# REPORT

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## Abstract:

To implement a Suffix tree to search for occurrences of a string in a document. The suffix tree is implemented in C++ using the Ukkonen’s algorithm.

## Objectives

The following problems to be solved for given dataset *AesopTales.txt*:

* List all the occurrences of a query-string in the set of documents.
* List only the first occurrence of a given query-string in every document. If the query-string is not present, find the first occurrence of the longest substring of the query-string.
* For a given query-string (query of words), list the documents ranked by the relevance.

## Approach:

The following steps were followed to build the tree:

Source: Geeks for Geeks:



Suffix extension is all about adding the next character into the suffix tree built so far.  
In extension j of phase i+1, algorithm finds the end of S[j..i] (which is already in the tree due to previous phase i) and then it extends S[j..i] to be sure the suffix S[j..i+1] is in the tree.

There are 3 extension rules:

### Rule 1:

If the path from the root labelled S[j..i] ends at leaf edge (i.e. S[i] is last character on leaf edge) then character S[i+1] is just added to the end of the label on that leaf edge.

### Rule 2:

If the path from the root labelled S[j..i] ends at non-leaf edge (i.e. there are more characters after S[i] on path) and next character is not s[i+1], then a new leaf edge with label s{i+1] and number j is created starting from character S[i+1]. A new internal node will also be created if s[1..i] ends inside (in-between) a non-leaf edge.

### Rule 3:

If the path from the root labelled S[j..i] ends at non-leaf edge (i.e. there are more characters after S[i] on path) and next character is s[i+1] (already in tree), do nothing.

### Document Ranking:

A score is given to each document based on the following criteria with an initial score of 0:

* If all m characters of the query match then score is given as (m × 2).
* If a word matches (whole) k times from the query and n such words match, score if given by .
* x is calculated as:
  + X = 2 if word is not a stop word.
  + X = 0.5 if words is a stop word.
* Thus, total score = + (m × 2).

**[IMPORTANT]** Reasons for this ranking is as follows:

* If the user is searching for a phrase and a document has it as a whole, it must be given a very high priority. Hence the +m\*2.
* If the user is searching for a query but is unsure of the sentence, he can search for the words present in the document he needs.
* Since the program is unsure if the user is going for case 1 or 2, the ‘X’ factor takes care of misinterpreting case 1 as case 2 by giving low score to matched stop words.

Example:

User searches: “*cats in the cradle and the silver spoon*”:

* The user is going for option one and is searching for a sentence match.
* If such a sentence exists, the document will get a +39 which is significant.
* But if the sentence does not exist, and a document has cats, cradle and spoon, it will get a +6.

User searches for *“cat kitten dog puppies”:*

* The user is going for option two.
* Since there are no stop words, the document with the most matches to these household pets will get the highest score.

## Git Link: <https://github.com/DarkFate13/suffix-tree>

## Average Timing:

|  |  |  |
| --- | --- | --- |
| Problem | Average Time with print (ms) | |
| List all the occurrences | Build: 1239.8 | Find: 0.0224 |
| List only the first occurrence | 1821.32 | |
| List document relevance | 1074.89 | |

## 

## Acknowledgement:

* This code is based on Geeks For Geeks implementation of [[Suffix tree](http://www.geeksforgeeks.org/generalized-suffix-tree-1/)] using C.
* I would like to thank my professors, Prof. N.S. Kumar and Prof. Channa Bankapur for their valuable advice.
* I would like to thank [[Tushar Roy](https://www.youtube.com/user/tusharroy2525)] for his [[video](https://www.youtube.com/watch?v=aPRqocoBsFQ)] on Ukkonens implementation of Suffix Tree.