Homework 2

309553048_陳柏丞

- **Execution：**
  - Ubuntu 18.04.5 LTS
    - make
    - ./yeast [input.cnf]

- **Abstract：**
  - Functions：
    - GetData()
    - UpdateTable()
    - ReduceClause()
    - FindUnitClause()
    - DPLL()
    - WriteSatis()
  - Main：
    - Check input arguments
    - GetData()
    - Random a value
    - DPLL()

- **Implementation：**

初始化：將資料讀進一個 vector，建立一個 table 紀錄 literal 的值

```
void GetData(
       std::string cnf_file,
       int &literal,
       int &clauses,
       std::vector<std::list<int>> &box,
       std::vector<int> &t )
{
    std::string s;
    std::ifstream cnf(cnf_file);
    if(!cnf) std::cout << "Can't read file: " << cnf_file << "\n", exit(0);
```

```cpp
    cnf >> s >> s;
    cnf >> literal >> clauses;

    // no w0
    box.push_back(std::list<int> ());

    for(int i=1; i<literal+1; i++)
        t.push_back(i), t.push_back(-i);

    int tmp;
    std::list<int> c_tmp;

    while(cnf >> tmp)
    {
        if(tmp == 0)
        {
            box.push_back(c_tmp);
            c_tmp.clear();
            continue;
        }

        c_tmp.push_back(tmp);
    }

    cnf.close();
}
```

選了某值 x，table 就不必再考慮 x

```cpp
std::vector<int> UpdateTable(int x, std::vector<int> table)
{
    std::vector<int> t_tmp;
    for(auto ele:table)
        if(ele != x && ele != -x) t_tmp.push_back(ele);

    return t_tmp;
}
```

將 x=true 的 clause 去除，x=false 的 clause 移除 x

```
std::vector<std::list<int>> ReduceClause(
        std::vector<std::list<int>> box,
        int x )
{
    std::vector<std::list<int>> box_tmp;
    box_tmp.push_back(std::list<int> ());

    for(int i=1; i<box.size(); i++)
    {
        auto it = std::find(box[i].begin(), box[i].end(), x);
        if(it == box[i].end())
            box[i].remove(-x), box_tmp.push_back(box[i]);
    }

    return box_tmp;
}
```

找尋是否為 Unit Clause

```
int FindUnitClause(std::vector<std::list<int>> box)
{
    for(int i=1; i<box.size(); i++)
        if(box[i].size() == 1) return box[i].front();

    return 0;
}
```

```
dpll($\varphi$):
    if $\varphi = \emptyset$: return TRUE
    if $\epsilon \in \varphi$: return FALSE
    if $\varphi$ contains unit clause $\{\ell\}$:
        return dpll($\varphi|\ell$)
    let $x$ = pick_variable($\varphi$)
    return dpll($\varphi|x$) OR dpll($\varphi|\bar{x}$)
```

```
bool DPLL(
        std::vector<std::list<int>> box,
        int x,
        std::vector<int> t,
        std::vector<int> &ans )
{
```

```cpp
    std::cout << "\nSelect: " << x;
    ans.push_back(x);
    box = ReduceClause(box, x);

    if(box.size() == 1) return true;

    for(int i=1; i<box.size(); i++)
        if(box[i].empty()) return false;

    if(FindUnitClause(box) != 0)
    {
        x = FindUnitClause(box);
        std::vector<int> t_tmp = UpdateTable(x, t);

        return DPLL(box, x, t_tmp, ans);
    }

    x = t[rand() % t.size()];
    std::vector<int> t_tmp = UpdateTable(x, t);

    if(DPLL(box, x, t_tmp, ans)) return true;
    else
    {
        std::cout << "\n\n-----[node] Select branch: " << -x << "-----";

        std::vector<int> ans_tmp;
        for(auto ele:ans)
        {
            if(abs(ele) == abs(-x)) break;
            ans_tmp.push_back(ele);
        }
        ans = ans_tmp;

        return DPLL(box, -x, t_tmp, ans);
    }

    return false;
}
```

檢查 table 的值並寫入 out.sat

```
void WriteSatis(
        std::ofstream &output,
        std::vector<int> ans,
        int literal )
{
    output << "s SATISFIABlE\n";
    std::vector<bool> ans_print(literal+1, true);
    for(auto ele:ans)
        if(ele < 0) ans_print[abs(ele)] = false;

    output << "v ";
    for(int i=1; i<ans_print.size(); i++)
    {
        if(ans_print[i]) output << i << ' ';
        else output << -i << ' ';
    }

    std::cout << "\n\n=> SATISFIABLE\n";
}
```

初始化資料 → 隨機取值 x → if DPLL(x) is true, 寫入 out.sat

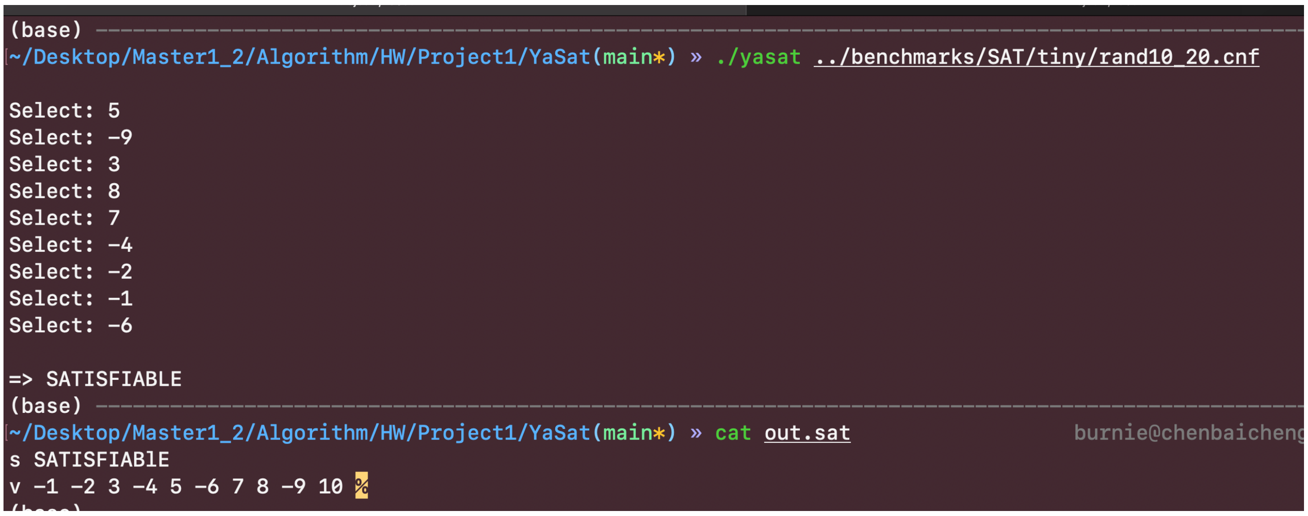
else DPLL(-x) → if DPLL(-x) is true/false, 寫入 out.sat

```
int main(int argc, char* argv[])
{
    if(argc < 2) return 0;
    std::string cnf_file = argv[1];

    int literal, clauses;
    std::vector<std::list<int>> clauseBox;
    std::vector<int> table, ans;

    GetData(cnf_file, literal, clauses, clauseBox, table);

    srand (time(NULL));
    int x = table[rand() % table.size()];
    std::vector<int> t_tmp = UpdateTable(x, table);

```

```cpp
    std::string sat_file = "out.sat";
    std::ofstream output(sat_file);

    if(DPLL(clauseBox, x, t_tmp, ans)) WriteSatis(output, ans, literal);
    else
    {
        std::cout << "\n\n*****[Root] Select branch: " << -x << "*****";

        if(DPLL(clauseBox, -x, t_tmp, ans)) WriteSatis(output, ans, literal);
        else output << "s UNSATISFIABLE\n", std::cout << "\n\n=> UNSTISFIABLE\n";
    }

    output.close();

    return 0;
}
```

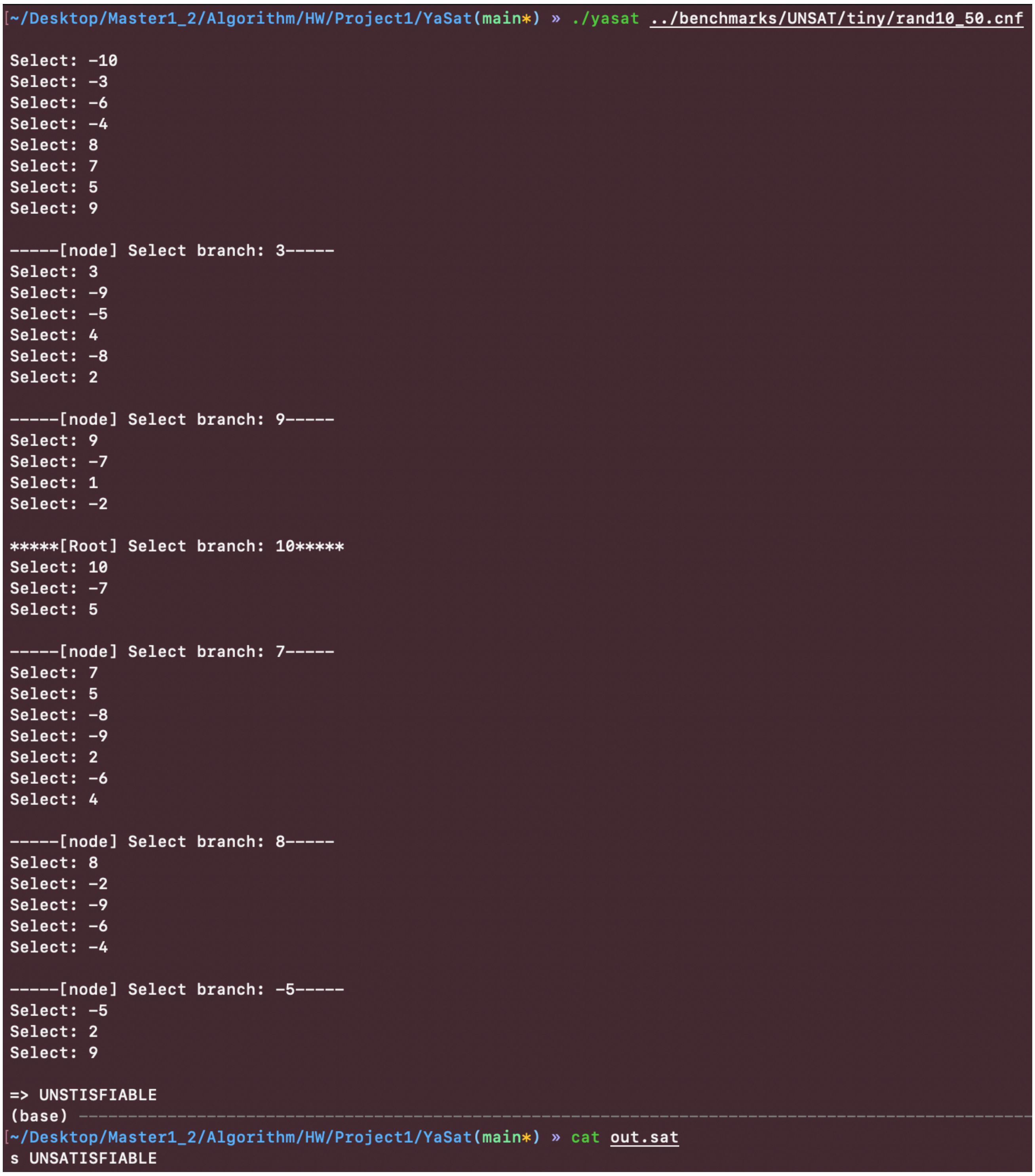
- **Result：**

1. rand10_20.cnf



```
(base) --------------------------------------------------------------------------------
~/Desktop/Master1_2/Algorithm/HW/Project1/YaSat(main*) » ./yasat ../benchmarks/SAT/tiny/rand10_20.cnf

Select: 5
Select: -9
Select: 3
Select: 8
Select: 7
Select: -4
Select: -2
Select: -1
Select: -6

=> SATISFIABLE
(base) --------------------------------------------------------------------------------
~/Desktop/Master1_2/Algorithm/HW/Project1/YaSat(main*) » cat out.sat                burnie@chenbaicheng
s SATISFIABlE
v -1 -2 3 -4 5 -6 7 8 -9 10 %
```

2. rand10_50.cnf



```
[~/Desktop/Master1_2/Algorithm/HW/Project1/YaSat(main*) » ./yasat ../benchmarks/UNSAT/tiny/rand10_50.cnf

Select: -10
Select: -3
Select: -6
Select: -4
Select: 8
Select: 7
Select: 5
Select: 9

-----[node] Select branch: 3-----
Select: 3
Select: -9
Select: -5
Select: 4
Select: -8
Select: 2

-----[node] Select branch: 9-----
Select: 9
Select: -7
Select: 1
Select: -2

*****[Root] Select branch: 10*****
Select: 10
Select: -7
Select: 5

-----[node] Select branch: 7-----
Select: 7
Select: 5
Select: -8
Select: -9
Select: 2
Select: -6
Select: 4

-----[node] Select branch: 8-----
Select: 8
Select: -2
Select: -9
Select: -6
Select: -4

-----[node] Select branch: -5-----
Select: -5
Select: 2
Select: 9

=> UNSTISFIABLE
(base) ------------------------------------------------------------------------------------------------
[~/Desktop/Master1_2/Algorithm/HW/Project1/YaSat(main*) » cat out.sat
s UNSATISFIABLE
```