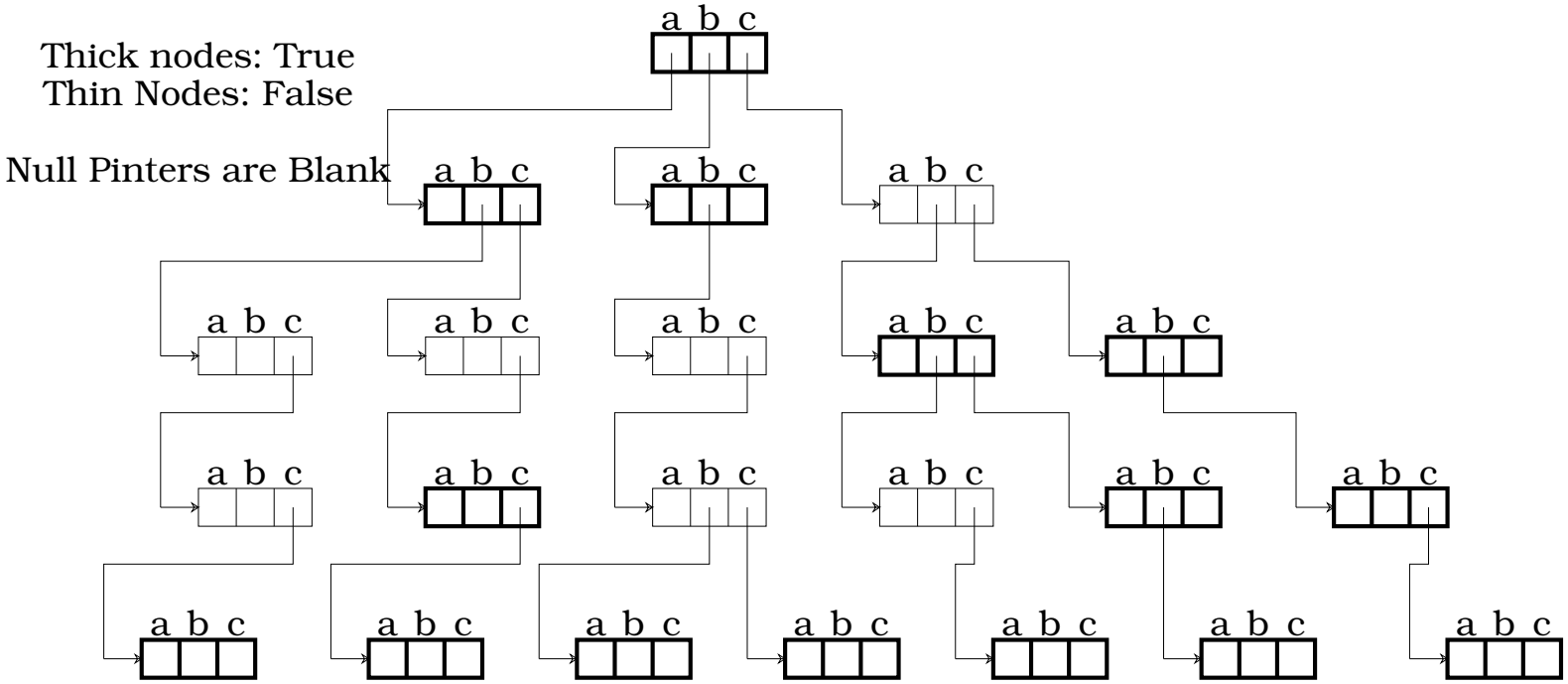
Tries (reTRIEval)

- A TRIE represents strings over some alphabet $\sum$ by its tree of prefixes.
- Each node in a TRIE is represented by a boolean variable and a vector of length m, where m is the number of elements in $\sum$.
- A function, normally computed in constant time, transforms each element in $\sum$ into an integer in $\{0, 1, \ldots, m-1\}$.
- For example, $\sum = \{a, b, c\}$ and $f(a) = 0$, $f(b) = 1$, and $f(c) = 2$.
- The EMPTY string is always in the set (cannot be deleted).

Example

$$\{a, abcc, acc, accc, b, bbcb, bbcc, cb, cbbc, cbc, cbcb, cc, ccb, ccbc\}$$



```
#include <iostream>
#include <string>
using namespace std;
const int TrieMaxElem = 26;
const int StrMaxElem = 80;

class Trie;

class TrieNode {
private:
    bool StrEnds;
    TrieNode *ptr[TrieMaxElem];
public:
    TrieNode();
    void SetStrEnds(){StrEnds = true;}
    void UnSetStrEnds(){StrEnds = false;}
    bool GetStrEnds(){return StrEnds;}
    void SetPtr(int i, TrieNode* j){ptr[i]=j;}
    TrieNode* GetPtr(int i){return ptr[i];}

};
```

```
TrieNode::TrieNode(){
    StrEnds = false;
    for(int i=0; i<TrieMaxElem; i++)
       ptr[i] = 0;
}
```

```
class Trie {
public:
    Trie() ;
    void Readlist();
    void Insert(char  x[]);
    bool Member(char  x[]);
    void Delete(char  x[]);
private:
    TrieNode *root;
    bool Delete(char x[], int i,
                    TrieNode *current );
    bool CheckTrieNodeEmpty(TrieNode *current);
};

Trie::Trie(){
    root = new TrieNode();
    root->SetStrEnds();
}
```

```
void Trie::Readlist(){
  int numtimes;
  char x[StrMaxElem];
  cout << endl;
  cout << "num of times" << endl;
  cin >> numtimes;
  for ( int i = 1 ; i <= numtimes ; i = i + 1 )
   { cout << "Input String" << endl;
     cin >> x;
     cout << x << endl;
     Insert( x );
   }
}
```

```
void Trie::Insert(char x[]) {
  TrieNode *current = root;
  int i = 0;
  while ( x[i] != '\0' )
   { int j = x[i] - 'a';
     if ( current->GetPtr(j) == 0 )
          current->SetPtr(j, new TrieNode());
     current = current->GetPtr(j);
     i = i + 1;
   }
  current->SetStrEnds();
}
```

```
void Trie::Delete(char x[])
{
  TrieNode *current = root;
  int i = 0;
  if (x[i] == '\0') return;
  bool j = Delete(x,i,current);
}
```

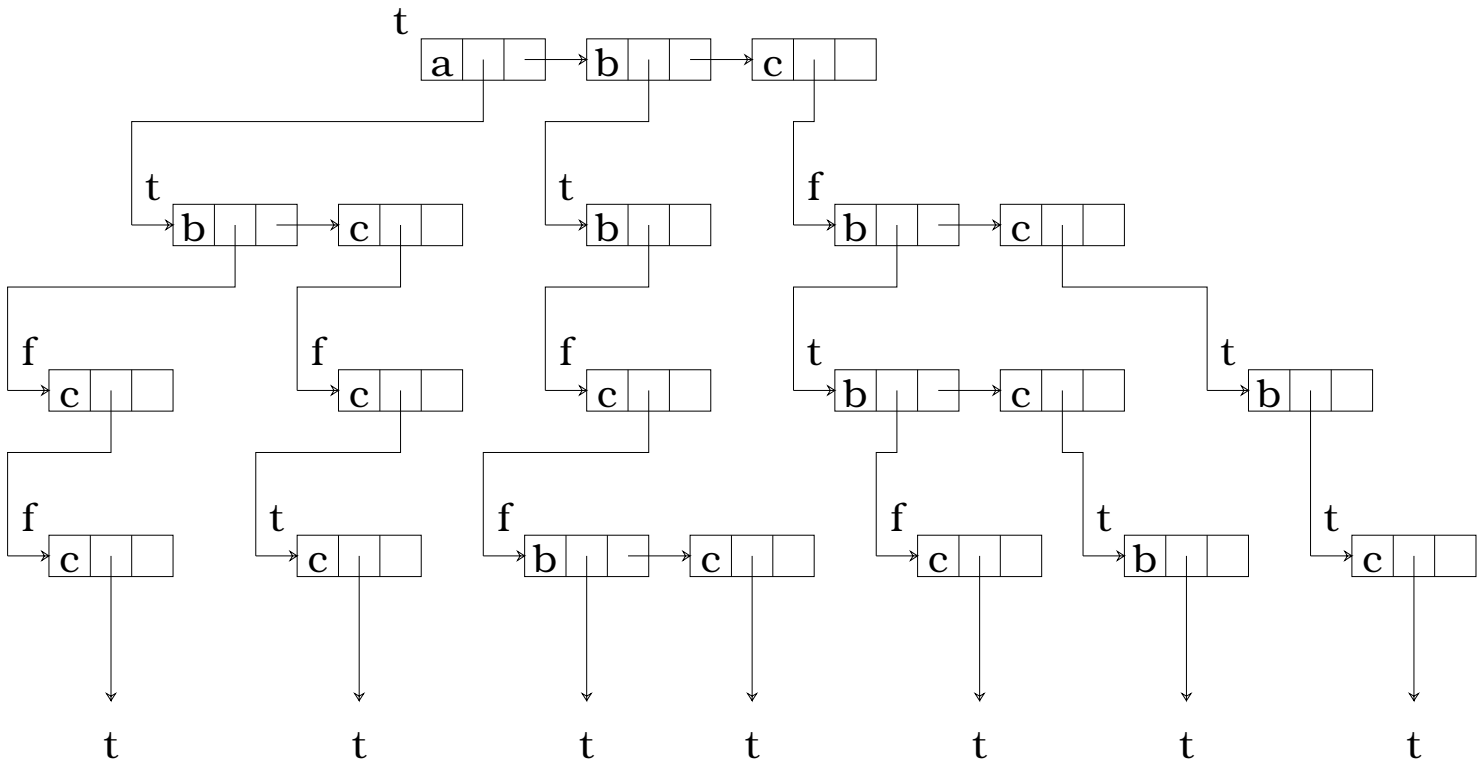
```
bool Trie::Delete(char x[], int i, TrieNode *current){
  if (current != 0)
     {if (x[i] == '\0')
           {current -> UnSetStrEnds();
            if (CheckTrieNodeEmpty(current))
                          {delete current; return true;} }
      else {if (Delete(x,i+1,current->GetPtr(x[i] - 'a')))
               {current->SetPtr(x[i] - 'a', 0);
               if (i != 0 && CheckTrieNodeEmpty(current))
                          {delete current; return true;} }
           }
     }
  return false;
}
```

```
bool Trie::CheckTrieNodeEmpty
                          (TrieNode *current)
{
 if (current -> GetStrEnds()) return false;
 for(int i = 0; i<TrieMaxElem; i++)
     if (current->GetPtr( i )) return false;
 return true;
}
```

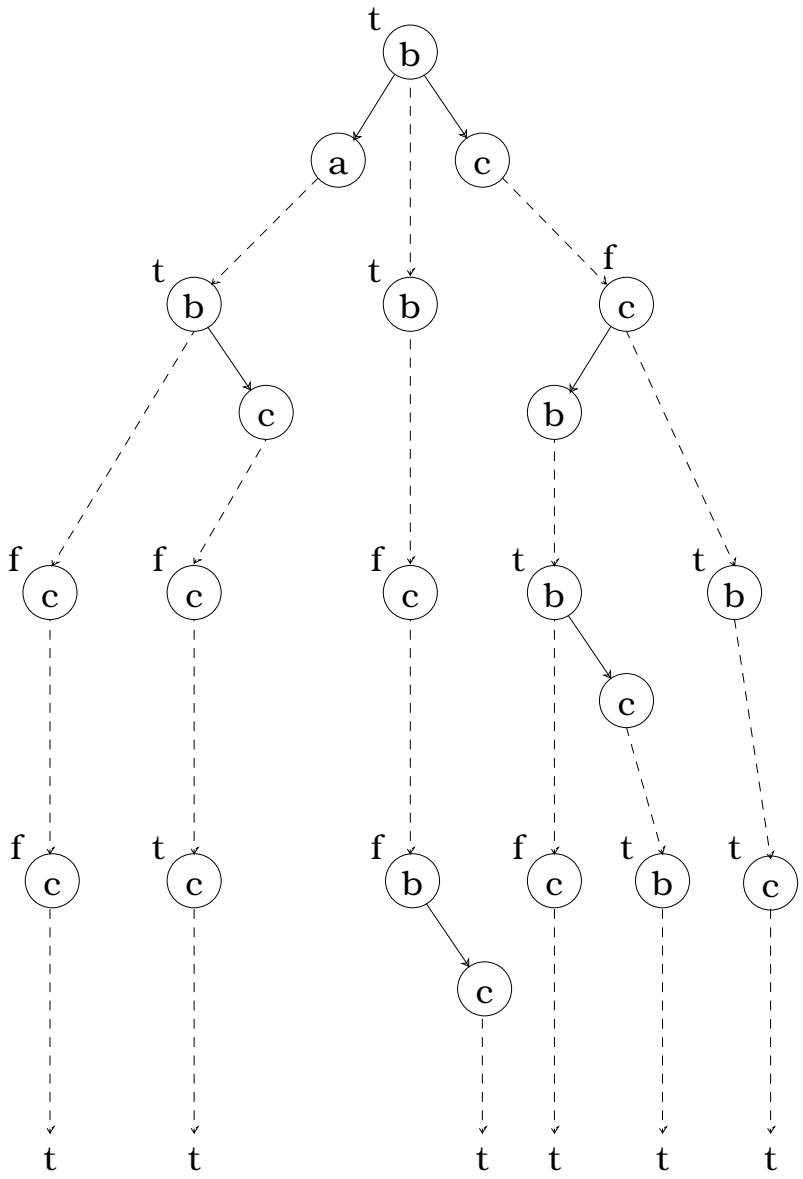
```
bool Trie::Member(char x[]) {
  TrieNode *current = root;
  int i = 0;
  while (x[i] != '\0')
    { int j = x[i] - 'a';
      if ( current->GetPtr(j) == 0 )
                return false ;
           else current = current->GetPtr(j);
      i = i+1;
    }
  return  current->GetStrEnds() ;
}
```

```
main()
{ int numtests;
  char newelem[StrMaxElem];
  Trie t;
  t.Readlist();
  cout << endl;
  cout << "num of tests" << endl;
  cin >> numtests;
  for ( int i = 1 ; i <= numtests ; i = i + 1 )
   { if (i == (i/2)*2)
      { cout << "Input Test String" << endl;
        cin >> newelem;
        cout << newelem << "IS A MEMBER?" <<
                t.Member(newelem) << endl; }
  else{ cout << "Delete Test String" << endl;
        cin >> newelem;
        t.Delete(newelem);
        cout << newelem << " Deleted" << endl; }
  }
}
```

Other Rep.: Linked List: Sussenguth 1963



Binary Search Tree: Clampett 1964



Other Rep.

- Balanced binary search trees
- Hybrid Representations
- Elimination of Leaf nodes