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Deductive Databases & Knowledge Based Systems

Sheet 1

Exercise 1

All the sub-exercises should be answered with First Order Logic in mind. Answer briefly!

1. Describe the relation between a **language**, an **interpretation**, and a **system**.
2. What is the difference between **functions** and **predicates**? Could you use functions instead of predicates or vice-versa?
3. What is the difference between a **term** and an **atom**
4. What is an **open** or **closed** formula?
5. What is a **rectified formula** and which problem does it address?
6. What is the difference between an interpretation and a substitution? Would it be a good idea to merge the **substitution** into the **interpretation**?
7. What is **closed world assumption** and why is it often used in deductive databases?

Exercise 2

All the sub-exercises should be answered with First Order Logic in mind.

1. Design a first order **language** for simple arithmetic's on natural numbers. One should be able to add numbers, subtract numbers, multiply two numbers, decide if a number is equal another number, and if a number is greater than another number.
2. Provide an **interpretation** for your language of the previous sub-exercise.
3. Provide a formula for following statements:
    a. "5 is greater than 2"
    b. "If x is greater than 0, then also x*y is greater than 0"
    c. "x is either greater than y, or x is equal to y, or x is smaller than y"
    d. "The sum of any two numbers is always smaller than the product of the same two numbers"
4. Evaluate the previous terms a-d. Are they always true? Can they be true?
   If a term is not always true but can be true, provide an example substitution which makes it true.

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Exercise 3

All the sub-exercises should be answered with First Order Logic in mind.

1. Given is a language $\mathcal{L} = (\Gamma, \Omega, \Pi, \mathrm{X})$ with $\Gamma := \{a, b\}, \Omega := \{f(x), g(x,y)\}, \Pi := \{P, Q(x,y), R(x)\}$, and $\mathrm{X} := \{\mathrm{x}, \mathrm{y}\}$.
    a. Provide at least 10 (different) terms for $\mathcal{L}$.
    b. Provide at least 6 (different) atoms for $\mathcal{L}$
2. Are the following "strings" valid formulas with respect to $\mathcal{L}$?
    a. $f(g(x,y))$
    b. P
    c. $Q(x,y) \vee Q(a,b)$
    d. $Q(g(f(a),x), f(y))$
    e. $\forall a(R(a))$
    f. $\exists x(f(x))$
    g. $R(x) \rightarrow \neg R(x)$
    h. $\neg R(\neg R(f(x)))$