INDIVIDUAL HOMEWORK 7, CPSC 421/501, FALL 2020

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Please note:

(1) You must justify all answers; no credit is given for a correct answer without justification.
(2) Proofs should be written out formally.
(3) Homework that is difficult to read may not be graded.
(4) You may work together on homework in groups of up to four, **but you must write up your own solutions individually and must acknowledge with whom you worked.** You must also acknowledge any sources you have used beyond the textbook and two articles on the class website.

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(1) Recall that

$\mathrm{HALT}_{\mathrm{TM}} = \{\langle M, w\rangle \mid M \text{ is a Turning machine that halts on input } w\}$.

Give a direct proof that $\mathrm{HALT}_{\mathrm{TM}}$ is undecidable (i.e., without using the fact that A_{TM} is undecidable); do so using the same strategy used to prove that A_{TM} is undecidable (see the proof Theorem 4.11 in [Sip], page 207, or class notes on 10_22): assume that some Turing machine H decides $\mathrm{HALT}_{\mathrm{TM}}$, and describe how to build a Turing machine D such that when you consider $D(\langle D\rangle)$ (i.e., the outcome of D on input $\langle D\rangle$), you get a contradiction.

(2) Is $\mathrm{HALT}_{\mathrm{TM}}$ (defined above) recognizable? Is the complement of $\mathrm{HALT}_{\mathrm{TM}}$ recognizable? Justify your answers.

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