LOGIC

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Uses: TABLEBROWSER

This document last edited on 20-Dec-1988 00:52:22.

NOTES ABOUT LOGIC MEDLEY RELEASE

This LOGIC release(1.3) is more robust than previous on top of Lyric; there are some bugs fixed. The major enhancement is the possibility of handle multiple SEDIT sessions: there is a global variable, *LOGIC-CLOSE-ON-COMPLETION-FLG* (defaulting to T), that controls the behaviour of the editing: NIL means not to close the editing window and not to perform a check on the correctness of the axiom just typed in, T means to check definitions and to close the editing window.

INTRODUCTION

This package is devoted to people who want to use a logic paradigm in their programming environment. LOGIC was initially developed in Franz Lisp at the Computer Science Department of the University of Milan: now a modified part of its kernel is running in Common Lisp, so it is possible to use it under every machine running CL: within the Xerox environment, some features are available in order to ease the construction of the programs.

All of the source codes are available: sorry if they are awful! But it's better to have efficiency than syntactic sugar ...

LOGIC MANUAL

LOGIC is essentially a theorem prover based on Horn clauses: the user is allowed to create many theories and within these theories to specify some predicates (clauses); as FOL does, it is also possible to specify some *semantic attachements* (SA), in order to use all the capabilities of the environment: in our implementation, these SAs are expressed in Lisp. A goal proof is performed within specifed theory(es); the user is allowed to dinamically change the theories involved.
These are the elements of the language:
• a *variable* is an atom beginning with '?'
• an *atomic formula* is a list beginning with the name of the predicate and followed by the terms: (on table book)
(mother ?x ?y)
• a *clause* is a list beginning with the consequent, followed by the special symbol ':-', and by the sequence of the antecedents:

((grandfather ?x ?y) :- (father ?x ?z) (father ?z ?y))
• a *set of clauses* is the definition of a predicate
(((append () ?a ?a)) ((append (?a . ?b) ?c (?a . ?d)) :- (append ?b ?c ?d)))
• a *theory* is a set of the definitions of some predicates

HOW TO LOAD AND INIT LOGIC

In order to use LOGIC, load the files LOGIC and LOGIC-UNIFIER. From within the Xerox Lisp Environment, you can also load the development environment LOGIC-DEVEL.DFASL. After loading the files, call the functions:

• (CREATE-BACKGROUND-THEORY): this function creates the main theory reading the data it needs from the file LOGIC.LGC.

• (CREATE-VARIABLES): this functions creates and initializes the variables used by the unifier; it takes a few time to perform its job. This call is due to a lack of the Xerox garbage collector: since the unifier uses techniques of redenomination, a great number of symbols is generated; the 1186 does not release the space used by these symbols, and so they fill up the GC table. The workaround is to re-use all the symbols generated.

If you want to port this code on another machine running CL, it is a matter of taste to eliminate this piece of code, with a little hacking on the source codes.

These are the functions available from the top-level executive of Lisp:

(ALL *VARS CONJ THS*) [Function]

Returns the *vars* that satisfies the goal (*conj*) in the list of theories (*ths*): the background theory is always used.For example you can ask the system to prove:
(ALL '(?a ?b) '((append ?a ?b (1 2 3))) '(append-theory))
--> ((NIL (1 2 3)) ((1) (2 3)) ((1 2) (3)) ((1 2 3) NIL))

(ANY *HOW-MANY VARS CONJ THS*) [Function]

Returns *how-many vars* that satisfies the goal:
(any 2 '?a '((append ?a ?b (1 2 3))) '(append-theory))
--> (NIL (1))

(ATTACH *SA-NAME DEFINITION THEORY-NAME*) [Function]

Allows to create semantic attachments:
(ATTACH 'createw '(lambda (name) (IL:CREATEW () name)) 'my-theory)
and now:
(ANY 1 () '((createw "Kiss me on my lips")) '(my-theory)

--> ;;creates a window on the screen

(CREATE-THEORY *THEORY-NAME*) [Function]

Creates a brand-new theory with that name: return the name of the theory created, not the theory itself.

(LIST-ALL-THEORIES) [Function]

Return a list of the defined theories, currently available.

(LOAD-THEORY *THEORY-NAME*) [Function]

Loads from the current directory the specified *theory-name*; the name of the theory file has the extension .LGC , and it must be previously created by the corresponding function SAVE-THEORY

(LOGIC-ADDA *PRED CLAUSES THEORY-NAME*) [Function]

Adds to the definitions of the predicate *pred* the specified *clauses*, that holds in the theory *theory-name*: the clauses are put in front of the already existing clauses:
(LOGIC-ADDA 'C '(((C 1)) ((C ?x) :- (A ?x))) 'my-theory)

(LOGIC-ADDZ *PRED CLAUSES THEORY-NAME*) [Function]

Adds to the definitions of the predicate *pred* the specified *clauses*, that holds in the theory *theory-name*: the clauses are put at the end of the already existing clauses:
(LOGIC-ADDZ 'C '(((C 2)) ((C ?x) :- (A ?x) (B :y))) 'my-theory)

(LOGIC-ASSERT *PRED CLAUSES THEORY-NAME*) [Function]

Replaces all previous definitions of the predicate *pred* with *clauses*.

(LOGIC-DELETE *PRED-OR-SA THEORY-NAME*) [Function]

Erases from the theory *theory-name* the definition of *pred-or-sa*, that may be either a predicate or a semantic attachment

(LOGIC-DELETE-FACT *FACT-NAME FACT-CLAUSE THEORY-NAME*) [Function]

Erases from the definition of the clauses on the predicate *FACT-NAME* the specified clause *FACT-CLAUSE*, within the theory *THEORY-NAME*.

(MERGE-THEORIES *NEW-THEORY-NAME &REST LIST-OF-THEORIES)* [Function]

Creates the new theory *NEW-THEORY-NAME* made up by all the predicates and sas that hold in all the theories *LIST-OF-THEORIES*: now no control is performed on the consistency in the merging of the theories

(PROVE *CONJ THS*) [Function]

Calls the prover on the specified goals *conj*. *THS* is a list of the theory(es) used. PROVE returns only T or NIL

(SAVE-THEORY *THEORY-NAME*) [Function]

Writes on the local directory the contents of the theory *theory-name*. You will find later a file whose name is composed by the theory name and the extension LGC.
The format of the contents of the file is the following:

```
theory-name
number of semantic attachments
<sa name1> <sa definition>
..
<sa nameN> <sa definition>
number of predicates
<predicate name 1> <clauses for predicate 1>
..
<predicate name N> <clauses for predicate N>
```

A theory file (with .LGC extension) may be created by the user employing a text editor like Emacs or VI (on Symbolics, SUNs etc.), avoiding the saving of the theory every change he performs.

(SHOW-DEFINITION *ELEMENT THEORY-NAME*) [Function]

Shows the definition of *element*, either a predicate or a semantic attachment.

(SHOW-THEORY *THEORY-NAME &OPTIONAL VERBOSE*) [Function]

Shows the contents (name of predicates and sas) of the theory *theory-name*; if *verbose* is T, all the definitions are shown.

THE BACKGROUND THEORY

In the background theory, many interesting primitive predicates are available:

! [Predicate]

The cut predicate, well-known to the PROLOG programmers: a tipical example of its use can be the definition of the predicate NOT:

```
(((not ?formula) :- (wff ?formula) ! (fail))
((not ?formula)))
```

(TRUE) [Predicate]
This predicate always succeds

(FAIL) [Predicate]
The predicate that never succeds

(PRINT ?arg) [Predicate]
Prints the argument ?arg passed by

(EVAL&PRINT ?arg) [Predicate]
This predicate evaluates and print the result of evaluation of the form ?arg:
(prove '((eval&print (+ 3 4))) '(my-theory))
7
T

(LOGIC-ADDA *?PREDICATE-NAME ?CLAUSES ?THEORY-NAME*) [Predicate]
Adds in front of the clauses that define the predicate ?PREDICATE-NAME in the theory ?theory-name the other clauses ?CLAUSES

(LOGIC-ADDZ *?PREDICATE-NAME ?CLAUSES ?THEORY-NAME*) [Predicate]
Adds to the end of the clauses that define the predicate ?PREDICATE-NAME in the theory ?theory-name the other clauses ?CLAUSES

(LOGIC-ASSERT *?PREDICATE-NAME ?CLAUSES ?THEORY-NAME*) [Predicate]
Replaces all definition for the predicate ?PREDICATE-NAME in the theory ?THEORY-NAME with the new clauses ?CLAUSES

(LOGIC-DELETE *?PREDICATE-OR-SA--NAME ?THEORY-NAME*) [Predicate]
Deletes all definition for predicate (or sa) ?PREDICATE-OR-SA-NAME in the theory ?THEORY-NAME

(LOGIC-DELETE-FACT *?FACT-NAME ?FACT-CLAUSE ?THEORY-NAME*) [Function]

Erases from the definition of the clauses on the predicate *FACT-NAME* the specified clause *FACT-CLAUSE*, within the theory *THEORY-NAME*.

(SET ?var value) [Predicate]

With this predicate it is possible to set a variable within the demonstration (remind that a variable always starts with a '?'):
(prove '((set ?x (list 'a 'b 3))(print ?x)) '(my-theory))
--> (a b 3)
T

(RETRACT ?theory-name) [Predicate]

Tells the interpreter that it must use no more the theory *?theory-name* during the ongoing demonstration; this elision is made only on the current active node of the demonstration tree

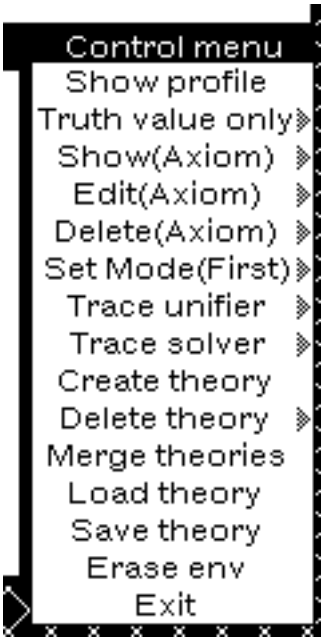
(USE-THEORY ?theory-name) [Predicate]

Tells to the interpreter that it must use the theory *?theory-name* for the ongoing demonstration.

(WFF ?formula) [Predicate]

This is a second order predicate that allows you to prove the truth value of the well formed formula *?formula*

If you load only the LOGIC files, this is the environment you have. On Xerox machines, you can also load the file LOGIC-DEVEL, that allows you to have the development environment: a new entry in your background menu is created, and so you are able to open a logic demonstration window.
This is the control menu:



SHOW-PROFILE: shows the current profile: the MODE of demonstration (FIRST, ALL, INTERACTIVE), and the tracing flags on unifier and solver

TRUTH VALUE ONLY: this flag controls if the prover returns all the goals with the variables instantiated or only the values T or NIL

SHOW AXIOM: shows the definition of an axiom or of a semantic attachment

EDIT AXIOM: edits the definition of an axiom or of a semantic attachment

DELETE AXIOM: deletes the definition of an axiom or of a semantic attachment

SET MODE: sets the mode of the demonstration: this may be ALL, FIRST or INTERACTIVE

TRACE SOLVER: the solver is the procedure of the interpreter that takes as arguments a tree, a formula and the clauses for that formula, and gives back the new tree obtained by the resolution operation; its behaviour is traced on a debugging window which has the middle menu capability of dribbling; the output file has the extension TRC.

TRACE UNIFIER: traces the going on of the unifier on a debugger window; this window too has the middle menu capability of dribbling its output. The pattern, the datum and the unification environment will be shown to the user.

CREATE THEORY: creates a new theory

DELETE THEORY: all the theories loaded are showed in a tablebrowser at the left of the main window; when you select one or more theories, this means that you want to use them for your demonstration; this command deletes the selected theories; you can however undelete or expunge them with the subitems of this entry. Remember that, for undeleting the selected theories with the tablebrowser mark( ), you must click middle button on it and press CTRL (PROP) key

MERGE THEORIES: merges the selected theories in a new theory; the user is prompted for the name of the new theory

LOAD THEORY: loads a theory from a file in the current directory

SAVE THEORY: save the selected theory(ies) on the corresponding files

ERASE ENV: erases all the environment of the window

EXIT: exits from the environment

Remember that, for every demonstration requested, there must be at least one theory selected in the tablebrowser at the left of the main window

I hope these notes help you to use LOGIC.

You can find some examples in the theory file LOGIC- EXAMPLES.LGC.

Any suggestion is welcome: since it is not fully tested, please notify every kind of error or bug you will find.

EXAMPLES

Choose LOGIC from the background menu: a new window will appear: choose LOAD THEORY from the control menu and type in LOGIC-EXAMPLES at the request in the prompt window: mark the theory loaded in the theories window and try:

((APPEND ?A ?B (1 2 3)))

the system will respond you

((APPEND NIL (1 2 3) (1 2 3)))

Click now on SHOW PROFILE: you will see

MODE: FIRST /Unifier: NOTRACE /Solver: NOTRACE /Values: NIL

Choose SET MODE ALL (submenu) and retry the same goal as before: you get the answer:

((APPEND NIL (1 2 3) (1 2 3)))

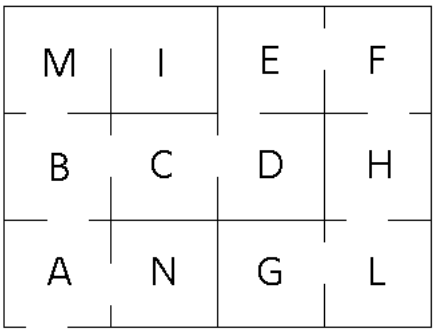
((APPEND (1) (2 3) (1 2 3)))

((APPEND (1 2) (3) (1 2 3)))

((APPEND (1 2 3) NIL (1 2 3)))

NIL

In the theory LOGIC- EXAMPLESa simple little maze is described: type in the goal:
((search a g))
that will find a path from the room 'a' to the room 'g'.



Here are other examples of goals you can try:
((sa-member 3 (1 2 3 4 5)))
((logic-member 3 (1 2 3 4 5)))
The first one is a SA, the latter is a predicate.
((NOT (A 1))) --> T

((NOTMEMBER 2 (1 3 4))) --> T
and so on.
Try now all the other features of the language.
You can ask the system for the same goals from the lisp listener:
(load-theory 'logic-examples)
(prove '((APPEND ?X ?Y (1 2 3 4)) '(logic-examples)) --> T
(all '(?X ?Y) '((APPEND ?X ?Y (1 2 3 4)) '(logic-examples))
--> ((NIL (1 2 3 4)) ((1) (2 3 4)) ((1 2) (3 4)) ((1 2 3) (4)) ((1 2 3 4) NIL))

Have fun!