HW 1: Extra problems

CS/ECE 374: Algorithms & Models of Computation, Fall 2017 Version: **1.0**

Solved problem

1 ***C comments*** are the set of strings over alphabet $\Sigma = \{*, /, A, \square, \ll\texttt{Enter}\gg\}$ that form a proper comment in the C program language and its descendants, like C++ and Java. Here $\ll\texttt{Enter}\gg$ represents the newline character, $\square$ represents any other whitespace character (like the space and tab characters), and A represents any non-whitespace character other than $*$ or $/$.[1] There are two types of C comments:

- Line comments: Strings of the form $// \cdots \ll\texttt{Enter}\gg$.
- Block comments: Strings of the form $/* \cdots */$.

Following the C99 standard, we explicitly disallow ***nesting*** comments of the same type. A line comment starts with $//$ and ends at the first $\ll\texttt{Enter}\gg$ after the opening $//$. A block comment starts with $/*$ and ends at the first $*/$ completely after the opening $/*$; in particular, every block comment has at least two $*$s. For example, each of the following strings is a valid C comment:

- $/***/$
- $//\square//\square\ll\texttt{Enter}\gg$
- $/*///\square*\square\ll\texttt{Enter}\gg**/$
- $/*\square//\square\ll\texttt{Enter}\gg\square*/$

On the other hand, *none* of the following strings is a valid C comments:

- $/*/$
- $//\square//\square\ll\texttt{Enter}\gg\square\ll\texttt{Enter}\gg$
- $/*\square/*\square*/\square*/$

1.A. Describe a DFA that accepts the set of all C comments.

1.B. Describe a DFA that accepts the set of all strings composed entirely of blanks ($\square$), newlines ($\ll\texttt{Enter}\gg$), and C comments.

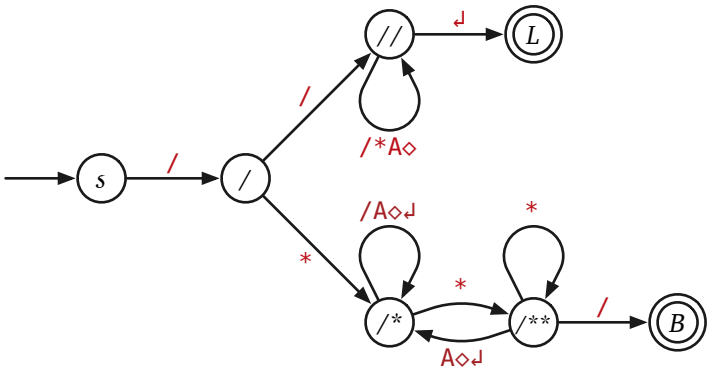
You must explain *in English* how your DFAs work. Drawings or formal descriptions without English explanations will receive no credit, even if they are correct.

[1] The actual C commenting syntax is considerably more complex than described here, because of character and string literals.

- The opening $/*$ or $//$ of a comment must not be inside a string literal ($"\cdots"$) or a (multi-)character literal ($'\cdots'$).
- The opening double-quote of a string literal must not be inside a character literal ($'"'$) or a comment.
- The closing double-quote of a string literal must not be escaped ($\backslash"$)
- The opening single-quote of a character literal must not be inside a string literal ($"\cdots'\cdots"$) or a comment.
- The closing single-quote of a character literal must not be escaped ($\backslash'$)

Solution:

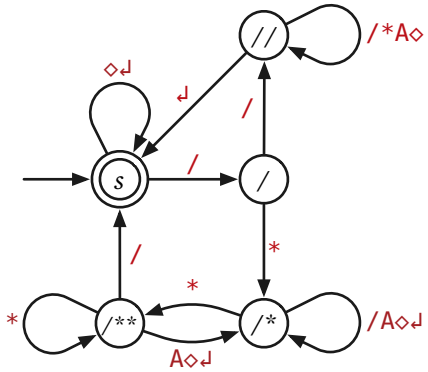
1.A. The following eight-state DFA recognizes the language of C comments. All missing transitions lead to a hidden reject state.



The states are labeled mnemonically as follows:

- s - We have not read anything.
- / - We just read the initial /.
- // - We are reading a line comment.
- L - We have read a complete line comment.
- /* - We are reading a block comment, and we did not just read a $*$ after the opening /$*$.
- /** - We are reading a block comment, and we just read a $*$ after the opening /$*$.
- B - We have read a complete block comment.

1.B. By merging the accepting states of the previous DFA with the start state and adding white-space transitions at the start state, we obtain the following six-state DFA. Again, all missing transitions lead to a hidden reject state.



- A backslash escapes the next symbol if and only if it is not itself escaped (\\) or inside a comment.

For example, the string "/*\\\"*/"/*"/*\"/*"*/ is a valid string literal (representing the 5-character string /*\"*/, which is itself a valid block comment!) followed immediately by a valid block comment. ***For this homework question, just pretend that the characters ', ", and \ don't exist.***

Commenting in C++ is even more complicated, thanks to the addition of *raw* string literals. Don't ask.

Some C and C++ compilers do support nested block comments, in violation of the language specification. A few other languages, like OCaml, explicitly allow nesting block comments.

The states are labeled mnemonically as follows:

- s - We are between comments.
- / - We just read the initial / of a comment.
- // - We are reading a line comment.
- /* - We are reading a block comment, and we did not just read a $*$ after the opening /$*$.
- /** - We are reading a block comment, and we just read a $*$ after the opening /$*$.

Rubric: 10 points = 5 for each part, using the standard DFA design rubric (scaled)

Rubric:[DFA design] For problems worth 10 points:

- 2 points for an unambiguous description of a DFA, including the states set Q, the start state s, the accepting states A, and the transition function δ.
  - **For drawings:** Use an arrow from nowhere to indicate s, and doubled circles to indicate accepting states A. If $A = \varnothing$, say so explicitly. If your drawing omits a reject state, say so explicitly. **Draw neatly!** If we can't read your solution, we can't give you credit for it,.
  - **For text descriptions:** You can describe the transition function either using a 2d array, using mathematical notation, or using an algorithm.
  - **For product constructions:** You must give a complete description of the states and transition functions of the DFAs you are combining (as either drawings or text), together with the accepting states of the product DFA.
- **Homework only:** 4 points for *briefly* and correctly explaining the purpose of each state *in English*. This is how you justify that your DFA is correct.
  - For product constructions, explaining the states in the factor DFAs is enough.
  - **Deadly Sin:** ("Declare your variables.") No credit for the problem if the English description is missing, *even if the DFA is correct.*
- 4 points for correctness. (8 points on exams, with all penalties doubled)
  - -1 for a single mistake: a single misdirected transition, a single missing or extra accept state, rejecting exactly one string that should be accepted, or accepting exactly one string that should be accepted.
  - -2 for incorrectly accepting/rejecting more than one but a finite number of strings.
  - -4 for incorrectly accepting/rejecting an infinite number of strings.
- DFA drawings with too many states may be penalized. DFA drawings with *significantly* too many states may get no credit at all.
- Half credit for describing an NFA when the problem asks for a DFA.