

CS 352 – Compiling and Programming Systems

Mid-term Examination, 10/26/11

Instructions: Read carefully through the whole exam first and plan your time. Note the relative weight of each question and part (as a percentage of the score for the whole exam). The total points is 100 (*ie*, your grade will be the percentage of your answers that are correct).

This exam is **closed book, closed notes**. You may *not* refer to any book or other materials.

You have **60 minutes** to complete both (2) questions. Write your answers on this paper (use both sides if necessary).

Name:

Student Number:

Signature:

1. (Regular expressions, finite automata; 40%) Consider the following languages L and M formed from the alphabet $\Sigma = \{a, b\}$:

$$L = \{l \in \Sigma^* \mid l \text{ consists of a single } a, \text{ optionally followed by a sequence of } bs\}$$

$$M = \{m \in \Sigma^* \mid m \text{ consists of an optional sequence of } as, \text{ followed by a single } b\}$$

- (a) (5%) Write a regular expression for each of L , M and $L \cup M$.

Answer:

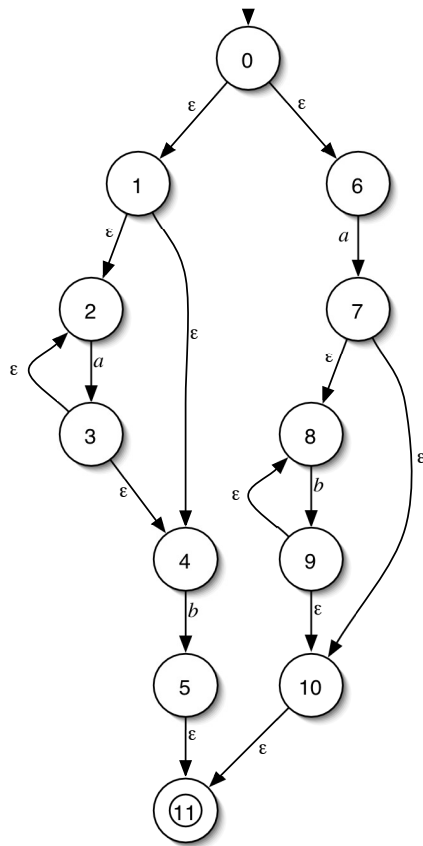
$$L = ab^*$$

$$M = a^*b$$

$$L \cup M = ab^* \mid a^*b$$

- (b) (15%) As described in class, *systematically* construct an NFA that accepts $L \cup M$.

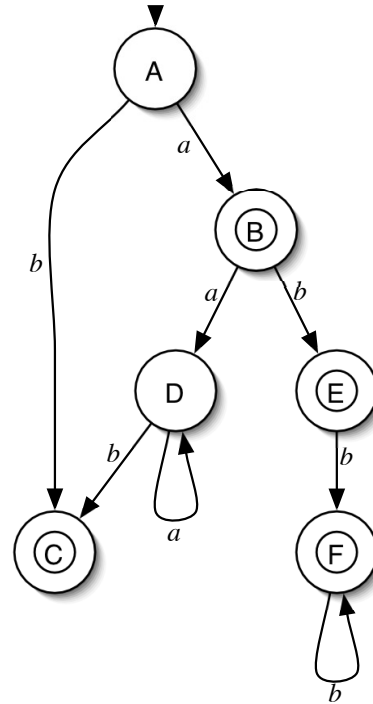
Answer:



(c) (15%) Using the subset construction, convert your NFA into a DFA. Make sure to indicate the start and final states of your DFA.

Answer:

	<i>a</i>	<i>b</i>
$A = \{0, 1, 2, 4, 6\}$	B	C
$B = \{2, 3, 4, 7, 8, 10, 11\}$	D	E
$C = \{5, 11\}$		
$D = \{2, 3, 4\}$	D	C
$E = \{5, 8, 9, 10, 11\}$		F
$F = \{8, 9, 10, 11\}$		F

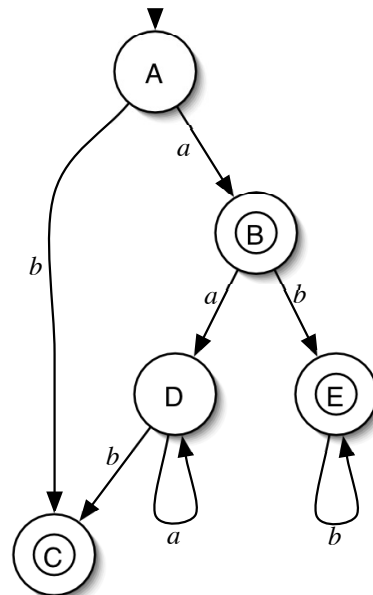


(d) (5%) Optimize your DFA by merging equivalent states.

Answer:

States *E* and *F* are equivalent.

	<i>a</i>	<i>b</i>
$A = \{0, 1, 2, 4, 6\}$	B	C
$B = \{2, 3, 4, 7, 8, 10, 11\}$	D	E
$C = \{5, 11\}$		
$D = \{2, 3, 4\}$	D	C
$E = \{5, 8, 9, 10, 11\}$		E



2. (Parsing; 60%) Consider the following simple grammar and the language it describes:

$$\begin{aligned} S &\rightarrow AB \\ A &\rightarrow Aa \\ A &\rightarrow \epsilon \\ B &\rightarrow bB \\ B &\rightarrow b \end{aligned}$$

(a) (5%) In words say what *language* this grammar describes?

Answer:

The language of 0 or more *as* followed by 1 or more *b*'s.

(b) (5%) Write a regular expression for this *language*.

Answer:

$$a^*bb^*$$

(c) (5%) Is this *language* LL(1)? Explain. [There is a simple argument.]

Answer:

Yes, the language is regular, and all regular languages are LL(1).

(d) (5%) Is this *grammar* LL(1)? Explain. [There is a simple argument.]

Answer:

No, the grammar is not LL(1) by inspection since it is left-recursive and the last two rules have a common prefix.

(e) (15%) Transform the grammar, if necessary, and derive an LL(1) parse table to parse this language.

Answer:

Grammar		FIRST	FOLLOW	a	b	$\$$
$S \rightarrow AB$	S	ab	$\$$	$S \rightarrow AB$	$S \rightarrow AB$	
$A \rightarrow A'$	A	$a\epsilon$	b	$A \rightarrow A'$	$A \rightarrow A'$	
$A' \rightarrow aA' \mid \epsilon$	A'	$a\epsilon$	b	$A' \rightarrow aA'$	$A' \rightarrow \epsilon$	
$B \rightarrow bB'$	B	b	$\$$		$B \rightarrow bB'$	
$B' \rightarrow B \mid \epsilon$	B'	$b\epsilon$	$\$$		$B' \rightarrow B$	$B' \rightarrow \epsilon$

or simplifying the grammar:

Grammar		FIRST	FOLLOW	a	b	$\$$
$S \rightarrow AbB$	S	ab	$\$$	$S \rightarrow AbB$	$S \rightarrow AbB$	
$A \rightarrow aA \mid \epsilon$	A	$a\epsilon$	b	$A \rightarrow aA$	$A \rightarrow \epsilon$	
$B \rightarrow bB \mid \epsilon$	B	$b\epsilon$	$\$$		$B \rightarrow bB$	$B \rightarrow \epsilon$

- (f) (15%) Consider the *original* (untransformed) grammar. Is the original *grammar* LR(0)? Explain. [Consider the sets of LR(0) items.]
Answer:

(g) (5%) Is the original grammar SLR(1)? Explain. [Do SLR(1) lookaheads resolve any LR(0) conflicts from the previous question?]

Answer:

(h) (5%) Is the original grammar LR(1)? Explain. [There is a simple argument.]

Answer: