Quiz One  
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Exercise 1

Given the sets $A$, $B$, $C$, $D$ and $E$, classify the following statements as either true or false and spell out the sets below.

$A = \{1, 2, 3, 4, 5\}$

$B = \{1, 2, 3, \{3\}, \{1, 4\}, \emptyset\}$

$C = \{4, 5, \{1, 4\}\}$

$D = \{\{1, 4\}\}$

$E = \{\emptyset\}$

Statements:

a) $1 \in A$
b) $3 \in B$
c) $3 \subseteq B$
d) $\{3\} \in B$
e) $\{3\} \subseteq B$
f) $\{1, 4\} \subseteq C$
g) $D \subseteq C$
h) $E \subseteq B$
i) $E \subseteq A$
j) $\emptyset \subseteq E$
k) $\emptyset \in E$
m) $\{1, 3, 4\} \subseteq B$

Sets:

a) $A \cap B$
b) $B \cup E$
c) $D - C$
d) $B - A$
e) $B \cup C$
f) $D \cup E$
j) $C \cap D$
k) $\varnothing(C - D)$
Exercise 2

Prove the following statement for any sets $A$, $B$ and $C$. Use exclusively the set-theoretical equalities in p. 18 of the reading. (If you want to use something else, you will have to prove it first.) Apply one rule per line with the following exception: commutativity can be applied several times in the same line, and associativity too.

$$(A - B) \cap C \subseteq (A \cap B) \cup C$$
Exercise 3
Examine the following data from Swahili, a language spoken in East Africa, and answer the questions that follow.

i. Give the Swahili morphemes for the following English translations:

<table>
<thead>
<tr>
<th>English</th>
<th>Swahili</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>me</td>
</tr>
<tr>
<td>you(subject)</td>
<td>you (object)</td>
</tr>
<tr>
<td>s/he</td>
<td>him/her</td>
</tr>
<tr>
<td>we</td>
<td>us</td>
</tr>
<tr>
<td>they</td>
<td>them</td>
</tr>
<tr>
<td>future marker</td>
<td>present perfect marker</td>
</tr>
<tr>
<td>past marker</td>
<td>present progressive marker</td>
</tr>
<tr>
<td>annoy</td>
<td></td>
</tr>
<tr>
<td>beat</td>
<td></td>
</tr>
<tr>
<td>pay</td>
<td></td>
</tr>
<tr>
<td>like</td>
<td></td>
</tr>
</tbody>
</table>

ii. What is the order of the morphemes in Swahili, in terms of subject, object, verb and tense?

iii. Give the Swahili word for the following English translations:

I have beaten them.
They are beating me.
They have annoyed me.
You have beaten us.
Exercise 4

Show that the following languages are regular. That is, construct state diagrams for (deterministic) FSA that recognize the following languages. For each language, assume that $\Sigma = \{a, b\}$ and use as few states as possible.

i) \{w: \text{w starts with the sub-string } ab \text{ and ends with } a\} 

ii) \{w: \text{the length of } w \text{ is } 3n, \text{ where } n \text{ is a natural number} \}
The set of natural numbers is \{1, 2, 3, 4, 5,\ldots\}.

iii) \{w: \text{every sub-string } aa \text{ in } w \text{ is immediately followed by a } bb \text{ sub-string} \}
E.g. the string \textbf{aaabb} does not belong to this language.