

Regex Theory: Write a (Simple) Regex Compiler

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Background & Explanation

Put simply, your goal in this assignment is to implement the process from the previous assignment in code. Specifically, you'll get a regular expression, you'll convert it to a DFA, and then the DFA will be ready to run on input strings in a single left-to-right pass to determine a match.

This is **much simpler** than the full-featured regex we've used in the practical regex assignments. The grammar contains only the following:

- `ab` to specify two tokens in sequence (token `a` followed by token `b`)
- `a|b` to specify two different options (token `a` OR token `b`)
- `(ab)` to group a regular expression into a single token
- `a*` to specify any number, including zero, of a token (token `a` any number of times)
- `a+` to specify any number, excluding zero, of a token (token `a` at least once)
- `a?` to specify an optional token (token `a` once or not at all)

...and does not contain any character classes. We also are only looking to see if the entire string matches or not, so you don't have to worry about finding a match on a substring.

This probably goes without saying, but **you may not import re to accomplish this assignment**. No fair using compiled regular expressions to compile regular expressions!

Input/Output Specification

You'll receive three command-line arguments – a language, a regular expression, and a txt file with test cases. You will compile the regular expression to a DFA and then run it on all the test cases. The required output is just like the Deterministic Finite Automata assignment – you'll print out a table showing the state connections, a list of final nodes, and the results of tests on the given strings.

Sample Runs

To help you out, I've given a couple of sample runs where I'm outputting what my computer does at each stage of the conversion process. **This is not required for you** – you only need to output the end. But hopefully this will help you debug.

On each of these sample runs, note that it is quite likely that you won't end up with your states numbered precisely as mine have been. This is ok. You should be able to take your own states and find a corresponding state to each of them in my output (the fancy mathematical term for this is that your solutions don't need to be identical to mine but they do need to be **isomorphic** to mine).

Finally, I want to point out a choice I made here that you don't have to also do, but that might be helpful. Note that during the NFA stages, I've made each state be a dict of characters to **tuples** so that I can store multiple connections with the same character. When we get to DFA, I convert back to the format I showed in the DFA assignment.

```
> compile_regex.py ab a|(ab|b*a)* dfa_ex_tests.txt
```

Converted to NFAwe:

*	eps	a	b
0	(2,)	(1,)	—
1	—	—	—
2	(5, 1)	(3,)	—
3	—	—	(2,)
4	—	(2,)	—
5	(4,)	—	(5,)

Final: [1]

Converted to NFA:

*	a	b
0	(1, 3, 2)	(5,)
1	—	—
2	(3, 2)	(5,)
3	—	(2,)
4	(2,)	—
5	(2,)	(5,)

Final: [0, 1, 2]

While converting to DFA, here are my new states: {(1, 2, 3): 6, (2, 3): 7, (2, 5): 8}

Converted to DFA:

*	a	b
0	6	5
1	—	—
2	7	5
3	—	2
4	2	—
5	2	5
6	7	8
7	7	8
8	7	5

Final: [0, 1, 2, 6, 7, 8]

While cleaning, after removing states unreachable from start:

*	a	b
0	6	5
2	7	5
5	2	5
6	7	8
7	7	8
8	7	5

Final: [0, 2, 6, 7, 8]

While removing redundant nodes, each tuple represents a pair of redundant nodes:

{(6, 7), (2, 8)}

{(0, 2)}

set()

^ The final 'set()' is on the last time through my redundancy search loop where no redundancies are found.

Cleaned DFA (everything after THIS POINT is the output YOU need to have):

*	a	b
0	6	5
5	0	5
6	6	0

Final: [0, 6]

True a

False b

True aa

False bb

True aba

False bab

True abba

True baab

True ababa

False babab

False abbbbb

True baaaaa

True abba

True baab

True abbaa

False baaabb

```
> compile_regex.py ab a(a|b*)a|b+ dfa_ex_tests.txt
```

Converted to NFAwe:

*	eps	a	b
0	—	(2,)	(5,)
1	—	—	—
2	(4,)	(3,)	—
3	—	(1,)	—
4	(3,)	—	(4,)
5	(1,)	—	(5,)

Final: [1]

Converted to NFA:

*	a	b
0	(2,)	(5,)
1	—	—
2	(3, 1)	(4,)
3	(1,)	—
4	(1,)	(4,)
5	—	(5,)

Final: [1, 5]

While converting to DFA, here are my new states: {(1, 3): 6}

Converted to DFA:

*	a	b
0	2	5
1	—	—
2	6	4
3	1	—
4	1	4
5	—	5
6	1	—

Final: [1, 5, 6]

While cleaning, after removing states unreachable from start:

*	a	b
0	2	5
1	—	—
2	6	4
4	1	4
5	—	5
6	1	—

Final: [1, 5, 6]

While removing redundant nodes, each tuple represents a pair of redundant nodes:

set()

^ The final 'set()' is on the last time through my redundancy search loop where no redundancies are found.

Cleaned DFA (everything after THIS POINT is the output YOU need to have):

*	a	b
0	2	5
1	—	—
2	6	4
4	1	4
5	—	5
6	1	—

Final: [1, 5, 6]

False a

True b

True aa

True bb

True aba

False bab

True abba

False baab

False ababa

False babab

False abbbb

False baaaaa

True abba

False baab

False abbaa

False baaabb

Process finished with exit code 0

Specification

Submit a single Python script to the link on the course website.

This assignment is **complete** if:

- The “Name” field on the Dropbox submission form contains your **class period**, then your **last name**, then your **first name**, in that order.
- Your code takes in 3 command line arguments, as specified above, and compiles and runs a regex, as specified above. Pay careful attention to the output you should have; note that you don’t need everything from my sample output.
- **YOUR CODE MAY NOT IMPORT re.** No fair using compiled regexes to compile regexes.