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AGEPUFF: A Simple Event-Driven
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card 1 of 1

AGEPUFF: A Simple Event-Driven Program

AGE Example Series: Number 2

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1. Introduction

This is the second in a series of example papers designed to give the reader a sense of how to formulate a problem in AGE. Each example in this series illustrates a different set of features of AGE. AGE Example Series: Number 1 describes a beginner's program, BOWL, using simple control settings and a small set of rules, in a domain familiar to everyone. The example described in this paper is a more realistic use of AGE. AGEPUFF is a system which diagnoses the presence and severity of pulmonary disease. AGEPUFF uses the same information a physician would use to make diagnosis; test measurements and predicted normal values for those measurements, patient history, and referral diagnoses.

AGEPUFF was designed as a simple blackboard model with an eventdriven control and several knowledge sources. Other features of AGE used in building AGEPUFF include;

- predefined hypothesis elements,
- credibility weights on values in the hypothesis structure and functions to adjust those weights based on the credibility of the conditions in the rules, and
- an implicit data level in the hypothesis structure and functions to retrieve that data.

Future examples in this series will include AGEPUFF/MODEL and PUFFBC, both of these programs solve the same problem as AGEPUFF, in the same domain, but have radically different control strategies.

2. The Task

Pulmonary disease or dysfunction is a general classification covering several diseases of the lungs and air passages. Pulmonary disease is indicated by various test measurements, normal values of those measurements, patient history and referral diagnoses. Pulmonary function testing consists of measuring flows and volumes while a patient is breathing deeply; Inspired Vital Capacity, Forced Expired Volume in one second, and Maximum Mid-expiratory Flow. The doctor also takes other measurements such as lung volumes and the diffusion of CO into the blood. These measurements are interpreted with respect to "normal" values for a typical patient of similar size and age. The results of this interpretation give an indication of the presence of pulmonary disease, its identity and severity.

The doctor's task is to deduce, by successively narrowing and reducing his diagnosis, the presence of pulmonary disease, which particular pulmonary disease (or combination) is present, and the subtype(s) of that disease, as well as the severity. AGEPUFF knows about three general types of pulmonary disease, Obstructive Airway Disease, Restrictive Lung Disease, and Diffusion Defect. More specifically, it knows about subtypes of OAD, including asthma, bronchitis, emphysema and dyspnea.

3. Problem Formulation

3.1. Three Level Data Structure

AGEPUFF uses a three level hypothesis structure to represent the evolving solution--the diagnosis. The first level is PATIENT and it contains information about the current patient. The second level is DISEASE. Here we predefined three elements, OAD, RLD, and NORMAL to store information about each of these diseases with respect to the current patient. The third level is DATA and it is an implicit level in the hypothesis structure representing the input data. Figure 3-1 shows the nodes associated with each level. Refer to 4.2 for the actual hypothesis structure of AGEPUFF.

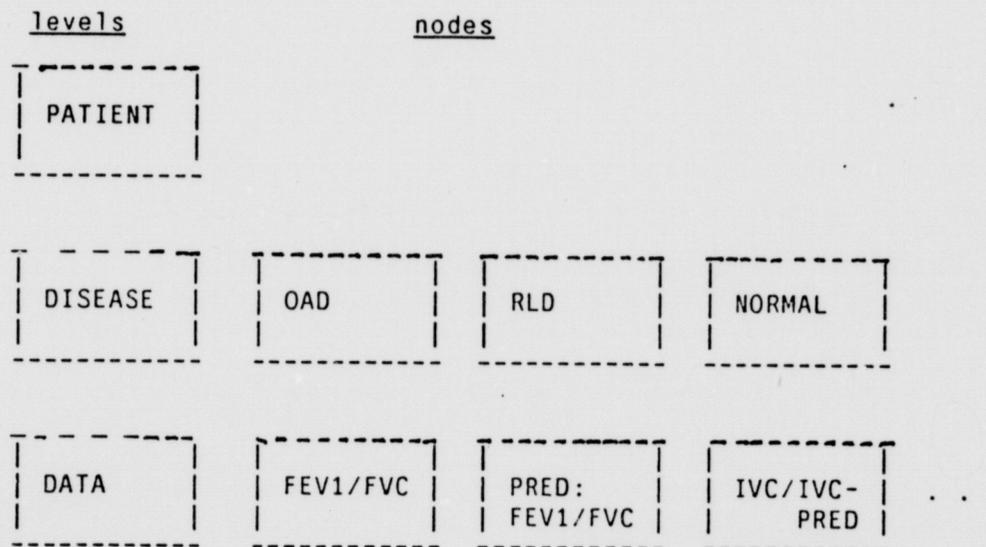


Figure 3-1: Hypothesis Structure

3.2. Input data

In AGEPUFF all input data is acquired prior to running the system. This requires that the user specify the input data names during control acquisition. Before each run the user can type in specific data for each name or read it all from a file defined earlier. This data can be referenced from the rules in the knowledge sources by the input data names and the function \$DATA.

3.3. Knowledge Sources

Five knowledge sources are used in AGEPUFF; DATA-ANALYSIS, TLCRULES, RLD-DEGREERULES, OAD-REVERSIBILITYRULES, and OAD-SUBTYPERULES. Refer to Figure 3-2 for a top-level organization of the KSs and Section 4.3 for a complete listing of the AGEPUFF knowledge sources.

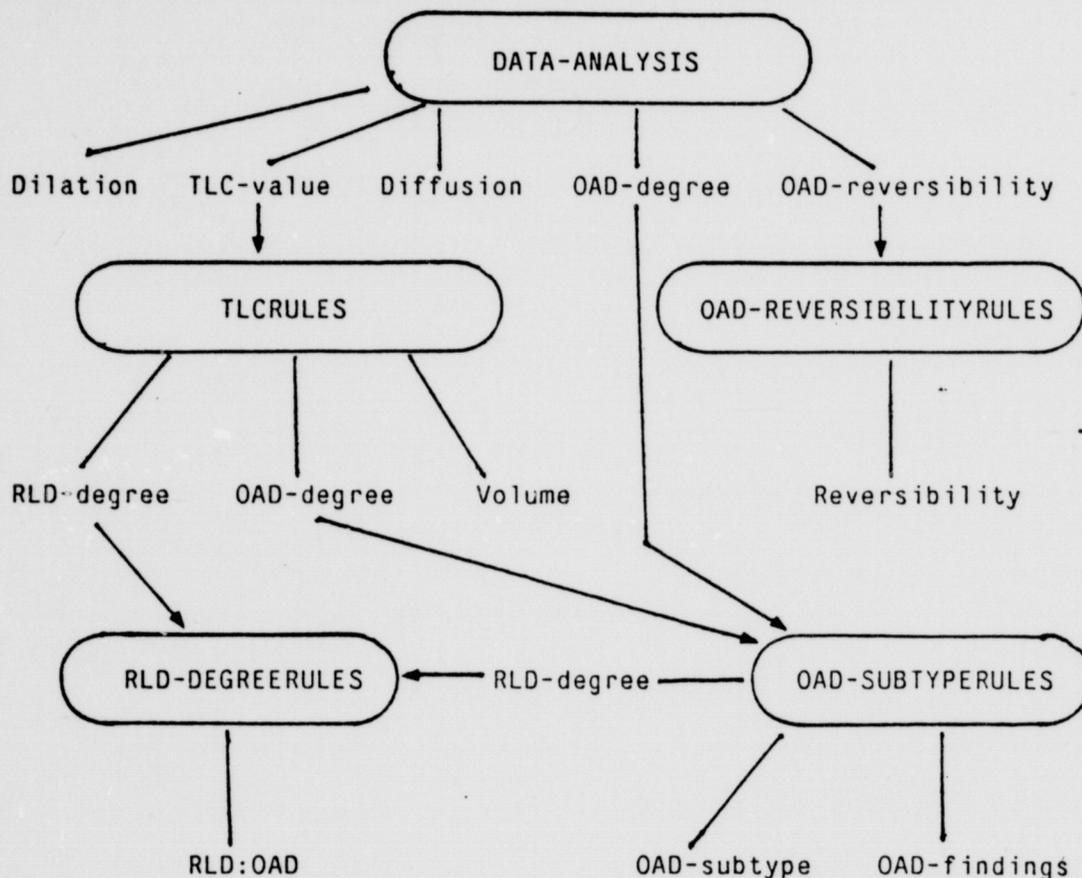


Figure 3-2: Knowledge Sources

DATA-ANALYSIS analyzes the input measurements, making direct interpretations about their diagnostic meaning, and computing further significant measurements. Most of the *DATA-ANALYSIS* rules currently implemented check for indications of OAD. For example, Rule 12 concludes moderate OAD if FVC/FVC-PRED (the ratio of measured Forced Vital Capacity to predicted normal FVC) is less than 50% and the difference between FEV1 (Forced Expired Volume in one second) and FVC is between -5 and 0. Rules 1 and 38 check for the availability of TLC (Total Lung Capacity) measurements. Rules 40-43 check for reversibility of OAD and rules 37, 44, and 45 for Diffusion Defect.

If data concerning TLC is available, then further rules for handling TLC values are invoked--*TLCRULES*. *TLCRULES* check the TLC values recorded in the hypothesis structure to determine overinflation and

provide more resolution of the degree of OAD or RLD. For example, in Rule 1, if the TLC/TLC-PRED ratio is greater than 100% and the RV/RV-pred ratio (Residual Volume to predicted residual volume) is between 140% and 160% then overinflation is concluded with mild OAD. If the TLC/TLC-PRED ratio is less than 50% then severe RLD is concluded. (Rule 4)

Next comes a refinement of the initial diagnosis. *RLD-DEGREERULES* check other measurements, patient history, and referral diagnoses for agreement with a RLD diagnosis. If both RLD and moderately-to-severe OAD have been concluded, the degree of RLD is reduced.

OAD-REVERSIBILITYRULES determine the degree of reversibility of OAD. The Resistance-Dilation:Change measurement confirms or adjusts the degree of reversibility.

OAD-SUBTYPERULES check for agreement with an OAD diagnosis and try to determine the subtype(s) of OAD afflicting the patient. Other measurements and patient history are used to confirm or refine the OAD diagnosis. Rules conclude the possibility of mild RLD; the existence and degree of emphysema, asthma, or bronchitis; and the effects on dyspnea and the effects of smoking.

3.4. Control Structure

MACRO-EVENTSPEC can be used to specify the control settings for AGEPUFF. This is a simple event-driven control structure, with a first-in, first-out selection method and two collection event types. The COLLECTION events are OAD-DEGREE and DATA-ANALYSIS. These two events are generated many times by some of the AGEPUFF KSs. The OAD-DEGREE and DATA-ANALYSIS events need to be collapsed to one event so that the successor KS is invoked only once following the collection. In other words, once a focus event has been selected, all similar OAD-DEGREE and DATA-ANALYSIS events are collected so they can't invoke the same consequences more than once. The CONTROLRULES, (T EVENT), are also generated by MACRO-EVENTSPEC. T means always invoke this rule, and EVENT is the step always taken.

The user's initialization function and termination condition are again created by MACRO-EVENTSPEC. The initialization function simply returns the name of the first KS to be invoked, DATA-ANALYSIS, to start the program. The TERMINATIONCONDITION checks for an empty EVENTLIST. Only the AGEPUFF post-processing function, POSTPROCESSINGFN, differs from the standard macro generated post-processing function. AGEPUFF.INTERPRETATION prints the input data and an interpretation of the information, or solution, in the hypothesis structure, in addition to printing the hypothesis structure itself.

- **Preconditions:** The DATA-ANALYSIS knowledge source has no condition because it is only invoked once, as the initial KS.
- **Hit Strategies:** DATA-ANALYSIS and OAD-SUBTYPERULES use a multiple hit strategy so that all applicable data is used and can influence the final outcome. All the other AGEPUFF KSs use a single hit strategy.
- **Local Variable Bindings:** In DATA-ANALYSIS the local variable bindings feature is used to store a computed difference between two data measurements. This particular difference measurement, DIFF:FEV1/FVC, is used several times in the DATA-ANALYSIS KS, so it is computed once in the local variable bindings and the value of the local variable is used by the rules, instead of recomputing the value each time it is used.
- **Unused Event Types:** Several rules have event types which do not invoke successor KSs. In general, these event types indicate the end of a line of reasoning or the end of the program. The event types OAD-FINDINGS and OAD-SUBTYPE are examples of unused event types in AGEPUFF; OAD-FINDINGS because the findings attribute filled by this event is an end result, and OAD-SUBTYPE because we have not implemented further refinements beyond OAD subtypes.
- **Credibility Weights:** The functions \$ANDMIN and \$ADJWT are used to evaluate the credibility of values referenced on the LHS(conditional) half of the AGEPUFF rules and to calculate and store them from the RHS(action) half of the rules. \$ANDMIN returns true if each of the conditions on the LHS is true with a credibility of at least .2. \$ANDMIN also computes a composite number, \$TALLY to represent the combined credibility of the conditions of a rule. \$ADJWT uses \$TALLY and the credibility weights already associated with an attribute and its value, to compute a new credibility weight.
- **Loading Files from another Directory:** If AGE cannot find the user's system files on the connect directory, it can search all directories in the user's Tenex or Tops-20 usergroup.
- **Reusing Previously Loaded Data:** After the first run of the user's system, AGE can reuse the input data for succeeding runs, without reloading it. Of course, if the user wants to rerun with new data, that can be loaded instead.

4. User Program

4.1. Loading the Program

What do you want to do? : get
 Get the user program from a file.
 What is the name of your system? : agepuff
 There are no files under that name on <AIELLO>
 Look on another directory? Y/N : y
 Type the directory name. [default = <AIELLO>] : <xage>
 Select the files to be loaded.

Type Y/N/<name>/A/Q
 -HYPOTHESIS : a
 Remaining names selected:
 -HYPOTHESIS -KNOWLEDGESOURCES -DATANAMES -USERFNS
 -CONTROLINFO -DESIGN
 FILE CREATED 23-Oct-80 12:58:22
 AGEPUFF-HYPOTHESISCOMS
 FILE CREATED 29-Oct-80 14:49:39
 AGEPUFF-KNOWLEDGESOURCESCOMS

FILE CREATED 6-DEC-77 14:53:50
 AGEPUFF-DATANAMESCOMS
 FILE CREATED 29-Oct-80 14:31:00
 AGEPUFF-USERFNSSCOMS

AGEPUFF-USERFNSSCOMS
 FILE CREATED 23-Oct-80 12:59:08
 AGEPUFF-CONTROLINFOCOMS
 FILE CREATED 23-Oct-80 12:59:18
 AGEPUFF-DESIGNCOMS
 End of GETSYS task.

4.2. Hypothesis Structure

What do you want to do? : ex
 Examine parts of the user system.
 What would you like to see?
 Type H/K/C/U/DA/DO : h

.....

LEVEL NODE OF LEVEL 1
PATIENT -
VOLUME - NIL
TLC/TLC-PRED - NIL
DILATION - NIL
DIFFUSION-DEFECT - NIL
FINDINGS - NIL

.....

.....

.....
LEVEL NODE OF LEVEL 2
DISEASE -
DEGREE - NIL
FINDINGS - NIL
SUBTYPE - NIL
REVERSIBILITY - NIL

.....
THE FOLLOWING ARE THE OTHER NODES (AND THEIR PROPERTY
LISTS) ON LEVEL 2

.....
OAD -

.....
RLD -

.....
NORMAL -

.....

4.3. Knowledge Sources

What would you like to see?
Type H/K/C/U/DA/DO : k

Which knowledge source would you like printed?
Type D/T/R/OAD-R/OAD-S/A : d

---->Knowledge Source: DATA-ANALYSIS

Precondition: NIL
Inference levels (from . to): (DATA . DISEASE)
 (DATA . PATIENT)
Links between levels: NIL
Hit Strategy: (MULTIPLE)
Local variable bindings: (DIFF:FEV1/FVC (IDIFFERENCE
 (CAR (\$DATA FEV1/FVC))
 (CAR (\$DATA PRED:FEV1/FVC))))

rule number: 1
if
 (KNOWN* (CAR (\$DATA TLC-BB:OBS/PRED)))

then

PROPOSE
 ev.type - TLC-VALUE
 ch.type - MODIFY
 hypo-clement - (QUOTE PATIENT)
 attr-value - (TLC/TLC-PRED (LIST (CAR (\$DATA TLC-BB:OBS/PRED)))1.0))
 link-node - NIL
 support - DATA-ANALYSIS
 comment - (RULE 26)

rule number: 2
if
 (NOTKNOWN* (CAR (\$DATA FEV1-DILATION:CHANGE)))
 (NOTKNOWN* (CAR (\$DATA RESISTENCE-DILATION:CHANGE)))

then

PROPOSE
 ev.type - DILATION
 ch.type - MODIFY
 hypo-clement - (QUOTE PATIENT)

attr-value - (DILATION (QUOTE (T -1.0)))
 link-node - NIL
 support - DATA-ANALYSIS
 comment - (RULE 29)

rule number: 3

if
 (GREATERP* (CAR (\$DATA FVC/FVC-PRED)) 80)
 (BETWEEN* DIFF:FEV1/FVC -15 -5)

then

PROPOSE

ev.type - OAD-DEGREE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((DEGREE (QUOTE (MILD .3)))
 (FINDINGS (QUOTE ((FEV1/FVC *FEV1/FVC1*) 1.0))))
 link-node - NIL
 support - DATA-ANALYSIS
 comment - (RULE 7)

rule number: 4

if
 (GREATERP* (CAR (\$DATA FVC/FVC-PRED)) 80)
 (BETWEEN* DIFF:FEV1/FVC -25 -15)

then

PROPOSE

ev.type - OAD-DEGREE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((DEGREE (QUOTE (MODERATE .5)))
 (FINDINGS (QUOTE ((FEV1/FVC *FEV1/FVC1*) 1.0))))
 link-node - NIL
 support - DATA-ANALYSIS
 comment - (RULE 7)

rule number: 5

if
 (GREATERP* (CAR (\$DATA FVC/FVC-PRED)) 80)
 (BETWEEN* DIFF:FEV1/FVC -35 -25)

then

PROPOSE

```

ev.type - OAD-DEGREE
ch.type - MODIFY
hypo-element - 'OAD
attr-value - ((DEGREE (QUOTE (MODERATELY-SEVERE .7)))
              (FINDINGS (QUOTE ((FEV1/FVC *FEV1/FVC1*) 1.0))))
link-node - NIL
support - DATA-ANALYSIS
comment - (RULE 7)

```

rule number: 6

```

if
  (GREATERP* (CAR ($DATA FVC/FVC-PRED)) 80)
  (LESSP* DIFF:FEV1/FVC -35)

```

then

PROPOSE

```

ev.type - OAD-DEGREE
ch.type - MODIFY
attr-value - ((DEGREE (QUOTE (SEVERE .9)))
              (FINDINGS (QUOTE ((FEV1/FVC *FEV1/FVC1*) 1.0))))
link-node - NIL
support - DATA-ANALYSIS
comment - (RULE 7)

```

rule number: 7

```

if
  (BETWEEN* (CAR ($DATA FVC/FVC-PRED)) 50 80)
  (BETWEEN* DIFF:FEV1/FVC -5 0)

```

then

PROPOSE

```

ev.type - OAD-DEGREE
ch.type - MODIFY
hypo-element - 'OAD
attr-value - ((DEGREE (QUOTE LIST (MILD .3)))
              (FINDINGS (QUOTE ((FEV1/FVC *FEV1/FVC2*) 1.0))))
link-node - NIL
support - DATA-ANALYSIS
comment - (RULE 8)

```

rule number: 8

```

if
  (BETWEEN* (CAR ($DATA FVC/FVC-PRED)) 50 80)
  (BETWEEN* DIFF:FEV1/FVC -15 -5)

```

then

PROPOSE

ev.type - OAD-DEGREE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((DEGREE (QUOTE (MODERATE .5)))
 (FINDINGS (QUOTE ((FEV1/FVC *FEV1/FVC2*) 1.0))))
 link-node - NIL
 support - DATA-ANALYSIS
 comment - (RULE 8)

rule number: 9

if

(BETWEEN* (CAR (\$DATA FVC/FVC-PRED)) 50 80)
 (BETWEEN* DIFF:FEV1/FVC -25 -15)

then

PROPOSE

ev.type - OAD-DEGREE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((DEGREE (QUOTE (MODERATELY-SEVERE .7)))
 (FINDINGS (QUOTE ((FEV1/FVC *FEV1/FVC2*) 1.0))))
 link-node - NIL
 support - DATA-ANALYSIS
 comment - (RULE 8)

rule number: 10

if

(BETWEEN* (CAR (\$DATA FVC/FVC-PRED)) 50 80)
 (LESSP* DIFF:FEV1/FVC -25)

then

PROPOSE

ev.type - OAD-DEGREE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((DEGREE (QUOTE (SEVERE .9)))
 (FINDINGS (QUOTE ((FEV1/FVC *FEV1/FVC2*) 1.0))))
 link-node - NIL
 support - DATA-ANALYSIS
 comment - (RULE 8)

rule number: 11

```

if
  (LESSP* (CAR ($DATA FVC/FVC-PRED)) 50)
  (BETWEEN* DIFF:FEV1/FVC 0 5)

then

PROPOSE
  ev.type - OAD-DEGREE
  ch.type - MODIFY
  hypo-clement - 'OAD
  attr-value - ((DEGREE (QUOTE (MILD .3)))
                (FINDINGS (QUOTE ((FEV1/FVC *FEV1/FVC3*) 1.0))))
  link-node - NIL
  support - DATA-ANALYSIS
  comment - (RULE 9)

```

rule number: 12

```

if
  (LESSP (CAR ($DATA FVC/FVC-PRED)) 50)
  (BETWEEN* DIFF:FEV1/FVC -5 0)

then

PROPOSE
  ev.type - OAD-DEGREE
  ch.type - MODIFY
  hypo-element - 'OAD
  attr-value - ((DEGREE (QUOTE (MODERATE .5)))
                (FINDINGS (QUOTE ((FEV1/FVC *FEV1/FVC3*) 1.0))))
  link-node - NIL
  support - DATA-ANALYSIS
  comment - (RULE 9)

```

rule number: 13

```

if
  (LESSP* (CAR ($DATA FVC/FVC-PRED)) 50)
  (BETWEEN* DIFF:FEV1/FVC -15 -5)

then

PROPOSE
  ev.type - OAD-DEGREE
  ch.type - MODIFY
  hypo-element - 'OAD
  attr-value - ((DEGREE (QUOTE (MODERATELY-SEVERE .7)))
                (FINDINGS (QUOTE ((FEV1/FVC *FEV1/FVC3*) 1.0))))
  link-node - NIL
  support - DATA-ANALYSIS

```

comment - (RULE 9)

rule number: 14

if

(LESSP* (CAR (\$DATA FVC/FVC-PRED)) 50)
(LESSP* DIFF:FEV1/FVC -15)

then

PROPOSE

ev.type - OAD-DEGREE
ch.type - MODIFY
hypo-element - 'OAD
attr-value - ((DEGREE (QUOTE (SEVERE .9)))
(FINDINGS (QUOTE ((FEV1/FVC *FEV1/FVC3*) 1.0))))
link-node - NIL
support - DATA-ANALYSIS
comment - (RULE 9)

rule number: 15

if

(GREATERP* (CAR (\$DATA FVC/FVC-PRED)) 80)
(BETWEEN* (CAR (\$DATA MMF/MMF-PRED)) 50 71)

then

PROPOSE

ev.type - OAD-DEGREE
ch.type - MODIFY
hypo-element - 'OAD
attr-value - ((DEGREE (QUOTE (MILD .3)))
(FINDINGS (QUOTE ((MMF/FVC *MMF/FVC1*) 1.0))))
link-node - NIL
support - DATA-ANALYSIS
comment - (RULE 10)

rule number: 16

if

(BETWEEN* (CAR (\$DATA MMF/MMF-PRED)) 35 50)
(LESSP* (CAR (\$DATA FVC/FVC-PRED)) 80)

then

PROPOSE

ev.type - OAD-DEGREE
ch.type - MODIFY
hypo-element - 'OAD

```

attr-value - ((DEGREE (QUOTE (MILD .3)))
              (FINDINGS (QUOTE ((MMF/FVC *MMF/FVC2*) 1.0))))
link-node - NIL
support - DATA-ANALYSIS
comment - (RULE 11)

```

rule number: 17

```

if
  (BETWEEN* (CAR ($DATA MMF/MMF-PRED)) 35 50)
  (GREQUAL* (CAR ($DATA FVC/FVC-PRED)) 80)

```

then

PROPOSE

```

cv.type - OAD-DEGREE
ch.type - MODIFY
hypo-element - 'OAD
attr-value - ((DEGREE (QUOTE (MODERATE .5)))
              (FINDINGS (QUOTE ((MMF/FVC *MMF/FVC2*) 1.0))))
link-node - NIL
support - DATA-ANALYSIS
comment - (RULE 11)

```

rule number: 18

```

if
  (BETWEEN* (CAR ($DATA MMF/MMF-PRED)) 25 35)
  (LESSP* (CAR ($DATA FVC/FVC-PRED)) 50)

```

then

PROPOSE

```

cv.type - OAD-DEGREE
ch.type - MODIFY
hypo-element - 'OAD
attr-value - ((DEGREE (QUOTE (MILD .5)))
              (FINDINGS (QUOTE ((MMF/FVC *MMF/FVC3*) 1.0))))
link-node - NIL
support - DATA-ANALYSIS
comment - (RULE 12)

```

rule number: 19

```

if
  (BETWEEN* (CAR ($DATA MMF/MMF-PRED)) 25 35)
  (BETWEEN* (CAR ($DATA FVC/FVC-PRED)) 50 80)

```

then

PROPOSE

ev.type - OAD-DEGREE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((DEGREE (QUOTE (MODERATE .7)))
 (FINDINGS (QUOTE ((MMF/FVC *MMF/FVC3*) 1.0))))
 link-node - NIL
 support - DATA-ANALYSIS
 comment - (RULE 12)

rule number: 20

if

(BETWEEN* (CAR (\$DATA MMF/MMF-PRED)) 25 35)
 (GREQUAL* (CAR (\$DATA FVC/FVC-PRED)) 80)

then

PROPOSE

ev.type - OAD-DEGREE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((DEGREE (QUOTE (MODERATELY-SEVERE .8)))
 (FINDINGS (QUOTE ((MMF/FVC *MMF/FVC3*) 1.0))))
 link-node - NIL
 support - DATA-ANALYSIS
 comment - (RULE 12)

rule number: 21

if

(LESSP* (CAR (\$DATA MMF/MMF-PRED)) 25)

then

PROPOSE

ev.type - OAD-DEGREE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((DEGREE (QUOTE (SEVERE .9)))
 (FINDINGS (QUOTE ((MMF/FVC *MMF/FVC4*) 1.0))))
 link-node - NIL
 support - DATA-ANALYSIS
 comment - (RULE 13)

rule number: 22

if

(BETWEEN* (CAR (\$DATA SLOPE:F50-F25/FVC)) 32 37)

then

PROPOSE

ev.type - OAD-DEGREE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((DEGREE (QUOTE (MILD .3)))
 (FINDINGS (QUOTE ((F5025 *F5025*) 1.0))))
 link-node - NIL
 support - DATA-ANALYSIS
 comment - (RULE 15)

rule number: 23

if

(BETWEEN* (CAR (\$DATA SLOPE:F50-F25/FVC)) 22 32)

then

PROPOSE

ev.type - OAD-DEGREE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((DEGREE (QUOTE (MODERATE .5)))
 (FINDINGS (QUOTE ((F5025 *F5025*) 1.0))))
 link-node - NIL
 support - DATA-ANALYSIS
 comment - (RULE 15)

rule number: 24

if

(BETWEEN* (CAR (\$DATA SLOPE:F50-F25/FVC)) 18 22)

then

PROPOSE

ev.type - OAD-DEGREE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((DEGREE (QUOTE (MODERATELY-SEVERE .7)))
 (FINDINGS (QUOTE ((F5025 *F5025*) 1.0))))
 link-node - NIL
 support - DATA-ANALYSIS
 comment - (RULE 15)

rule number: 25

if

(LESSP* (CAR (\$DATA SLOPE:F50-F25/FVC)) 18)

then

PROPOSE

ev.type - OAD-DEGREE
ch.type - MODIFY
hypo-element - 'OAD
attr-value - ((DEGREE (QUOTE (SEVERE .8)))
(FINDINGS (QUOTE ((F5025 *F5025*) 1.0))))
link-node - NIL
support - DATA-ANALYSIS
comment - (RULE 15)

rule number: 26

if

(BETWEEN* (CAR (\$DATA RV/TLC:OBS/PRED)) 5 10)

then

PROPOSE

ev.type - OAD-DEGREE
ch.type - MODIFY
hypo-element - 'OAD
attr-value - ((DEGREE (QUOTE (MILD .3)))
(FINDINGS (QUOTE ((AIRTRAPPING *AIRTRAP*) 1.0))))
link-node - NIL
support - DATA-ANALYSIS
comment - (RULE 16)

rule number: 27

if

(BETWEEN* (CAR (\$DATA RV/TLC:OBS/PRED)) 10 15)

then

PROPOSE

ev.type - OAD-DEGREE
ch.type - MODIFY
hypo-element - 'OAD
attr-value - ((DEGREE (QUOTE (MODERATE .5)))
(FINDINGS (QUOTE ((AIRTRAPPING *AIRTRAP*) 1.0))))
link-node - NIL
support - DATA-ANALYSIS
comment - (RULE 16)

rule number: 28

if

(BETWEEN* (CAR (\$DATA RV/TLC:OBS/PRED)) 15 20)

then

PROPOSE

ev.type - OAD-DEGREE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((DEGREE (QUOTE (MODERATELY-SEVERE .7)))
 (FINDINGS (QUOTE ((AIRTRAPPING *AIRTRAP*) 1.0))))
 link-node - NIL
 support - DATA-ANALYSIS
 comment - (RULE 16)

rule number: 29

if

(GREQUAL* (CAR (\$DATA RV/TLC:OBS/PRED)) 20)

then

PROPOSE

ev.type - OAD-DEGREE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((DEGREE (QUOTE (SEVERE .9)))
 (FINDINGS (QUOTE ((AIRTRAPPING *AIRTRAP*) 1.0))))
 link-node - NIL
 support - DATA-ANALYSIS
 comment - (RULE 16)

rule number: 30

if

(BETWEEN* (CAR (\$DATA DLCO:OBS/PRED)) 70 80)

then

PROPOSE

ev.type - DIFFUSION
 ch.type - MODIFY
 hypo-element - 'PATIENT
 attr-value - ((DIFFUSION-DEFECT (QUOTE (MILD .3)))
 (FINDINGS (QUOTE ((DIFFUSION *DLCO*)
 1.0))))
 link-node - NIL
 support - DATA-ANALYSIS
 comment - (RULE 23)

rule number: 31

```
if
  (NOTKNOWN* (CAR ($DATA TLC-BB:OBS/PRED)))
  (KNOWN* (CAR ($DATA TLC-DLCO:OBS/PRED)))
```

then

PROPOSE

```
ev.type - TLC-VALUE
ch.type - MODIFY
hypo-element - 'PATIENT
attr-value - (TLC/TLC-PRED (LIST (CAR ($DATA TLC-DLCO:OBS/PRED)) 1.0))
link-node - NIL
support - DATA-ANALYSIS
comment - (RULE 27)
```

rule number: 32

```
if
  (OR (KNOWN* (CAR ($DATA FEV1-DILATION:CHANGE)))
  (KNOWN* (CAR ($DATA RESISTENCE-DILATION:CHANGE))))
```

then

PROPOSE

```
ev.type - DILATION
ch.type - MODIFY
hypo-element - 'PATIENT
attr-value - (DILATION (QUOTE (T 1.0)))
link-node - NIL
support - DATA-ANALYSIS
comment - (RULE 58)
```

rule number: 33

```
if
  (LESSP* (CAR ($DATA FEV1-DILATION:CHANGE)) 1)
```

then

PROPOSE

```
ev.type - OAD-REVERSIBILITY
ch.type - MODIFY
hypo-element - 'OAD
attr-value - ((REVERSIBILITY (QUOTE (INSIGNIFICANT .7)))
  (FINDINGS (QUOTE ((DILATION *DILATION*) 1.0))))
link-node - NIL
support - DATA-ANALYSIS
comment - (RULE 20)
```

rule number: 34

if

(BETWEEN* (CAR (\$DATA FEV1-DILATION:CHANGE)) 1 5)

then

PROPOSE

ev.type - OAD-REVERSIBILITY

ch.type - MODIFY

hypo-element - 'OAD

attr-value - ((REVERSIBILITY (QUOTE (SLIGHT .3)))
(FINDINGS (QUOTE ((DILATION *DILATION*) 1.0))))

link-node - NIL

support - DATA-ANALYSIS

comment - (RULE 20)

rule number: 35

if

(BETWEEN* (CAR (\$DATA FEV1-DILATION:CHANGE)) 5 10)

then

PROPOSE

ev.type - OAD-REVERSIBILITY

ch.type - MODIFY

hypo-element - 'OAD

attr-value - ((REVERSIBILITY (QUOTE (GOOD .5)))
(FINDINGS (QUOTE ((DILATION *DILATION*) 1.0))))

link-node - NIL

support - DATA-ANALYSIS

comment - (RULE 20)

rule number: 36

if

(GREQUAL* (CAR (\$DATA FEV1-DILATION:CHANGE)) 10)

then

PROPOSE

ev.type - OAD-REVERSIBILITY

ch.type - MODIFY

hypo-element - 'OAD

attr-value - ((REVERSIBILITY (QUOTE (SIGNIFICANT .8)))
(FINDINGS (QUOTE ((DILATION *DILATION*) 1.0))))

link-node - NIL

support - DATA-ANALYSIS

comment - (RULE 20)

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What would you like to see?

Type H/K/C/U/DA/DO : k

Which knowledge source would you like printed?

Type D/T/R/OAD-R/OAD-S/A : t

-->Knowledge Source: TLCRULES

Precondition: (TLC-VALUE)
 Inference levels (from . to): (DATA . DISEASE)
 Links between levels: NIL
 Hit Strategy: (SINGLE)
 Local variable bindings: NIL

 rule number: 1

if
 (GREATERP* (CAR (\$HIGHVAL (QUOTE PATIENT)
 TLC/TLC-PRED)) 100)
 (BETWEEN* (CAR (\$DATA RV/RV-PRED)) 140 160)

then

PROPOSE
 ev.type - OAD-DEGREE
 ch.type - MODIFY
 hypo-clement - 'OAD
 attr-value - ((DEGREE (QUOTE (MILD .3)))
 (FINDINGS (QUOTE ((OVERINFLATION *OVERINFL*) 1.0))))
 link-node - NIL
 support - TLCRULES
 comment - (RULE 5)

rule number: 2

if
 (GREATERP* (CAR (\$HIGHVAL (QUOTE PATIENT) TLC/TLC-PRED)) 100)
 (BETWEEN* (CAR (\$DATA RV/RV-PRED)) 160 200)

then

PROPOSE
 ev.type - OAD-DEGREE
 ch.type - MODIFY

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```

hypo-element - 'OAD
attr-value - ((DEGREE (QUOTE (MODERATE .5)))
              (FINDINGS (QUOTE ((OVERINFLATION *OVERINFL*) 1.0))))
link-node - NIL
support - TLCRULES
comment - (RULE 5)

```

rule number: 3

```

if
(GREATERP* (CAR ($HIGHVAL (QUOTE PATIENT) TLC/TLC-PRED)) 100)
(GREQUAL* (CAR ($DATA RV/RV-PRED)) 200)

```

then

PROPOSE

```

ev.type - OAD-DEGREE
ch.type - MODIFY
hypo-element - 'OAD
attr-value - ((DEGREE (QUOTE (SEVERE .8)))
              (FINDINGS (QUOTE ((OVERINFLATION *OVERINFL*) 1.0))))
link-node - NIL
support - TLCRULES
comment - (RULE 5)

```

rule number: 4

```

if
(LESSP* (CAR ($HIGHVAL (QUOTE PATIENT) TLC/TLC-PRED)) 50)

```

then

PROPOSE

```

ev.type - RLD-DEGREE
ch.type - MODIFY
hypo-element - 'RLD
attr-value - ((DEGREE (QUOTE (SEVERE .9)))
              (FINDINGS (QUOTE ((TLC/RLD *TLC1*) 1.0))))
link-node - NIL
support - TLCRULES
comment - (RULE 6)

```

rule number: 5

```

if
(BETWEEN* (CAR ($HIGHVAL (QUOTE PATIENT) TLC/TLC-PRED)) 50 60)

```

then

PROPOSE

```

ev.type - RLD-DEGREE
ch.type - MODIFY
hypo-element - 'RLD
attr-value - ((DEGREE (QUOTE (MODERATELY-SEVERE .3)))
              (FINDINGS (QUOTE ((TLC/RLD *TLC1*) 1.0))))
link-node - NIL
support - TLCRULES
comment - (RULE 6)

```

rule number: 6

```

if
  (BETWEEN* (CAR ($HIGHVAL (QUOTE PATIENT) TLC/TLC-PRED)) 60 70)

```

then

PROPOSE

```

ev.type - RLD-DEGREE
ch.type - MODIFY
hypo-element - 'RLD
attr-value - ((DEGREE (QUOTE (MODERATE .5)))
              (FINDINGS (QUOTE ((TLC/RLD *TLC1*) 1.0))))
link-node - NIL
support - TLCRULES
comment - (RULE 6)

```

rule number: 7

```

if
  (BETWEEN* (CAR ($HIGHVAL (QUOTE PATIENT) TLC/TLC-PRED)) 70 80)

```

then

PROPOSE

```

ev.type - RLD-DEGREE
ch.type - MODIFY
hypo-element - 'RLD
attr-value - ((DEGREE (QUOTE (MILD .3)))
              (FINDINGS (QUOTE ((TLC/RLD *TLC1*) 1.0))))
link-node - NIL
support - TLCRULES
comment - (RULE 6)

```

rule number: 8

```

if
  (BETWEEN* (CAR ($HIGHVAL (QUOTE PATIENT) TLC/TLC-PRED)) 80 120)
  (BETWEEN* (CAR ($DATA FVC/FVC-PRED)) 80 120)
  (BETWEEN* (CAR ($DATA RV/RV-PRED)) 80 120)

```

then

PROPOSE

ev.type - VOLUME

ch.type - MODIFY

hypo-element - PATIENT

attr-value - ((VOLUME (QUOTE (NORMAL 1.0))))

(FINDINGS (QUOTE ((LUNG-VOLUME *VOLUMES*) 1.0))))

link-node - NIL

support - TLCRULES

comment - (RULE 4)

What would you like to see?
Type H/K/C/U/DA/DO : k

Which knowledge source would you like printed?
Type D/T/R/OAD-R/OAD-S/A : r

-->Knowledge Source: RLD-DEGREERULES

Precondition: (RLD-DEGREE)
Inference levels (from . to): (DISEASE . DISEASE)
Links between levels: NIL
Hit Strategy: (SINGLE)
Local variable bindings: NIL

rule number: 1

if
(KNOWN* (\$VALUE 'RLD 'DEGREE))
- (GREATERQDEG* (\$VALUE 'OAD 'DEGREE) MODERATE)

then

PROPOSE
ev.type - RLD:OAD
ch.type - MODIFY
hypo-element - 'RLD
attr-value - (DEGREE (LIST (SHIFTDOWN* DEGREE RLD) 1.0))
link-node - NIL
support - RLD-DEGREERULES
comment - (RULE 18)

What would you like to see?
Type H/K/C/U/DA/DO : k

Which knowledge source would you like printed?
Type D/T/R/OAD-R/OAD-S/A : oad-r

-->Knowledge Source: OAD-REVERSIBILITYRULES

Precondition: (OAD-REVERSIBILITY)
Inference levels (from . to): (DISEASE . DISEASE)
Links between levels: NIL
Hit Strategy: (SINGLE)
Local variable bindings: NIL

rule number: 1

if

(LESSEQDEG* (\$VALUE (QUOTE OAD) REVERSIBILITY) SLIGHT)
(LESSP* (CAR (\$DATA RESISTENCE-DILATION:CHANGE)) .5)

then

PROPOSE

ev.type - REVERSIBILITY
ch.type - MODIFY
hypo-element - 'OAD
attr-value - ((REVERSIBILITY (QUOTE (NOCHANGE 1.0)))
(FINDINGS (QUOTE ((REVERSIBILITY *REV1*) 1.0))))
link-node - NIL
support - OAD-REVERSIBILITYRULES
comment - (RULE 21)

rule number: 2

if

(GREATERQDEG* (\$VALUE (QUOTE OAD) REVERSIBILITY) GOOD)
(LESSP* (CAR (\$DATA RESISTENCE-DILATION:CHANGE)) .5)

then

PROPOSE

ev.type - REVERSIBILITY
ch.type - MODIFY
hypo-element - 'OAD

```

attr-value - ((REVERSIBILITY (QUOTE (SMALLCHANGE 1.0)))
              (FINDINGS (QUOTE ((REVERSIBILITY *REV3*) 1.0))))
link-node - NIL
support - OAD-REVERSIBILITYRULES
comment - (RULE 22)

```

rule number: 3

```

if
  (LESSEQDEG* ($VALUE (QUOTE OAD) REVERSIBILITY) SLIGHT)
  (GREQUAL* (CAR ($DATA RESISTENCE-DILATION:CHANGE)) .5)

```

then

PROPOSE

```

ev.type - REVERSIBILITY
ch.type - MODIFY
hypo-element - 'OAD
attr-value - ((REVERSIBILITY (QUOTE (SLIGHTCHANGE 1.0)))
              (FINDINGS (QUOTE ((REVERSIBILITY *REV2*) 1.0))))
link-node - NIL
support - OAD-REVERSIBILITYRULES
comment - (RULE 19)

```

rule number: 4

```

if
  (GREATEQDEG* ($VALUE 'OAD REVERSIBILITY) GOOD)
  (GREQUAL* (CAR ($DATA RESISTENCE-DILATION:CHANGE)) .5)

```

then

PROPOSE

```

ev.type - REVERSIBILITY
ch.type - MODIFY
hypo-element - 'OAD
attr-value - ((REVERSIBILITY (QUOTE (BIGCHANGE 1.0)))
              (FINDINGS (QUOTE ((REVERSIBILITY *REV4*) 1.0))))
link-node - NIL
support - OAD-REVERSIBILITYRULES
comment - (RULE 25)

```

What would you like to see?
Type H/K/C/U/DA/DO : k

Which knowledge source would you like printed?
Type D/T/R/OAD-R/OAD-S/A : oad-s

-->Knowledge Source: OAD-SUBTYPERULES

Precondition: (OAD-DEGREE)
Inference levels (from . to): (DISEASE . DISEASE)
(DISEASE . DISEASE)
(PATIENT . DISEASE)
Links between levels: NIL
Hit Strategy: (MULTIPLE)
Local variable bindings: NIL

rule number: 1

if
(GREQUAL.* (CAR (\$HIGHVAL (QUOTE PATIENT) TLC/TLC-PRED)) 80)
(LESSP* (CAR (\$DATA FVC/FVC-PRED)) 80)
(LESSP* (CAR (\$DATA IVC/IVC-PRED)) 80)
(GREATEQDEG* (\$VALUE (QUOTE OAD) DEGREE) MODERATE)

then

PROPOSE

ev.type - RLD-DEGREE
ch.type - MODIFY
hypo-element - 'RLD
attr-value - ((DEGREE (QUOTE (MILD .3)))
(FINDINGS (QUOTE ((TLC/RLD *TLC2*) 1.0))))
link-node - NIL
support - OAD-SUBTYPERULES
comment - (RULE 30)

rule number: 2

if
(GREATEQDEG* (\$VALUE (QUOTE OAD) DEGREE) MILD)
(GREATEQDEG* (\$VALUE (QUOTE PATIENT) DIFFUSION-DEFECT) MILD)
(GREQUAL.* (CAR (\$DATA TLC-BB:OBS/PRED)) 110)
(GREQUAL.* (CAR (\$DATA RV/TLC:OBS/PRED)) 10)

then

PROPOSE

ev.type - OAD-SUBTYPE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((SUBTYPE (QUOTE (EMPHYSEMA .9)))
 (FINDINGS (QUOTE ((EMPHYSEMA *EMPHYSEMA1*) 1.0))))
 link-node - NIL
 support - OAD-SUBTYPERULES
 comment - (RULE 31)

rule number: 3

if

(GREATEQDEG* (\$VALUE (QUOTE OAD) DEGREE) MILD)
 (GREATEQDEG* (\$VALUE (QUOTE PATIENT) DIFFUSION-DEFECT) MILD)
 (GREQUAL* (CAR (\$DATA TLC-BB:OBS/PRED)) 100)
 (GREQUAL* (CAR (\$DATA RV/TLC:OBS/PRED)) 15)

then

PROPOSE

ev.type - OAD-SUBTYPE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((SUBTYPE (QUOTE (EMPHYSEMA .9)))
 (FINDINGS (QUOTE ((EMPHYSEMA *EMPHYSEMA2*) 1.0))))
 link-node - NIL
 support - OAD-SUBTYPERULES
 comment - (RULE 32)

rule number: 4

if

(GREATEQDEG* (\$VALUE (QUOTE OAD) DEGREE) MILD)
 (GREATEQDEG* (\$VALUE (QUOTE PATIENT) DIFFUSION-DEFECT) MILD)
 (GREATEQDEG* (\$VALUE (QUOTE RLD) DEGREE) MILD)
 (GREQUAL* (CAR (\$DATA RV/TLC:OBS/PRED)) 20)

then

PROPOSE

ev.type - OAD-SUBTYPE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((SUBTYPE (QUOTE (EMPHYSEMA .9)))
 (FINDINGS (QUOTE ((EMPHYSEMA *EMPHYSEMA3*) 1.0))))
 link-node - NIL

support - OAD-SUBTYPERULES
 comment - (RULE 33)

rule number: 5

if
 (GREATERQDEG* (\$VALUE (QUOTE OAD) DEGREE) MILD)
 (GREATERQDEG* (\$VALUE (QUOTE PATIENT) DIFFUSION-DEFECT) MILD)
 (LESSP* (CAR (\$DATA TLC-BB:OBS/PRED)) 110)
 (NOTKNOWN* (\$VALUE (QUOTE RLD) DEGREE))

then

PROPOSE

ev.type - OAD-SUBTYPE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((SUBTYPE (QUOTE (EMPHYSEMA -3)))
 (FINDINGS (QUOTE ((EMPHYSEMA *EMPHYSEMA4*) 1.0))))
 link-node - NIL
 support - OAD-SUBTYPERULES
 comment - (RULE 34)

rule number: 6

if
 (GREATERQDEG* (\$VALUE (QUOTE OAD) DEGREE) MILD)
 (GREATERQDEG* (\$VALUE (QUOTE OAD) DIFFUSION-DEFECT) MILD)
 (NOTKNOWN* (CAR (\$DATA TLC-BB:OBS/PRED)))
 (LESSP* (CAR (\$DATA DLCO:OBS/PRED)) 110)

then

PROPOSE

ev.type - OAD-SUBTYPE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((SUBTYPE (QUOTE (EMPHYSEMA -9)))
 (FINDINGS (QUOTE ((EMPHYSEMA *EMPHYSEMA5*) 1.0))))
 link-node - NIL
 support - OAD-SUBTYPERULES
 comment - (RULE 35)

rule number: 7

if
 (GREATERQDEG* (\$VALUE (QUOTE OAD) DEGREE) MILD)
 (GREQUAL* (CAR (\$DATA SMOKING-PACKYEARS)) 0)

then

PROPOSE

ev.type - OAD-FINDINGS
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - (FINDINGS (QUOTE ((SMOKING *SMOKE*) 1.0)))
 link-node - NIL
 support - OAD-SUBTYPERULES
 comment - (RULE 36)

rule number: 8

if

(GREATERQDEG* (\$VALUE (QUOTE RLD) DEGREE) MILD)
 (GREATERQDEG* (\$VALUE (QUOTE PATIENT) DIFFUSION-DEFECT) MILD)
 (SAME* (CAR (\$DATA REFERRAL-DIAGNOSIS)) FIBROSIS)

then

PROPOSE

ev.type - OAD-SUBTYPE
 ch.type - MODIFY
 hypo-element - OAD
 attr-value - ((SUBTYPE (QUOTE (EMPHYSEMA -.3)))
 (FINDINGS (QUOTE ((EMPHYSEMA *EMPHYSEMA6*) 1.0))))
 link-node - NIL
 support - OAD-SUBTYPERULES
 comment - (RULE 37)

rule number: 9

if

(GREATERQDEG* (\$VALUE (QUOTE OAD) DEGREE) MILD)
 (KNOWN* (CAR (\$DATA DLCO:OBS/PRED)))
 (NOTKNOWN* (\$VALUE (QUOTE PATIENT) DIFFUSION-DEFECT))

then

PROPOSE

ev.type - OAD-SUBTYPE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((SUBTYPE (QUOTE (EMPHYSEMA -.3)))
 (FINDINGS (QUOTE ((EMPHYSEMA *EMPHYSEMA7*) 1.0))))
 link-node - NIL
 support - OAD-SUBTYPERULES
 comment - (RULE 38)

rule number: 10

```

if
(GREATEQDEG* ($VALUE (QUOTE OAD) DEGREE) MODERATE)
(OR (GREATEQDEG* (CAR ($DATA DYS-PNEA-DEGREE)) MILD)
(SAME* (CAR ($DATA REFERRAL-DIAGNOSIS)) DYS-PNEA))

```

```

then

```

```

PROPOSE

```

```

ev.type - OAD-FINDINGS
ch.type - MODIFY
hypo-element - 'OAD
attr-value - (FINDINGS (QUOTE ((DYS-PNEA *DYS-PNEA*) 1.0)))
link-node - NIL
support - OAD-SUBTYPERULES
comment - (RULE 39)

```

```

rule number: 11

```

```

if
(GREATERP* (CAR ($DATA SMOKING-PACKYEARS)) 0)
(OR (SAME* ($VALUE (QUOTE OAD) DEGREE) MILD)
(SAME* ($VALUE (QUOTE OAD) DEGREE) MODERATE))
(LESSP* (CAR ($DATA QUIT-SMOKING)) .1)

```

```

then

```

```

PROPOSE

```

```

ev.type - OAD-FINDINGS
ch.type - MODIFY
hypo-element - 'OAD
attr-value - (FINDINGS (QUOTE ((SMOKING *QUIT-SMOKING*) 1.0)))
link-node - NIL
support - OAD-SUBTYPERULES
comment - (RULE 40)

```

```

rule number: 12

```

```

if
(GREATEQDEG* ($VALUE (QUOTE OAD) DEGREE) MILD)
(GREATEQDEG* ($VALUE (QUOTE OAD) REVERSIBILITY) GOOD)
(SAME* (CAR ($DATA REFERRAL-DIAGNOSIS)) ASTHMA)

```

```

then

```

```

PROPOSE

```

```

ev.type - OAD-SUBTYPE
ch.type - MODIFY
hypo-element - 'OAD
attr-value - ((SUBTYPE (QUOTE (ASTHMA .3)))
(FINDINGS (QUOTE ((ASTHMA *ASTHMA1*) 1.0))))

```

link-node - NIL
 support - OAD-SUBTYPERULES
 comment - (RULE 45)

rule number: 13

if
 (SAME* (CAR (\$DATA REFERRAL-DIAGNOSIS)) ASTHMA)
 (GREATERP* (CAR (\$DATA DLCC:OBS/PRED)) 110)

then

PROPOSE

ev.type - OAD-SUBTYPE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((SUBTYPE (QUOTE (ASTHMA .3)))
 (FINDINGS (QUOTE ((ASTHMA *ASTHMA2*) 1.0))))
 link-node - NIL
 support - OAD-SUBTYPERULES
 comment - (RULE 46)

rule number: 14

if
 (GREATERQDEG* (\$VALUE (QUOTE OAD) DEGREE) MILD)
 (GREATERQDEG* (CAR (\$DATA COUGH:SEVERITY)) MILD)
 (GREATERQDEG* (CAR (\$DATA SPUTEM:DEGREE)) MILD)

then

PROPOSE

ev.type - OAD-SUBTYPE
 ch.type - MODIFY
 hypo-element - 'OAD
 attr-value - ((SUBTYPE (QUOTE (BRONCHITIS .3)))
 (FINDINGS (QUOTE ((BRONCHITIS *BRONCHITIS1*) 1.0))))
 link-node - NIL
 support - OAD-SUBTYPERULES
 comment - (RULE 47)

4.4. Control Settings

What do you want to do? : ex
Examine parts of the user system.

What would you like to see?
Type H/K/C/U/DA/DO : c

INITIALIZATION FUNCTION = AGEPUFF-INIT

TERMINATION FUNCTION = AGEPUFF.DONE

EVENT CONTROL INFORMATION:

SELECTION METHOD = BREADTHFIRST

COLLECTIONRULES = (OAD-DEGREE DATA-ANALYSIS)

EXPECTATION CONTROL INFORMATION:

SELECTION METHOD = NIL

MATCHER = NIL

GOAL CONTROL INFORMATION:

SELECTION METHOD = NIL

MATCHER = NIL

SEEKING METHOD = NIL

CONTROL RULES

condition = EXPECTATIONLIST step type = EXPECT

condition = T step type = EVENT

POSTPROCESSING FUNCTION = (AGEPUFF.INTERPRETATION)

4.5. User Defined Functions

```

(KNOWN*
(LAMBDA (DATUM)
  (* DATUM
    can be an atom -
    input data; or a list of lists -
    ((value wt) .. (value wt)))
(COND
  ((OR (NULL DATUM)
    (EQUAL DATUM (QUOTE (NIL)))) NIL)
  ((ATOM DATUM) DATUM)
  ((EQ (LENGTH DATUM) 1)
    (COND
      ((GREATERP (CADAR DATUM) .2) (CADAR DATUM))
      (T NIL)))
  (T T))))

(NOTKNOWN*
(LAMBDA (DATUM)
  (NOT (KNOWN* DATUM))))

(SAME*
(NLAMBDA (DAT1 DAT2)
  (* DAT2 is an atom: DAT1 is an atom or a list of lists)
  (SETQ DAT1 (EVAL DAT1))
  (COND
    ((NULL DAT2) NIL)
    ((ATOM DAT1)
      (EQ DAT1 DAT2))
    (T (EQ (CADAR DAT1)
      DAT2))))))

(GREATERP*
[LAMBDA (DATUM VALUE)
  (GREATERP DATUM VALUE)]

(LESSP*
[LAMBDA (DATUM VALUE)
  (LESSP DATUM VALUE)]

(BETWEEN*
(LAMBDA (DATUM VAL1 VAL2)
  (COND
    ((AND (OR (GREATERP DATUM VAL1)
      (EQP DATUM VAL2))

```

```

(LESSP DATUM VAL2))))))

(GREQUAL*
(LAMBDA (DATUM VALUE)
(COND
((OR (GREATERP DATUM VALUE)
(EQP DATUM VALUE))))))

(LESSEQDEG*
[NLAMBDA (DEG1 DEG2)
[if (ATOM (EVAL DEG1))
then (DEG1 - <(EVAL DEG1) 1.0>)
else (DEG1 - (HIGHESTDEGREE* (EVAL DEG1)
(if (NOTKNOWN* <DEG1>)
then NIL
else (PROG (TEMP)
[TEMP - (SOME (QUOTE (MILD MODERATE MODERATELY-SEVERE
SEVERE))
(FUNCTION (LAMBDA (DTM)
(EQ DTM DEG2]
(if (~ (DEG1:1 MEMB TEMP)) OR (DEG1 EQ TEMP:1)
then (RETURN T))

(GREATEQDEG*
(NLAMBDA (DEG1 DEG2)
(COND
((ATOM (EVAL DEG1))
(SETQ DEG1 (LIST (EVAL DEG1) 1.0)))
(T (SETQ DEG1 (HIGHESTDEGREE* (EVAL DEG1))))))
(COND
((NOTKNOWN* (LIST DEG1)) NIL)
(T (MEMB (CAR DEG1)
(SOME (QUOTE (MILD MODERATE MODERATELY-SEVERE SEVERE))
(FUNCTION (LAMBDA (DTM)
(EQ DTM DEG2))))))))))

(HIGHESTDEGREE*
(LAMBDA (DEGREE)
(* DEGREE is a list of lists -
((value wt) ... (value wt)))

(COND
((ASSOC (QUOTE SEVERE) DEGREE)
(ASSOC (QUOTE SEVERE) DEGREE))
((ASSOC (QUOTE MODERATELY-SEVERE) DEGREE)
(ASSOC (QUOTE MODERATELY-SEVERE) DEGREE))
((ASSOC (QUOTE MODERATE) DEGREE)
(ASSOC (QUOTE MODERATE) DEGREE))
((ASSOC (QUOTE MILD) DEGREE)
(ASSOC (QUOTE MILD) DEGREE))

```

```
((ASSOC (QUOTE SLIGHT) DEGREE)
 (ASSOC (QUOTE SLIGHT) DEGREE))))
```

```
(AGEPUFF-INIT
 (LAMBDA NIL
 (QUOTE DATA-ANALYSIS)))
```

```
(AGEPUFF.INTERPRETATION
 [LAMBDA NIL
 (TERPRI)
 (PRIN1 " ---- DATA FOR PATIENT ")
 (PRIN1 ($DATA PATIENTID))
 (PRIN1 " ----")
 (TERPRI)
 (for DATA in INPUTDATA do (SPACES 3)
 (PRIN1 DATA:1)
 (SPACES 3)
 (PRINT DATA:2))
 (TERPRI)
 (PRIN1 " ---- CURRENT HYPOTHESIS ----")
 (PRHYPO)
 (TERPRI)
 (PRIN1 " ---- INTERPRETATION ----")
 (TERPRI)
 (for NODE in '(OAD RLD NORMAL PATIENT)
 do (for FINDING in ($VALUE NODE FINDINGS)
 do (PRIN1 (EVAL FINDING:1:2))
 (TERPRI))
```

```
(AGEPUFF.DONE
 (LAMBDA NIL
 (NULL EVENTLIST)))
```

```
($HIGHVAL
 (NLAMBDA (NOODE ATTR/LINK)
 (* VALUE retrieval function.)
```

(* NOODE -
an expression evaluating to a hypothesis element
containing a desired value, can also be a backchain
data item.)

(* ATTR/LINK -
the explicit name of an attribute or link. This is not
evaluated.)

(* WHICH -
allows the user to specify ALL, for all the values, or
LATEST, for the last value added.
The default is ALL.)

(* Returns the value of the attr of the node, or the node pointed to by the link from node.)

```
(PROG (VALS HIGHVAL HIGHWT)
  (SETQ VALS (COND
    ((EQ (QUOTE 1A) (TOPVALUE CHAININGCASE)) (EVAL NOODE))
    (T (GETPROP (EVAL NOODE) ATTR/LINK))))
  (SETQ HIGHVAL (CAR VALS))
  (SETQ HIGHWT (CADR HIGHVAL))
  (for VV in (CDR VALS) do (COND
    ((GREATERP (CADR VV) HIGHWT)
      (SETQ HIGHVAL VV)
      (SETQ HIGHWT (CADR VV))))))
  (RETURN HIGHVAL)))
```

5. Program Run

What do you want to do? : RUN
Execute the user program.

Trace menu: Step/Focus/ADdtolist/Ks/RUlnumber/Lhs/RHs/Nodechanges/
Collection
ALI/Quit
Type ? for help

Trace>
Type A/R/E/Q : Q

Choose your breaks thusly: A(dd) | R(emove)
B(efore) | A(fter)
L(hs) | R(hs) | K(s)
<rulenumber > <ksname > | <ksname > | ALL
Type ? for help

Choose break
action:QUIT

Do you want to use the previously loaded data? Y/N : N

Do you want to get the input data from a file or from your terminal?

Type <filename>/T : <XAGE>AGEPUFF-PATIENT1

FILE CREATED 1-DEC-77 09:30:58

AGEPUFF-PATIENTICOMS

(INDATA reset)

((SPUTEM:DEGREE MODERATELY-SEVERE)(COUGH:SEVERITY MILD)

(QUIT-SMOKING 0)(DYSAPNEA-DEGREE MODERATELY-SEVERE)

(REFERRAL-DIAGNOSIS BRONCHITIS)(SMOKING-PACKYEARS 48)

(RV/RV-PRED 191)(TLC-DLCO:OBS/PRED 83)(DLCO:OBS/PRED 48)

(RV/TLC:OBS/PRED 21)(SLOPE:F50-F25/FVC 19)(MMF/MMF-PRED 19)

(FVC/FVC-PRED 87)(RESISTENCE-DILATION:CHANGE 19)

(FEV1-DILATION:CHANGE 4)(TLC-BB:OBS/PRED 127)(IVC/IVC-PRED 80)

(PRED:FEV1/FVC 83)(FEV1/FVC 50))

--- DATA FOR PATIENT NIL ---

SPUTEM:DEGREE MODERATELY-SEVERE

COUGH:SEVERITY MILD

QUIT-SMOKING 0

DYSAPNEA-DEGREE MODERATELY-SEVERE

REFERRAL-DIAGNOSIS BRONCHITIS

SMOKING-PACKYEARS 48

RV/RV-PRED 191

TLC-DLCO:OBS/PRED 83

DLCO:OBS/PRED 48

RV/TLC:OBS/PRED 21
 SLOPE:F50-F25/FVC 19
 MMF/MMF-PRED 19
 FVC/FVC-PRED 87
 RESISTENCE-DILATION:CHANGE 19
 FEV1-DILATION:CHANGE 4
 TLC-BB:OBS/PRED 127
 IVC/IVC-PRED 80
 PRED:FEV1/FVC 83
 FEV1/FVC 50

----- CURRENT HYPOTHESIS -----

.....
 LEVEL NODE OF LEVEL 1
 PATIENT -
 VOLUME - NIL
 TLC/TLC-PRED - ((127 1.0))
 DILATION - ((T 1.0))
 DIFFUSION-DEFECT - ((MODERATELY-SEVERE .8))
 FINDINGS - (((DIFFUSION *DLCO*) 1.0))

.....

.....
 LEVEL NODE OF LEVEL 2
 DISEASE -
 DEGREE - NIL
 FINDINGS - NIL
 SUBTYPE - NIL
 REVERSIBILITY - NIL
 INST - (NORMAL RLD OAD)

.....
 THE FOLLOWING ARE THE OTHER NODES (AND THEIR PROPERTY
 LISTS) ON LEVEL 2

.....
 OAD -
 PROTO - (DISEASE)
 DEGREE - ((MODERATE .5)
 (SEVERE .99)
 (MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((REVERSIBILITY *REV2*) 1.0)
 ((BRONCHITIS *BRONCHITIS1*) 1.0)
 ((DYSPNEA *DYSPNEA*) 1.0)
 ((SMOKING *SMOKE*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA2*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA1*) 1.0)
 ((OVERINFLATION *OVERINFL*) 1.0))

((DILATION *DILATION*) 1.0)
 ((AIRTRAPPING *AIRTRAP*)1.0)
 ((F5025 *F5025*)1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - ((BRONCHITIS .3)
 (EMPHYSEMA .99)
 (EMPHYSEMA .9))
 REVERSIBILITY - ((SLIGHTCHANGE 1.0)
 (SLIGHT .3))

.....
 RLD -
 PROTO - (DISEASE)
 DEGREE - NIL
 FINDINGS - NIL
 SUBTYPE - NIL
 REVERSIBILITY - NIL

.....
 NORMAL -
 PROTO - (DISEASE)
 DEGREE - NIL
 FINDINGS - NIL
 SUBTYPE - NIL
 REVERSIBILITY - NIL

----- INTERPRETATION -----

Improvement in airway resistance indicates some reversibility of airway obstruction, although flow rates showed small change following dilation.

The presence of a productive cough is an indication that the OAD is of the bronchitic type.

The airway obstruction accounts the patient's dyspnea.

Airway obstruction is consistent with the patient's smoking history.

OAD, Diffusion Defect, and elevated RV indicate emphysema.

OAD, Diffusion Defect, elevated TLC, and elevated RV together indicate emphysema.

Elevated lung volumes indicate overinflation.

Change in expired flow rates following bronchodilation shows that there is reversibility of airway obstruction.

Airtrapping is indicated by the elevated difference between observed and predicted RV/TLC ratios.

Obstruction is indicated by curvature of the flow volume loop.

Flow rate from 25-75 of expired volume is reduced, indicating severe airway obstruction.

Forced Vital Capacity is normal and peak flow rates are reduced, suggesting airway obstruction.

Low diffusion capacity indicates loss of alveolar capillary surface.

End of RUN task.

What do you want to do? : Q

Exit from LISP.

End recording on <AIELLO>DRIB-AIELLO-XAGE.19-NOV-80;1

6. Program Run with Trace

What do you want to do? : RUN
Execute the user program.

Trace menu: Step/Focus/ADdtolist/Ks/RUlenumber/Lhs/RHs/Nodechanges/
Collection/ALI/Quit
Type ? for help

Trace>

Type A/R/E/Q : A

Trace>

one of:

S(tep) - Print steps as they are selected

F(ocus) - Print event, expectation, goal as it is focused

A(ddtolist) - Print events, expectations, goals as they are added to
their respective lists

K(s) - Print name of knowledge source as it is invoked

RU(lenumber) - Print rule number of rule as it is fired

L(hs) - Print left hand side of rule as it is fired

RH(s) - Print right hand side of rule as it is fired

N(odechanges) - Print nodes as they are added; also before and after
as they are modified

C(ollection) - Print collection rule as collection occurs

AL(l) - Trace everything available

Q(uit) - Quit menu

Trace>FOCUSPRINTFLAG

Trace>KSPRINTFLAG

Trace>RULENUMBERPRINTFLAG

Trace>NODECHANGESPRINTFLAG

Trace>QUIT

Trace>

Type A/R/E/Q : Q

Choose your breaks thusly: A(dd) | R(emove)

B(efore) | A(fter)

L(hs) | R(hs) | K(s)

< rulenumbe r > < ksname > | < ksname >

| ALL

Type ? for help

Choose break

action:QUIT

Do you want to use the previously loaded data? Y/N : Y

Knowledge source invoked - DATA-ANALYSIS

Number of applicable rule: 1 (* DATA-ANALYSIS uses a MULTIPLE
hit strategy, requiring all

Number of applicable rule: 5 applicable rules to be evaluated
before any actions, changes to

Number of applicable rule: 21 nodes in the hypothesis, are
executed.)

Number of applicable rule: 24

Number of applicable rule: 29

Number of applicable rule: 30

Number of applicable rule: 32

Number of applicable rule: 36

Node before application of rule:

PATIENT -

NUM - 0

LLIST - (PATIENT)

VOLUME - NIL

TLC/TLC-PRED - NIL

DILATION - NIL

DIFFUSION-DEFECT - NIL

FINDINGS - NIL

Node after application of rule:

PATIENT -

NUM - 0

LLIST - (PATIENT)

VOLUME - NIL

TLC/TLC-PRED - ((127 1.0))

DILATION - NIL

DIFFUSION-DEFECT - NIL

FINDINGS - NIL

PROTO - (DISEASE)

DEGREE - NIL

FINDINGS - NIL

SUBTYPE - NIL

REVERSIBILITY - NIL

Node after application of rule:

OAD -

PROTO - (DISEASE)

DEGREE - ((MODERATELY-SEVERE.7))

FINDINGS - (((FEV1/FVC *FEV1/FVC1*) 1.0))

SUBTYPE - NIL

REVERSIBILITY - NIL

Node before application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((MODERATELY-SEVERE .7))
 FINDINGS - (((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - NIL
 REVERSIBILITY - NIL

Node after application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - NIL
 REVERSIBILITY - NIL

Node before application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - NIL
 REVERSIBILITY - NIL

Node after application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - NIL
 REVERSIBILITY - NIL

Node before application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0))

((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - NIL
 REVERSIBILITY - NIL

Node after application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((SEVERE .99)
 (MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((AIRTRAPPING *AIRTRAP*) 1.0)
 ((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - NIL
 REVERSIBILITY - NIL

Node before application of rule:

PATIENT -
 NUM - 0
 LLIST - (PATIENT)
 VOLUME - NIL
 TLC/TLC-PRED - ((127 1.0))
 DILATION - NIL
 DIFFUSION-DEFECT - NIL
 FINDINGS - NIL

Node after application of rule:

PATIENT -
 NUM - 0
 LLIST - (PATIENT)
 VOLUME - NIL
 TLC/TLC-PRED - ((127 1.0))
 DILATION - ((T 1.0))
 DIFFUSION-DEFECT - NIL
 FINDINGS - NIL

Node before application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((SEVERE .99)
 (MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((AIRTRAPPING *AIRTRAP*) 1.0)
 ((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - NIL

REVERSIBILITY - NIL

Node after application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((SEVERE .99)
 (MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((DILATION *DILATION*) 1.0)
 ((AIRTRAPPING *AIRTRAP*) 1.0)
 ((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - NIL
 REVERSIBILITY - ((SLIGHT .3))

Node before application of rule:

PATIENT -
 NUM - 0
 LLIST - (PATIENT)
 VOLUME - NIL
 TLC/TLC-PRED - ((127 1.0))
 DILATION - ((T 1.0))
 DIFFUSION-DEFECT - NIL
 FINDINGS - NIL

Node after application of rule:

PATIENT -
 NUM - 0
 LLIST - (PATIENT)
 VOLUME - NIL
 TLC/TLC-PRED - ((127 1.0))
 DILATION - ((T 1.0))
 DIFFUSION-DEFECT - ((MODERATELY-SEVERE .8))
 FINDINGS - (((DIFFUSION *DLCO*) 1.0))

Focus event - (TLC-VALUE PATIENT ((TLC/TLC-PRED (127 1.0)))
 DATA-ANALYSIS EVI NIL)

(* This event, EVI, was generated

Knowledge source invoked - TLCRULES by Rule 1 of DATA-ANALYSIS.

It was the first rule executed

Number of applicable rule: 2 and therefore this event is the
 first event on the EVENTLIST.

Node before application of rule: It is chosen for the FOCUSEVENT

OAD - by the FIFO selectionmethod.

PROTO - (DISEASE) Also, noticed that TLC-VALUE,

DEGREE - ((SEVERE .99) the name of this event, is the

(MODERATELY-SEVERE .91) precondition for TL.CRULES. See

(SEVERE .9) page 25.

(MODERATELY-SEVERE .7))
 FINDINGS - (((DILATION *DILATION*) 1.0)
 ((AIRTRAPPING *AIRTRAP*) 1.0)
 ((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - NIL
 REVERSIBILITY - ((SLIGHT .3))

Node after application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((MODERATE .5)
 (SEVERE .99)
 (MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((OVERINFLATION *OVERINFL*) 1.0)
 ((DILATION *DILATION*) 1.0)
 ((AIRTRAPPING *AIRTRAP*) 1.0)
 ((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - NIL
 REVERSIBILITY - ((SLIGHT .3))

Focus event - (OAD-DEGREE OAD ((DEGREE (MODERATELY-SEVERE .7))
 (FINDINGS ((FEV1/FVC *FEV1/FVC1*) 1.0)))
 DATA-ANALYSIS EV2 NIL)

Knowledge source invoked - OAD-SUBTYPERULES (* Another MULTIPLE hit KS.)

Number of applicable rule: 2

Number of applicable rule: 3

Number of applicable rule: 7

Number of applicable rule: 10

Number of applicable rule: 14

Node before application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((MODERATE .5)
 (SEVERE .99)
 (MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))

FINDINGS - (((OVERINFLATION *OVERINFL*) 1.0)
 ((DILATION *DILATION*) 1.0)
 ((AIRTRAPPING *AIRTRAP*) 1.0)
 ((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - NIL
 REVERSIBILITY - ((SLIGHT .3))

Node after application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((MODERATE .5)
 (SEVERE .99)
 (MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((EMPHYSEMA *EMPHYSEMA1*) 1.0)
 ((OVERINFLATION *OVERINFL*) 1.0)
 ((DILATION *DILATION*) 1.0)
 ((AIRTRAPPING *AIRTRAP*) 1.0)
 ((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - ((EMPHYSEMA .9))
 REVERSIBILITY - ((SLIGHT .3))

Node before application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((MODERATE .5)
 (SEVERE .99)
 (MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((EMPHYSEMA *EMPHYSEMA1*) 1.0)
 ((OVERINFLATION *OVERINFL*) 1.0)
 ((DILATION *DILATION*) 1.0)
 ((AIRTRAPPING *AIRTRAP*) 1.0)
 ((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - ((EMPHYSEMA .9))
 REVERSIBILITY - ((SLIGHT .3))

Node after application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((MODERATE .5)
 (SEVERE .99)

(MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((EMPHYSEMA *EMPHYSEMA2*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA1*) 1.0)
 ((OVERINFLATION *OVERINFL*) 1.0)
 ((DILATION *DILATION*) 1.0)
 ((AIRTRAPPING *AIRTRAP*) 1.0)
 ((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - ((EMPHYSEMA .99)
 (EMPHYSEMA .9))
 REVERSIBILITY - ((SLIGHT .3))

Node before application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((MODERATE .5)
 (SEVERE .99)
 (MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((EMPHYSEMA *EMPHYSEMA2*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA1*) 1.0)
 ((OVERINFLATION *OVERINFL*) 1.0)
 ((DILATION *DILATION*) 1.0)
 ((AIRTRAPPING *AIRTRAP*) 1.0)
 ((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - ((EMPHYSEMA .99)
 (EMPHYSEMA .9))
 REVERSIBILITY - ((SLIGHT .3))

Node after application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((MODERATE .5)
 (SEVERE .99)
 (MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((SMOKING *SMOKE*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA2*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA1*) 1.0)
 ((OVERINFLATION *OVERINFL*) 1.0)
 ((DILATION *DILATION*) 1.0)
 ((AIRTRAPPING *AIRTRAP*) 1.0)
 ((F5025 *F5025*) 1.0)

((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - ((EMPHYSEMA .99)
 (EMPHYSEMA .9))
 REVERSIBILITY - ((SLIGHT .3))

Node before application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((MODERATE .5)
 (SEVERE .99)
 (MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((SMOKING *SMOKE*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA2*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA1*) 1.0)
 ((OVERINFLATION *OVERINFL*) 1.0)
 ((DILATION *DILATION*) 1.0)
 ((AIRTRAPPING *AIRTRAP*) 1.0)
 ((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - ((EMPHYSEMA .99)
 (EMPHYSEMA .9))
 REVERSIBILITY - ((SLIGHT .3))

Node after application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((MODERATE .5)
 (SEVERE .99)
 (MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((DYSPNEA *DYSPNEA*) 1.0)
 ((SMOKING *SMOKE*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA2*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA1*) 1.0)
 ((OVERINFLATION *OVERINFL*) 1.0)
 ((DILATION *DILATION*) 1.0)
 ((AIRTRAPPING *AIRTRAP*) 1.0)
 ((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - ((EMPHYSEMA .99)
 (EMPHYSEMA .9))
 REVERSIBILITY - ((SLIGHT .3))

Node before application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((MODERATE .5)
 (SEVERE .99)
 (MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((DYSPNEA *DYSPNEA*) 1.0)
 ((SMOKING *SMOKE*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA2*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA1*) 1.0)
 ((OVERINFLATION *OVERINFL*) 1.0)
 ((DILATION *DILATION*) 1.0)
 ((AIRTRAPPING *AIRTRAP*) 1.0)
 ((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - ((EMPHYSEMA .99)
 (EMPHYSEMA .9))
 REVERSIBILITY - ((SLIGHT .3))

Node after application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((MODERATE .5)
 (SEVERE .99)
 (MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((BRONCHITIS *BRONCHITIS1*) 1.0)
 ((DYSPNEA *DYSPNEA*) 1.0)
 ((SMOKING *SMOKE*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA2*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA1*) 1.0)
 ((OVERINFLATION *OVERINFL*) 1.0)
 ((DILATION *DILATION*) 1.0)
 ((AIRTRAPPING *AIRTRAP*) 1.0)
 ((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - ((BRONCHITIS .3)
 (EMPHYSEMA .99)
 (EMPHYSEMA .9))
 REVERSIBILITY - ((SLIGHT .3))

Focus event - (DILATION PATIENT ((DILATION (T 1.0))) DATA-ANALYSIS
 EV6 NIL)

Focus event - (OAD-REVERSIBILITY OAD ((REVERSIBILITY (
 DATA-ANALYSIS EV7 NIL)

Knowledge source invoked - OAD-REVERSIBILITYRULES

Number of applicable rule: 3

Node before application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((MODERATE .5)
 (SEVERE .99)
 (MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((BRONCHITIS *BRONCHITIS1*) 1.0)
 ((DYSPNEA *DYSPNEA*) 1.0)
 ((SMOKING *SMOKE*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA2*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA1*) 1.0)
 ((OVERINFLATION *OVERINFL*) 1.0)
 ((DILATION *DILATION*) 1.0)
 ((AIRTRAPPING *AIRTRAP*) 1.0)
 ((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - ((BRONCHITIS .3)
 (EMPHYSEMA .99)
 (EMPHYSEMA .9))
 REVERSIBILITY - ((SLIGHT .3))

Node after application of rule:

OAD -
 PROTO - (DISEASE)
 DEGREE - ((MODERATE .5)
 (SEVERE .99)
 (MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((REVERSIBILITY *REV2*) 1.0)
 ((BRONCHITIS *BRONCHITIS1*) 1.0)
 ((DYSPNEA *DYSPNEA*) 1.0)
 ((SMOKING *SMOKE*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA2*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA1*) 1.0)
 ((OVERINFLATION *OVERINFL*) 1.0)
 ((DILATION *DILATION*) 1.0)
 ((AIRTRAPPING *AIRTRAP*) 1.0)
 ((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))

SUBTYPE - ((BRONCHITIS .3)
 (EMPHYSEMA .99)
 (EMPHYSEMA .9))
 REVERSIBILITY - ((SLIGHTCHANGE 1.0)
 (SLIGHT .3))

Focus event - (DIFFUSION PATIENT ((DIFFUSION-DEFECT
 (MODERATELY-SEVERE .8)) (FINDINGS ((DIFFUSION *DLCO*) 1.0)))
 DATA-ANALYSIS EV8 NIL)

Focus event - (OAD-SUBTYPE OAD ((SUBTYPE (EMPHYSEMA .9)) (FINDINGS
 ((EMPHYSEMA *EMPHYSEMA1*) 1.0))) OAD-SUBTYPERULES EV10 NIL)

Focus event - (OAD-SUBTYPE OAD ((SUBTYPE (EMPHYSEMA .99)) (FINDINGS
 ((EMPHYSEMA *EMPHYSEMA2*) 1.0))) OAD-SUBTYPERULES EV11 NIL)

Focus event - (OAD-FINDINGS OAD ((FINDINGS ((SMOKING *SMOKE*) 1.0)))
 OAD-SUBTYPERULES EV12 NIL)

Focus event - (OAD-FINDINGS OAD ((FINDINGS ((DYSPNEA *DYSPNEA*) 1.0)))
 OAD-SUBTYPERULES EV13 NIL)

Focus event - (OAD-SUBTYPE OAD ((SUBTYPE (BRONCHITIS .3)) (FINDINGS
 ((BRONCHITIS *BRONCHITIS1*) 1.0))) OAD-SUBTYPERULES EV14 NIL)

Focus event - (REVERSIBILITY OAD ((REVERSIBILITY (SLIGHTCHANGE 1.0))
 (FINDINGS ((REVERSIBILITY *REV2*) 1.0)))
 OAD-REVERSIBILITYRULES EV15 NIL)

(* AGE tries to act on all of the events on the
 EVENTLIST, but the last seven events do not
 generate further conclusions. Refer to item
 • , Section 3.4.

----- DATA FOR PATIENT NIL -----
 SPUTEM:DEGREE MODERATELY-SEVERE
 COUGH:SEVERITY MILD
 QUIT-SMOKING 0
 DYSPNEA-DEGREE MODERATELY-SEVERE
 REFERRAL-DIAGNOSIS BRONCHITIS
 SMOKING-PACKYEARS 48
 RV/RV-PRED 191

TLC-DLCO:OBS/PRED 83
 DLCO:OBS/PRED 48
 RV/TLC:OBS/PRED 21
 SLOPE:F50-F25/FVC 19
 MMF/MMF-PRED 19
 FVC/FVC-PRED 87
 RESISTENCE-DILATION:CHANGE 19
 FEV1-DILATION:CHANGE 4
 TLC-BB:OBS/PRED 127
 IVC/IVC-PRED 80
 PRED:FEV1/FVC 83
 FEV1/FVC 50

----- CURRENT HYPOTHESIS -----

.....
 LEVEL NODE OF LEVEL 1
 PATIENT -
 VOLUME - NIL
 TLC/TLC-PRED - ((127 1.0))
 DILATION - ((T 1.0))
 DIFFUSION-DEFECT - ((MODERATELY-SEVERE .8))
 FINDINGS - (((DIFFUSION *DLCO*)
 1.0))

.....

.....
 LEVEL NODE OF LEVEL 2
 DISEASE -
 DEGREE - NIL
 FINDINGS - NIL
 SUBTYPE - NIL
 REVERSIBILITY - NIL
 INST - (NORMAL RLD OAD)

.....
 THE FOLLOWING ARE THE OTHER NODES (AND THEIR PROPERTY
 LISTS) ON LEVEL 2

.....
 OAD -
 PROTO - (DISEASE)
 DEGREE - ((MODERATE .5)
 (SEVERE .99)
 (MODERATELY-SEVERE .91)
 (SEVERE .9)
 (MODERATELY-SEVERE .7))
 FINDINGS - (((REVERSIBILITY *REV2*) 1.0)
 ((BRONCHITIS *BRONCHITIS1*) 1.0)
 ((DYSPNEA *DYSPNEA*) 1.0)
 ((SMOKING *SMOKE*) 1.0)

((EMPHYSEMA *EMPHYSEMA2*) 1.0)
 ((EMPHYSEMA *EMPHYSEMA1*) 1.0)
 ((OVERINFLATION *OVERINFL*) 1.0)
 ((DILATION *DILATION*) 1.0)
 ((AIRTRAPPING *AIRTRAP*) 1.0)
 ((F5025 *F5025*) 1.0)
 ((MMF/FVC *MMF/FVC4*) 1.0)
 ((FEV1/FVC *FEV1/FVC1*) 1.0))
 SUBTYPE - ((BRONCHITIS .3)
 (EMPHYSEMA .99)
 (EMPHYSEMA .9))
 REVERSIBILITY - ((SLIGHTCHANGE 1.0)
 (SLIGHT .3))

.....
 RLD -
 PROTO - (DISEASE)
 DEGREE - NIL
 FINDINGS - NIL
 SUBTYPE - NIL
 REVERSIBILITY - NIL

.....
 NORMAL -
 PROTO - (DISEASE)
 DEGREE - NIL
 FINDINGS - NIL
 SUBTYPE - NIL
 REVERSIBILITY - NIL

.....

----- INTERPRETATION -----

Improvement in airway resistance indicates some reversibility of airway obstruction, although flow rates showed small change following dilation.

The presence of a productive cough is an indication that the OAD is of the bronchitic type.

The airway obstruction accounts the patient's dyspnea.

Airway obstruction is consistent with the patient's smoking history.

OAD, Diffusion Defect, and elevated RV indicate emphysema.

OAD, Diffusion Defect, elevated TLC, and elevated RV together indicate emphysema.

Elevated lung volumes indicate overinflation.

Change in expired flow rates following bronchodilation shows that there is reversibility of airway obstruction.

Airtrapping is indicated by the elevated difference between observed and predicted RV/TLC ratios.

Obstruction is indicated by curvature of the flow volume loop.
Flow rate from 25-75 of expired volume is reduced, indicating severe airway obstruction.

Forced Vital Capacity is normal and peak flow rates are reduced, suggesting airway obstruction.

Low diffusion capacity indicates loss of alveolar capillary surface.

End of RUN task.

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