Advanced C Programming
Exam, Competition, Code Review

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Final Exam

Assignments

1. Declarations, Bindings, ... (multiple choice)
2. Find Errors in Code Fragments
3. Improve Code Fragments
4. Profiling, Makefiles, ...
5. Bit Operations
6. Know the Compiler
7. Code/Data Structure Design (possibly related to SAT)

Out of Scope

1. Open MP
2. Syntax Checks
## Advanced C SAT Competition

### Problems

<table>
<thead>
<tr>
<th>Problem</th>
<th>File Name</th>
<th>Variables</th>
<th>Clauses</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>2bitmap_06.cnf</td>
<td>252</td>
<td>767</td>
<td>satisfiable</td>
</tr>
<tr>
<td>2.</td>
<td>qg2-08.cnf</td>
<td>512</td>
<td>148957</td>
<td>satisfiable</td>
</tr>
<tr>
<td>3.</td>
<td>qg3-09.cnf</td>
<td>729</td>
<td>16732</td>
<td>satisfiable</td>
</tr>
<tr>
<td>4.</td>
<td>uf250-01.cnf</td>
<td>250</td>
<td>1065</td>
<td>satisfiable</td>
</tr>
<tr>
<td>5.</td>
<td>uf250-013.cnf</td>
<td>250</td>
<td>1065</td>
<td>satisfiable</td>
</tr>
<tr>
<td>6.</td>
<td>uuf250-01.cnf</td>
<td>250</td>
<td>1065</td>
<td>unsatisfiable</td>
</tr>
<tr>
<td>7.</td>
<td>uuf250-013.cnf</td>
<td>250</td>
<td>1065</td>
<td>unsatisfiable</td>
</tr>
</tbody>
</table>

### Out of Scope

- Medium hard unsatisfiable problems.
- Competition problems from 2008.
Advanced C SAT Competition: Setup

Parameters

- 300 sec per problem
- 41 SAT programs entered
- all programs compiled with -O3
- most recent version taken
- hardware: 3.16GHz Xeon, 6MB Cache, 16GB RAM, 4 CPUs, 2 Jobs
Advanced C SAT Competition: Results

<table>
<thead>
<tr>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>▶ 16 programs crashed on at least one example</td>
</tr>
<tr>
<td>▶ 3 programs produced wrong results</td>
</tr>
<tr>
<td>▶ 29 programs could not solve any problem</td>
</tr>
<tr>
<td>▶ 4 programs solved one problem</td>
</tr>
<tr>
<td>▶ 2 programs solved two problems</td>
</tr>
<tr>
<td>▶ 2 programs solved three problems</td>
</tr>
<tr>
<td>▶ 1 program solved four problems</td>
</tr>
<tr>
<td>▶ 1 program solved five problems</td>
</tr>
<tr>
<td>▶ 1 program solved six problems</td>
</tr>
<tr>
<td>▶ 1 program solved seven problems</td>
</tr>
</tbody>
</table>
# Advanced C SAT Competition: Comparison

<table>
<thead>
<tr>
<th>Program</th>
<th>2bitmax</th>
<th>qg2</th>
<th>qg3</th>
<th>uf-1</th>
<th>uf-13</th>
<th>uuf-1</th>
<th>uuf-13</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAT</td>
<td>44.83</td>
<td>126.10</td>
<td>3.95</td>
<td>17.07</td>
<td>32.23</td>
<td>88.62</td>
<td>45.71</td>
</tr>
<tr>
<td>PROP</td>
<td>7.14</td>
<td>2.37</td>
<td>14.71</td>
<td>37.99</td>
<td>tout</td>
<td>tout</td>
<td>tout</td>
</tr>
<tr>
<td>Mini</td>
<td>0.00</td>
<td>3.23</td>
<td>2.99</td>
<td>0.05</td>
<td>1.71</td>
<td>1.99</td>
<td>2.11</td>
</tr>
</tbody>
</table>
**Merging Replacement Resolution**

<table>
<thead>
<tr>
<th>Tricks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. link complementary literals</td>
</tr>
<tr>
<td>2. consider clause length</td>
</tr>
<tr>
<td>3. sort literals</td>
</tr>
<tr>
<td>4. do fingerprint of first $n$-atoms</td>
</tr>
</tbody>
</table>
Example 1: Queues

typedef struct QUEUE_HELP
{
    int first;    /* first element */
    int last;     /* if last = -1 the queue is empty */
    int step;     /* amount to grow */
    int size;     /* current array size */
    void** queue; /* cyclic array of void * */
}
QUEUE_NODE;

typedef QUEUE_NODE *QUEUE;
void* queue_Get(Queue q)

/**********************************************
INPUT:    A queue.
RETURNS: The first element is removed from
          the queue and returned.
NOTE:     Should only be called on a nonempty queue.
***********************************************/
{
    void* res = q->queue[q->first];

    ASSERT(!queue_IsEmpty(q));

    if (q->first == q->last) { /*last element*/
        q->last = -1;           /*we are empty*/
    } else {
        q->first = (q->first+1) % q->size;
    }

    return res;
}
Example 2: DPLL

```c
int solver_Solve(SOLVER sol)
{
    int unit_literal;
    if (sol->contradiction) {
        sol->contradiction = 0;
        return 0;
    }
    if (clause_AllTrue(sol->set)) return 1;
    else if (clause_SomeFalse(sol->set)) return 0;
    else {
        unit_literal = clause_FindUnitLiteral(sol->set);
        if (unit_literal) {
            solver_Decide(sol, unit_literal);
            return solver_Solve(sol);
        } else {
            int var, pos;
            var = solver_UndefinedVar(sol);
            pos = solver_Decide(sol, -var);
            if (solver_Solve(sol)) return 1;
            else {
                solver_Backtrack(sol, pos);
                solver_Decide(sol, var);
                return solver_Solve(sol);
            }
        }
    }
}
return 0;
}```