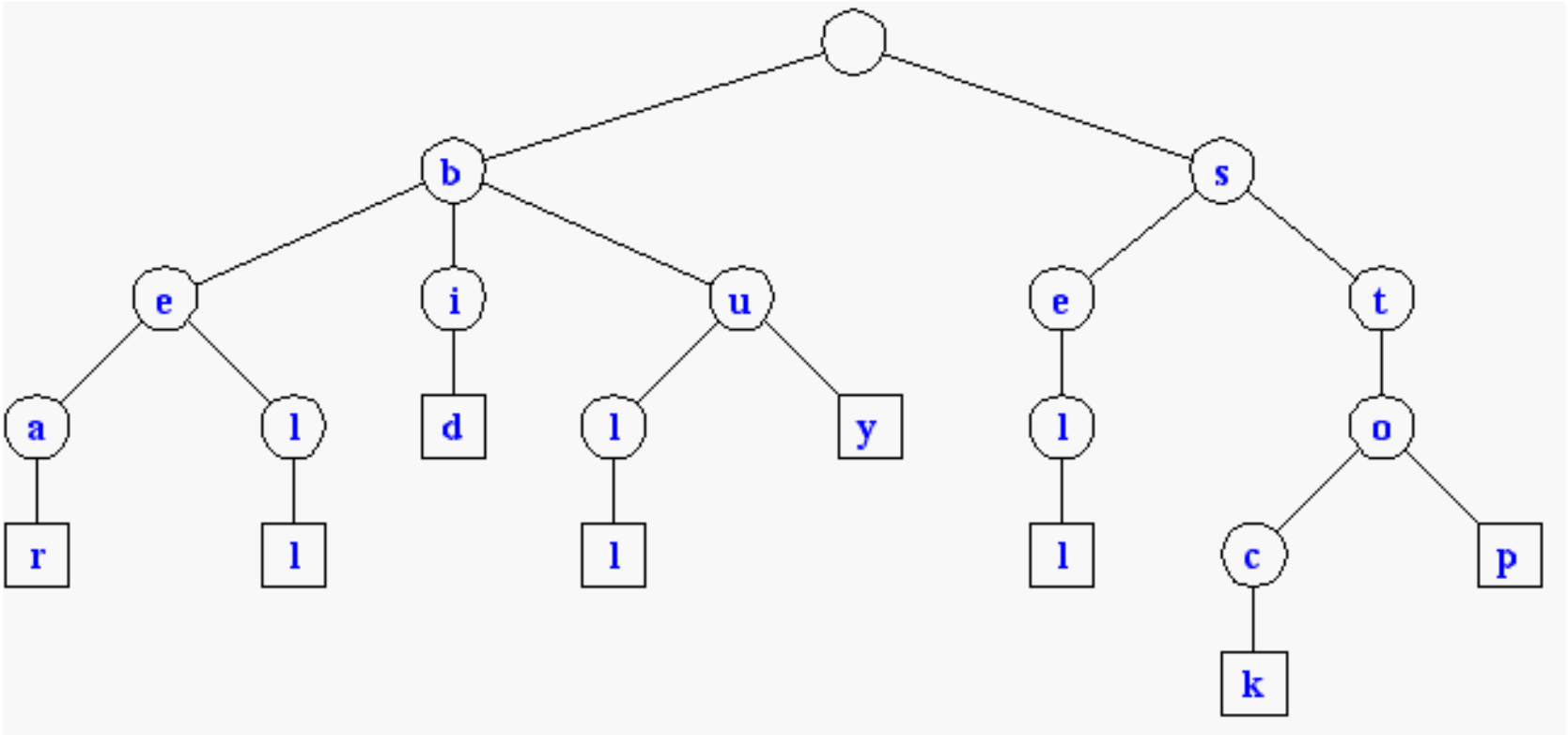
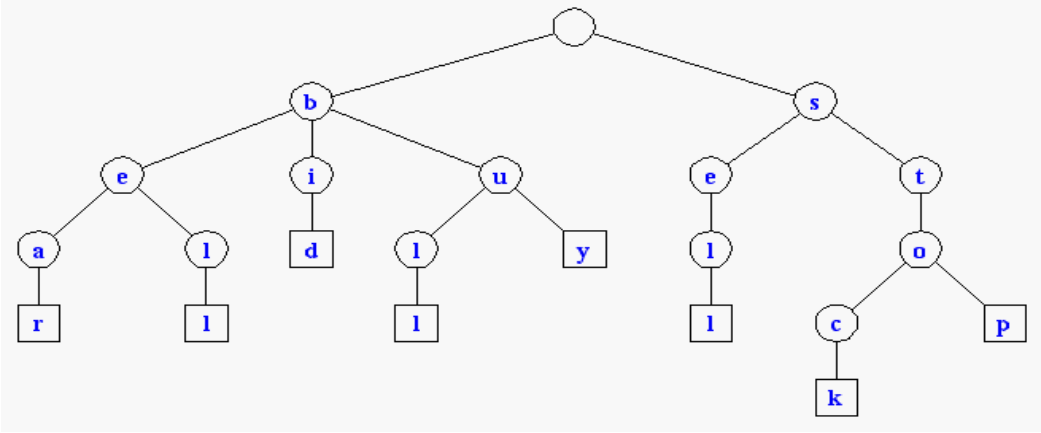
Tries

- Standard Tries
- Compressed Tries
- Suffix Tries



Standard Tries

- The ***standard trie*** for a set of strings S is an ordered tree such that:
  - each node but the root is labeled with a character
  - the children of a node are alphabetically ordered
  - the paths from the external nodes to the root yield the strings of S
- Example: standard trie for the set of strings S = { bear, bell, bid, bull, buy, sell, stock, stop }



•A standard trie uses O(n) space. Operations (find, insert, remove) take time O(dm) each, where:

-n = total size of the strings in S,

-m =size of the string parameter of the operation

-d =alphabet size,

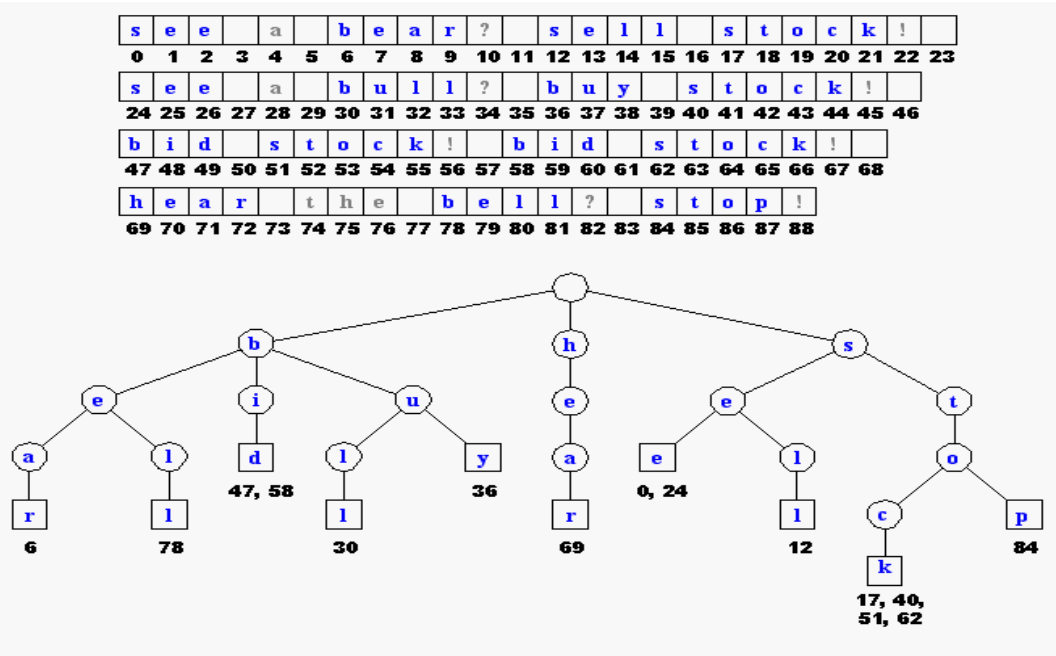
Applications of Tries

- A standard trie supports the following operations on a preprocessed text in time O(m), where m = |X|

  -***word matching***: find the first occurence of word X in the text

  -***prefix matching***: find the first occurrence of the longest prefix of word X in the text

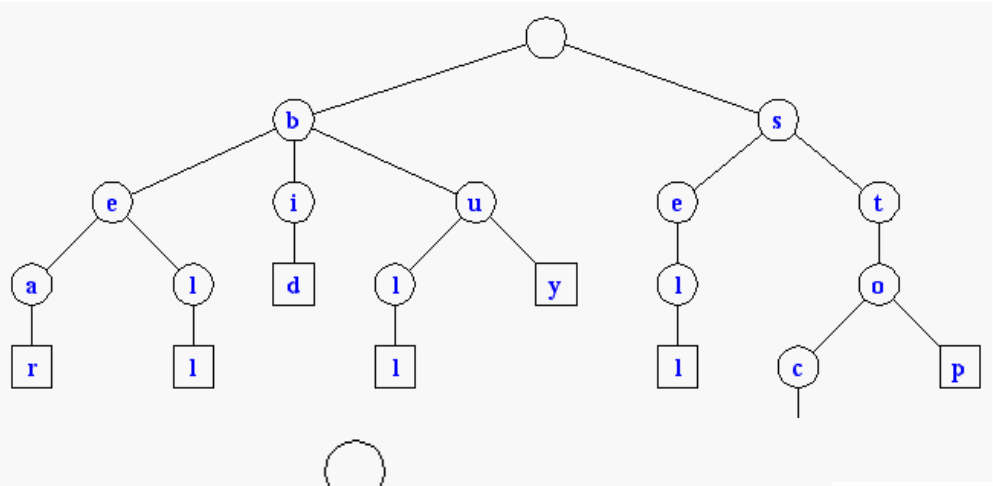
- Each operation is performed by tracing a path in the trie starting at the root



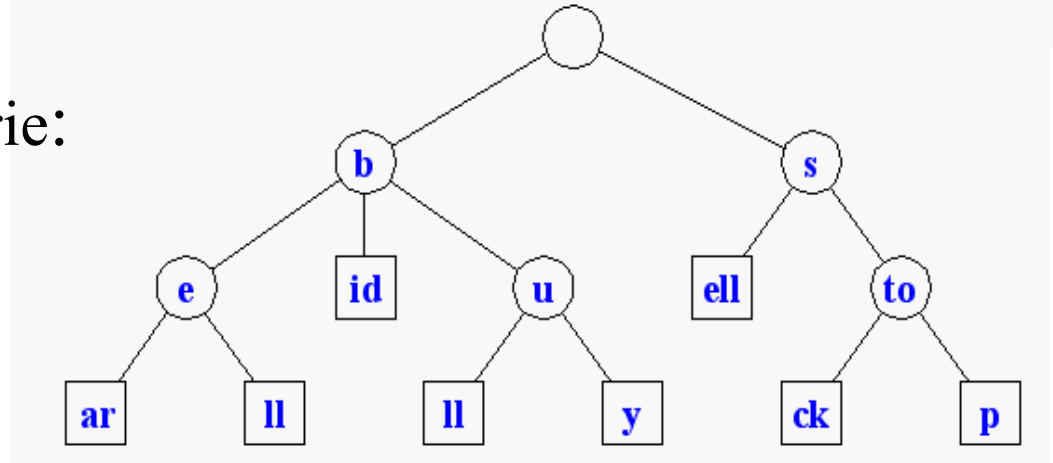
Compressed Tries

- Trie with nodes of degree at least 2
- Obtained from standard trie by compressing chains of ***redundant nodes***

Standard Trie:

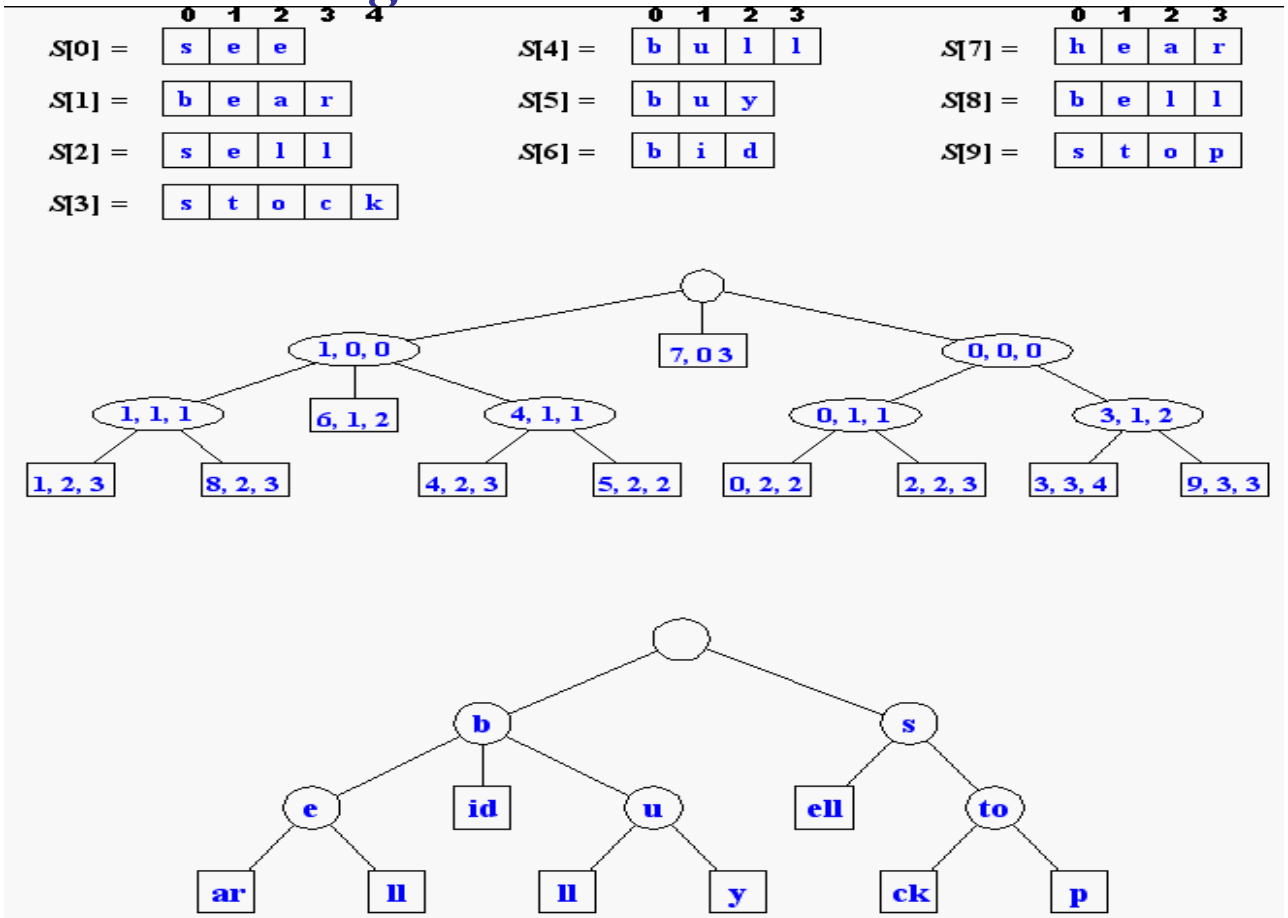


Compressed Trie:

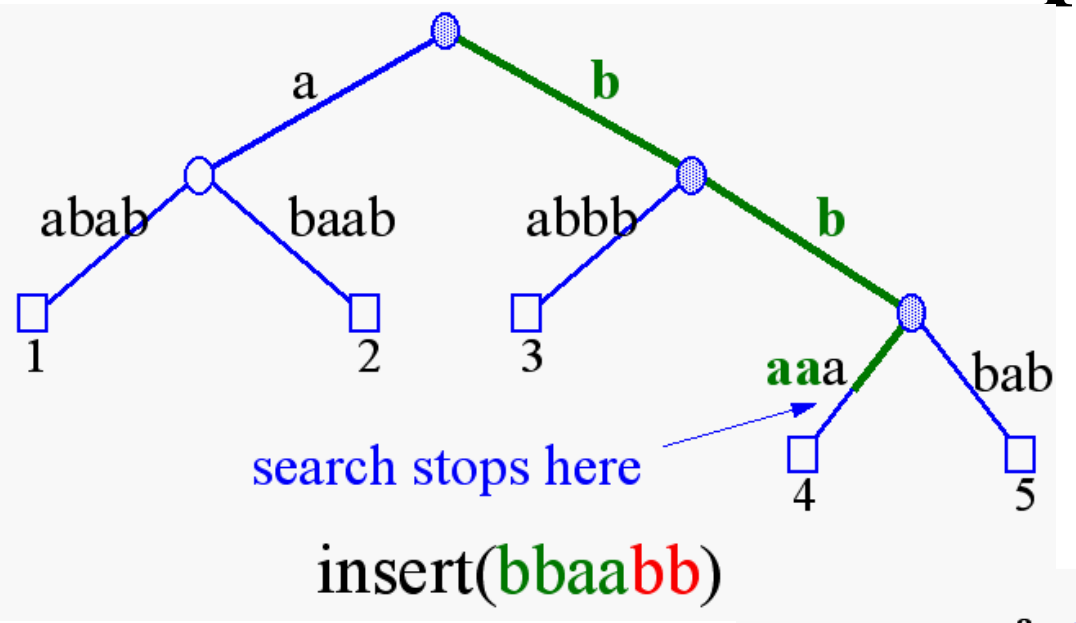


Compact Storage of Compressed Tries

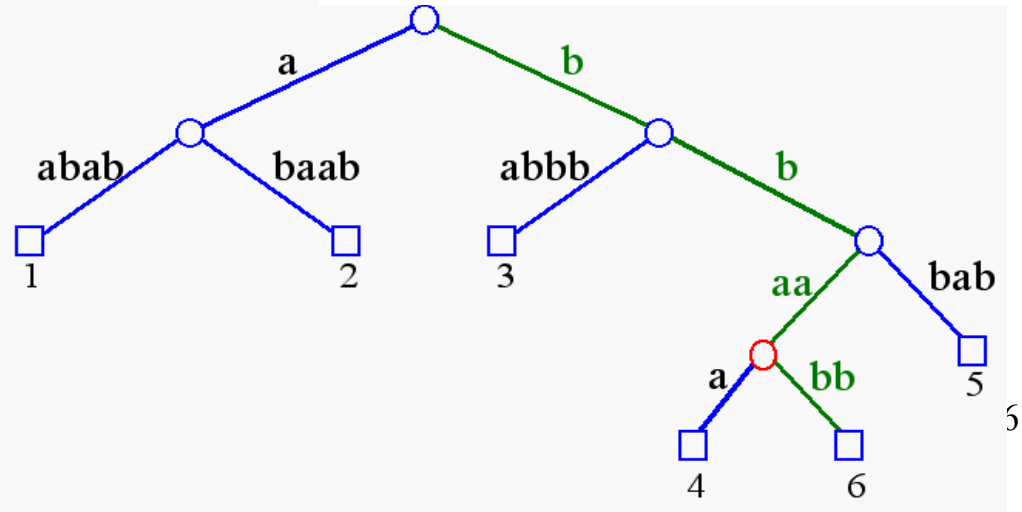
- A compressed trie can be stored in space O(s), where s = |S|, by using O(1) space ***index ranges*** at the nodes



Insertion and Deletion into/from a Compressed Trie



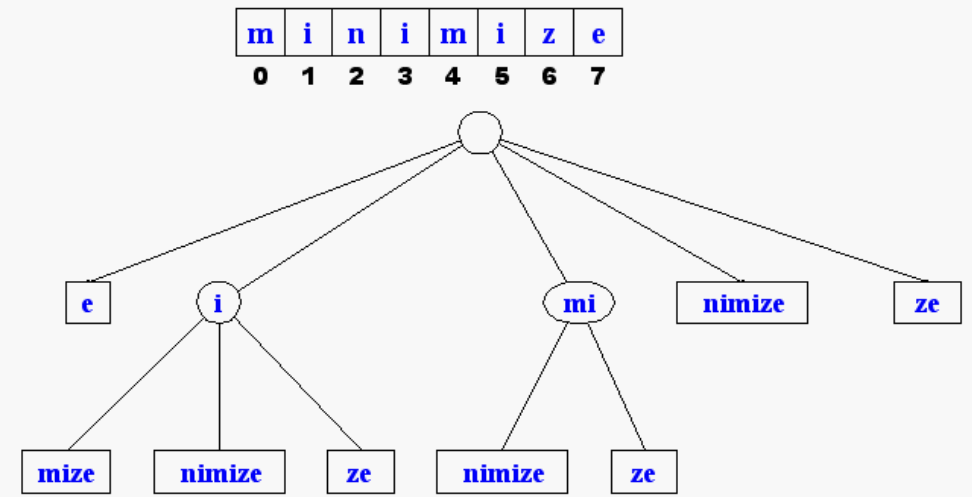
insert(bbaabb)



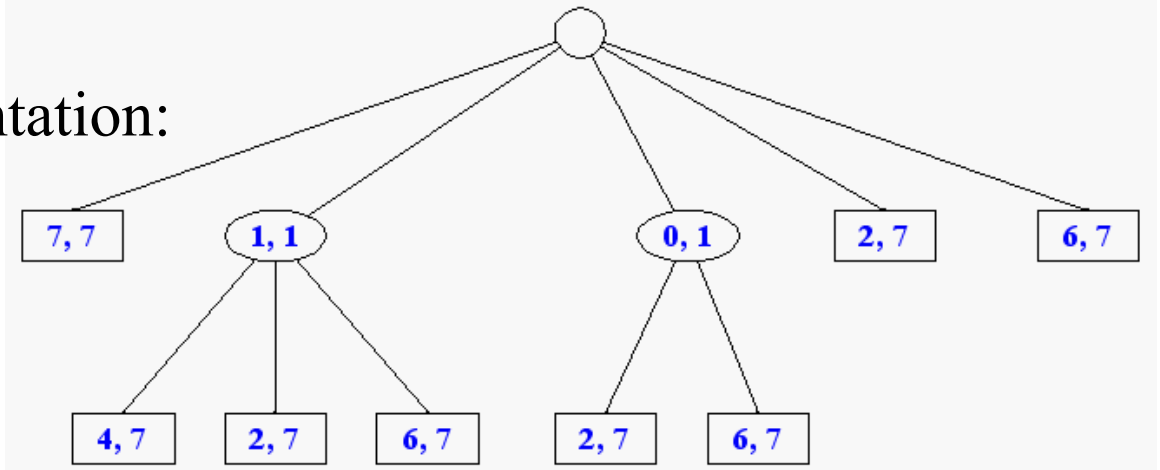
Suffix Tries

- A ***suffix trie*** is a compressed trie for all the suffixes of a text

Example:



Compact representation:



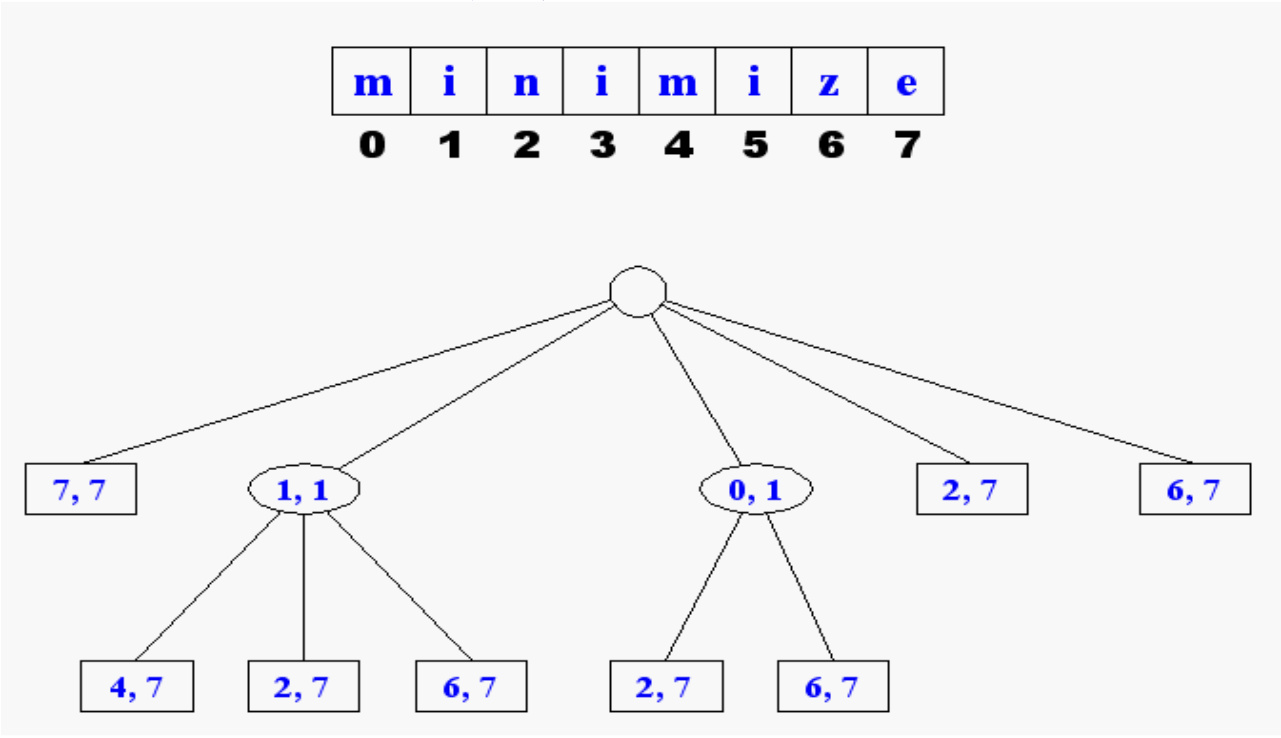
Properties of Suffix Tries

- The ***suffix trie*** for a text X of size ***n*** from an alphabet of size ***d***

  -stores all the ***n(n-1)/2 suffixes*** of X in O(n) space

  -supports arbitrary ***pattern matching*** and prefix matching queries in ***O(dm) time***, where m is the length of the pattern

  -can be constructed in ***O(dn) time***



Tries and Web Search Engines

- The ***index of a search engine*** (collection of all searchable words) is stored into a compressed trie
- Each leaf of the trie is associated with a word and has a list of pages (URLs) containing that word, called ***occurrence list***
- The trie is kept in internal memory
- The occurrence lists are kept in external memory and are ranked by relevance
- Boolean queries for sets of words (e.g., Java and coffee) correspond to set operations (e.g., intersection) on the occurrence lists
- Additional ***information retrieval*** techniques are used, such as
  - stopword elimination (e.g., ignore “the” “a” “is”)
  - stemming (e.g., identify “add” “adding” “added”)
  - link analysis (recognize authoritative pages)

Tries and Internet Routers

- Computers on the internet (hosts) are identified by a unique 32-bit IP (***internet protocol***) addres, usually written in "dotted-quad-decimal" notation
- E.g., www.iitd.ac.in is 103.27.9.24
- Use nslookup on Unix to find out IP addresses
- An organization uses a subset of IP addresses with the same prefix, e.g., IITD uses 103.27.*.*, Yale uses 130.132.*.*
- Data is sent to a host by fragmenting it into packets. Each packet carries the IP address of its destination.
- The internet whose nodes are ***routers***, and whose edges are communication links.
- A router forwards packets to its neighbors using IP ***prefix matching*** rules. E.g., a packet with IP prefix 103.27. should be forwarded to the IITD gateway router.
- Routers use tries on the alphabet 0,1 to do prefix matching.