

# Principles of Knowledge Representation and Reasoning

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## Exercise Sheet 9

Due: July 1, 2008

### Exercise 9.1 (Base Relations, 5 marks)

(a) For which of the following sets of base relations  $\mathbf{B}$ , the following statements are true? Justify your answers.

- $\mathbf{B}$  is JEPD
- $\mathbf{B}$  is closed under converse.
- $\mathbf{A}$  is closed under composition of base relations.

- (a)  $\{<, =, >\}$  over  $\mathbb{N}$   
(b)  $\{<, =, >\}$  over  $\mathbb{Q}$   
(c)  $\{⊂, =, ⊃\}$  over  $2^{\{1,2,\dots,10\}}$   
(d)  $\{\leq, =, \geq\}$  over  $\mathbb{Q}$   
(e)  $\{\leq, >\}$  over  $\mathbb{Q}$

(b) Prove that

$$\left(\bigcup_{i=1}^n A_i\right) \circ \left(\bigcup_{j=1}^m B_j\right) = \bigcup_{i=1}^n \bigcup_{j=1}^m (A_i \circ B_j).$$

### Exercise 9.2 (Constraint Satisfaction Problems, 5 marks)

Consider the constraint satisfaction problem  $\langle V = \{v_1, v_2, v_3\}, D, C = \{R_{12}, R_{23}\} \rangle$ :

$$\begin{aligned} D &= \{1, \dots, 10\} \\ R_{12} &= \{(x, y) \mid x + y = 8\} \\ R_{23} &= \{(x, y) \mid x + y \leq 5\} \end{aligned}$$

- (a) Use algorithm **EnforceArcConsistency** to find an equivalent arc consistent network. Make the steps traceable by stating the new domain and the causative constraint whenever a domain changes.
- (b) Find an equivalent path consistent CSP by applying algorithm **EnforcePathConsistency** to your arc consistent problem from part (a). Whenever a constraint changes, state  $i, j, k$  and the revised constraint.