



**1. Briefly describe a reason that one should study formal languages.**

It is important to study formal languages as the principles and concepts apply to many different types of systems. Formal language fundamentals have not changed in over 40 years, and likely will not change any time in the near future.

**2. Webber Chap. 1 Exercise 1**

Restate each of the following languages by listing its contents. For example, if the language is shown as  $\{x \in \{a, b\}^* \mid |x| \leq 2\}$ , your answer should be  $\{\epsilon, a, b, aa, bb, ab, ba\}$ .

- (a)  $\{x \in \{a, b, c\}^* \mid |x| \leq 2\}$   
 $\{\epsilon, a, b, c, aa, bb, cc, ab, ba, ac, ca, bc, cb\}$
- (b)  $\{xy \mid x \in \{a, aa\} \text{ and } y \in \{aa, aaa\}\}$   
 $\{aaa, aaaa, aaaaa\}$
- (c)  $\{\}^*$   
 $\{\epsilon\}$
- (d)  $\{a^n \mid n \text{ is less than } 20 \text{ and divisible by } 3\}$   
 $\{\epsilon (n=0), aaa (n=3), aaaaaa (n=6), aaaaaaaaa (n=9), aaaaaaaaaaaa (n=12), aaaaaaaaaaaaaa (n=15), aaaaaaaaaaaaaaaaaa (n=18)\}$
- (e)  $\{a^n b^m \mid n < 2 \text{ and } m < 3\}$   
 $\{\epsilon, a, b, bb, ab, abb\}$

**3. Webber Chap. 1 Exercise 2**

List all strings of length 3 or less in each of the following languages:

- (a)  $\{a\}^*$   
 $\epsilon, a, aa, aaa$
- (b)  $\{a, b\}^*$   
 $\epsilon, a, aa, aaa, b, bb, bbb, abb, aab, baa, bba, aba, bab$
- (c)  $\{a^n b^m\}^*$   
 $\epsilon, ab,$
- (d)  $\{xy \mid x \in \{a\}^* \text{ and } y \in \{b\}^*\}$   
 $\epsilon, a, b, aa, bb, ab, aaa, bbb, aab, abb$
- (e)  $\{a^n b^m \mid n > m\}$   
 $a, aa, aaa, aab$

**4. Webber Chap. 1 Exercise 4**

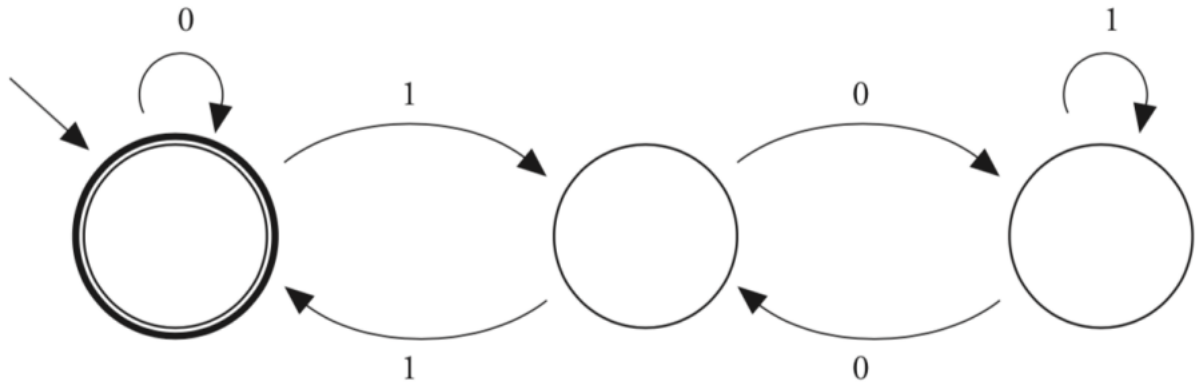
Restate each of the following languages using set former notation

- (a) the language of all strings over the alphabet  $\{a, b\}$  that begin with a  
 $\{ax \mid x \in \{a, b\}^*\}$
- (b) the language of all even-length strings over the alphabet  $\{a, b, c\}$   
 $\{x \in \{a, b, c\}^* \mid |x| \text{ is even}\}$

- (c) the language of strings consisting of zero or more copies of the string ba  
 $\{(\text{ba})^n \mid n > 0\}$
- (d) the language of strings consisting of any number of as followed by the same number of bs, followed by the same number of cs  
 $\{a^n b^n c^n\}$

5. **Webber Chap. 2 Exercise 2**

For each of the following strings, say whether it is in the language accepted by this DFA:

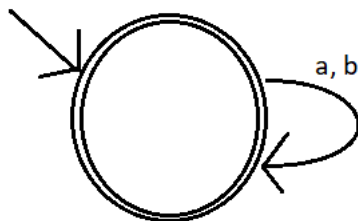


- (a) 0 - accepted
- (b) 11 - accepted
- (c) 110 - accepted
- (d) 1001 - accepted
- (e) 101 - rejected

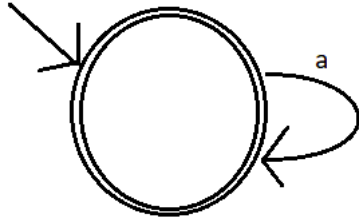
6. **Webber Chap. 2 Exercise 4**

For each of the following languages, draw a DFA accepting that language. The alphabet for the DFA in all cases should be  $\{a, b\}$

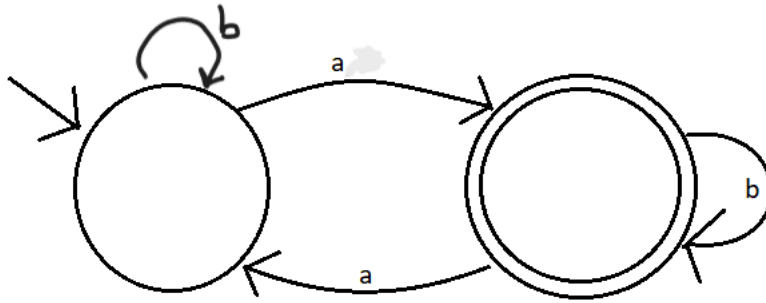
- (a)  $\{a, b\}^*$



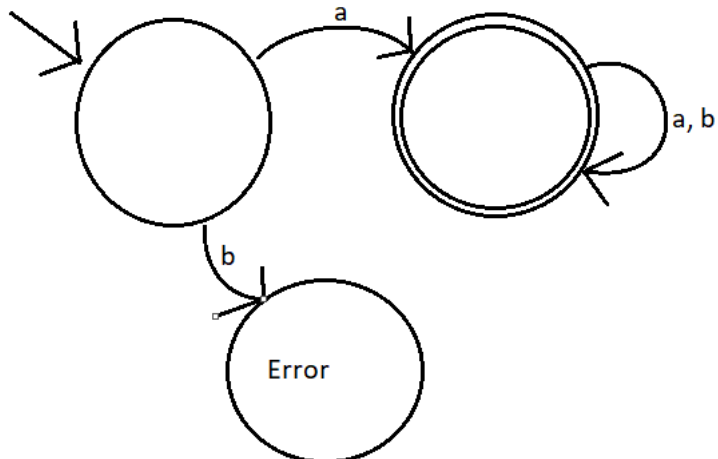
(b)  $\{a\}^*$



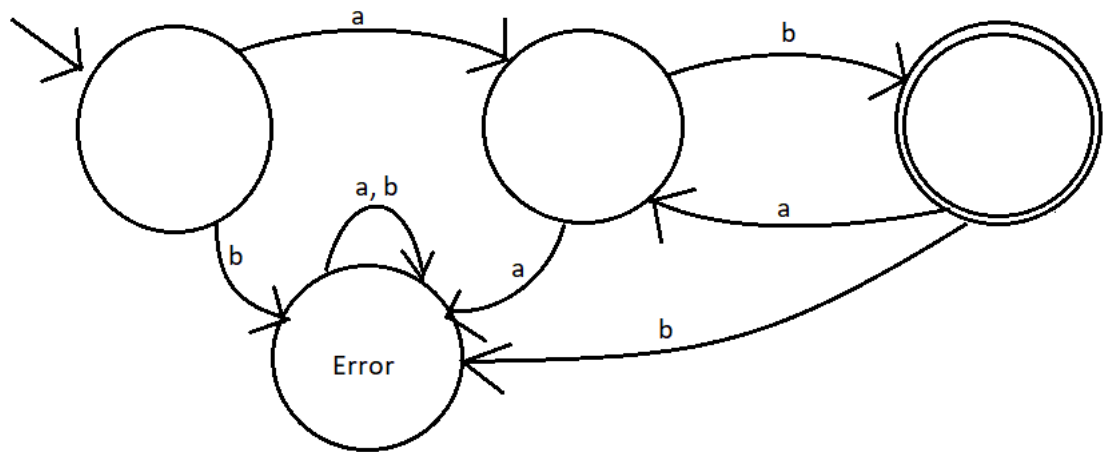
(c)  $\{x \in \{a, b\}^* \mid \text{the number of a's in } x \text{ is odd}\}$



(d)  $\{ax \mid x \in \{a, b\}^*\}$



(e)  $\{(ab)^n\}$





## GPT-3.5

## 1. Prompt: list the contents of the following language:

(a)  $\{x \in \{a, b, c\}^* \mid |x| \leq 2\}$

Here are the contents of this language:

$\epsilon$  (empty string), a, b, c, aa, ab, ac, ba, bb, bc, ca, cb, cc

This answer matches mine.

(b)  $\{xy \mid x \in \{a, aa\} \text{ and } y \in \{aa, aaa\}\}$

Here are the contents of this language:

aaa, aaaa, aaaaa, aaaaaa, aa, aaaa

I disagree with this answer. I do not think that 'aaaaaa' is part of this language. The largest string you can make from these two languages is 'aaaaa'. Additionally, if  $\epsilon$  is not a part of these languages, then the smallest string would be 'aa'.

(c)  $\{\}^*$

In this case, the language contains only one string:

$\epsilon$  (the empty string)

This answer matches mine.

(d)  $\{a^n \mid n \text{ is less than 20 and divisible by 3}\}$

Here are the contents of this language:

$\epsilon$  (empty string), aaa, aaaaaa, aaaaaaaaa, aaaaaaaaaaaa, aaaaaaaaaaaaaa, aaaaaaaaaaaaaaaaaa

While the first few answers are correct ( $n=3, n=6, n=9, n=12$ ), the next answers generated by ChatGPT have an amount of 'a's that is not divisible by 3 or is not less than 20

(e)  $\{a^n b^m \mid n < 2 \text{ and } m < 3\}$

Here are the contents of this language:

$\epsilon$  (empty string), a, aa, b, bb, ab, aab

This answer matches mine.

## 2. Prompt: List all strings of length 3 or less in each of the following languages:

(a)  $\{a\}^*$

Here are some examples of strings in this language:

$\epsilon$  (empty string), a, aa, aaa

This answer matches mine.

(b)  $\{a, b\}^*$

Here is a list of some strings in this language:

$\epsilon$ , a, b, aa, ab, ba, bb, aaa, aab, aba, abb, baa, bab, bba, bbb

This answer matches mine.

(c)  $\{a^n b^m\}^*$

Here are some example strings from this language:

$\epsilon$ , a, b, aa, ab, ba, bb, aaa, aab, abb, bbb

(d)  $\{xy \mid x \in \{a\}^* \text{ and } y \in \{b\}^*\}$

Here are some example strings from this language:

$\epsilon$ , a, aa, ab, aab, b, bb, abb, aaa, bbb

This answer matches mine. Any amount of as followed by any amount of bs.

(e)  $\{a^n b^m \mid n > m\}$

Here are some strings in this language:

aa (n=2, m=0), aaa (n=3, m=0), aab (n=2, m=1)

This answer matches mine. There must be more as than bs.