NTIN090 — Introduction to complexity and computability theory

Exam questions, academic year 2023/24

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Two questions will be asked during the oral part of the exam, one from group A and one from group B.

It is required that you are able to prove all propositions we have proved during the lecture (although not necessarily to reproduce the proofs presented during the lecture, alternative proofs are welcome).

A

(A1) Rice's theorem, the proof using m-reducibility.

(A2) Savitch's theorem.

(A3) Deterministic space hierarchy.

(A4) Deterministic time hierarchy.

(A5) Cook-Levin theorem (NP-completeness of SAT)

B

(B1) Universal Turing machine and the undecidability of the language accepted by universal Turing machine (acceptance problem).

(B2) RAM and its equivalence with Turing machines.

(B3) Properties of (Turing) decidable and partially decidable languages (closure properties, Post's theorem, enumerators).

(B4) Definition of the basic complexity classes and the proof of $\mathrm{NTIME}(f(n)) \subseteq \mathrm{SPACE}(f(n))$.

(B5) Definition of the basic complexity classes and the theorem on the relation of space and time ($(\forall L \in \mathrm{NSPACE}(f(n)))(\exists c_L)[L \in \mathrm{TIME}(2^{c_L f(n)})]$).

(B6) Two definitions of class NP and their equivalence.

(B7) Polynomial reduction of SAT to 3-SAT.

(B8) Polynomial reduction of 3-SAT to Vertex Cover.

(B9) Definitions of class FPT and kernel and their relation. Kernelization of Vertex Cover

(B10) Definition of class FPT, parameterized algorithm for Vertex Cover based on search with bounded depth (with the complexity which is better than $O^*(2^k)$).

(B11) Class #P and #P-completeness, proof of the hardness of counting cycles in a graph.

(B12) Class co-NP and co-NP-completeness.

(B13) Pseudo-random generator, one-way functions and they relation to cryptography (symmetric cryptography, bit-commitment).

(B14) An example of a fine-grained reduction (either a reduction from SETH to OV, or OV to regular pattern matching).