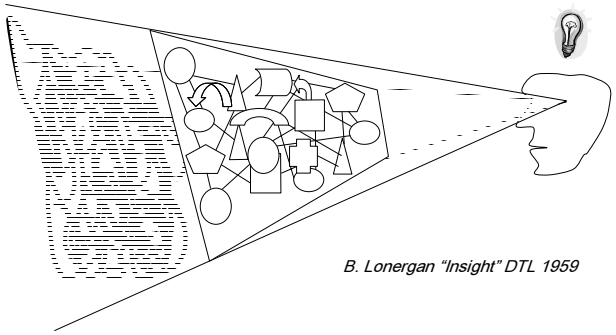
Ripple Down Rules

University of New South Wales
Sydney, Australia

the thing-in-itself
noumenon

the thing-as-it-is-known
phenomenon

insight

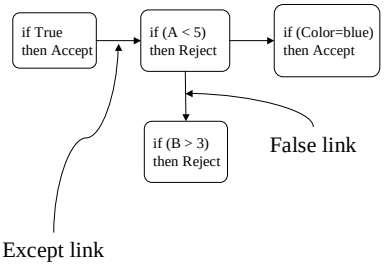


B. Lonergan "Insight" DTL 1959

Why is Knowledge Acquisition difficult?

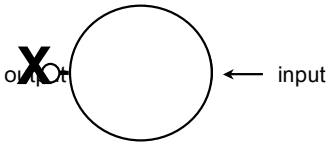
- Experts can solve problems.
- They have usually difficulties to provide general rules of their problem solving.
- Experts provide justifications of their decisions, e.g. for a colleague.

Ripple Down Rules



Ripple Down Rules

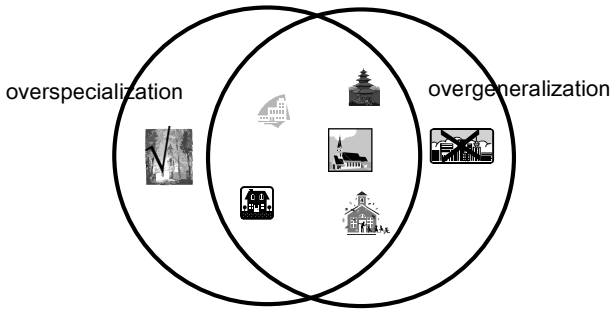
Ripple Down Rules (RDR)



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

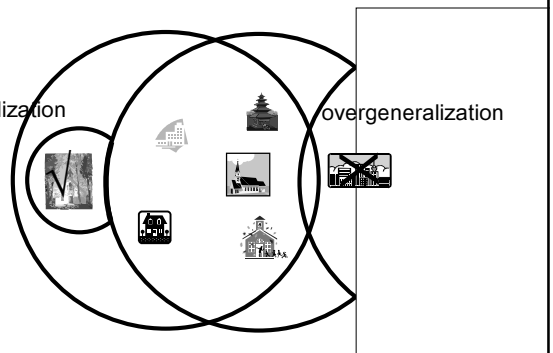
5

Building a classifier



6

Building a classifier



7

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

Show stored cases to the expert one by one

- Case by case development while in use

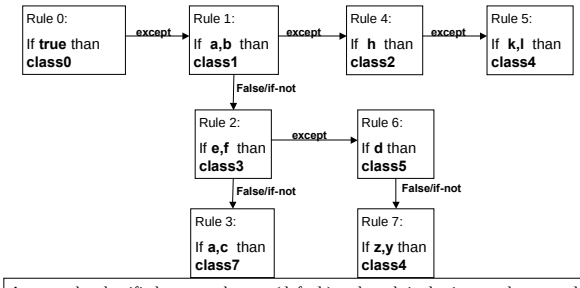
constant expert/user cost (?)

8

Ripple Down Rules

Different types of RDR frameworks

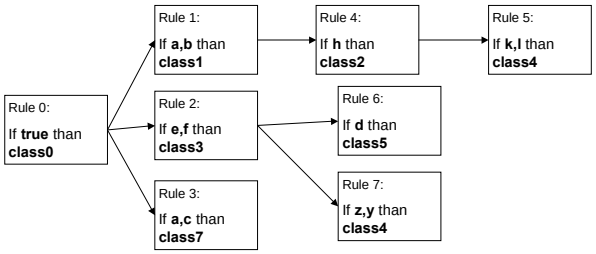
- Single Classification RDR (SCRDR)



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)

Different types of RDR frameworks

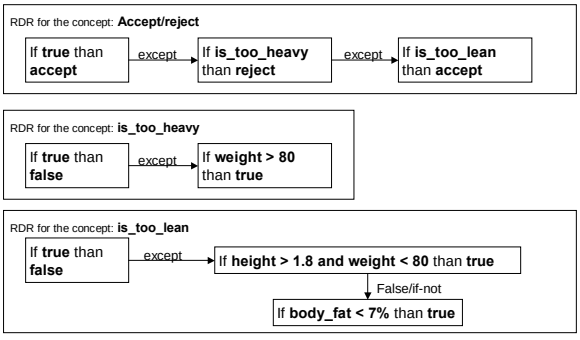
- **Multiple Classification RDR** (**MCRDR**): More than one classifications can be made from a single case. Uses a multi-way tree instead of a binary tree.



All branches in an MCRDR KB are exception branches. For a case {e,f,d,z,y} the above knowledge base would return two conclusions: class5 and class4. (From "Incremental Knowledge Acquisition for Search Control Heuristics", by Ghassan Beydoun, PhD Thesis, UNSW, 2000)

Different types of RDR frameworks

- **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



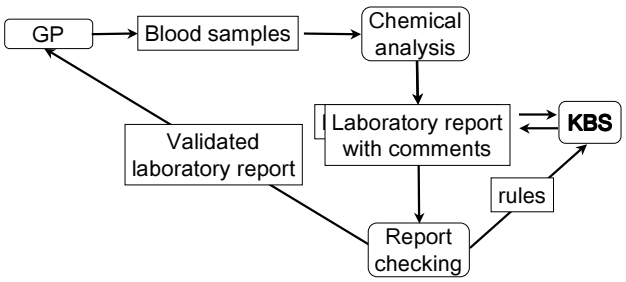
Commercial application

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

12

Ripple Down Rules

Chemical Pathology Laboratory Workflow



13

Sample report

	Cholesterol	Triglyceride	HDL-C	LDL-C	Notes
range	<5.5	<2.0	>1.1	<3.4	
19.12.02	6.5*	0.8	1.3	4.8*	Zocor 20mg
20.02.03	7.3*	1.8	1.2	5.3*	Zocor 20mg

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

14

Feature Identification

```
Sex.... M      Years.. 5      Days... 1825   Ref Dr. PM     Cpy Dr
Col Mt. C      Col Cn. MYA    Req Lb. MYA    Res Lb. MYA
Date                             210597 210697 210797 210897 210997 211097
Time                             14:05  19:07  6:25   3:34   1:02   4:07
Cholesterol ch         [   < 5.5 ]5.5    5.5    5.4    5.4    5.3    5.3
Cholesterol hd         [   > 1.1 ]1.7    3.3    3.4    3.4    3.3    3.3
Triglyceride           [   < 2.0 ]3.0    1.4    1.8    1.9    2.5    3.1
Cr derived                       3.2    1.7    1.8    4.3    3.2    4.1
vl derived                       3.2    1.7    1.8    4.3    3.2    4.1
Ld derived                       3.2    1.7    1.8    4.3    3.2    4.1
Lipid lowering drugs             ZOCOR  ZOCOR  ZOCOR  ZOCOR  ZOCOR  ZOCOR
```

this Tri is HIGH
this Tri > last Tri
this Tri is highest seen
this Tri < 3.5
etc, etc

15

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

16

Summary

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

17

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

Different types of tasks for RDR

- NLP applications
  - cue phrase based systems, such as citation classifiers, automatic summarisation
  - machine translation

Ripple Down Rules

RDR Scope

- **Single Classification** • Preston, Srinivasan,
- **Multiple Classification** • Kang, Preston
- **Configuration** • Preston, Ramadan
- **Resource allocation** • Richards
- **Heuristic search** • Beydoun & Hoffman
- **Document management** • Kang, Ho, Wobcke
- **Information extraction** • Hoffman, Kang, Bao

MIB, HNK, Sricom, Tesco (Ivis), **PKS**

21

RDR Scope

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

22

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

constant user/expert cost

23

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 Reseach:**
  - An RDR style approach to general Software Engineering

24