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Introduction to Artificial Intelligence
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Project 2: SatSearch Writeup

I have created 10 different test files, with varying numbers of literals per clause (L), numbers of variables (V), and numbers of clauses (C), specified in the file names. I used 4 of the different SearchControls I implemented: vanillaSearch, superFancySearch, almostSuperFancySearch (does not have backjumping), and onlyUPAndPLSearch (only uses unit propagation and pure literals, without backtracking or special variable choosing strategies). From the data it is apparent that vanillaSearch failed twice, on tests 2 and 9, whereas the others succeeded. This can be due to a number of things, but it does not seem to be an algorithmic issue since the other tests completed fine. Backtracking makes a significant difference in the running times, significantly reducing running time and average depth, as well as the depth of the solution found. This can be best seen when comparing tests 2, 3, 5, and 6 from superFancySearch and almostSuperFancySearch. The onlyUPAndPLSearch shows that removing the ability to pick variables strategically also reduces performance across the board, though not as much as not backjumping does. Interestingly enough, the unit propagation and pure literals might even have slowed the search process down compared to vanillaSearch, leading me to think that the benefits of such processes might not be fully realized with such (relatively) small inputs. However, the combination of UP and PL, along with backjumping and strategic variable assignment picks clearly shows that superFancySearch is indeed the super fanciest. The mix of advantages allows the search to skip much of the search space while the other functions are left with only some advantages over vanillaSearch, and in the case of onlyUPAndPLSearch, advantages that don't quite completely outweight the disadvantages.

TEST DATA

String o1 = *doSearchWithTimeLimit*("./Examples/10L-25V-10C.dimacs", *vanillaSearch*, 15000L);

```
{11=true, 1=true, 12=true, 13=true, 14=true, 15=true, 16=true,
10=true}
Successful search.
Solution found at depth 8.
Elapsed time: 4 ms.
Expanded 8 nodes of average depth 3.5.
```

String o2 = *doSearchWithTimeLimit* ("./Examples/10L-25V-25C.dimacs", vanillaSearch, 15000L);

```
Unsatisfiable
Failed search.
Elapsed time: 10 ms.
Expanded 45 nodes of average depth 11.244445.
Reached 2 leaves at average depth 23.0.
Imputed branching factor: 1.0305955447520094.
```

String o3 = *doSearchWithTimeLimit* ("./Examples/10L-30V-40C.dimacs", vanillaSearch, 15000L);

```
{22=true, 23=true, 24=true, 25=true, 26=true, 27=true, 28=true,
29=true, 30=true, 10=true, 11=true, 12=true, 13=true, 14=true,
15=true, 16=true, 17=true, 18=true, 19=true, 1=true, 2=true, 3=true,
4=true, 5=true, 6=true, 7=true, 8=true, 20=true, 21=true}
Successful search.
Solution found at depth 29.
Elapsed time: 7 ms.
Expanded 29 nodes of average depth 14.0.
```

String o4 = *doSearchWithTimeLimit* ("./Examples/20L-20V-10C.dimacs", vanillaSearch, 15000L);

```
{11=true, 1=true, 12=true, 13=true, 14=true, 10=true}
Successful search.
Solution found at depth 6.
Elapsed time: 4 ms.
Expanded 6 nodes of average depth 2.5.
```

String o5 = *doSearchWithTimeLimit* ("./Examples/20L-20V-20C.dimacs", vanillaSearch, 15000L);

```
{11=true, 1=true, 12=true, 13=true, 14=true, 15=true, 10=true}
Successful search.
Solution found at depth 7.
Elapsed time: 4 ms.
Expanded 7 nodes of average depth 3.0.
```

String o6 = *doSearchWithTimeLimit* ("./Examples/20L-30V-40C.dimacs", vanillaSearch, 15000L);

```
{11=true, 12=true, 13=true, 14=true, 15=true, 16=true, 17=true,
18=true, 19=true, 1=true, 2=true, 20=true, 10=true}
Successful search.
Solution found at depth 13.
Elapsed time: 7 ms.
Expanded 13 nodes of average depth 6.0.
```

String o7 = *doSearchWithTimeLimit* ("./Examples/5L-10V-25C.dimacs", vanillaSearch, 15000L);

```
{1=true, 2=true, 3=true, 4=true, 5=true, 10=true}
Successful search.
Solution found at depth 6.
Elapsed time: 6 ms.
Expanded 6 nodes of average depth 2.5.
```

String o8 = *doSearchWithTimeLimit* ("./Examples/5L-25V-10C.dimacs", vanillaSearch, 15000L);

```
{11=true, 1=false, 12=true, 13=true, 2=true, 14=true, 15=true,
16=true, 17=true, 18=true, 20=true, 10=true}
Successful search.
Solution found at depth 12.
Elapsed time: 8 ms.
Expanded 26 nodes of average depth 6.576923.
Reached 1 leaves at average depth 15.0.
Imputed branching factor: 1.0.
```

String o9 = *doSearchWithTimeLimit* ("./Examples/5L-25V-25C.dimacs", vanillaSearch, 15000L);

```
Unsatisfiable
Failed search.
Elapsed time: 8 ms.
Expanded 25 nodes of average depth 6.24.
Reached 2 leaves at average depth 13.0.
Imputed branching factor: 1.0547660764816467.
```

String o10 = *doSearchWithTimeLimit* ("./Examples/5L-5V-5C.dimacs", vanillaSearch, 15000L);

```
{1=true, 2=true}
Successful search.
Solution found at depth 2.
Elapsed time: 3 ms.
Expanded 2 nodes of average depth 0.5.
```

String o1 = *doSearchWithTimeLimit*("./Examples/10L-25V-10C.dimacs", *superFancySearch*, 15000L);

```
{22=true, 11=false, 23=true, 24=true, 13=true, 25=true, 15=false,
16=true, 1=false, 2=true, 4=true, 7=false, 8=false, 9=false, 21=false}
Successful search.
Solution found at depth 0.
Elapsed time: 2 ms.
```

String o2 = *doSearchWithTimeLimit*("./Examples/10L-25V-25C.dimacs", *superFancySearch*, 15000L);

```
{22=false, 11=false, 12=false, 23=false, 24=true, 14=false, 16=true,
17=false, 18=true, 19=false, 1=false, 3=true, 4=true, 5=false,
8=false, 9=false, 20=false}
Successful search.
Solution found at depth 2.
Elapsed time: 7 ms.
Expanded 2 nodes of average depth 0.5.
```

String o3 = *doSearchWithTimeLimit*("./Examples/10L-30V-40C.dimacs", *superFancySearch*, 15000L);

```
{22=true, 23=false, 17=true, 29=true, 18=false, 19=true, 1=false,
3=false, 4=false, 5=true, 7=false, 8=true, 30=true, 20=true, 21=true}
Successful search.
Solution found at depth 3.
Elapsed time: 9 ms.
Expanded 3 nodes of average depth 1.0.
```

String o4 = *doSearchWithTimeLimit*("./Examples/20L-20V-10C.dimacs", *superFancySearch*, 15000L);

```
{11=true, 13=false, 14=true, 3=true, 4=true, 17=false, 18=false}
Successful search.
Solution found at depth 1.
Elapsed time: 6 ms.
Expanded 1 nodes of average depth 0.0.
```

String o5 = *doSearchWithTimeLimit*("./Examples/20L-20V-20C.dimacs", *superFancySearch*, 15000L);

```
{11=true, 19=false, 12=true, 4=true, 6=false}
Successful search.
Solution found at depth 2.
Elapsed time: 7 ms.
Expanded 2 nodes of average depth 0.5.
```

String o6 = *doSearchWithTimeLimit*("./Examples/20L-30V-40C.dimacs", *superFancySearch*, 15000L);

```
{22=true, 11=false, 12=true, 23=false, 2=true, 25=true, 14=false,
5=true, 7=true, 29=false, 30=false, 10=true}
Successful search.
Solution found at depth 2.
Elapsed time: 20 ms.
Expanded 2 nodes of average depth 0.5.
```

String o7 = *doSearchWithTimeLimit*("./Examples/5L-10V-25C.dimacs", *superFancySearch*, 15000L);

```
{1=false, 3=true, 4=false, 5=true, 6=false, 8=true, 9=true, 10=true}
Successful search.
Solution found at depth 2.
Elapsed time: 6 ms.
Expanded 2 nodes of average depth 0.5.
```

String o8 = *doSearchWithTimeLimit*("./Examples/5L-25V-10C.dimacs", *superFancySearch*, 15000L);

```
{22=true, 12=false, 14=false, 15=true, 16=false, 1=false, 2=false,
3=true, 4=true, 6=true, 7=false, 8=false, 9=true, 21=false, 10=false}
Successful search.
Solution found at depth 0.
Elapsed time: 4 ms.
```

String o9 = *doSearchWithTimeLimit*("./Examples/5L-25V-25C.dimacs", *superFancySearch*, 15000L);

```
{11=false, 22=false, 23=true, 12=false, 24=false, 14=false, 25=false,
15=false, 16=false, 18=false, 2=false, 4=false, 5=false, 6=false,
7=true, 8=false, 9=true, 20=true, 21=true}
Successful search.
Solution found at depth 0.
Elapsed time: 5 ms.
```

String o10 = *doSearchWithTimeLimit*("./Examples/5L-5V-5C.dimacs", *superFancySearch*, 15000L);

```
{1=true, 2=true, 3=false, 4=false, 5=true}
Successful search.
Solution found at depth 1.
Elapsed time: 12 ms.
Expanded 1 nodes of average depth 0.0.
```

String o1 = *doSearchWithTimeLimit*("./Examples/10L-25V-10C.dimacs", *almostSuperFancySearch*, 15000L);

```
{22=true, 11=false, 23=true, 24=true, 13=true, 25=true, 15=false,
16=true, 1=false, 2=true, 4=true, 7=false, 8=false, 9=false, 21=false}
Successful search.
Solution found at depth 0.
Elapsed time: 2 ms.
```

String o2 = *doSearchWithTimeLimit*("./Examples/10L-25V-25C.dimacs", *almostSuperFancySearch*, 15000L);

```
{22=false, 11=false, 12=false, 23=false, 24=true, 14=false, 16=true,
17=false, 18=true, 19=false, 1=false, 3=true, 4=true, 5=false,
8=false, 9=false, 20=false}
Successful search.
Solution found at depth 2.
Elapsed time: 21 ms.
Expanded 2 nodes of average depth 0.5.
```

String o3 = *doSearchWithTimeLimit*("./Examples/10L-30V-40C.dimacs", *almostSuperFancySearch*, 15000L);

```
{22=true, 23=false, 17=true, 29=true, 18=false, 19=true, 1=false,
3=false, 4=false, 5=true, 7=false, 8=true, 30=true, 20=true, 21=true}
Successful search.
Solution found at depth 3.
Elapsed time: 19 ms.
Expanded 3 nodes of average depth 1.0.
```

String o4 = *doSearchWithTimeLimit*("./Examples/20L-20V-10C.dimacs", *almostSuperFancySearch*, 15000L);

```
{11=true, 13=false, 14=true, 3=true, 4=true, 17=false, 18=false}
Successful search.
Solution found at depth 1.
```

```
Elapsed time: 5 ms.
Expanded 1 nodes of average depth 0.0.
```
String o5 = *doSearchWithTimeLimit*("./Examples/20L-20V-20C.dimacs", *almostSuperFancySearch*, 15000L);
```
{11=true, 19=false, 12=true, 4=true, 6=false}
Successful search.
Solution found at depth 2.
Elapsed time: 10 ms.
Expanded 2 nodes of average depth 0.5.
```
String o6 = *doSearchWithTimeLimit*("./Examples/20L-30V-40C.dimacs", *almostSuperFancySearch*, 15000L);
```
{22=true, 11=false, 12=true, 23=false, 2=true, 25=true, 14=false,
5=true, 7=true, 29=false, 30=false, 10=true}
Successful search.
Solution found at depth 2.
Elapsed time: 16 ms.
Expanded 2 nodes of average depth 0.5.
```
String o7 = *doSearchWithTimeLimit*("./Examples/5L-10V-25C.dimacs", *almostSuperFancySearch*, 15000L);
```
{1=false, 3=true, 4=false, 5=true, 6=false, 8=true, 9=true, 10=true}
Successful search.
Solution found at depth 2.
Elapsed time: 7 ms.
Expanded 2 nodes of average depth 0.5.
```
String o8 = *doSearchWithTimeLimit*("./Examples/5L-25V-10C.dimacs", *almostSuperFancySearch*, 15000L);
```
{22=true, 12=false, 14=false, 15=true, 16=false, 1=false, 2=false,
3=true, 4=true, 6=true, 7=false, 8=false, 9=true, 21=false, 10=false}
Successful search.
Solution found at depth 0.
Elapsed time: 2 ms.
```
String o9 = *doSearchWithTimeLimit*("./Examples/5L-25V-25C.dimacs", *almostSuperFancySearch*, 15000L);
```
{11=false, 22=false, 23=true, 12=false, 24=false, 14=false, 25=false,
15=false, 16=false, 18=false, 2=false, 4=false, 5=false, 6=false,
7=true, 8=false, 9=true, 20=true, 21=true}
Successful search.
Solution found at depth 0.
Elapsed time: 6 ms.
```
String o10 = *doSearchWithTimeLimit*("./Examples/5L-5V-5C.dimacs", *almostSuperFancySearch*, 15000L);
```
{1=true, 2=true, 3=false, 4=false, 5=true}
Successful search.
Solution found at depth 1.
Elapsed time: 4 ms.
```

```
Expanded 1 nodes of average depth 0.0.
```

String o1 = *doSearchWithTimeLimit*("./Examples/10L-25V-10C.dimacs", *onlyUPAndPLSearch*, 15000L);

```
{22=true, 11=false, 23=true, 24=true, 13=true, 25=true, 15=false,
16=true, 1=false, 2=true, 4=true, 7=false, 8=false, 9=false, 21=false}
Successful search.
Solution found at depth 0.
Elapsed time: 16 ms.
```

String o2 = *doSearchWithTimeLimit*("./Examples/10L-25V-25C.dimacs", *onlyUPAndPLSearch*, 15000L);

```
{12=true, 13=true, 14=false, 25=true, 16=false, 17=false, 18=true,
19=false, 1=true, 5=false, 7=false, 8=false, 9=false, 10=true,
21=false}
Successful search.
Solution found at depth 2.
Elapsed time: 7 ms.
Expanded 2 nodes of average depth 0.5.
```

String o3 = *doSearchWithTimeLimit*("./Examples/10L-30V-40C.dimacs", *onlyUPAndPLSearch*, 15000L);

```
{22=false, 23=false, 26=true, 27=true, 28=false, 29=false, 30=false,
10=true, 11=true, 12=true, 13=true, 14=false, 15=false, 16=true,
17=false, 18=false, 19=false, 1=true, 2=false, 4=true, 5=true, 6=true,
7=false, 8=true, 9=false, 20=false, 21=true}
Successful search.
Solution found at depth 4.
Elapsed time: 16 ms.
Expanded 4 nodes of average depth 1.5.
```

String o4 = *doSearchWithTimeLimit*("./Examples/20L-20V-10C.dimacs", *onlyUPAndPLSearch*, 15000L);

```
{1=true, 12=false, 14=true, 4=true, 16=false, 5=true, 6=true, 7=false,
8=false}
Successful search.
Solution found at depth 1.
Elapsed time: 16 ms.
Expanded 1 nodes of average depth 0.0.
```

String o5 = *doSearchWithTimeLimit*("./Examples/20L-20V-20C.dimacs", *onlyUPAndPLSearch*, 15000L);

```
{11=false, 1=true, 10=true}
Successful search.
Solution found at depth 2.
Elapsed time: 7 ms.
Expanded 2 nodes of average depth 0.5.
```

String o6 = *doSearchWithTimeLimit*("./Examples/20L-30V-40C.dimacs", *onlyUPAndPLSearch*, 15000L);

```
{11=true, 1=true, 14=false, 26=true, 28=true, 9=true, 30=false,
10=true, 21=false}
Successful search.
Solution found at depth 3.
Elapsed time: 13 ms.
Expanded 3 nodes of average depth 1.0.
```

String o7 = *doSearchWithTimeLimit*("./Examples/5L-10V-25C.dimacs", *onlyUPAndPLSearch*, 15000L);

```
{1=true, 2=true, 3=true, 4=true, 6=true, 8=false, 9=false, 10=true}
Successful search.
Solution found at depth 3.
Elapsed time: 6 ms.
Expanded 3 nodes of average depth 1.0.
```

String o8 = *doSearchWithTimeLimit*("./Examples/5L-25V-10C.dimacs", *onlyUPAndPLSearch*, 15000L);

```
{22=true, 12=false, 14=false, 15=true, 16=false, 1=false, 2=false,
3=true, 4=true, 6=true, 7=false, 8=false, 9=true, 21=false, 10=false}
Successful search.
Solution found at depth 0.
Elapsed time: 3 ms.
```

String o9 = *doSearchWithTimeLimit*("./Examples/5L-25V-25C.dimacs", *onlyUPAndPLSearch*, 15000L);

```
{11=false, 22=false, 23=true, 12=false, 24=false, 14=false, 25=false,
15=false, 16=false, 18=false, 2=false, 4=false, 5=false, 6=false,
7=true, 8=false, 9=true, 20=true, 21=true}
Successful search.
Solution found at depth 0.
Elapsed time: 9 ms.
```

String o10 = *doSearchWithTimeLimit*("./Examples/5L-5V-5C.dimacs", *onlyUPAndPLSearch*, 15000L);

```
{1=true, 2=true, 3=false, 4=false, 5=true}
Successful search.
Solution found at depth 1.
Elapsed time: 3 ms.
Expanded 1 nodes of average depth 0.0.
```
