1 Search Heuristics for N-Queens

1.1 First-Fail Minimum-Value

The standard first-fail heuristic is the first-fail minimum-value heuristic, the search tree for it is shown in the figure below.

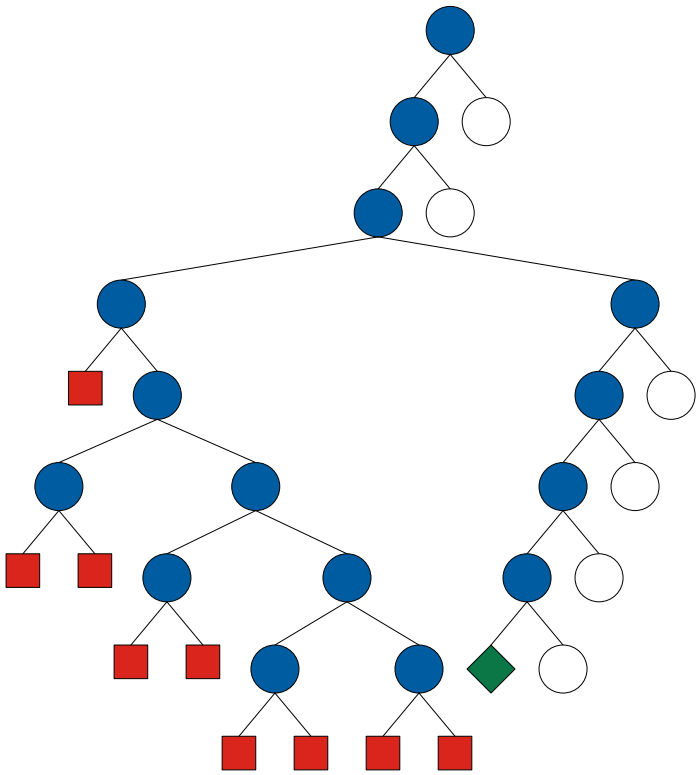

Figure 1: First-fail Minimum-value for queen problem instance of size 10

It visits 25 nodes and 9 failures before finding the first solution.

1.2 First-Fail Median-domain-value

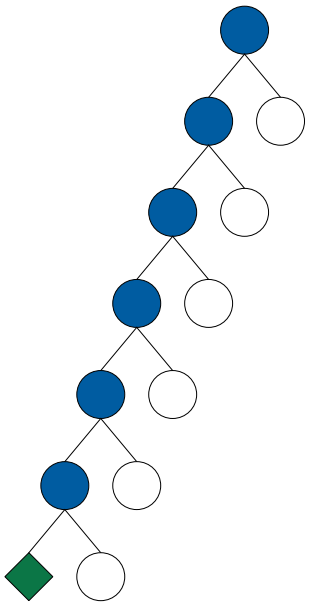

Figure 2: First-fail Median-value for queen problem instance of size 10

The search visits 7 nodes and 0 failures before finding the first solution.

1.3 Knight-move heuristic (min-min median-domain-value)

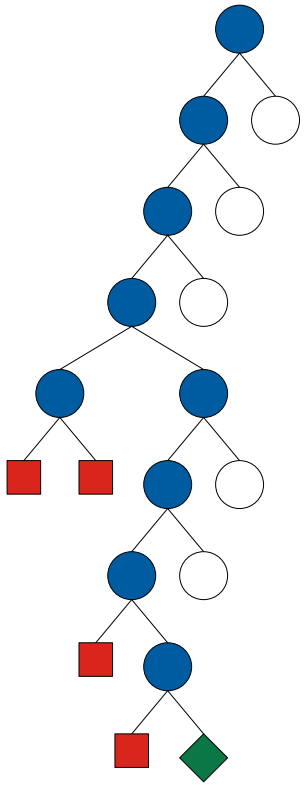

Figure 3: Knight-move Median-value for queen problem instance of size 10

This search visits 14 nodes and 4 failures before finding the first solution.

1.4 Knight-move heuristic (min-min val-min)

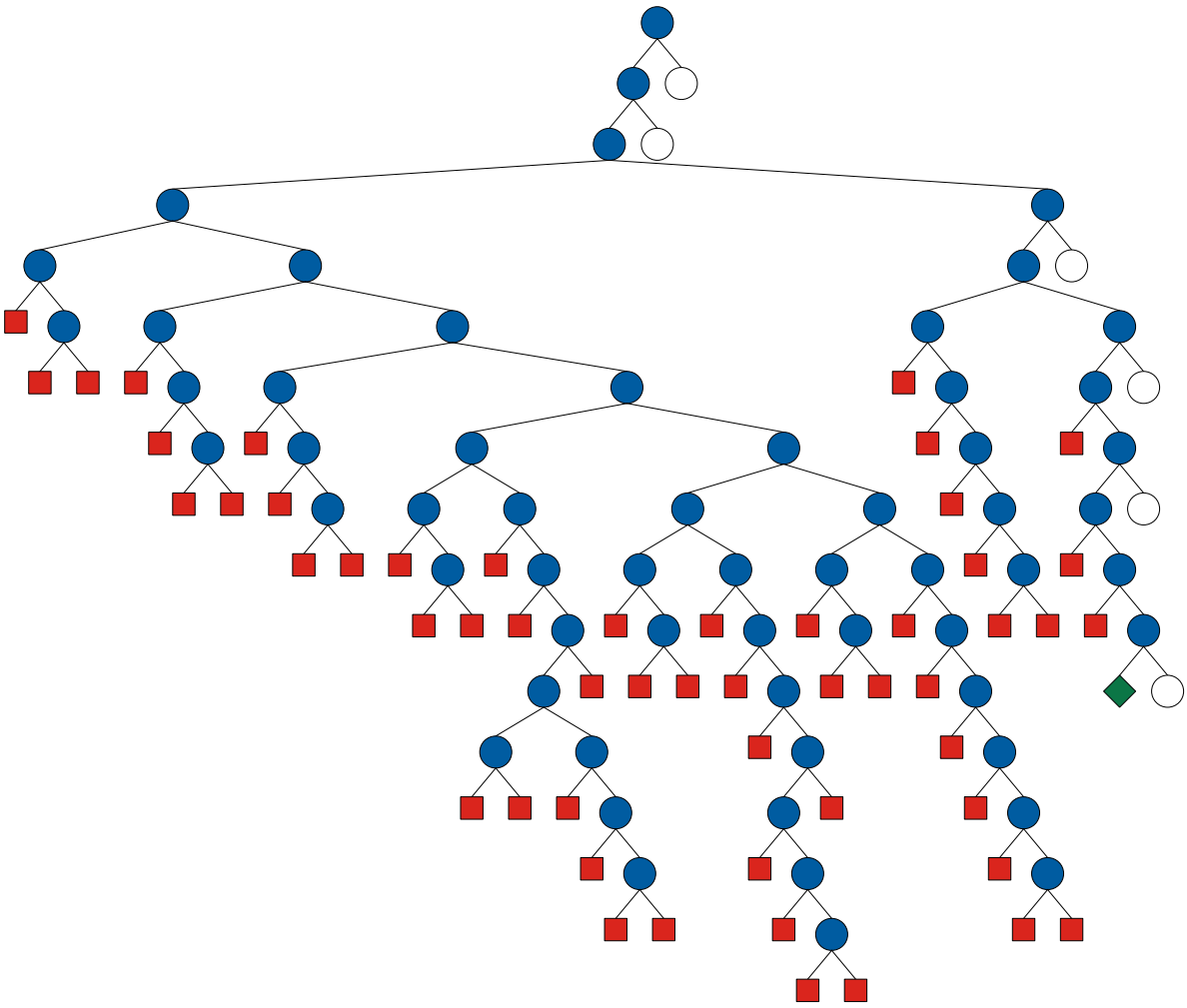

Figure 4: Knight-move minimum-value for queen problem instance of size 10

This search visits 113 nodes and 53 failures before finding the first solution.

2 Conclusion

Clearly for the problem instance $n = 10$, first-fail median-domain-value was the most effective search heuristic. For $n = 10$ we can order the heuristics as follows:

first-fail median-domain-value (ffmdv) $\succ$ *knight-move median-domain-value (kmmdv)* $\succ$ *first-fail minimum-value (ffmv)* $\succ$ *knight-move minimum-value (kmmv)*

However what heuristic is best depends a lot on the problem instance. For example as shown in the table below, the first-fail heuristic greatly out-performs the knight-move heuristic for larger

n. Also the minimum-value first-fail outperforms the medium-value first-fail for larger n even though medium-value was more efficient for n=10.

Search Heuristic	**n**	**nodes**	**failures**
ffmdv	10	25	9
kmmdv	10	14	4
ffmv	10	25	9
kmmv	10	113	53
ffmdv	100	202	60
kmmdv	100	?	? - No solution in reasonable time
ffmv	100	138	22
kmmv	100	?	? - No solution in reasonable time
ffmdv	1000	2993	998
kmmdv	1000	?	? - No solution in reasonable time
ffmv	1000	996	2
kmmv	1000	?	? - No solution in reasonable time

Why is the heuristic called knight-move heuristic? Because the move that threatens the most other queens and is safe is the knight's move typically.