KRR: Activity 6 – Introduction to Rule Based Reasoning

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Introduction

Rule-based Systems (RBS), also know as Expert Systems, were considered a promising endeavour in AI research during the 70's and 80's. That assumption no longer holds true :-).

However, RBS and their extension, Complex Event Processing (CEP), are still widely used in domains where existing domain expertise needs to be put to use, or where explainability of a decision making process is required.

Such domains include: business process management, financial services (e.g. algorithmic trading, risk management systems, order analysis) or applications in IoT and WoT.

One of the best known engines for rule-based processing is CLIPS and it will be used for this lab activity.

Exemplification based on CLIPS

Getting started

- Download CLIPS: `http://www.clipsrules.net/?q=node/3`
- Follow the Intro to CLIPS tutorial and TA explanation thereof at: `http://sequoia.ict.pwr.wroc.pl/~witold/ai/CLIPS_tutorial/`

Tasks

T1 To get accustomed to writing CLIPS programs, the first task involves modelling and running inferences for the genealogy problem from the previous lab activities.

- Define the needed initial facts: `Person`, `hasChild`. For the `Person` fact define two slots: `name` and `gender`.
- Write the necessary rules that infer the following relations: `hasSibling`, `Grandchild`, `hasUncle`, `hasAunt`, `hasNiece` and `hasNephew`.

T2 Model the following problem using CLIPS.

There is a number of boxes in which we have to pack a number of objects. A box must be completely filled with as many objects as possible from a collection of objects, such as to save space.

There are 3 types of objects: heavy objects, medium weight objects, and light objects. In each box we can put at most:

- 3 heavy objects OR
- 2 heavy objects and 2 medium weight objects OR
- 3 medium weight objects OR
- 1 heavy object and 5 light objects OR
- 1 heavy object, 2 medium weight objects and 3 light objects OR
- 6 light objects

The number of boxes and the number and type of objects (heavy, medium, light) are given as input to the program, and facts have to be created accordingly. Write a CLIPS program that is placing/packaging all the given objects in as few boxes as possible. Detect the case in which there is no solution to the problem and the case in which there are several solutions. In this last case, provide only one solution.

Test your program based on the following cases:

- **Case A)** 4 boxes, 4 heavy objects, 6 medium weight objects and 8 light ones. This case has at least one solution.
- **Case B)** 2 boxes, 7 medium objects. This case has no solution.
- **Case C)** 2 boxes, 3 heavy objects, 4 medium weight objects and 4 light ones. This case has no solution.

Solution hint Define a template `solution` fact, with multiple slots that specify the number of available boxes and remaining objects to be placed. As you build the solution, keep a multislot in your `solution` template, in which you append *packaging* options from the above mentioned combinations list.

Write 4 types of rules with decreasing saliency:

- Solution construction rules - identify a packaging option that befits any existing *partial* solution and use it
- Solution destruction rules - if a partial solution has exhausted all its packaging options and there are still unplaced objects remaining, retract the solution
- Solution finalize rule - if a solution has placed all the objects, emit a *finalized* fact that can be used to halt the program execution.
- No solution rule - a rule that checks if no `solution` facts exist in the knowledge base and outputs a "No solution" message.