Compiler Construction

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Exercise Sheet 2

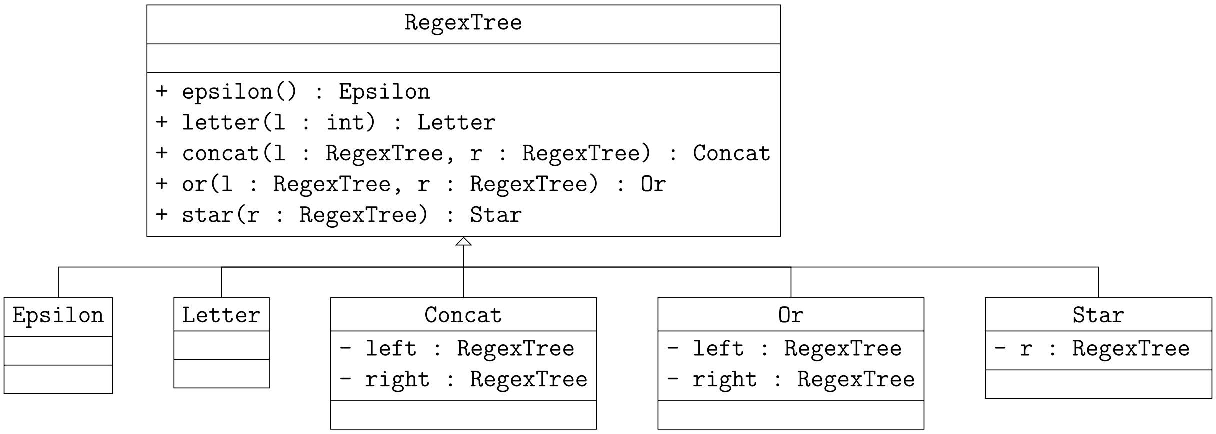
Assignment 2.1 Berry-Sethi Algorithm (Sophisticated Approach)

Use the Berry-Sethi Algorithm and transform the expression $r = (\epsilon|ba)(c(a|b)^*)$ as follows:

1. Draw the regular expression as a tree.
2. Compute the `empty` attribute.
3. Compute the `first` attribute.
4. Compute the `next` attribute.
5. Compute the `last` attribute.
6. Construct and draw the automaton.
7. Is the resulting automaton deterministic or not?
8. Is the resulting automaton minimal or not?

Assignment 2.2 Berry-Sethi is alive!

Get your hands dirty! Basically your task is to implement the sophisticated Berry-Sethi approach in Java. In order to do so we have to represent a regular expression as a tree. You might want to start with the following class layout:



We represent elements from our alphabet Σ by objects of the class `Letter` and assume that our alphabet Σ are all unicode characters.

So far, we cannot properly parse (we will change this in the following weeks). Therefore, as an input we do not parse a regular expression given as a string and construct our tree from that, instead, we construct the tree directly via helper methods defined in the class `RegexTree`. For example, the following call

```
concat(star(or(letter('a'), letter('b'))),
       concat(letter('a'),
              or(letter('a'), letter('b'))))
```

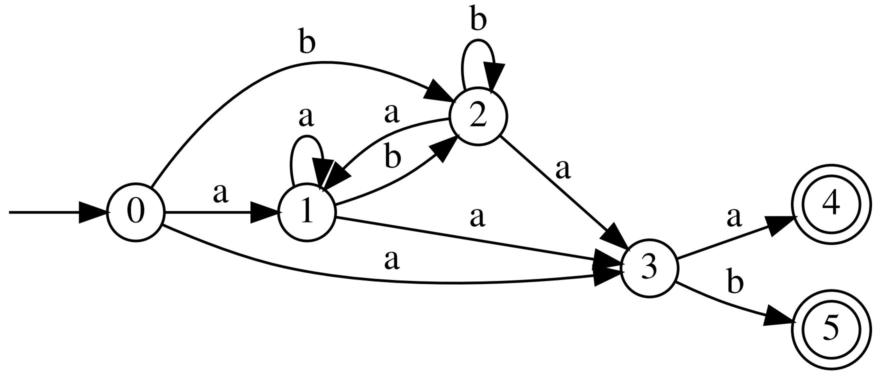
returns a corresponding tree of the regular expression `(a|b)*(a(a|b))`.

Extend the classes to suit your needs. Compute the attributes `empty`, `first`, `next`, and `last`. Hint: You can traverse the tree by directly implementing corresponding methods in the tree-classes, or, you can implement the visitor-pattern. The latter approach is typically the better way to do the job (in a few weeks you will learn the visitor-pattern in class anyway).

Now we want to visualize the non-deterministic finite automata. Make use of the Graphviz DOT language in order to visualize the automata. A corresponding NFA from the example regular expression from above is given in the DOT language as follows:

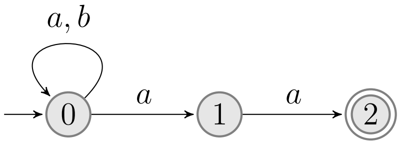
```
digraph nfa {
  rankdir=LR;
  size="8,5"
  node [shape=none,width=0,height=0,margin=0]; start [label=""];
  node [shape=doublecircle];
  4;5;
  node [shape=circle];
  0 -> 1 [label="a"];
  0 -> 3 [label="a"];
  0 -> 2 [label="b"];
  1 -> 1 [label="a"];
  1 -> 3 [label="a"];
  1 -> 2 [label="b"];
  3 -> 4 [label="a"];
  3 -> 5 [label="b"];
  2 -> 1 [label="a"];
  2 -> 3 [label="a"];
  2 -> 2 [label="b"];
  start -> 0;
}
```

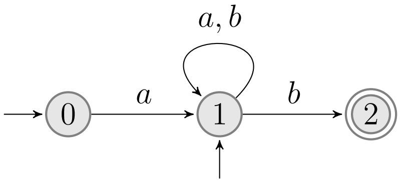
Assuming that the content from above is saved in a file named `nfa.gv`, you can then layout the automata via the command `dot -Tpdf nfa.gv -O` resulting in a PDF file `nfa.gv.pdf`:

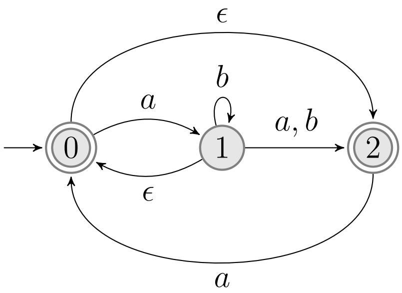


Assignment 2.3 Powerset Construction

Transform the following NFAs to DFAs using the powerset construction. If necessary add a $\emptyset$-state.

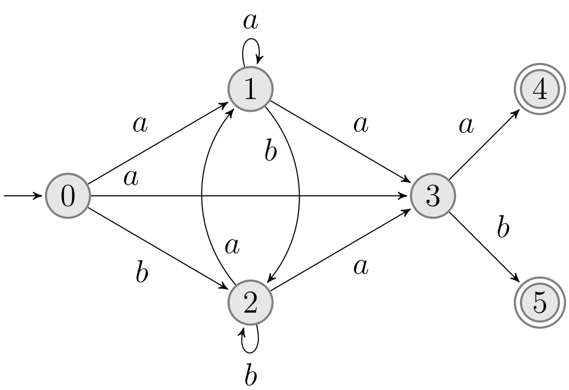
1. 

2. 

3. 

Assignment 2.4 Partial Powerset Construction

Consider the following NFA from the lecture:



Construct only the part of the corresponding DFA that is needed for the input *baaa*.