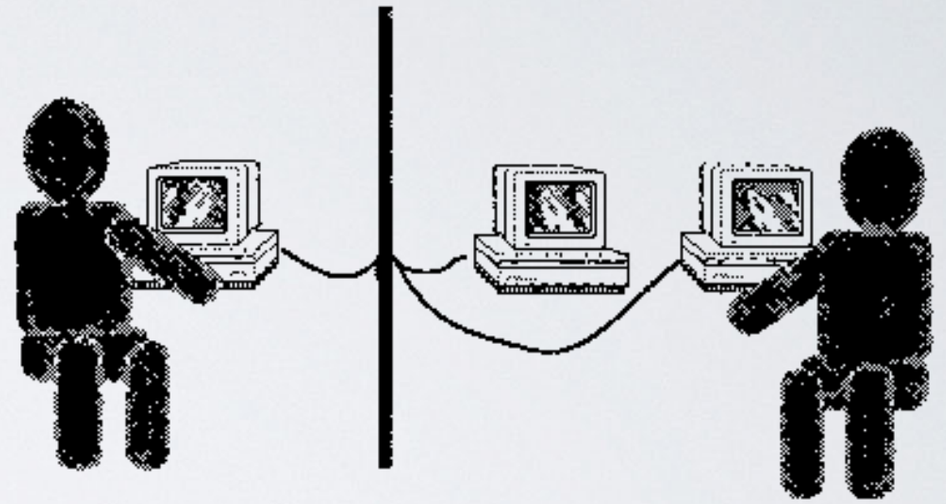

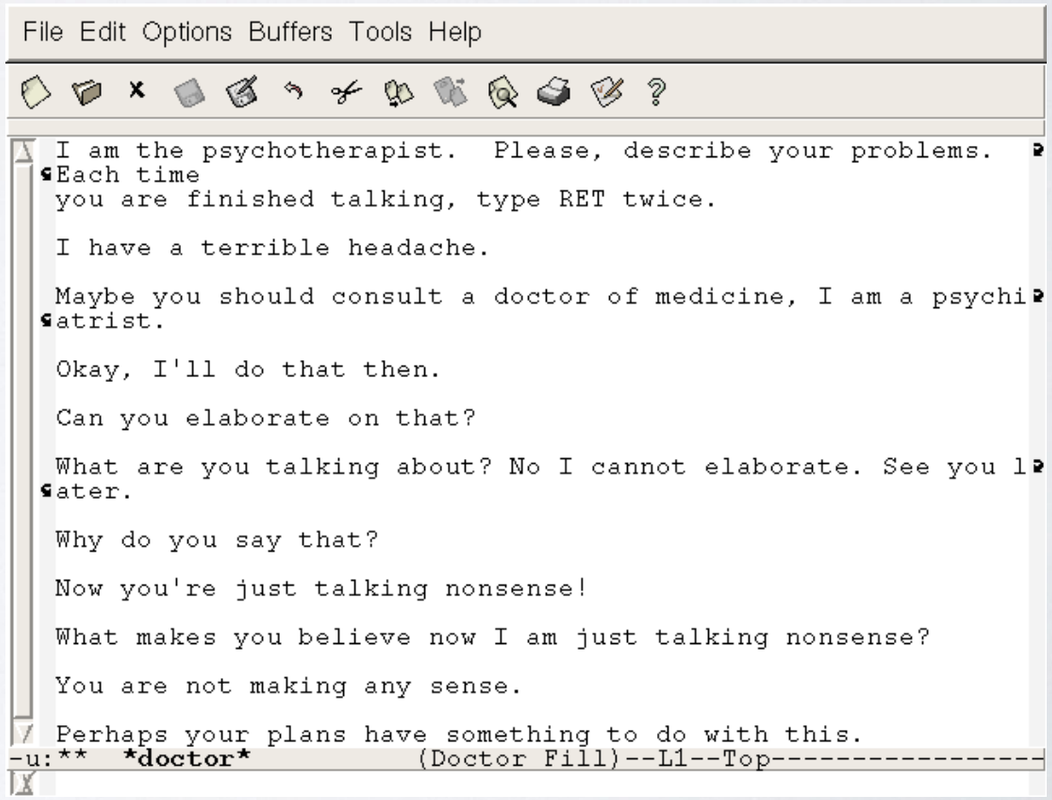

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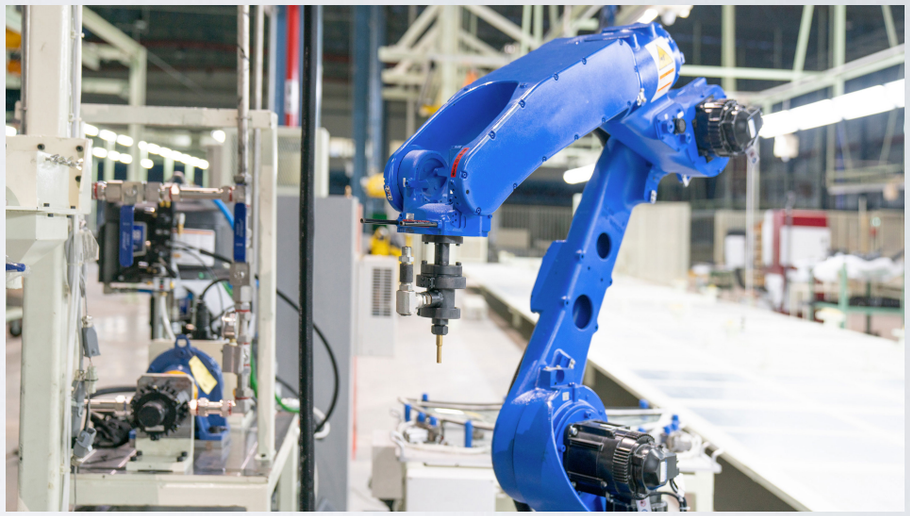

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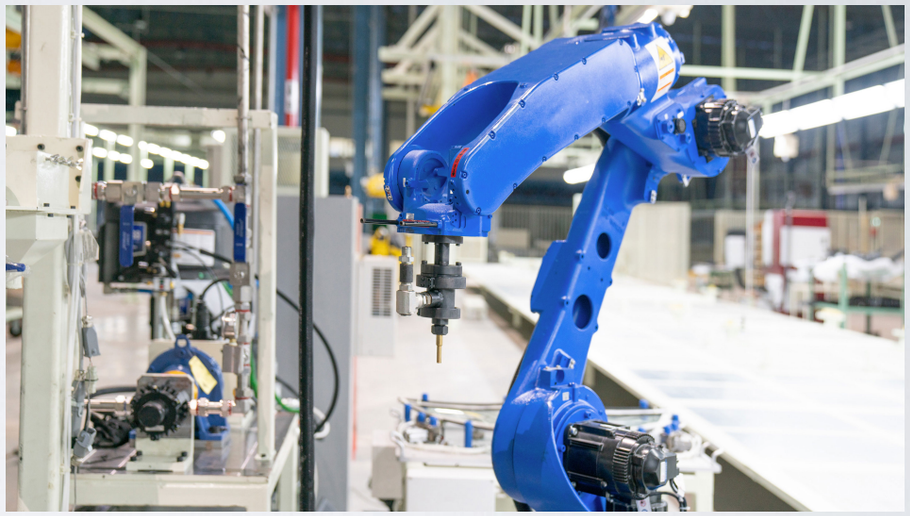

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Artificial Neural Networks / Deep Learning will be an extra Course in grade 4 and 5 (DSAI)

MORE RECENT DEVELOPMENTS

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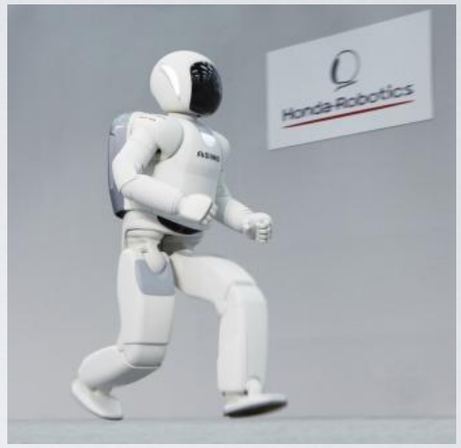

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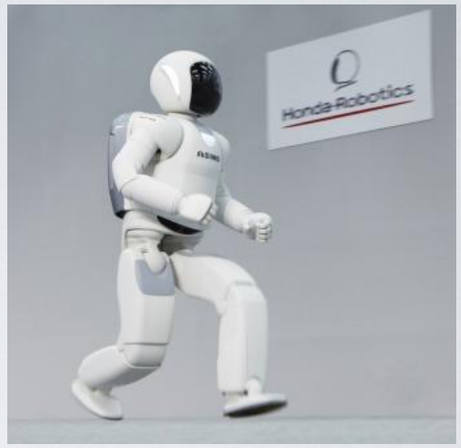

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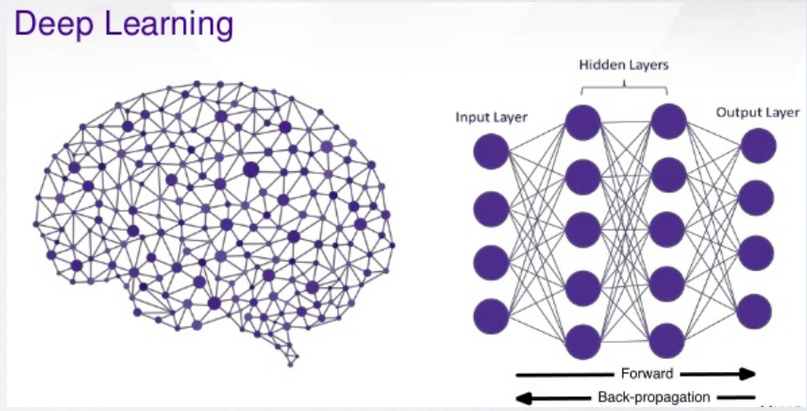

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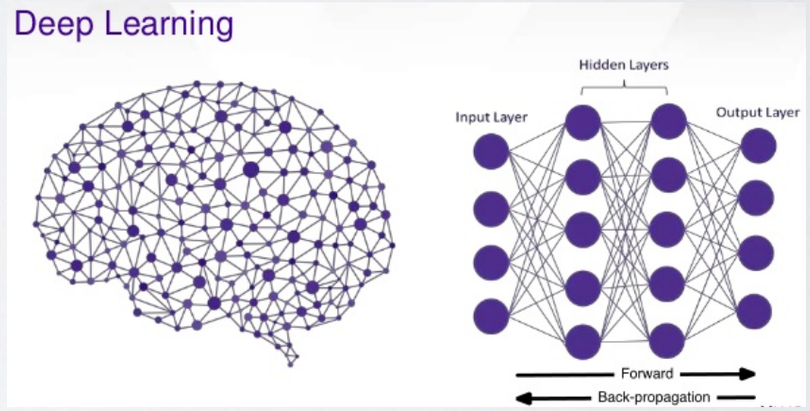

- 2020s: Generative AI, Large Language Models, …

ChatGPT

ADMINISTRIVIA

HOW IS THE COURSE ORGANIZED?

- Lecture (~ 1 unit)
  - Present and discuss necessary concepts in class
- Exercise (~ 1 unit)
  - Discuss home works and other examples

HOW TO GET A GRADE – EXERCISES

- Every week some small examples
- To be solved at home
- Tick your examples next week
- Present them in the exercise hour
- In case of illness: contact the teacher right after you are back and present the examples in a f2f-session

HOW TO GET A GRADE – MINI PUZZLES

- Approx. two to three per semester
- Announced a week in advance
- Results are averaged
- Weight: 50 %

HOW TO GET A GRADE – SUMMARY

- Overall Score in LOAL =
  - Score(Puzzles and Tests) *
  - (Score(Exercises) / 2 + 0.55)
- This score and the Java score is then averaged to get a final grade in POSE

COMMUNICATION: MS TEAMS

- For general announcements and “offline” discussions online

…

HOW TO GET A GRADE – TESTS

- Date 1 (winter term): Announced on our Teams chat
- Date 2 (summer term): Announced on our Teams chat
- Weight: 50 %

WHY TO STUDY THEORETICAL INFORMATICS? – PART 2

- Better mathematical knowledge enables to write better software

- Theoretical informatics applied

BETTER MATHEMATICAL KNOWLEDGE I

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- Traditional algorithm to calculate the gcd of two integers a and b ($a > 0, b \geq 0$)

- Calculate the prime factors of a and b

- Multiply the common prime factors both numbers -> gcd

BETTER MATHEMATICAL KNOWLEDGE 1

- Traditional algorithm to calculate the gcd of two integers a and b ($a > 0, b \geq 0$)
  - Calculate the prime factors of a and b
  - Multiply the common prime factors both numbers -> gcd
- Try it out with a = 24 and b = 16

BETTER MATHEMATICAL KNOWLEDGE 2

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- Euclidean algorithm to calculate the gcd

- $\gcd(a, 0) = a$

- $\gcd(a, b) = \gcd(b, a \bmod b)$

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- Again try it out with $a = 24$ and $b = 16$

BETTER MATHEMATICAL KNOWLEDGE 3

- Calculate the gcd of 1989 and 867
  - Using prime factors
  - Using Euclid's algorithm with modulo
- Compare the efficiency of these algorithms

THEORETICAL COMPUTER SCIENCE APPLIED

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- Formal languages → Compiler construction

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- Production Systems → Game playing, expert systems, Planning, Robotics

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- Complexity theory → Efficiency of algorithms
- Cryptography → Computer security
- Production Systems → Game playing, expert systems, Planning, Robotics
- ANN → Face detection, image analysis