Tutorial 4

COMP 355: Introduction to Theoretical Computer Science

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Outline

1. Regular Expressions
2. Finite Automata and Regular Expressions

Contents of the section

1 Regular Expressions

2 Finite Automata and Regular Expressions

Regular Expressions

Example

Express the following languages using regular expressions.

1. L is the language that consists of alternating 0's and 1's.
2. L is the language that consists of either 1's or 0's in multiples of 3.
3. L is the language consists of words of length 5 using English alphabet that start with ax.

Regular Expressions

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Solution

1. $L = (01)^*$
2. $L = (000)^* + (111)^*$
3. $L = ax(\{\lambda\} + \Sigma + \Sigma^2 + \Sigma^3)$ where Σ is English alphabet.

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Finite Automata to Regular Expression

Our conversion starts with first converting the FA to a Generalized NFA (GNFA). GNFA has the following characteristics/conditions:

1. The start state has transition arrows going to every other state but **no arrows** coming in from any other states.
2. There is only a **single accept** state, and it has arrows coming in from every other state but no arrows going to any other state. Furthermore, the accept state is not the same as the start state.
3. Except for the start and accept states, one arrow goes from every state to every other state and also from each state to itself.

GNFA Construction

- If condition 1 is not already satisfied then create a new start state and connect it to the old start state with λ connection.
- If condition 2 is not satisfied then create a new accept state and connect the old accept state(s) by λ connection to it. Turn the old accept states to non-accept states.
- If condition 3 is not satisfied for some state q create *dummy* connections with $\emptyset$ transitions.

Example

Turn the following NFA to a GNFA.

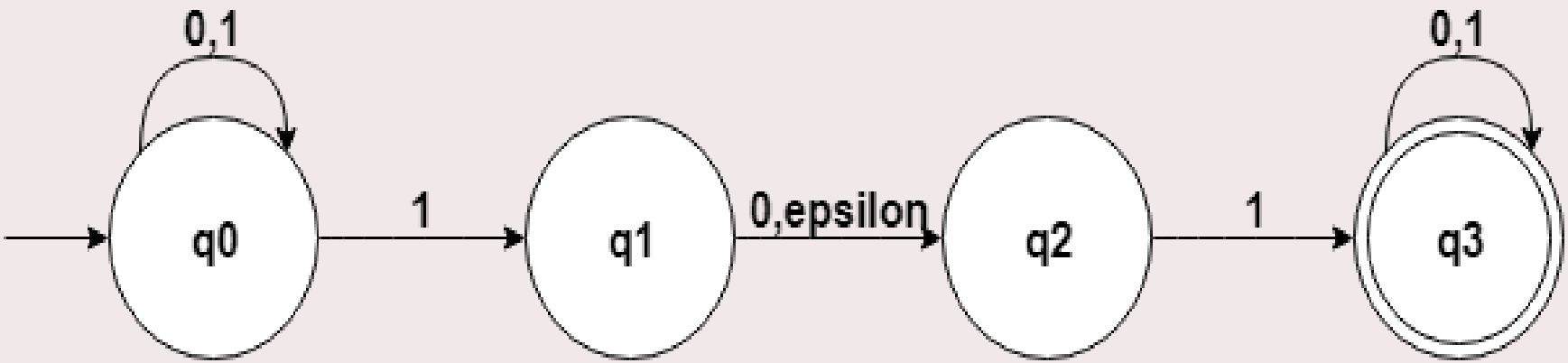

Figure: NFA diagram.

Example

Find the regular expression of the following GNFA over $\Sigma = \{a, b\}$:

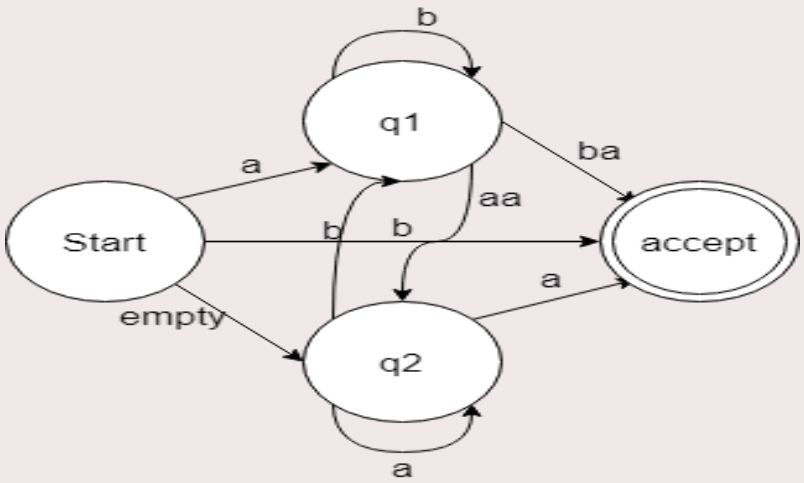

Figure: GNFA to RegEx.

Example

Build an NFA for the following regular expression:

$$R = (00 + 11)^*1$$