I. Implementation

With reading file, read line by line, then add new word has been read into tree, the tree balanced by itself.

Rotate left and right: implemented following rotating algorithms.

In case of look up a word, recursively traversing to left tree if the keyword is smaller than root, to the right tree if the keyword is bigger than the root, else, print out the meaning of this key. If reach the leaf node and found nothing print the notification that not found keyword in tree.

In case of adding new word, if new word is existed, do nothing. If the tree is empty, create new tree and the new word as the root. If the keyword is smaller than current root, recursively add into the left tree, if adding makes tree unbalanced, rotate current tree to the right. Else, recursively add into right tree, if unbalanced, rotate left.

In case of edit meaning of a word, just search the position of the given word, if existed then I replace the old mean with new mean. Then, editing costs no time but searching for its position.

In case of deleting a word, recursively traverse the tree and look for the keyword, if existed, set the value to “” .

In case of saving, traverse the the tree and output all *not “” keyword (cause of deleting word)* following LNR order.

II. Experiments

File reading:

```
Enter file name: (must has .txt) Oxford English Dictionary.txt
File loaded in 332ms.
```

```
Enter file name: (must has .txt) Oxford English Dictionary.txt
File loaded in 338ms.
```

Look up a word:

```
Enter a word to lookup: Chicken
ΓÇön. 1 a domestic fowl. B its flesh as food. 2 young bird of a domestic fowl. 3 youthful person (is no chicken). ΓÇöadj
. Colloq. Cowardly. ΓÇöv. (foll. By out) colloq. Withdraw through cowardice. [old english]
Running time: 0ms.
```

```
Enter a word to lookup: Zygote
n. Biol. Cell formed by the union of two gametes. [greek zugotos yoked: related to *zeugma]
Running time: 0ms.
```

Editing word:

```
Enter a word to edit: Zygote
Enter mean:New
Running time: 0ms.
Press any key to continue
```

Then, new mean:

```
Enter a word to lookup: Zygote
New
Running time: 1ms.
```

Adding word:

```
Enter a word: Nguyen Quang Truong
Enter mean:test
Running time: 0ms.
Press any key to continue
```

```
Enter a word to lookup: Nguyen Quang Truong
test
Running time: 0ms.
```

Deleting word:

```
Enter a word to delete: Nguyen Quang Truong
Running time: 1ms.
```

```
Enter a word to lookup: Nguyen Quang Truong
This word is not exists.
Running time: 0ms.
```

Saving to file:

```
Enter file name to save (must has .txt): Test.txt
Test.txt is saved.
Running time: 264ms.
```

III. Time complexities

I don't put Edit bellow because Edit just Search and replace values, nothing different in time complexities.

Bellow are average time complexities:

Data stucture	**Search**	**Insert**	**Delete**
Array	O(n)	O(n)	O(n)
Hash table	O(1)	O(1)	O(1)
BST	O(log n)	O(log n)	O(log n)
AVL tree	O(log n)	O(log n)	O(log n)

IV. Analyze

Strong points:

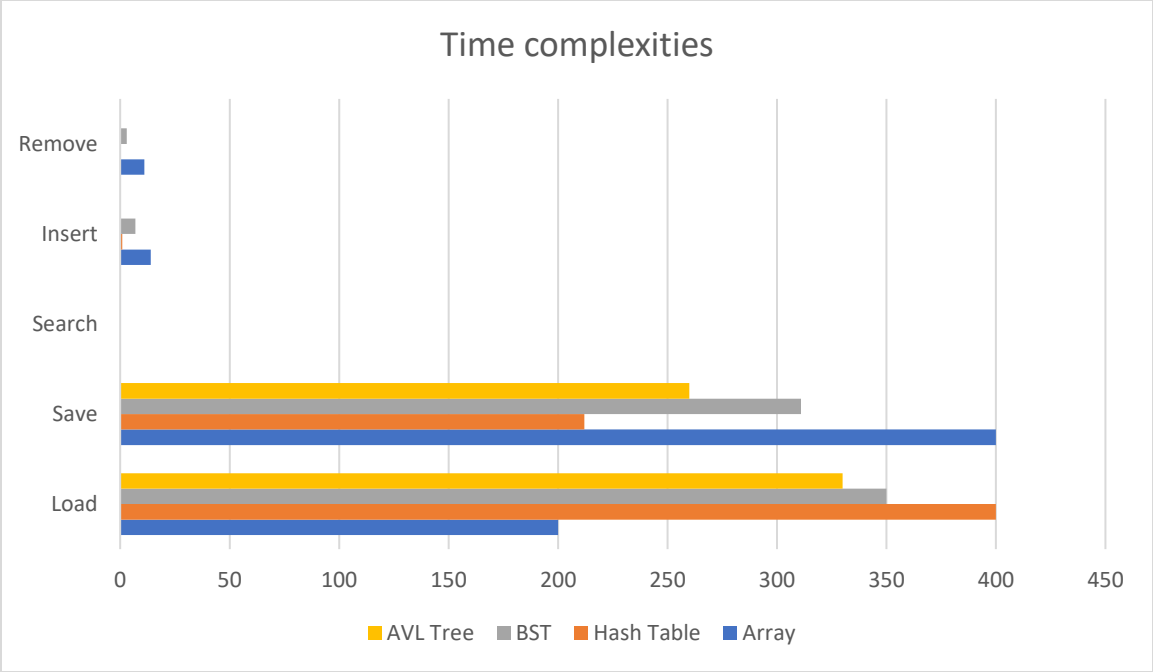
- The height of tree is always balanced.
- Better search time.
- Self-balancing capabilities.

Weakness:

- Hard to implement.
- High cost due to frequently rotating.

V. Table and graph

Time	Array	Hash Table	BST	AVL Tree
Load	200	400	350	330
Sort	160	-	-	-
Save	400	212	311	260
Look up	0	0	0	0
Insert	14	1	7	0
Remove	11	0	3	0
Edit	0	0	0	0



VI. Guide to use

I create a menu that allows user to use my program easier. But there is something I must remind:

File name inputted must has .txt at the end.

While using menu, the inputted choice value must an integer.