CSE-318: Artificial Intelligence Sessional

Report on Offline-2 (CSP)

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- **Value Ordering Heuristic:**
  I. Random
  II. Least Constraining Value Heuristic

Least Constraining value heuristic is also applied for **comparing with it**. For a particular variable, we choose the value that is least constraining to this variable using this heuristic. We will select the value that will reduce the domain of the least number of other unassigned variables. This heuristic works well because we keep more available values that can be assigned to other unassigned variables.
Although Node Count is better in Least Constraining value than that of Random Heuristic, still Random Heuristic runs faster than Least Constraining value heuristic. So, I comment out Least Constraining value order heuristic order call in case of value selecting and applied Random Heuristic.
The data represented here is found by Random Heuristics.

- **Variable Ordering Heuristic**:
  5 heuristics were given for each algorithm.
  1. VAH1: The variable chosen is the one with the smallest domain.
  2. VAH2: The variable chosen is the one with the maximum degree to unassigned variables. Also, called max-forward-degree.
  3. VAH3: The variable chosen by VAH1, Ties are broken by VAH2.
  4. VAH4: The variable chosen is the one that minimizes the VAH1 / VAH2.
  5. VAH5: A random unassigned variable is chosen.

- **Table**:
  Summarizing results from running each dataset

Problem	Solver	VAH	Runtime (s)	No. of Nodes	Backtrack Count
d-10-01	Backtracking	VAH1	.047	1881	1667
		VAH2	6.104	875981	788357
		VAH3	.009	2231	1982
		VAH4	.064	12991	11666
		VAH5	15.88	14526461	13073789
		VAH1	.032	195	6

	Forward Checking	VAH2	1.573	22501	8743
		VAH3	.005	159	5
		VAH4	.06	31896	9414
		VAH5	3.979	634076	278815
d-10-06	Backtracking	VAH1	.045	339	281
		VAH2	.741	125889	113276
		VAH3	.008	869	758
		VAH4	.152	32079	288847
		VAH5	6.67	709069	638138
	Forward Checking	VAH1	.039	237	15
		VAH2	.162	21523	7399
		VAH3	.004	253	14
		VAH4	.587	2623	814
		VAH5	2.135	350011	149750
d-10-07	Backtracking	VAH1	.006	5117	4579
		VAH2	1.721	314077	282643
		VAH3	.002	417	349
		VAH4	2.804	471037	423907
		VAH5	10.294	9718257	8746405
	Forward Checking	VAH1	.004	463	30
		VAH2	.143	2696	1012
		VAH3	.001	61	1
		VAH4	2.458	56354	16738
		VAH5	5.311	885937	379331
d-10-08	Backtracking	VAH1	.04	2538	2259
		VAH2	.069	12578	11295
		VAH3	.008	6128	5490
		VAH4	.014	4088	3654
		VAH5	20.98	4534668	4081176
	Forward Checking	VAH1	.02	72	3
		VAH2	.016	157	46
		VAH3	.005	131	8
		VAH4	.013	496	178
		VAH5	11.737	2058752	863428
d-10-09	Backtracking	VAH1	.034	305	247

		VAH2	124.834	27711485	24940309
		VAH3	.008	655	562
		VAH4	22.984	5179265	4661311
		VAH5	48.103	47800165	43020121
	Forward Checking	VAH1	.023	58	0
		VAH2	.247	4409	2232
		VAH3	.002	86	3
		VAH4	.148	3176	1068
		VAH5	1.124	185623	76276
d-15-01	Backtracking	VAH1	*	*	*
		VAH2	*	*	*
		VAH3	*	*	*
		VAH4	*	*	*
		VAH5	*	*	*
	Forward Checking	VAH1	*	*	*
		VAH2	*	*	*
		VAH3	*	*	*
		VAH4	*	*	*
		VAH5	*	*	*

- Conclusion:
  In Forward Checking, the overall time is better in almost all cases than backtracking as it tracks earlier failure. But in case of VAH5, forward checking doesn't perform consistently better as the order is random. If the order is same in case of Backtracking and Forward checking in VAH5, forward checking will perform better. Overall, VAH3 is the best among all the variable order heuristic whereas VAH1 performs second best.
  VAH1 selects the variable with smallest domain and VAH3 breaks ties when there is any duplicate size of domain as smallest domain. VAH2 works poorly but VAH4 is better than VAH2 as we are minimizing VAH1/VAH2 in VAH4.