Homework 2

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Knapsack

Generating Knapsack Problems

In order to get a random knapsack problem, I wanted to make sure that we had a variety of different kinds of Items. So I created 5 different classifications of items: Small Items with weights and values between 1 and 32, Medium Items with weights and values between 1 and 128, Large Items with weights and values between 1 and 512, High Value Items with weights between 1 and 64 and values between 256 and 512, and High Weight Items with weights between 256 and 512 and values between 1 and 64. A Knapsack problem is composed of 256 Small Items, 256 MediumItems, 128 LargeItems, 128 HighValueItems, and 128HighWeightItems randomly shuffled together. The capacity of the knapsack is 1024. The values and weights are randomly generated.

Running Times

The running times for the knapsack problem are as follows:
Algorithm: Greedy Knapsack (Double)
Minimum Time: 1.385 ms
Maximum Time: 2.9050000000000002 ms
Average Time: 1.8916999999999997 ms

Algorithm: 0/1 Dynamic Programming
Minimum Time: 0.377 ms
Maximum Time: 8.188 ms
Average Time: 4.156999999999999 ms

Algorithm: Minimum Cost Knapsack
Minimum Time: 709.389 ms
Maximum Time: 780.577 ms
Average Time: 733.5092999999999 ms

Algorithm: FPTAS Knapsack
Minimum Time: 1579.941 ms

Maximum Time: 12269.074 ms
Average Time: 3685.9759 ms

These results mostly make sense, the Greedy algorithm should definetly be
the fastest although we can see that the fastest time for maximum knapsack did
manage to be faster then the fastest greedy time somehow. It should be noted
that the Greedy algorithm is at a slight disadvantage as it has to convert its
results into integers, which the other algorithms do not have to do.

Minimum Cost taking more time then the maximum solution just means that
the sums of the values were larger then the maximum weight of the knapsack
which is definetly the case. FPTAS taking twice as long as minimum cost is not
terribly suprising the constants in FPTAS are much larger then the constants
in Minimum Cost and epsilon was set to between 0.1 and 0.9.

Quality of Solutions

I didn't take the time to specifically test what the averages of FPTAS or Greedy
returned compared to what the real optimal solutions returned by maximum or
minimum knapsack but in the FuzzTesting file I did make sure that Greedy
always got at least within 1/2 of the true answer and that FPTAS always got
within the expected range based on the epsilon value.

Traveling Salesman

The traveling salesman problems I tested on at worst were 1.8 times optimal
and at best were 1.41 times optimal.

tsp_problemsburma14.tsp.gz: 4704.0 - 3323.0 - 1.4155883238037918
tsp_problemsali535.tsp.gz: 345022.0 - 202310.0 - 1.7054124857891355
tsp_problemsberlin52.tsp.gz: 12156.0 - 7542.0 - 1.6117740652346857
tsp_problemsbier127.tsp.gz: 189412.0 - 118282.0 - 1.6013594629783061
tsp_problemsch130.tsp.gz: 10332.0 - 6110.0 - 1.6909983633387888
tsp_problemsch150.tsp.gz: 11756.0 - 6528.0 - 1.8008578431372548
tsp_problemsd198.tsp.gz: 23476.0 - 15780.0 - 1.4877059569074778
tsp_problemsd493.tsp.gz: 58542.0 - 35002.0 - 1.6725329981143935
tsp_problemseil51.tsp.gz: 750.0 - 426.0 - 1.7605633802816902
tsp_problemsd657.tsp.gz: 84982.0 - 48912.0 - 1.737446843310435

SAT Solver

For sat solvers the dpll runtimes varied dramatically. Unsatisfiable problems
took significantly longer then satisfiable problems as they had to check every
possible combination of variables. GSAT took a pretty constant time to run
as every time it was run with 100 tries and 100 flips for each try. Randomized

rounding saw its runtimes increased with numver of clauses as expected but remained incredibly fast.

In terms of clause satisfaction, DPLL returned either 0 for unsatisfiable problem or 1 for completely satisfied. GSAT and Randomized Rounding were consistently able to satisfy upwards of 90% of the clauses.

SAT Solver Benchmark Results - 2024-12-14 01:12:21

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Generating test cases with 32 variables...

Running benchmarks...
Benchmarking with 16 clauses...
DPLL-32-vars/16 clauses: 0.882 ms
DPLL-32-vars/16 clauses: 4.7e-2 ms
DPLL-32-vars/16 clauses: 4.5000000000000005e-2 ms
DPLL-32-vars/16 clauses: 6.1e-2 ms
DPLL-32-vars/16 clauses: 4.7e-2 ms
GSAT-32-vars/16 clauses: 29.028000000000002 ms
GSAT-32-vars/16 clauses: 31.938000000000002 ms
GSAT-32-vars/16 clauses: 35.429 ms
GSAT-32-vars/16 clauses: 31.947000000000003 ms
GSAT-32-vars/16 clauses: 40.659 ms
Randomized-Rounding-32-vars/16 clauses: 0.153 ms
Randomized-Rounding-32-vars/16 clauses: 9.2e-2 ms
Randomized-Rounding-32-vars/16 clauses: 8.0e-2 ms
Randomized-Rounding-32-vars/16 clauses: 7.4e-2 ms
Randomized-Rounding-32-vars/16 clauses: 8.2e-2 ms
Average time for 16 clauses:
DPLL: 0.2164 ms
GSAT: 33.800200000000004 ms
Randomized Rounding:9.62e-2 ms
Average clause satisfaction:
DPLL: 1.0
GSAT: 0.9625
Randomized Rounding:1.0

Individual Problem Clause Satisfactions:
DPLL: [1.0,1.0,1.0,1.0,1.0]
GSAT: [1.0,1.0,0.9375,1.0,0.875]
Randomized Rounding:[1.0,1.0,1.0,1.0,1.0]

Benchmarking with 32 clauses...
DPLL-32-vars/32 clauses: 0.747 ms
DPLL-32-vars/32 clauses: 9.3e-2 ms
DPLL-32-vars/32 clauses: 7.6e-2 ms
DPLL-32-vars/32 clauses: 8.0e-2 ms
DPLL-32-vars/32 clauses: 1.278 ms
GSAT-32-vars/32 clauses: 61.439 ms
GSAT-32-vars/32 clauses: 51.49 ms
GSAT-32-vars/32 clauses: 67.028 ms

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GSAT-32-vars/32 clauses: 69.155 ms
GSAT-32-vars/32 clauses: 66.79599999999999 ms
Randomized-Rounding-32-vars/32 clauses: 0.154 ms
Randomized-Rounding-32-vars/32 clauses: 0.129 ms
Randomized-Rounding-32-vars/32 clauses: 0.12999999999999998 ms
Randomized-Rounding-32-vars/32 clauses: 0.13699999999999998 ms
Randomized-Rounding-32-vars/32 clauses: 0.13999999999999999 ms
Average time for 32 clauses:
DPLL: 0.4548 ms
GSAT: 63.1816 ms
Randomized Rounding:0.13799999999999998 ms
Average clause satisfaction:
DPLL: 1.0
GSAT: 0.95
Randomized Rounding:0.99375

Individual Problem Clause Satisfactions:
DPLL: [1.0,1.0,1.0,1.0,1.0]
GSAT: [0.96875,1.0,0.9375,0.90625,0.9375]
Randomized Rounding:[0.96875,1.0,1.0,1.0,1.0]

Benchmarking with 48 clauses...
DPLL-32-vars/48 clauses: 0.219 ms
DPLL-32-vars/48 clauses: 0.13899999999999998 ms
DPLL-32-vars/48 clauses: 0.254 ms
DPLL-32-vars/48 clauses: 0.242 ms
DPLL-32-vars/48 clauses: 94.821 ms
GSAT-32-vars/48 clauses: 95.959 ms
GSAT-32-vars/48 clauses: 74.661 ms
GSAT-32-vars/48 clauses: 98.428 ms
GSAT-32-vars/48 clauses: 92.166 ms
GSAT-32-vars/48 clauses: 81.239 ms
Randomized-Rounding-32-vars/48 clauses: 0.27599999999999997 ms
Randomized-Rounding-32-vars/48 clauses: 0.187 ms
Randomized-Rounding-32-vars/48 clauses: 0.212 ms
Randomized-Rounding-32-vars/48 clauses: 0.289 ms
Randomized-Rounding-32-vars/48 clauses: 0.20900000000000002 ms
Average time for 48 clauses:
DPLL: 19.134999999999998 ms
GSAT: 88.4906 ms
Randomized Rounding:0.2346 ms
Average clause satisfaction:
DPLL: 1.0
GSAT: 0.9541666666666666
Randomized Rounding:0.9958333333333332

Individual Problem Clause Satisfactions:
DPLL: [1.0,1.0,1.0,1.0,1.0]
GSAT: [0.9375,1.0,0.9166666666666666,0.9375,0.9791666666666666]
Randomized Rounding:[1.0,1.0,0.9791666666666666,1.0,1.0]

Benchmarking with 64 clauses...
DPLL-32-vars/64 clauses: 0.17 ms
DPLL-32-vars/64 clauses: 2.904 ms
DPLL-32-vars/64 clauses: 1.175 ms
DPLL-32-vars/64 clauses: 23.757 ms
DPLL-32-vars/64 clauses: 0.17300000000000001 ms
GSAT-32-vars/64 clauses: 112.65899999999999 ms
GSAT-32-vars/64 clauses: 131.994 ms
GSAT-32-vars/64 clauses: 139.638 ms
GSAT-32-vars/64 clauses: 107.107 ms
GSAT-32-vars/64 clauses: 110.901 ms
Randomized-Rounding-32-vars/64 clauses: 0.428 ms
Randomized-Rounding-32-vars/64 clauses: 0.328 ms
Randomized-Rounding-32-vars/64 clauses: 0.296 ms
Randomized-Rounding-32-vars/64 clauses: 0.251 ms
Randomized-Rounding-32-vars/64 clauses: 0.33599999999999997 ms
Average time for 64 clauses:
DPLL: 5.6358 ms
GSAT: 120.4598 ms
Randomized Rounding:0.3278 ms
Average clause satisfaction:
DPLL: 1.0
GSAT: 0.94375
Randomized Rounding:0.978125

Individual Problem Clause Satisfactions:
DPLL: [1.0,1.0,1.0,1.0,1.0]
GSAT: [0.96875,0.90625,0.890625,0.984375,0.96875]
Randomized Rounding:[1.0,0.96875,1.0,1.0,0.921875]

Benchmarking with 80 clauses...
DPLL-32-vars/80 clauses: 68.79599999999999 ms
DPLL-32-vars/80 clauses: 9.506 ms
DPLL-32-vars/80 clauses: 4.101999999999999 ms
DPLL-32-vars/80 clauses: 1061.566 ms
DPLL-32-vars/80 clauses: 33.116 ms
GSAT-32-vars/80 clauses: 175.507 ms
GSAT-32-vars/80 clauses: 136.125 ms

GSAT-32-vars/80 clauses: 139.97799999999998 ms
GSAT-32-vars/80 clauses: 168.984 ms
GSAT-32-vars/80 clauses: 209.985 ms
Randomized-Rounding-32-vars/80 clauses: 0.49299999999999994 ms
Randomized-Rounding-32-vars/80 clauses: 0.352 ms
Randomized-Rounding-32-vars/80 clauses: 0.389 ms
Randomized-Rounding-32-vars/80 clauses: 0.61 ms
Randomized-Rounding-32-vars/80 clauses: 0.36000000000000004 ms
Average time for 80 clauses:
DPLL: 235.4172 ms
GSAT: 166.11579999999998 ms
Randomized Rounding:0.44079999999999997 ms
Average clause satisfaction:
DPLL: 1.0
GSAT: 0.9324999999999999
Randomized Rounding:0.9574999999999999

Individual Problem Clause Satisfactions:
DPLL: [1.0,1.0,1.0,1.0,1.0]
GSAT: [0.8875,0.975,0.975,0.9,0.925]
Randomized Rounding:[0.95,1.0,0.975,0.9125,0.95]

Benchmarking with 96 clauses...
DPLL-32-vars/96 clauses: 5.178 ms
DPLL-32-vars/96 clauses: 150.953 ms
DPLL-32-vars/96 clauses: 21.064 ms
DPLL-32-vars/96 clauses: 0.519 ms
DPLL-32-vars/96 clauses: 5456.076999999999 ms
GSAT-32-vars/96 clauses: 157.202 ms
GSAT-32-vars/96 clauses: 149.988 ms
GSAT-32-vars/96 clauses: 161.729 ms
GSAT-32-vars/96 clauses: 200.02900000000002 ms
GSAT-32-vars/96 clauses: 167.922 ms
Randomized-Rounding-32-vars/96 clauses: 0.513 ms
Randomized-Rounding-32-vars/96 clauses: 0.636 ms
Randomized-Rounding-32-vars/96 clauses: 0.46099999999999997 ms
Randomized-Rounding-32-vars/96 clauses: 0.5419999999999999 ms
Randomized-Rounding-32-vars/96 clauses: 0.524 ms
Average time for 96 clauses:
DPLL: 1126.7582 ms
GSAT: 167.374 ms
Randomized Rounding:0.5352 ms
Average clause satisfaction:
DPLL: 1.0
GSAT: 0.9625

Randomized Rounding:0.925

Individual Problem Clause Satisfactions:
DPLL: [1.0,1.0,1.0,1.0,1.0]
GSAT: [0.9791666666666666,1.0,0.9791666666666666,0.8958333333333334,0.9583333333333334]
Randomized Rounding:[0.9479166666666666,0.9479166666666666,0.8958333333333334,0.8958333333333334

Benchmarking with 112 clauses...
DPLL-32-vars/112 clauses: 3843.378 ms
DPLL-32-vars/112 clauses: 25.213 ms
DPLL-32-vars/112 clauses: 152.993 ms
DPLL-32-vars/112 clauses: 6.569 ms
DPLL-32-vars/112 clauses: 300.78700000000003 ms
GSAT-32-vars/112 clauses: 220.592 ms
GSAT-32-vars/112 clauses: 223.528 ms
GSAT-32-vars/112 clauses: 204.514 ms
GSAT-32-vars/112 clauses: 236.35999999999999 ms
GSAT-32-vars/112 clauses: 190.021 ms
Randomized-Rounding-32-vars/112 clauses: 0.709 ms
Randomized-Rounding-32-vars/112 clauses: 0.636 ms
Randomized-Rounding-32-vars/112 clauses: 0.7789999999999999 ms
Randomized-Rounding-32-vars/112 clauses: 0.617 ms
Randomized-Rounding-32-vars/112 clauses: 0.656 ms
Average time for 112 clauses:
DPLL: 865.7880000000001 ms
GSAT: 215.00300000000001 ms
Randomized Rounding:0.6794 ms
Average clause satisfaction:
DPLL: 0.8
GSAT: 0.9285714285714285
Randomized Rounding:0.9125

Individual Problem Clause Satisfactions:
DPLL: [0.0,1.0,1.0,1.0,1.0]
GSAT: [0.9196428571428571,0.9196428571428571,0.9464285714285714,0.8928571428571429,0.964285714285
Randomized Rounding:[0.9107142857142857,0.9285714285714286,0.9285714285714286,0.875,0.91964285714

Benchmarking with 128 clauses...
DPLL-32-vars/128 clauses: 121.85799999999999 ms
DPLL-32-vars/128 clauses: 1739.051 ms
DPLL-32-vars/128 clauses: 2878.2999999999997 ms
DPLL-32-vars/128 clauses: 2953.5190000000002 ms
DPLL-32-vars/128 clauses: 360.153 ms
GSAT-32-vars/128 clauses: 255.803 ms

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GSAT-32-vars/128 clauses: 217.31 ms
GSAT-32-vars/128 clauses: 226.433 ms
GSAT-32-vars/128 clauses: 249.277 ms
GSAT-32-vars/128 clauses: 253.206 ms
Randomized-Rounding-32-vars/128 clauses: 0.9840000000000001 ms
Randomized-Rounding-32-vars/128 clauses: 0.726 ms
Randomized-Rounding-32-vars/128 clauses: 0.848 ms
Randomized-Rounding-32-vars/128 clauses: 0.876 ms
Randomized-Rounding-32-vars/128 clauses: 0.6920000000000001 ms
Average time for 128 clauses:
DPLL: 1610.5762 ms
GSAT: 240.4058 ms
Randomized Rounding:0.8252 ms
Average clause satisfaction:
DPLL: 0.6
GSAT: 0.9359375
Randomized Rounding:0.9203125

Individual Problem Clause Satisfactions:
DPLL: [1.0,1.0,0.0,0.0,1.0]
GSAT: [0.921875,0.96875,0.953125,0.921875,0.9140625]
Randomized Rounding:[0.90625,0.90625,0.9296875,0.953125,0.90625]

Benchmarking with 144 clauses...
DPLL-32-vars/144 clauses: 235.25099999999998 ms
DPLL-32-vars/144 clauses: 1103.3059999999998 ms
DPLL-32-vars/144 clauses: 1473.4199999999998 ms
DPLL-32-vars/144 clauses: 1116.245 ms
DPLL-32-vars/144 clauses: 57.836 ms
GSAT-32-vars/144 clauses: 251.973 ms
GSAT-32-vars/144 clauses: 253.41200000000003 ms
GSAT-32-vars/144 clauses: 237.662 ms
GSAT-32-vars/144 clauses: 248.292 ms
GSAT-32-vars/144 clauses: 288.089 ms
Randomized-Rounding-32-vars/144 clauses: 1.0150000000000001 ms
Randomized-Rounding-32-vars/144 clauses: 1.014 ms
Randomized-Rounding-32-vars/144 clauses: 0.923 ms
Randomized-Rounding-32-vars/144 clauses: 1.067 ms
Randomized-Rounding-32-vars/144 clauses: 0.8540000000000001 ms
Average time for 144 clauses:
DPLL: 797.2116 ms
GSAT: 255.8856 ms
Randomized Rounding:0.9745999999999999 ms
Average clause satisfaction:
DPLL: 0.6

GSAT: 0.9541666666666666
Randomized Rounding:0.9263888888888889

Individual Problem Clause Satisfactions:
DPLL: [1.0,1.0,0.0,0.0,1.0]
GSAT: [0.9583333333333334,0.9583333333333334,0.9791666666666666,0.9652777777777778,0.9097222222222
Randomized Rounding:[0.9444444444444444,0.9305555555555556,0.9444444444444444,0.875,0.9375]

Benchmarking with 160 clauses...
DPLL-32-vars/160 clauses: 1964.972 ms
DPLL-32-vars/160 clauses: 528.207 ms
DPLL-32-vars/160 clauses: 753.749 ms
DPLL-32-vars/160 clauses: 335.703 ms
DPLL-32-vars/160 clauses: 397.697 ms
GSAT-32-vars/160 clauses: 359.59499999999997 ms
GSAT-32-vars/160 clauses: 268.383 ms
GSAT-32-vars/160 clauses: 308.187 ms
GSAT-32-vars/160 clauses: 338.716 ms
GSAT-32-vars/160 clauses: 336.769 ms
Randomized-Rounding-32-vars/160 clauses: 1.383 ms
Randomized-Rounding-32-vars/160 clauses: 0.934 ms
Randomized-Rounding-32-vars/160 clauses: 1.346 ms
Randomized-Rounding-32-vars/160 clauses: 1.365 ms
Randomized-Rounding-32-vars/160 clauses: 1.119 ms
Average time for 160 clauses:
DPLL: 796.0656 ms
GSAT: 322.33000000000004 ms
Randomized Rounding:1.2293999999999998 ms
Average clause satisfaction:
DPLL: 0.2
GSAT: 0.9099999999999999
Randomized Rounding:0.915

Individual Problem Clause Satisfactions:
DPLL: [0.0,1.0,0.0,0.0,0.0]
GSAT: [0.86875,0.96875,0.93125,0.8875,0.89375]
Randomized Rounding:[0.9,0.98125,0.8875,0.88125,0.925]

Benchmarking with 176 clauses...
DPLL-32-vars/176 clauses: 681.767 ms
DPLL-32-vars/176 clauses: 1251.112 ms
DPLL-32-vars/176 clauses: 171.19799999999998 ms
DPLL-32-vars/176 clauses: 635.2379999999999 ms
DPLL-32-vars/176 clauses: 1953.365 ms

GSAT-32-vars/176 clauses: 369.99100000000004 ms
GSAT-32-vars/176 clauses: 408.27599999999995 ms
GSAT-32-vars/176 clauses: 404.742 ms
GSAT-32-vars/176 clauses: 877.287 ms
GSAT-32-vars/176 clauses: 461.234 ms
Randomized-Rounding-32-vars/176 clauses: 5.008 ms
Randomized-Rounding-32-vars/176 clauses: 5.834 ms
Randomized-Rounding-32-vars/176 clauses: 2.0500000000000003 ms
Randomized-Rounding-32-vars/176 clauses: 2.5469999999999997 ms
Randomized-Rounding-32-vars/176 clauses: 1.881 ms
Average time for 176 clauses:
DPLL: 938.5360000000001 ms
GSAT: 504.3059999999999 ms
Randomized Rounding:3.464 ms
Average clause satisfaction:
DPLL: 0.0
GSAT: 0.925
Randomized Rounding:0.9068181818181819

Individual Problem Clause Satisfactions:
DPLL: [0.0,0.0,0.0,0.0,0.0]
GSAT: [0.9545454545454546,0.9090909090909091,0.9488636363636364,0.9204545454545454,0.892045454545
Randomized Rounding:[0.8977272727272727,0.9375,0.9090909090909091,0.8920454545454546,0.8977272727

Benchmarking with 192 clauses...
DPLL-32-vars/192 clauses: 222.199 ms
DPLL-32-vars/192 clauses: 1451.341 ms
DPLL-32-vars/192 clauses: 1615.375 ms
DPLL-32-vars/192 clauses: 6137.663 ms
DPLL-32-vars/192 clauses: 233.73 ms
GSAT-32-vars/192 clauses: 427.745 ms
GSAT-32-vars/192 clauses: 388.444 ms
GSAT-32-vars/192 clauses: 395.62 ms
GSAT-32-vars/192 clauses: 437.53 ms
GSAT-32-vars/192 clauses: 400.96500000000003 ms
Randomized-Rounding-32-vars/192 clauses: 1.7049999999999998 ms
Randomized-Rounding-32-vars/192 clauses: 1.474 ms
Randomized-Rounding-32-vars/192 clauses: 1.673 ms
Randomized-Rounding-32-vars/192 clauses: 1.846 ms
Randomized-Rounding-32-vars/192 clauses: 1.717 ms
Average time for 192 clauses:
DPLL: 1932.0616000000002 ms
GSAT: 410.06080000000003 ms
Randomized Rounding:1.6830000000000003 ms
Average clause satisfaction:

DPLL: 0.0
GSAT: 0.8947916666666668
Randomized Rounding:0.8895833333333334

Individual Problem Clause Satisfactions:
DPLL: [0.0,0.0,0.0,0.0,0.0]
GSAT: [0.875,0.9114583333333334,0.90625,0.8645833333333334,0.9166666666666666]
Randomized Rounding:[0.8854166666666666,0.8958333333333334,0.8697916666666666,0.9114583333333334

Benchmarking with 208 clauses...
DPLL-32-vars/208 clauses: 712.27 ms
DPLL-32-vars/208 clauses: 799.8340000000001 ms
DPLL-32-vars/208 clauses: 1034.313 ms
DPLL-32-vars/208 clauses: 1506.1970000000001 ms
DPLL-32-vars/208 clauses: 453.745 ms
GSAT-32-vars/208 clauses: 397.515 ms
GSAT-32-vars/208 clauses: 446.038 ms
GSAT-32-vars/208 clauses: 384.513 ms
GSAT-32-vars/208 clauses: 376.902 ms
GSAT-32-vars/208 clauses: 454.65 ms
Randomized-Rounding-32-vars/208 clauses: 1.9729999999999999 ms
Randomized-Rounding-32-vars/208 clauses: 1.916 ms
Randomized-Rounding-32-vars/208 clauses: 1.8940000000000001 ms
Randomized-Rounding-32-vars/208 clauses: 1.764 ms
Randomized-Rounding-32-vars/208 clauses: 2.053 ms
Average time for 208 clauses:
DPLL: 901.2717999999999 ms
GSAT: 411.92359999999996 ms
Randomized Rounding:1.92 ms
Average clause satisfaction:
DPLL: 0.0
GSAT: 0.925
Randomized Rounding:0.8971153846153845

Individual Problem Clause Satisfactions:
DPLL: [0.0,0.0,0.0,0.0,0.0]
GSAT: [0.9567307692307693,0.8894230769230769,0.9471153846153846,0.9471153846153846,0.884615384615
Randomized Rounding:[0.8846153846153846,0.875,0.9134615384615384,0.9038461538461539,0.90865384615

Benchmarking with 224 clauses...
DPLL-32-vars/224 clauses: 841.634 ms
DPLL-32-vars/224 clauses: 554.037 ms
DPLL-32-vars/224 clauses: 752.386 ms
DPLL-32-vars/224 clauses: 505.834 ms

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DPLL-32-vars/224 clauses: 1067.58 ms
GSAT-32-vars/224 clauses: 453.46999999999997 ms
GSAT-32-vars/224 clauses: 431.404 ms
GSAT-32-vars/224 clauses: 372.976 ms
GSAT-32-vars/224 clauses: 400.155 ms
GSAT-32-vars/224 clauses: 494.291 ms
Randomized-Rounding-32-vars/224 clauses: 2.0799999999999996 ms
Randomized-Rounding-32-vars/224 clauses: 2.285 ms
Randomized-Rounding-32-vars/224 clauses: 1.9829999999999999 ms
Randomized-Rounding-32-vars/224 clauses: 2.055 ms
Randomized-Rounding-32-vars/224 clauses: 2.236 ms
Average time for 224 clauses:
DPLL: 744.2942 ms
GSAT: 430.45920000000007 ms
Randomized Rounding:2.1277999999999997 ms
Average clause satisfaction:
DPLL: 0.0
GSAT: 0.9303571428571427
Randomized Rounding:0.9044642857142857

Individual Problem Clause Satisfactions:
DPLL: [0.0,0.0,0.0,0.0,0.0]
GSAT: [0.9151785714285714,0.9285714285714286,0.9776785714285714,0.9553571428571429,0.875]
Randomized Rounding:[0.90625,0.9241071428571429,0.8928571428571429,0.9330357142857143,0.866071428

Benchmarking with 240 clauses...
DPLL-32-vars/240 clauses: 900.899 ms
DPLL-32-vars/240 clauses: 739.272 ms
DPLL-32-vars/240 clauses: 88.76299999999999 ms
DPLL-32-vars/240 clauses: 337.792 ms
DPLL-32-vars/240 clauses: 80.281 ms
GSAT-32-vars/240 clauses: 431.562 ms
GSAT-32-vars/240 clauses: 499.437 ms
GSAT-32-vars/240 clauses: 490.631 ms
GSAT-32-vars/240 clauses: 446.737 ms
GSAT-32-vars/240 clauses: 449.322 ms
Randomized-Rounding-32-vars/240 clauses: 2.2009999999999996 ms
Randomized-Rounding-32-vars/240 clauses: 2.536 ms
Randomized-Rounding-32-vars/240 clauses: 2.5370000000000004 ms
Randomized-Rounding-32-vars/240 clauses: 2.536 ms
Randomized-Rounding-32-vars/240 clauses: 2.3080000000000003 ms
Average time for 240 clauses:
DPLL: 429.4014 ms
GSAT: 463.53780000000006 ms
Randomized Rounding:2.4236 ms

Average clause satisfaction:
DPLL: 0.0
GSAT: 0.9258333333333335
Randomized Rounding:0.8866666666666667

Individual Problem Clause Satisfactions:
DPLL: [0.0,0.0,0.0,0.0,0.0]
GSAT: [0.95,0.9,0.9041666666666667,0.9416666666666667,0.9333333333333333]
Randomized Rounding:[0.9125,0.8833333333333333,0.8916666666666667,0.9041666666666667,0.8416666666

Benchmarking with 256 clauses...
DPLL-32-vars/256 clauses: 103.377 ms
DPLL-32-vars/256 clauses: 1968.0089999999998 ms
DPLL-32-vars/256 clauses: 1151.271 ms
DPLL-32-vars/256 clauses: 240.445 ms
DPLL-32-vars/256 clauses: 251.17099999999996 ms
GSAT-32-vars/256 clauses: 596.701 ms
GSAT-32-vars/256 clauses: 556.8610000000001 ms
GSAT-32-vars/256 clauses: 474.779 ms
GSAT-32-vars/256 clauses: 472.223 ms
GSAT-32-vars/256 clauses: 636.7230000000001 ms
Randomized-Rounding-32-vars/256 clauses: 2.721 ms
Randomized-Rounding-32-vars/256 clauses: 3.42 ms
Randomized-Rounding-32-vars/256 clauses: 3.199 ms
Randomized-Rounding-32-vars/256 clauses: 2.679 ms
Randomized-Rounding-32-vars/256 clauses: 2.8379999999999996 ms
Average time for 256 clauses:
DPLL: 742.8546 ms
GSAT: 547.4574 ms
Randomized Rounding:2.9714 ms
Average clause satisfaction:
DPLL: 0.0
GSAT: 0.915625
Randomized Rounding:0.89453125

Individual Problem Clause Satisfactions:
DPLL: [0.0,0.0,0.0,0.0,0.0]
GSAT: [0.89453125,0.8828125,0.94140625,0.94140625,0.91796875]
Randomized Rounding:[0.9140625,0.88671875,0.8984375,0.87890625,0.89453125]