Ripple Down Rules

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Why is Knowledge Acquisition difficult?

- Experts can solve problems.
- They have usually difficulties to provide general rules of their problem solving.
- Experts provide justifications of their decisions, e.g. for a colleague.

Ripple Down Rules

if True then Accept
if (A < 5) then Reject
if (B > 3) then Reject
if (Color=blue) then Accept

Except link
**Ripple Down Rules**

Ripple Down Rules (RDR)

If output is X and conditions A, B, C etc are satisfied then replace X with Y (or add Y to the output)

**Building a classifier**

![Diagram showing overspecialization and overgeneralization]

Key ideas

- Automatic rule placement
- Expert identifies features that distinguish the case from:
  - A single past case
  - A selection of past cases
  - All seen cases

- *Case by case development while in use*
### Ripple Down Rules

#### Different types of RDR frameworks

- **Single Classification RDR (SCRDR)**
  - Rule 0: If true than class 0
  - Rule 1: If a,b than class 1
  - Rule 2: If e,f than class 3
  - Rule 3: If a,c than class 7
  - Rule 4: If h than class 2
  - Rule 5: If k,l than class 4
  - Rule 6: If d than class 5
  - Rule 7: If z,y than class 4

A case to be classified starts at the root (default) node and ripples its way down to a leaf node. The conclusion returned by the knowledge base is the conclusion of the last satisfied rule in the path to a leaf node. (From “Incremental Knowledge Acquisition for Search Control Heuristics”, by Ghassan Beydoun, PhD Thesis, UNSW, 2000)

- **Multiple Classification RDR (MCRDR)**: More than one classifications can be made from a single case. Uses a multi-way tree instead of a binary tree.

- **Nested RDR (NRDR)**: NRDR allows users to define (and if required re-define) new concepts using SCRDR trees, and build an RDR knowledge base using these concepts

#### Commercial application

- **PKS (Australia)**
  - classification tasks
  - Pathology (medical diagnostic testing advice)
- **HNK (Korea)**
  - classification tasks
  - help desks & document management
- Etc .. Etc ..
Ripple Down Rules

Chemical Pathology Laboratory Workflow

Sample report

<table>
<thead>
<tr>
<th>Cholesterol</th>
<th>Triglyceride</th>
<th>HDL-C</th>
<th>LDL-C</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>range</td>
<td>&lt;5.5</td>
<td>&lt;2.0</td>
<td>&gt;1.1</td>
<td>&lt;3.4</td>
</tr>
<tr>
<td>19.12.02</td>
<td>6.5*</td>
<td>0.8</td>
<td>1.3</td>
<td>4.8*</td>
</tr>
<tr>
<td>20.02.03</td>
<td>7.3*</td>
<td>1.8</td>
<td>1.2</td>
<td>5.3*</td>
</tr>
</tbody>
</table>

Raised cholesterol level persists on Zocor treatment. Consider increasing dose of Zocor and repeat lipid profile in 4 weeks. Note that hypothyroidism may impair response to Zocor; suggest TSH level at time of next review.

Study

- Very large private pathology practice
- Labs across Australia and in Asia
- All activity logged by PKS
- 20 knowledge bases developed by the pathologists
- 7 presented here
### Ripple Down Rules

#### Summary
- Cases interpreted: 6,302,456
- Rules added: 16,558
- Error (?) rate: 0.2% (1.3%)
- Total time: 353 hours
  - 77 secs per rule

#### Different types of tasks for RDR
- RDRs for building CBR systems
- RDR for image classification

#### Different types of tasks for RDR
- NLP applications
  - directed web crawlers that search for specific information
  - interactive product recommendation systems for the WWW
- Machine translation
  - cue phrase based systems, such as citation classifiers, automatic summarisation
  - machine translation
Ripple Down Rules

RDR Scope

- **Single Classification**
  - Preston, Srinivasan, Kang, Preston
- **Multiple Classification**
  - Preston, Ramadan
- **Configuration**
  - Richards
- **Resource allocation**
  - Beydoun & Hoffman
- **Heuristic search**
  - Kang, Ho, Wobcke
- **Document management**
  - Hoffman, Kang, Bao
- **Information extraction**
  - MIB, HNK, Sricom, Tesco (ivis), PKS

Comparison

- Non-incremental approaches
  - Assume a perfect system is possible
  - Try to build it again and again
- Incremental approaches
  - Assume there will always be errors
  - Concentrate on fixing the errors
    - Fix error without altering the rest of the system

Research problems to be solved:

- What is a suitable set of concepts for expressing justifications?
  - Those concepts have to provide a proper basis for generalisation
  - If unsuitable concepts are used, the KA process will take much longer and will result in much larger RDR trees.

- Future Research:
  - An RDR style approach to general Software Engineering

RDR Scope

- **Ontology development**
- **planning**
- **Translation**
- **Workflow management**
- **Image Processing**
- **GA training**
- **animation**
- Cao, Martinez-Bejar
- Finlayson
- Hoffman
- Hofstade
- Kerr, Misra
- Beckman
- Kadous, So