

CS 591 S2—Formal Language Theory: Integrating Experimentation and Proof—Fall 2018

Problem Set 6

Due by 12:30pm on Thursday, November 29

You must submit your problem set solution as a hard copy, either: at the beginning of class; or, no later than 12:05pm, via the CS Department drop box labeled “CS 591 S2”. In addition, see the instructions in Problem 2 for emailing the Forlan code for Problem 2(c) to me, no later than 12:30pm.

Problem 1 (15 points)

Let G be the grammar

$$A \rightarrow \% \mid A0A1A.$$

Find and draw a pair of parse trees showing that G is ambiguous. Use Forlan to show that your answer is correct. Include a transcript of your Forlan session. (Nothing from this problem should be emailed to me.)

Problem 2 (85 points)

Define a language X by:

$$X = \{ 1^i 2^j 3^k \mid i, j, k \in \mathbb{N} \text{ and } k \leq i + j \leq 2k \}.$$

E.g., because $4 \leq 3+2 \leq 2*4$, we have that $1^3 2^2 3^4 \in X$. But $1^3 2^2 3^6 \notin X$, because $6 \not\leq 3+2$. And $1^3 2^2 3^2 \notin X$, because $3+2 \not\leq 2*2$.

(a) Prove that X is not regular. [20 points]

(b) Find a grammar G such that **alphabet** $G = \{1, 2, 3\}$ and $L(G) = X$. [15 points]

(continued on next page)

(c) In a file `ps6-p2-gram.txt`, express G in Forlan's syntax. Write a Forlan program `ps6-p2-testing.sml` defining a function

```
val test = fn : gram -> bool
```

that, given a purported solution `gram` to part (b), checks that the alphabet of `gram` is $\{1, 2, 3\}$, and also tests `gram` on all elements of $\{1, 2, 3\}^*$ of length no more than 10.

Include printouts of `ps6-p2-gram.txt` and `ps6-p2-testing.sml` in your hard copy submission, as well as a transcript of the following Forlan session:

```
- val gram = Gram.input "ps6-p2-gram.txt";
val gram = - : gram
- use "ps6-p2-testing.sml";
[opening ps6-p2-testing.sml]
...
val test = fn : gram -> bool
val it = () : unit
- test gram;
val it = true : bool
```

Also email `ps6-p2-gram.txt` and `ps6-p2-testing.sml` as plain text attachments to me (`stough@bu.edu`), with a subject line including “[591S2:PS6]”. [15 points]

(d) Prove that your solution to part (b) is correct. [35 points]