CSCI 2200 — Foundations of Computer Science (FoCS)
Homework 5 (document version 1.0)

Overview

- This homework is due by 11:59PM on Thursday, December 8
- You may work on this homework in a group of no more than four students; unlike recitation problem sets, **your teammates may be in any section**
- You may use at most **three** late days on this assignment
- Please start this homework early and ask questions during office hours and at your December 7 recitation section; also ask (and answer) questions on the Discussion Forum
- Please be concise in your answers; even if your solution is correct, if it is not well-presented, you may still lose points
- You can type or hand-write (or both) your solutions to the required graded problems below; **all work must be organized in one PDF that lists all teammate names**
- You are strongly encouraged to use LaTeX, in particular for mathematical symbols; see references in Course Materials
- **EARNING LATE DAYS:** for each homework that you complete using LaTeX (including any tables, graphs, etc., i.e., no hand-written anything), you earn one additional late day; you can draw graphs and other diagrams in another application and include them as image files
- To earn a late day, you must submit your LaTeX files (i.e., `*.tex`) along with your one required PDF file—please name the PDF file `hw5.pdf`
- Also note that the earned late day can be used retroactively, even back to the first homework assignment!

Warm-up exercises

The problems below are good practice problems to work on. Do not submit these as part of your homework submission. **These are ungraded problems.**

- **Problem 13.46.**
- **Problem 13.55.**
- **Problem 13.58.**
- **Problem 14.1.**
- **Problem 14.2.**
- **Problem 14.18.**
- **Problem 14.19.**
- **Problem 14.48.**
- **Problem 15.6.**
- **Problem 15.18.**
- **Problem 15.32.**
- **Problem 15.33.**
- **Problem 15.35.**
- **Problem 15.46.**
- **Problem 16.26.**
- **Problem 24.2.**
- **Problem 24.3.**
- **Problem 24.9.**
- **Problem 24.11(a-e,g,i-v,x-z).**

Graded problems

The problems below are required and will be graded.

- ***Problem 13.42.**
- ***Problem 13.50.**
- ***Problem 14.15(b-c).**
- ***Problem 14.34.**
- ***Problem 14.63(g).**
- ***Problem 15.12.**
- ***Problem 24.11(f,h,w).**
- ***Problem 25.7.**

Some of the above problems (graded and ungraded) are transcribed in the pages that follow.

Graded problems are noted with an asterisk (*).

If any typos exist below, please use the textbook description.

- ***Problem 13.42.** To determine if a graph G with 50 vertices is 3-colorable, you test all possible 3-colorings. Your computer checks a million 3-colorings per second. Estimate how long it is going to take, in the worst case.

- ***Problem 13.50.** How many 7-digit phone-numbers are non-decreasing (each digit is not less than the previous one.)

- ***Problem 14.15(b-c).** Consider the binary strings consisting of 10 bits.

  (b) How many contain (i) 5 or more consecutive 1's (ii) 5 or more consecutive 0's?

  (c) How many contain 5 or more consecutive 0's or 5 or more consecutive 1's?

- ***Problem 14.34.** Consider all permutations of $\{1, 2, 3, 4, 5, 6\}$. A permutation is good if any of the sub-sequences 12, 23, or 56 appear. How many good permutations are there?

- ***Problem 14.63(g).** Here are some counting problems on graphs to challenge you.

  (g) How many Hamiltonian cycles are in $K_{n,n}$? [Hint: a Hamiltonian cycle is a cycle on graph $G = (V, E)$ that starts and ends at vertex $v_0 \in V$, visiting each vertex in set $V - \{v_0\}$ (i.e., all other vertices) exactly once.]

- ***Problem 15.12.** Roll a 6-sided die 5 times. What is the probability: (a) some number repeats (b) you get no sixes?

- ***Problem 24.11(f,h,w).** Give DFAs for the following languages, a.k.a., computing problems.

  (f) $\mathcal{L} = \{1^{\bullet 2n}01^{\bullet 2k+1} \mid n, k \geq 0\}$.

  (h) Strings which begin with 10 and end with 01.

  (w) Strings whose length is divisible by 3.

- ***Problem 25.7.** Give a DFA and a CFG for each problem.

  (a) $\mathcal{L} = \{01^{\bullet n} \mid n \geq 0\}$

  (b) $\mathcal{L} = \{0^{\bullet n}1^{\bullet n} \mid 0 \leq n \leq 5\}$

  (c) $\mathcal{L} = \{$ strings which end in a 1 $\}$.