Our own Tables

Module Description

In this module, we will learn how to create our own tables. This is not specific to ndnSIM, but it is a good practice to create our own tables to store the information we need in c++.

Tasks

Sno	Name	Age	Gender
0	John	20	Male
1	Jane	19	Female
2	Jack	21	Male
3	Smith	22	Male

We will create a table to store the above information in different ways.

1. Using `vector`
2. Using `map`
3. Using `set`

Each has its own advantages and disadvantages.

Vector vs Map vs Set

	Vector	Map	Set
Order	Ordered	Ordered	Unordered
Search	O(n)	O(log n)	O(log n)
Insert	O(1)	O(log n)	O(log n)
Delete	O(n)	O(log n)	O(log n)
Memory	More	More	Less
Duplicates	Allowed	Not Allowed	Not Allowed
When to use	When you need to access elements by index	When you need to access elements by key	When you need to access elements by key and you don't need duplicates
Library	`#include <vector>`	`#include <map>`	`#include <set>`

	Vector	Map	Set
Note	`vector` is a sequence container and also known as Dynamic Array or Array List	`map` is an associative container that stores elements in key value combination	`set` is an associative container that contains a sorted set of unique objects of type Key

Procedure

Using `vector`

```
#include <iostream>
#include <vector>
#include <string>

class Info {
    explicit Info(std::string p_name, uint8_t p_age, char p_gender) {
        this -> m_name = p_name;
        this -> m_age = p_age;
        this -> m_gender = p_gender;
    }

    static void print_header() {
        std::cout << "Name\tAge\tGender\n";
    }

    void print_info() {
        std::cout << m_name << "\t" << m_age << "\t" <<
(m_gender=='M'?"Male":"Female") << "\n";
    }

    private:
    std::string m_name;
    uint8_t m_age;
    char m_gender; // 'M' or 'F'
};

int main(int argc, char*argv[]) {
    std::vector<Info> info_table;

    info_table.push_back(Info("John", 20, 'M'));
    info_table.push_back(Info("Jane", 19, 'F'));
    info_table.push_back(Info("Jack", 21, 'M'));
    info_table.push_back(Info("Smith", 22, 'M'));

    Info::print_header();

    for (auto info : info_table) {
        info.print_info();
    }
}
```

Using `map`

```
#include <iostream>
#include <map>
#include <string>
#include <tuple>

class Info {
    explicit Info(std::string p_name, uint8_t p_age, char p_gender) {
        this -> m_name = p_name;
        this -> m_age = p_age;
        this -> m_gender = p_gender;
    }

    static void print_header() {
        std::cout << "Name\tAge\tGender\n";
    }

    void print_info() {
        std::cout << m_name << "\t" << m_age << "\t" <<
(m_gender=='M'?"Male":"Female") << "\n";
    }

    private:
    std::string m_name;
    uint8_t m_age;
    char m_gender; // 'M' or 'F'
};


int main(int argc, char*argv[]) {
    std::map<int, Info> info_table;

    info_table[0] = Info("John", 20, 'M');
    info_table[1] = Info("Jane", 19, 'F');
    info_table[2] = Info("Jack", 21, 'M');
    info_table[3] = Info("Smith", 22, 'M');

    Info::print_header();

    for(std::pair<int, const Info&> info : info_table) {
        info.second.print_info();
    }
}
```

Using `set`

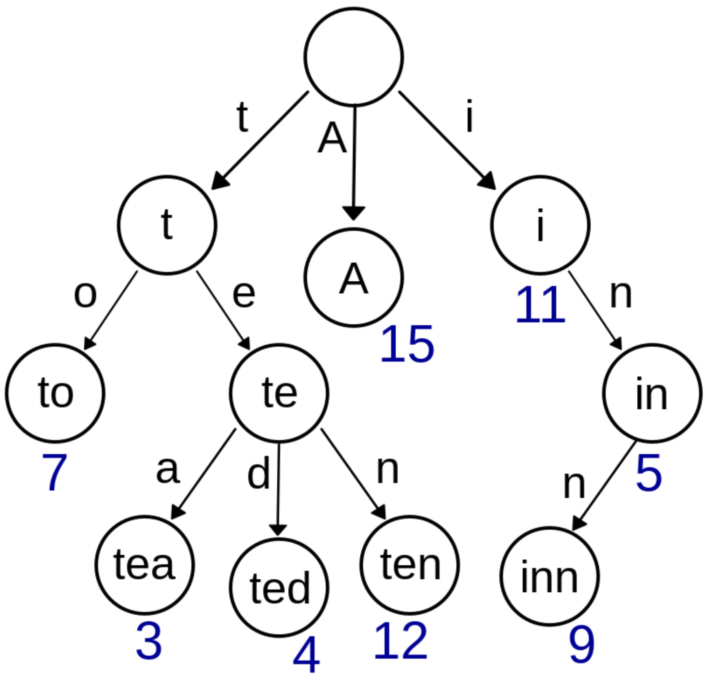
```cpp
#include <iostream>
#include <set>
#include <string>

class Info {
    explicit Info(std::string p_name, uint8_t p_age, char p_gender) {
        this -> m_name = p_name;
        this -> m_age = p_age;
        this -> m_gender = p_gender;
    }

    static void print_header() {
        std::cout << "Name\tAge\tGender\n";
    }

    void print_info() {
        std::cout << m_name << "\t" << m_age << "\t" <<
(m_gender=='M'?"Male":"Female") << "\n";
    }

    private:
    std::string m_name;
    uint8_t m_age;
    char m_gender; // 'M' or 'F'
};

int main(int argc, char*argv[]) {
    std::set<Info> info_table;

    info_table.insert(Info("John", 20, 'M'));
    info_table.insert(Info("Jane", 19, 'F'));
    info_table.insert(Info("Jack", 21, 'M'));
    info_table.insert(Info("Smith", 22, 'M'));

    Info::print_header();

    for (auto info : info_table) {
        info.print_info();
    }
}
```

Here we discussed about generic case but we can use the same to implement for complex structures with knowledge of smart pointers, lvalues, rvalues, references, etc.

Trie

Trie is a tree-like data structure whose nodes store the letters of an alphabet. By structuring the nodes in a particular way, words and strings can be retrieved from the structure by traversing down a branch path of the tree.

This data structure is used to store information with name of the interest as the key.



```cpp
#include <iostream>
#include <string>
#include <vector>
#include <memory>

class Trie {
    public:
    Trie() {
        m_root = std::make_shared<Node>();
    }

    void insert(std::string word) {
        std::shared_ptr<Node> current = m_root;
        for (char c : word) {
            if (current -> m_children[c - 'a'] == nullptr) {
                current -> m_children[c - 'a'] = std::make_shared<Node>();
            }
            current = current -> m_children[c - 'a'];
        }
        current -> m_is_word = true;
    }

    bool search(std::string word) {
        std::shared_ptr<Node> current = m_root;
        for (char c : word) {
            if (current -> m_children[c - 'a'] == nullptr) {
                return false;
            }
            current = current -> m_children[c - 'a'];
        }
        return current -> m_is_word;
    }

    bool startsWith(std::string prefix) {
        std::shared_ptr<Node> current = m_root;
        for (char c : prefix) {
            if (current -> m_children[c - 'a'] == nullptr) {
                return false;
            }
            current = current -> m_children[c - 'a'];
        }
        return true;
    }

    private:
    struct Node {
        std::vector<std::shared_ptr<Node>> m_children;
        bool m_is_word;

        Node() {
            m_children.resize(26);
            m_is_word = false;
        }
    };

    std::shared_ptr<Node> m_root;
};

int main(int argc, char*argv[]) {
    Trie trie;
    trie.insert("apple");
    std::cout << trie.search("apple") << "\n";   // returns true
    std::cout << trie.search("app") << "\n";     // returns false
    std::cout << trie.startsWith("app") << "\n"; // returns true
    trie.insert("app");
    std::cout << trie.search("app") << "\n";     // returns true
}
```