CSE 318

OFFLINE-2 ON CSP

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Section: A1

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**TABLE:**

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| --- | --- | --- | --- | --- | --- |
| Problem | Solver | VAH | #Node | #Backtrack | #Runtime |
| d-10-01 | BT | VAH1 | 2030 | 1802 | 0.256 |
| BT | VAH2 | 24548130 | 22093292 | 2438.119 |
| BT | VAH3 | 320 | 263 | 0.067 |
| BT | VAH4 | 340 | 281 | 0.061 |
| BT | VAH5 | \* | \* | \* |
| FC | VAH1 | 228 | 15 | 0.016 |
| FC | VAH2 | 8911852 | 4135325 | 76.074 |
| FC | VAH3 | 57 | 0 | 0.018 |
| FC | VAH4 | 59 | 1 | 0.016 |
| FC | VAH5 | 450391 | 193061 | 4.481 |
| d-10-06 | BT | VAH1 | 338 | 281 | 0.113 |
| BT | VAH2 | 2387948 | 2149130 | 2047.05 |
| BT | VAH3 | 2558 | 2279 | 0.384 |
| BT | VAH4 | 338 | 281 | 0.171 |
| BT | VAH5 | \* | \* | \* |
| FC | VAH1 | 57 | 0 | 0.009 |
| FC | VAH2 | 16391732 | 7337490 | 145.466 |
| FC | VAH3 | 279 | 19 | 0.051 |
| FC | VAH4 | 57 | 0 | 0.008 |
| FC | VAH5 | 2127650 | 940932 | 21.745 |
| d-10-07 | BT | VAH1 | 5486 | 4912 | 0.283 |
| BT | VAH2 | 21705816 | 19535209 | 3005.581 |
| BT | VAH3 | 1036 | 907 | 0.188 |
| BT | VAH4 | 4386 | 3922 | 0.364 |
| BT | VAH5 | \* | \* | \* |
| FC | VAH1 | 574 | 37 | 0.068 |
| FC | VAH2 | 5040371 | 2110532 | 43.103 |
| FC | VAH3 | 129 | 6 | 0.016 |
| FC | VAH4 | 464 | 36 | 0.305 |
| FC | VAH5 | 1029733 | 431753 | 9.197 |
| d-10-08 | BT | VAH1 | 2757 | 2457 | 0.185 |
| BT | VAH2 | 30139027 | 27125100 | 1538.402 |
| BT | VAH3 | 26767 | 24066 | 1.109 |
| BT | VAH4 | 447 | 378 | 0.092 |
| BT | VAH5 | \* | \* | \* |
| FC | VAH1 | 300 | 22 | 0.039 |
| FC | VAH2 | 4292668 | 2026948 | 39.154 |
| FC | VAH3 | 2701 | 256 | 0.137 |
| FC | VAH4 | 69 | 2 | 0.018 |
| FC | VAH5 | 12353057 | 5344661 | 105.352 |

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| --- | --- | --- | --- | --- | --- |
| d-10-09 | BT | VAH1 | 304 | 247 | 0.064 |
| BT | VAH2 | 57460264 | 51714211 | 1998.361 |
| BT | VAH3 | 171904 | 154687 | 4.867 |
| BT | VAH4 | 64124 | 57685 | 2.821 |
| BT | VAH5 | \* | \* | \* |
| FC | VAH1 | 57 | 0 | 0.012 |
| FC | VAH2 | 12096134 | 5698521 | 98.174 |
| FC | VAH3 | 17217 | 2088 | 0.446 |
| FC | VAH4 | 6439 | 786 | 0.269 |
| FC | VAH5 | 33433093 | 14550763 | 280.902 |
| d-15-01 | BT | VAH1 | 27423483 | 25595199 | 2029.136 |
| BT | VAH2 | \* | \* | \* |
| BT | VAH3 | 3955143 | 3691415 | 446.765 |
| BT | VAH4 | 10293363 | 9607087 | 1213.72 |
| BT | VAH5 | \* | \* | \* |
| FC | VAH1 | 1828284 | 204202 | 37.907 |
| FC | VAH2 | \* | \* | \* |
| FC | VAH3 | 263728 | 26820 | 6.388 |
| FC | VAH4 | 686276 | 72553 | 16.603 |
| FC | VAH5 | \* | \* | \* |

Green means the best scheme, Yellow is second best for each solver for each test case.

\* means intractable; taking more than 30 minutes.

All the tests are done in a corei3, 4GB RAM laptop. In high configuration devices the results may vary.

No value order heuristic used (serial). The time taken to find the least constraining value didn’t help much to improve the overall timing in backtracking. Though it could help in forward checking.

**Conclusion:** Clearly VAH2 and VAH5 are the worst in time, number of nodes and number of backtracks. As in VAH5 a random variable is assigned, in simple backtracking it is kind of a brute force. That’s why the output is intractable. Though in forward checking due to reducing the domain time to time, the output is taking from 4 to 300 sec in VAH5. But number of nodes and number of backtracks are clearly higher as it is not an ideal approach.

In VAH2 we are considering max forward degree. But when the input becomes large, max forward degree of several variables become same. Choosing the one with maximum degree doesn’t guarantee that it is the optimum choice. If we choose a wrong value for that variable then all of the variables constrained with it must be changed. That’s why it is taking long time in backtracking (intractable for 15 by 15), though in forward checking a little faster due to updating domain.

VAH1, VAH3 and VAH4 are the three best heuristics here giving output for all cases in reasonable time. Because in all of the three, the most constrained variable is considered as a major, in VAH3 degree heuristic as a tie breaking and in VAH4 the ratio of both.

Though in most of the cases VAH3 and VAH4 give less number of nodes and backtracks than VAH1 (not all cases). As when two variables are equally constrained, choosing the one with maximum degree usually give better result in practice.

Since backtracking doesn’t reduce the domain of neighboring variables, it is taking more time than forward checking, where we infer new domain reductions after an assignment every time.

Thus, if we consider time, VAH1, VAH3, VAH4 perform almost equally well, (though VAH3 and VAH4 give better result sometimes). But considering all cases (time, number of backtracks and number of nodes) VAH3 and VAH4 are better than VAH1 in most of the cases.

**Result:**

1. VAH3 is better according to my opinion. VAH4 is also good but comparing floating point ratio for large input cases may diverse the result.
2. VAH1 is the second best.

Both arguments are for only a limited number of test cases. Experimenting on a large data set may change the ranking.