

# “CS 374” Spring 2015 — Homework 3

Due Tuesday, February 17, 2015 at 10am

---

## ••• Some important course policies •••

---

- **You may work in groups of up to three people.** However, each problem should be submitted by exactly one person, and the beginning of the homework should clearly state the names and NetIDs of each person contributing.
- **You may use any source at your disposal**—paper, electronic, or human—but you *must* cite *every* source that you use. See the academic integrity policies on the course web site for more details.
- **Submit your pdf solutions in Moodle.** See instructions on the course website and submit a separate pdf for each problem. Ideally, your solutions should be typeset in LaTeX. If you hand write your homework make sure that the pdf scan is easy to read. Illegible scans will receive no points.
- **Avoid the Three Deadly Sins!** There are a few dangerous writing (and thinking) habits that will trigger an automatic zero on any homework or exam problem. Yes, we are completely serious.
  - Give complete solutions, not just examples.
  - Declare all your variables.
  - Never use weak induction.
- Unlike previous editions of this and other theory courses we are not using the “I don’t know” policy.

---

**See the course web site for more information.**

If you have any questions about these policies,  
please don’t hesitate to ask in class, in office hours, or on Piazza.

---

1. (a) Use the method of the pumping lemma to show that the language  $\{ww \mid w \in \{0, 1\}^*\}$  is not regular.
- (b) Use the method of the pumping lemma to show that the language  $\{0^i 1^j \mid \gcd(i, j) \neq 1\}$  is not regular.
- (c) Use the method of distinguishing suffixes to show that the language  $\{a^i b^j c^k \mid i < j < k\}$  is not regular.
- (d) Use the method of distinguishing suffixes to show that the language  $\{wx x \mid w, x \in \{0, 1\}^+\}$  is not regular.

2. Let the grammar  $G = (V, \Sigma, P, \langle \text{STMT} \rangle)$  be as follows.

$\Sigma = \{\text{if, condition, then, else, } a = 1\}$

$V = \{\langle \text{STMT} \rangle, \langle \text{ASSIGN} \rangle, \langle \text{IF-THEN} \rangle, \langle \text{IF-THEN-ELSE} \rangle\}$

Production set  $P$  is

$$\begin{aligned} \langle \text{STMT} \rangle &\rightarrow \langle \text{ASSIGN} \rangle \mid \langle \text{IF-THEN} \rangle \mid \langle \text{IF-THEN-ELSE} \rangle \\ \langle \text{IF-THEN} \rangle &\rightarrow \text{if condition then } \langle \text{STMT} \rangle \\ \langle \text{IF-THEN-ELSE} \rangle &\rightarrow \text{if condition then } \langle \text{STMT} \rangle \text{ else } \langle \text{STMT} \rangle \\ \langle \text{ASSIGN} \rangle &\rightarrow a = 1 \end{aligned}$$

- (a) Show that the grammar  $G$  is ambiguous.
  - (b) Give an unambiguous grammar that generates the same language as  $G$ .
3. Give CFGs for the following languages, and clearly explain how they work and the role of each nonterminal. Grammars can be very difficult to understand, and if the grader does not understand how your construction is intended to generate the language, then you will receive 0 points.
    - (a)  $\{w \mid w \in \{0, 1\}^* \text{ and } w \text{ is not a palindrome}\}$
    - (b)  $\{a^i b^j c^k \mid j = i + k\}$
    - (c)  $\{a^i b^j c^k d^l \mid i + l = j + k\}$