

CSE105 Closed Book Quiz, Thursday, Oct. 21, 1999

- Write a regular expression over the alphabet of lower-case letters $\{\mathbf{a-z}\}$ to describe the language that consists of all strings containing exactly one occurrence of each vowel, such that the vowels appear in alphabetical order **a e i o u**. (For example the string **xyaxyewhyiwhy** is in the language, but **eioubxyz** and **aaeiouxyz** are not.)

Let $\Sigma = \{a-z, *, /\} - \{a, e, i, o, u\}$. Then the regular expression for the given language is

$$\Sigma^* a \Sigma^* b \Sigma^* c \Sigma^* d \Sigma^* e \Sigma^*$$

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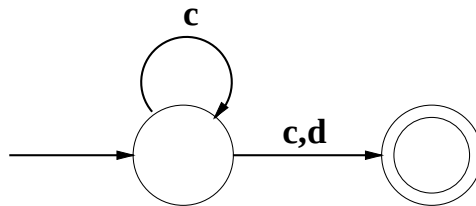
$$/ * \Sigma^* * /$$

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- Construct an NFA that recognizes the language described by the regular expression

$$(c^* \circ d) \cup (c \circ c^*)$$

where $\circ$ is the concatenation operator.



- Show the following language is non-regular:

$$L = \{a^n b^n \mid n \geq 0\}$$

The proof is by contradiction. Assume L is regular. Then we know we can apply the pumping lemma. Let p be the pumping length given by the pumping lemma. Let the target string s be $a^p b^p$. Since $s \in L$ and has length greater than p , We know that s can be partitioned into strings x , y , and z such that:

- $|xy| \leq p$;
- $|y| > 0$; and
- $\forall i \geq 0, xy^i z \in L$.

By conditions a and b , $y = a^k$, where $0 < k \leq p$. However, $xy^2 z = a^{p+k} b^p$ is not in L since there are more a 's than b 's, contradicting condition c . Therefore, L cannot be regular.

- True or False: The concatenation of two regular languages is regular.

True.