Übung Künstliche Intelligenz SS 2007
Wirtschaftsinformatik und Maschinelles Lernen (ISMLL)
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Übungsblatt 5

Abgabe: Dienstag, 29.05.07 bis 13 Uhr

Exercise 1 Constraint Satisfaction Problems (CSP) (20 Points)

a) [7 pts.] Define in your own words the terms: constraint satisfaction problem, backtracking search, minimum remaining values (MRV), degree heuristic, least constraining value (LCV), forward checking and arc consistency.

b) [13 pts.] Show how a single ternary constraint such as "A+B=C" can be turned into three binary constraints by using an auxiliary variable. You may assume finite domains (Hint: consider a new variable that takes on values which are pairs of other values, and consider constraints such as "X is the first element of the pair Y".) Next, show how constraints with more than three variables can be treated similarly. Finally, show how unary constraints can be eliminated by altering the domains of variables. (This exercise was taken from the text book, pg. 159).

Exercise 2 Search for CSPs (20 Points)

a) [10 pts.] Consider the following CSP:

Variables: {A, B, C, D}
Domain: {1, 2, 3}
Binary Constraints: $A \neq B$, $A \neq C$, $B > C$, $B < D$

1. Draw a constraint graph for this problem and write out the implicit constraints as explicit sets of legal pairs.
2. Assuming an alphabetical ordering on both variables and values, show the assignments considered by each step of backtracking with forward checking. After each assignment, indicate the remaining domains of all unassigned variables. E.g., completely naive Depth First Search (DFS) would search A=1, A=1 B=1, A=1 B=1 C=1, A=1 B=1 C=1 D=1, A=1 B=1 C=1 D=2, A=1 B=1 C=1 D=3, then pop back up to A=1 B=1 C=2, and so on, but never remove any values from unassigned domains.
3. Show the assignments and domains, again with backtracking (DFS) and forward checking, but now using the MRV and LCV heuristics. (Break MRV ties by the degree heuristic, then alphabetically; break LCV ties numerically, smaller values first.) Is this faster than part (2)? Justify your answer.

b) [10 pts.] In a cryptarithmetic problem one tries to find a substitution of digits for letters such that the resulting sum is arithmetically correct, with the added restriction that no leading zeros are allowed (see pg. 11 from the Constraint Satisfaction Problems slides). Solve the cryptarithmetic problem, shown on the back, by hand, using backtracking DFS, forward checking, and the MRV and LCV heuristics.

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