

A LADDER USER'S GUIDE (REVISED)

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## ABSTRACT

LADDER (Language Access to Distributed Data with Error Recovery) is a computer system designed to provide answers to questions posed at the terminal in a subset of natural language regarding a distributed data base of naval command and control information. The system accepts a fairly wide range of natural-language questions about the data. For each question LADDER plans a sequence of appropriate queries to the data base management system, determines on which machines the queries are to be processed, establishes links to those machines over the Arpanet, monitors the processing of the queries and recovers from certain errors in execution, and prepares a relevant answer to the original question.

This user's guide is intended for the person who knows how to log in to the host operating system, as well as how to enter and edit a line of text. It does not explain how LADDER works, but rather how to use it on a demonstration basis.

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## I INTRODUCTION

LADDER (Language Access to Distributed Data with Error Recovery) is a computer system designed to provide answers to questions posed at the terminal in a subset of natural language regarding a distributed data base of naval command and control information.\* The system accepts a fairly wide range of natural-language questions about the data. For each question LADDER plans a sequence of appropriate queries to the data base management system, determines on which machines the queries are to be processed, establishes links to those machines over the Arpanet, monitors the processing of the queries and recovers from certain errors in execution, and prepares a relevant answer to the original question.

This user's guide is intended to provide a relatively brief characterization of the system's current capabilities. It presumes that a prospective user can already log in to a host computer supporting LADDER, and that he can type in (and, if necessary, correct) a line of text.

The LADDER system, operational since June 1976, is undergoing continual improvement. The concepts underlying the development and operation of such a system are described in detail in the technical literature [1] [2] [3] [4]. LADDER is written in INTERLISP [5] and uses SRI's LIFER package [6] [7] for building natural-language interfaces.

LADDER is currently installed on four hosts on the Arpanet: SRI-KL at SRI International, and ISIB and ISID at the Information Sciences Institute of the University of Southern California (ISI). It is also

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installed on a PDP-10 in the Advanced Command Control Architectural Testbed (ACCAT) at the Naval Ocean Systems Center. At SRI-KL and ISID, LADDER runs under the TOPS-20 operating system; at ISIB and ACCAT, it runs under TENEX.

The data bases used by LADDER are described in detail elsewhere [8] [9]. They are currently stored on a data base management system called Datacomputer [10]. Use of the LADDER system on a demonstration basis does not require familiarity with any of these references.

If you have any questions or comments, please direct them to the authors of this manual \*.

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\* ARPANET messages can be sent to SACERDOTI@SRI-KL or SAGALOWICZ@SRI-KL

## II INITIAL PROTOCOL

To run LADDER, simply type

LADDER

followed by a carriage return to the system when you are at the EXEC level. LADDER will ask for your name. Type in your name (spaces are acceptable) and terminate the name with a carriage return. Since we keep a transcript of every LADDER session to obtain examples of questions we cannot yet handle, the name helps us by identifying the user.\* LADDER will then ask a number of questions. In the LADDER systems running on the Arpanet these are:

Do you want instructions? -- Answer Y for "yes" or N for "no." If no answer is received after a reasonable interval, LADDER will assume instructions are needed.

Do you want to use 2 Datacomputers? -- LADDER is designed to operate in an environment in which the data base is distributed over multiple instantiations of the Datacomputer data base management system [10]. However, your questions can be processed more quickly if all the data are on a single Datacomputer. You can therefore choose to have LADDER simulate a truly distributed environment by answering Y for "yes," or you can obtain faster response by answering N for "no." If you answer yes, LADDER will act as if half the files were on one Datacomputer and half on another, even though the two instantiations of Datacomputer used (depending on the status of the various machines on the network that support the Datacomputer software) will probably be on the same actual machine. If you provide no answer, only one instantiation of Datacomputer will be used.

Do you want to specify a default location? -- The system can answer many kinds of questions, such as "Where is the nearest ship?" that contain an implied "from here." By answering Y, for "yes," to this question you may choose a "here" for the session. LADDER will request that you type in a port name, ship name, or a latitude-longitude pair in the format 12-34N, 34-56W. By answering N, for

---

\* Please remember to end your session with LADDER by typing DONE. Otherwise the transcript file may be lost.

"no," you will obtain the default "here," which is Norfolk, Virginia.

Do you wish distance/direction questions to default to GREAT CIRCLE or RHUMB LINE? -- There are two methods by which LADDER computes distances to answer questions such as "What is the distance to the nearest ship?" One method, called "great circle," computes the shortest distance over the surface of the earth. The other, called "rhumb line," computes the distance over a path that corresponds to a straight line on a Mercator projection map. You may choose a default method by typing G, for "great circle," or R, for "rhumb line." After a reasonable interval, if no selection is made, the system will choose the great-circle method for you. In any particular question you may always name the distance computation you want (for example, "What is the great-circle distance to the nearest ship?").

At the ACCAT facility the system will ask:

Do you want to use the BLUEFILE, FC, or WES data base? -- The program can query either a copy of the unclassified Blue File used on the Arpanet, the classified FC data base that contains a snapshot of actual naval command-control data, or a classified WES data base that consists of some of the FC files augmented by dynamically generated data created by the WES simulation system. By typing B, F, or W, you can select the appropriate data base. The default data base, chosen by LADDER if you fail to respond, is the Blue File.



### III INTERACTING WITH LADDER IN ENGLISH

Once the initial protocol has been completed, all interactions with LADDER are performed in a subset of English. This section will provide some general guidelines about the English-language interface. Subsequent sections will describe particular classes of commands and questions.

When LADDER prompts you with a question number followed by a left arrow (which appears as an underscore on some terminals), type in your question, terminating it with a carriage return.\* Punctuation is permitted but not required. LADDER accepts input in any combination of upper- and lowercase. Backspacing is done by typing control-A or the delete key, depending on whether the host operating system is TENEX or TOPS-20, respectively. The processing of a question may be aborted at any time by typing control-D. Further procedures for editing a line of input are described in Section 14 of the INTERLISP manual [5].

An attempt has been made to accept a wide range of English-language inputs that are relevant to both the data base and the task of command-control decision making. The examples given in the following sections are therefore to be taken as suggested, rather than mandatory, forms. Users are encouraged to try out different constructions, as this is how gaps are exposed in our coverage of potential questions. Note that while all the examples are presented below in uppercase, you may use uppercase, lowercase, or a combination of the two in actually typing to LADDER.

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\* In general, LADDER will interpret any carriage return as the end of a question. If you are typing a question longer than one line, either do not type a carriage return until the end, or precede the carriage return with a blank.

#### IV QUERYING THE DATA BASE

LADDER makes very strong presumptions about what you are going to type to it. In particular, it assumes that data base queries are relevant to the data base it is designed to access. Questions about kinds of information that are not contained in the data base (for example, sensor ranges) normally cannot be parsed (i.e. they cannot be recognized by LADDER as an instance of any pattern in the grammar). Questions about ships, places, or facts that are not in the data base will result in failures to parse or in incomplete answers. For example, the question,

HOW FAR IS THE KITTY HAWK FROM MALTA?

cannot be parsed, because Malta is not in the data base and hence not in LADDER's vocabulary. The question,

GIVE THE POSITION AND STATE OF READINESS OF EACH CARRIER

will not give information about the positions of any Soviet carriers that might be retrieved, because no information on their state of readiness is available. If you are planning to use LADDER for any extended work, it is strongly recommended that you obtain the document cited earlier ([8] or [9]) concerning the data base you will be accessing.

Since the data bases that LADDER accesses are concerned with ships, ship characteristics, and ship movements, we shall first describe the many ways you can refer to ships.

##### A. Referring to Ships

Ships can be specified by name (e.g., Pogy), class (e.g., Kitty Hawk), type (e.g., cargo freighter), or naval ship classification (e.g., SSBN). LADDER recognizes the names of all US Navy ships, plus those foreign and merchant ships that are in the Blue File data base.

Examples of valid ship specifications are:

THE CHARLES F. ADAMS  
ETHAN ALLEN CLASS SUBMARINES  
CGN  
INTELLIGENCE COLLECTORS.

The specification of a ship can be modified by appending its country, kind of operation, or distinguishing feature. For example:

AMERICAN CRUISER  
NUCLEAR-POWERED NAVAL VESSELS  
THE FASTEST DUTCH MERCHANT SHIP.

The specification can also be modified by more complex phrases and clauses, expressing comparisons of characteristics, comparisons with other ships, specifications of position, or indications of a ship's route, cargo, or casualty status. For example:

CARRIERS MORE THAN 1000 FEET LONG  
AMERICAN NAVAL SHIPS FASTER THAN THE FASTEST DUTCH MERCHANT  
SHIP  
UNITED STATES CARGO FREIGHTERS IN THE NORTH ATLANTIC  
LIBERIAN TANKERS EN ROUTE TO AMERICA  
SHIPS CARRYING CONSTRUCTION MATERIALS TO BRITAIN  
CRUISERS IN THE MED THAT ARE NOT AT READINESS RATING C1.

Additional types of modifications can be performed by specifying the values of particular attributes. For example:

FOREIGN SHIPS CARRYING WHEAT  
SHIPS WITH A DOCTOR ABOARD  
OILERS WITH A DISPLACEMENT GREATER THAN 30000  
THE NEAREST SHIP TO THE KENNEDY WITH AN OPERATIONAL AIR SEARCH  
RADAR.

#### B. Asking Questions about Ships

Many simple questions about ships seek to determine what ships satisfy a given set of restrictions. These questions correspond closely to the more complex restrictions on ships described in the previous section.

You can ask for ships of any particular class (e.g., Kitty Hawk), type (e.g., cargo freighter), or naval classification (e.g., SSBN).

Examples of simple restriction-type questions are:

NAME THE LOS ANGELES CLASS SUBMARINES  
WHAT SHIPS ARE HEAVY CRUISERS?  
LIST THE SHIPS OF TYPE DDG.

Additional restrictions can be specified by appending a country, kind of operation, or distinguishing feature. For example:

IS THE FOX AN AMERICAN CRUISER?  
PRINT THE NUCLEAR-POWERED NAVAL VESSELS!  
WHAT IS THE FASTEST DUTCH MERCHANT SHIP?

Questions can ask for more complex restrictions, such as comparisons of characteristics, comparisons with other ships, specifications of position, indications of route, cargo, or casualty status. For example:

ARE ANY SUBMARINES MORE THAN 300 FEET LONG?  
WHAT AMERICAN NAVAL SHIPS ARE FASTER THAN THE FASTEST DUTCH  
MERCHANT SHIP  
ARE THERE ANY FOREIGN CARGO FREIGHTERS WITHIN 300 MILES OF  
CAPETOWN?  
NAME THE U. S. TANKERS WHOSE CURRENT SPEED OF ADVANCE IS  
LESS THAN 10 KNOTS  
REPORT ALL SHIPS CARRYING COALS TO LONDON!  
DESCRIBE THE CRUISERS THAT ARE NOT AT READINESS RATING C1.

Additional types of modifications can be produced by specifying attributes of the ships. For example:

SHOW ME THE DESTROYERS WHOSE RADAR IS INOPERATIVE.  
DO ANY SHIPS WITHIN 400 MILES OF LUANDA HAVE A DOCTOR ABOARD?  
WHAT ARE THE OILERS WHOSE LAST REPORTED POSITION IS WITHIN 250  
MILES  
NAME THE NEAREST SHIP TO THE KENNEDY WITH AN OPERATIONAL AIR  
SEARCH RADAR

### C. Questions about Attributes of Ships

Most of the questions typically asked of a data base are concerned with the current values of attributes that are explicitly stored. LADDER provides many formats for specifying such questions. The simplest forms ask for the stored attributes. For example:

WHAT IS THE RADIO CALL SIGN OF THE FOX?  
WHAT STANDARD DISPLACEMENT IS EACH OILER WITHIN 400 NAUTICAL  
MILES OF GIBRALTAR  
PRINT THE CURRENT POSITION AND FUEL STATUS OF THE DESTROYERS  
IN THE MED.

Many more formats permit asking in subtler ways about attributes of ships. For example:

HOW IS THE SOUTH CAROLINA POWERED  
WHERE WERE THE OILERS LAST REPORTED?  
WHERE WILL EACH DUTCH CARGO FREIGHTER GO?  
HOW FAST IS EACH SOVIET MERCHANT VESSEL IN THE NORTH ATLANTIC?  
WHEN IS THE CALIFORNIA SCHEDULED TO ARRIVE ON STATION?  
TO WHAT TASK GROUP DOES EACH DDG BELONG?  
WHAT CLASS DOES THE HOEL BELONG TO  
WHY IS THE AMERICA AT READINESS RATING C5?  
WHO COMMANDS THE STERETT?

## V QUESTIONS INVOKING CALCULATIONS

A major advantage in having a computer serve as the interface between a decision-maker and a data base is that the computer can perform complex calculations on the retrieved data much faster and more reliably than a person. We have implemented some examples of this kind of capability in LADDER, but have not attempted to provide for all the calculations a naval decision-maker might need.

LADDER attempts to handle questions concerning distances between ships, which involve calculations dependent upon position information retrieved from the data base, as well as questions concerning steaming times, which require position information in addition to current and maximum speed values from the data base. LADDER also has a route calculation routine for avoiding land masses. This routine uses a model of the sea areas of the world and the junction points that must be traversed between them. Because the particular model used by the current version of LADDER is very simple it may give inexact answers. However, the performance of the routines would undoubtedly improve with a more detailed model. Some typical questions you can ask are:

HOW MANY MILES IS THE CONSTELLATION FROM HER NEXT PORT OF CALL  
HOW FAR IS EACH AMERICAN DESTROYER FROM THE SOVIET CARRIERS?  
WHAT SHIPS CARRYING DOCTORS ARE WITHIN EIGHT HOURS' STEAMING  
TIME OF THE PECOS?  
WHAT IS THE NORMAL TRANSIT TIME FOR THE KENNEDY FROM NORFOLK  
TO GIBRALTAR?  
DOES THE SARATOGA HAVE ENOUGH FUEL TO REACH BUENOS AIRES  
WITHOUT REFUELING  
HOW LONG WOULD IT TAKE FOR THE WAINWRIGHT TO GET TO NAPLES?  
WHAT IS THE BEST ROUTE FOR THE SUNFISH TO THE SKORY?

## VI DISPLAYING DATA GRAPHICALLY

In the ACCAT, LADDER is interfaced with the Situation Display Graphics Subsystem (SDGS) [11] developed by ISI. A number of special commands are provided in LADDER to cause information to be displayed in map format.

Since it is possible to have several situation displays active at the same time, all commands can be preceded or followed by phrases such as:

```
ON DISPLAY NUMBER 3
ON DISPLAY 3
ON TEKTRONIX NUMBER 3
```

If such a phrase is not included, the system assumes that the command is directed at the same display as the previous one. Unless otherwise specified, the first command is assumed to be directed to display number 1.

To initiate a display, the user must issue an ACTIVATE command, such as:

```
ACTIVATE THE DISPLAY
TURN ON THE SITUATION DISPLAY!
START DISPLAY NUMBER 3.
```

The situation display system will then ask for a "device parameter file" which the user should name. For precise information on the format of such a file, the reader should consult the SDGS implementers at ISI.

The user must define a particular map before displaying any data base information. This is done with the SELECT command, which consists of the words "select" or "show" followed by a specification of a region. For example:

```
SELECT A MAP OF THE NORTH ATLANTIC.
SELECT THE AREA WITHIN 500 NAUTICAL MILES OF THE WORDEN.
SHOW A MAP OF RADIUS 500 MILES AROUND THE FOX.
```

After a map is displayed, ships or sets of ships may be added to or removed from it using the SHOW or ERASE commands. The context of these commands is presumed to be the area on the display. For example, after you type SELECT A MAP OF THE MEDITERRANEAN, the command DISPLAY ALL THE CARRIERS will cause only carriers in the Mediterranean to be retrieved from the data base and displayed.

A number of other commands can also be directed to the SDGS to control auxiliary information (such as sensor envelopes and speed vectors) to be displayed on the screen or erased from it. Most of them can be specialized for a subset of the ships displayed by adding any phrase that describes those ships. Examples of such commands are:

```
DISPLAY AMPLIFYING INFORMATION FOR ALL SHIPS!  
HIGHLIGHT UK SHIPS  
STOP HIGHLIGHTING UK CARRIERS.  
DISPLAY SENSOR ENVELOPES FOR RUSSIAN SUBS.  
DON'T DISPLAY SENSORS  
DISPLAY VECTORS.  
DON'T DISPLAY SPEED VECTOR.  
DISPLAY COURSE VECTOR.  
RETAIN SHIPS.  
DON'T RETAIN SHIPS  
DISPLAY SHIP NAMES!  
DON'T DISPLAY CODES.  
FILL LAND MASSES.  
DON'T CROSS-HATCH LAND AREAS!  
HATCH LAND.
```

For a specific explanation of these commands, the user is again referred to the SDGS implementers.

An additional command is provided to permit a graphic image to be saved by SDGS. This command takes the form

```
SAVE <IMAGE>
```

and directs the SDGS to save the map, so that subsequent selections of the same map during the same session will be done more efficiently.

When through with the display, the user can explicitly deactivate it with a DISABLE command, for example:

```
DISABLE DISPLAY 2
```

Otherwise all displays will be terminated when the LADDER session is ended.



## VII EXTENDING THE RANGE OF QUESTIONS

It is impossible to provide a natural-language interface system such as LADDER with an ability to accept all the questions that could conceivably be asked about a given data base. Furthermore, frequent users will want to develop their own shorthand questions for accessing the data they often use. To meet these needs, LADDER allows each user, by means of example, to extend the grammar dynamically for handling new types of questions. The DEFINE command is used to extend the grammar in four ways: by adding a synonym, a new phrase, a paraphrase of a single question, or a paraphrase of a sequence of questions, which we call a macroparaphrase. To add a synonym of a word that is known to the system, just type

```
DEFINE <new-synonym> LIKE <known-word>.
```

For example,

```
DEFINE CONNIE LIKE CONSTELLATION.
```

will permit a question such as

```
WHO COMMANDS CONNIE?
```

to be handled.

To add a new phrase, type

```
DEFINE "<new-phrase>" LIKE "<known-phrase>"
```

where <known-phrase> is any sequence of words that the system could accept in some sentence. Either <new-phrase> or <known-phrase> can be a single word. Examples of this feature include:

```
DEFINE "MEDSHIPS" LIKE "SHIPS WITH A DOCTOR ABOARD"  
DEFINE "TIN CAN" LIKE "DESTROYER"  
DEFINE "SHIPS OF INTEREST" LIKE "SHIPS WITH A DOCTOR ABOARD  
    WITHIN 400 MILES OF PECOS."
```

These new phrases are handled by LADDER by substituting the known phrase for the former whenever it occurs in a question, before the parsing of the sentence begins. LADDER will retype your question with the substitution as it is performed.

A list of all the user-defined extensions currently in effect can be requested by typing:

```
WHAT ARE THE DEFINITIONS?
```

The UNSUBSTITUTE command allows the definitions of new phrases to be eliminated. For example,

```
DON'T USE TIN CAN.
```

will cause LADDER to forget the definition of TIN CAN.

LADDER permits the user to add an entirely new question format by example. To do so, you must furnish LADDER an example of how the extension is to be used in the context of a complete sentence. This is done by typing

```
DEFINE "<new-sentence>" LIKE "<known-sentence>",
```

where <known-sentence> can already be handled. For example:

```
DEFINE "CARRIERSTAT MEDITERRANEAN" LIKE "WHAT IS THE CURRENT  
POSITION, FUEL STATE, AND READINESS STATUS OF ALL  
CARRIERS IN THE MEDITERRANEAN?"
```

will cause the new pattern

```
CARRIERSTAT <MACRO.LOC>
```

to be added to the grammar. Subsequently questions like

```
CARRIERSTAT NORTH ATLANTIC?
```

will be accepted by LADDER.

The current version of LADDER provides a facility for allowing a new question to substitute for a sequence of old questions, each of which is already understood by LADDER. The DEFINE command is still used, but the model (the part following "like") can be a sequence of questions. For example:

```
DEFINE "GIVE AN OVERVIEW OF JFK" LIKE "WHAT IS THE TYPE,  
LENGTH, BEAM, AND DISPLACEMENT OF JFK? WHAT WEAPONS DOES  
SHE CARRY? WHO COMMANDS HER? WHAT IS HIS LINEAL NUMBER?"
```

will add to the grammar the pattern:

```
GIVE AN OVERVIEW <OF> <SHIP>.
```

This will permit questions such as

```
GIVE AN OVERVIEW OF ALL THE US SUBMARINES
```

to be answered. Please note that the sentences in the model must be

separated by appropriate punctuation (question marks or periods). LADDER cannot parse run-on sentences.

When the DEFINE command is processed by LADDER, each sentence in the model is parsed (spelling correction will be performed if necessary), but the data base is not queried to answer the questions. When a macroparaphrase is processed by LADDER, each question in the model is typed out before LADDER proceeds to answer it.

The quote marks are optional for all versions of the DEFINE command. Their use is recommended, however, as it speeds up processing considerably.

If a sentence form that you use is not successfully parsed by LADDER, you can follow it immediately with a definition of your form in terms of a sentence that LADDER can already handle. This is done by typing:

```
IE <known-sentence>.
```

where <known-sentence> can be understood by LADDER. For example, if you type:

```
HOW FAR APART ARE ROTTERDAM AND OSLO?
```

LADDER will issue an error message indicating that APART is not in its vocabulary and the question could not be understood. You could then type:

```
IE WHAT IS THE DISTANCE FROM ROTTERDAM TO OSLO?
```

This will have exactly the same effect as if you had typed:

```
DEFINE "HOW FAR APART ARE ROTTERDAM AND OSLO"  
LIKE "WHAT IS THE DISTANCE FROM ROTTERDAM TO OSLO?"
```

so that, for example,

```
HOW FAR APART ARE THE FOX AND THE KENNEDY?
```

will be correctly interpreted.

## VIII ELLIPTICAL QUESTIONS AND COMMANDS

LADDER accepts not only a complete sentence, but also a sentence fragment that can be interpreted in the context of the preceding sentence. The syntactic term for this condition, in which words of a second sentence are left out but implied, is ellipsis.

When an input cannot be interpreted as a complete sentence, LADDER types out the message, "Trying Ellipsis:" and then verifies whether it is analogous to any contiguous string of words in the preceding sentence. If it is, the input is substituted for that string and the new sentence is printed out. LADDER then proceeds to carry out the resulting request. Examples of valid elliptical inputs in the context of the previous question, WHAT IS THE LENGTH OF THE SANTA INEZ include:

```
THE BEAM AND DRAFT
HOME PORT OF THE AMERICAN CARRIERS
PRINT THE NATIONALITY
KITTY HAWK
```

If, however, no analogy can be found between the new input and any substring of the preceding input, LADDER prints out "Ellipsis has failed," and prints an error message.

WHAT ABOUT <frag>? can also be used as an alternative to <frag> where <frag> is a sentence fragment. Thus LADDER will accept the sequence:

```
WHAT IS THE LENGTH OF THE FOX?
WHAT ABOUT DRAFT?
```

Elliptical fragments can also be added to the end of the previous sentence, as in the sequence:

```
WHAT ARE THE US CARRIERS?
IN THE MED?
```

## IX THE BATCH PACKAGE IN LADDER

For the purpose of the GUARD system [12] for multi-level security, LADDER can be used essentially in batch mode. In Appendix B, we specifically explain the use of LADDER as part of the GUARD system; here, we just explain the commands provided by LADDER for its use in a batch mode.

For each query or series of queries that you want to issue in batch mode, the user must prepare a file--named <filename> for the sake of explanation, and transfer that file to the directory to which you are connected when using LADDER (this will usually be your own directory). <filename> contains LADDER queries or commands, each being expressed as a list of words, for example:

```
(WHERE IS THE FOX)
(HOW LONG IS SHE)
(WHO COMMANDS HER)
```

The physical end of the file indicates the end of the query list.

Once this file has been prepared, the command to LADDER:

```
!GUARD(<filename>)
```

will cause LADDER to type each query, execute it, type the appropriate responses, then proceed similarly with the next query.

When processing of the last query in the file has been completed, LADDER will type

```
***GUARD-END***
```

To stop LADDER, the user should just issue a conventional LADDER query, such as

```
DONE
```

or, if put inside a file,

```
(DONE)
```

## X LADDER ERROR MESSAGES AND ERROR CONDITIONS

### A. Errors in Parsing the Inputs

When an input cannot be parsed, LADDER attempts to give the user some helpful information as to why it failed. It will have been able to find a partial interpretation for some (possibly empty) part of the sentence at the point where it failed. If the next word at that point is one that is not in LADDER's vocabulary, a message to that effect will be printed. It is still possible that a synonym of the unknown word would be understandable to LADDER. It is more likely, however, that the unknown word refers to something not included in the data base.

At this point, LADDER will have compiled a list of the valid words and metasympols that could possibly be used at the point where the input failed. (This list is used for the attempt at spelling correction.) If this list is sufficiently small, LADDER will print out "Options for the next word or metasympol are:" followed by the list. As described in Section XI, you can determine the meanings of the metasympols.

### B. Errors in Querying the Data Base

Many things beyond the control of LADDER or the user can go wrong in accessing data from a remote computer over the ARPANET. LADDER attempts to recover from many of these error conditions automatically, and will inform the user as it does so.

When LADDER establishes a network connection to an instantiation of the Datacomputer data base management system, it prints out "CONNECTING TO DATACOMPUTER AT <site>," where <site> is the remote computer. If the remote site is operational but the Datacomputer there is not, an error condition will be noted rather quickly. If, however, the remote site is not operational at all, LADDER will not be aware of a problem until the

attempt to establish a network connection times out. (The time required for this to occur is a set parameter of the local operating system under which LADDER is running.)

In any case, when a site is found to be inaccessible, LADDER will attempt to access a backup site, with appropriate notification to the user. When its set of backup sites has been exhausted, an appropriate message is printed.

In a similar manner, if an error condition ensues when an attempt is made to open a file, LADDER will attempt to access a backup file (which may involve establishing a new network connection to another site). Again the user is kept informed of what is happening. If no backup is available for a given file, a message to that effect is written and the query is aborted.

#### C. LADDER Bugs

Should LADDER simply break because of a program bug, the system will most likely print out some obscure message, as well as the next event number followed by a semicolon instead of a left arrow. In this case, type control-D to restore the left arrow and then type RESET.

It is possible but unlikely that LADDER will simply "hang" in the middle of processing some request. This is often due to an extraordinary load on either the machine running LADDER or the machine running the Datacomputer software. Should you lose patience, typing control-D and then RESET, as indicated above will restore LADDER to a state in which it can process new inputs. Care should be taken not to do this too often, because it tends to make LADDER run out of memory space.

## XI CONTROLLING THE LADDER SYSTEM

LADDER provides the user with a considerable degree of flexibility in controlling its behavior. All commands to the system are typed in English.

### A. Controlling the Amount of Output

When you type a question to LADDER, it will be printed on your terminal. This will normally be followed by a paraphrase of the queries to the data base required to reply to it. This paraphrase provides a means for the user to confirm that LADDER has interpreted his question properly. There may be more than one such paraphrase if more than one data base query is required to answer a given question. For example, if the user asks

WHAT SHIPS WITH A DOCTOR ABOARD ARE WITHIN 900 NAUTICAL MILES  
OF THE BRITISH BOMBARDIER?

LADDER will print out

For SHIP equal to BRITISH BOMBARDIER, give the POSITION and  
DATE.

and, subsequently,

For DOCTR equal to D and great-circle distance to 46-33N,  
21-29W less than or equal to 900, give the SHIP.

(46-33N, 21-29W is the position of the British Bombardier, determined from the previous query.) These two paraphrases together constitute LADDER's interpretation of the user's question.

#### 1. Timing

LADDER will type a dot whenever a command is sent to the Datacomputer and will count the number of three-second intervals that elapse as it waits for the answer. This will inform users that LADDER is functioning properly and awaiting a response from the data base.



The timing feature is initially enabled. It may be turned off by typing

TURN OFF TIMING.

or by setting the verbosity (as described immediately below) to -2. It may be restored by typing

TURN ON TIMING.

## 2. Verbosity

Normally, after the paraphrase of the data base query is printed, the Datalanguage program corresponding to that query is also printed, together with any serious-error messages from the Datacomputer. Timing information, as described above, is provided as the Datacomputer processes the program. Finally the answer is printed. You may have LADDER print a greater or smaller portion of the interaction with the Datacomputer by varying a parameter called the "verbosity." Verbosity values and the corresponding system behavior are listed below:

<u>Verbosity value</u>	<u>What is printed</u>
-2	your question, LADDER's interpretation, and LADDER's answer
-1	the above plus a dot for each Datalanguage program plus timing information (if enabled)
0	the above plus the Datalanguage program
1	the above plus serious data base error messages
2	the above plus all data base error messages
3	the above plus synchronization messages
4	the above plus comments and all other messages

The verbosity may be changed by typing

SET VERBOSITY TO BE <n>

where <n> is a number between -2 and 4.

## B. Changing the Current Location

The current default location where the questioner is presumed to be may be changed by typing

```
SET LOCATION TO BE <place>.
```

where <place> is a ship name, port name, or latitude-longitude pair in the format 12-34N, 34-56W.

## C. Switching the Data Base

Currently the installations of LADDER on the Arpanet can access a copy of the Blue File stored at any of the following sites: CCA, SRI-KL, ISIC, or ISIE. At any time during a session, you may change to a different site by typing

```
USE THE DATA BASE AT <site>.
```

where <site> is one of the aforementioned sites. You can also request that LADDER not access the data base at all. (This is particularly useful if your main interest is in exploring the capabilities of the language-processing portion of the system.) By typing

```
DON'T USE THE DATA BASE
```

you will cause LADDER to return a dummy answer whenever the data base would normally be queried. NOTE: This may occasionally cause some of the LISP routines that process and format data to fail, because the dummy answer is incompatible with the expected format for that query. If this should happen, you will see an obscure error message. Simply type control-D and go on to the next question.

## D. Querying the Grammar

To help you learn more about the range of questions that LADDER can accept, we provide a set of questions about the language definition itself. To find out about a particular metasympol, type

```
HOW IS <metasympol> USED?
```

where <metasympol> is a metasympol in the grammar. LADDER will present the appropriate information, as indicated in the following example:

HOW IS <INOPERATIVE> USED?

"<INOPERATIVE>" may be any sequence of words following one of the patterns:

<INOPERATIVE> => NOT <OPERATIVE>

"<INOPERATIVE>" may be any member of the set {BROKEN DOWN  
INOPERATIVE NONFUNCTIONAL}

Finished

To find all the top-level patterns accepted by the system, type  
PRINT THE PATTERNS.

E. Help Concerning the Data Base

To get a list of the data base fields, type  
WHAT FIELDS ARE THERE?

For a one-line definition of a field, type  
DESCRIBE <field>,

where <field> is the data base name of a field. The first question of this sort in a session will take a little time, since a help file must be loaded.

For a one-line definition of all the fields, type  
WHAT DO YOU KNOW ABOUT?

Appendix A

SAMPLE SESSION WITH LADDER

Appendix A  
SAMPLE SESSION WITH LADDER

This appendix shows how LADDER might be used to help solve an actual Navy problem. Let us suppose that the Tancred, a Norwegian freighter, has reported an explosion and fire on board, and has asked for assistance. The initial portion of the following session with LADDER might be in response to such a situation. (Questions about the weather and about air coverage would normally be asked as well, but the Blue File data base has no data concerning these subjects.)

@LADDER

Language Access to Distributed Data with Error Recovery  
--SRI International--

Please type in your name: A. User

Do you want instructions? (type FIRST LETTER of response) Yes

This program has access to 14 files that constitute a facsimile of a Navy command and control data base for the ATLANTIC and MEDITERRANEAN areas. From the ACCAT network, the data is accessed at NOSC in San Diego; from the ARPANET, the data is accessed via the Datacomputer at CCA in Cambridge, Massachusetts, with backup at ISIC and ISIE in Los Angeles, plus SRI in Menlo Park. The data base includes physical characteristics and position information for all ships, with more detailed operational information about U. S. Navy ships. Data about embarked USN units, convoys of merchant ships, and ports of arrival and departure are also available.

The system accepts queries stated in English, and will translate them into calls to a DBMS. It will respond to the question DESCRIBE THE FIELDS with a short description of each of the 72 fields in the data base. For further information about the contents of the data base, a Technical Note is available from NOSC.

To use the system, simply type in your question after LADDER prints the question number and a left arrow (←). Punctuation is accepted but not required. A question is terminated by a carriage return. Characters may be deleted by typing <ctrl>A or DEL(ete), depending on the host operating system. Processing of any question may be aborted by typing <ctrl>D.

IMPORTANT NOTE: the current version of the query answering system can perform only simple calculations on the values in the data base. For example, it cannot answer questions about the composition of organizational units.

Some typical questions include:

WHAT IS THE NEAREST SHIP TO LUANDA WITH A DOCTOR ABOARD?  
HOW FAR IS THE CONSTELLATION FROM CHARLESTON?  
WHERE IS THE LOS ANGELES?  
THE LONGEST SHIP CARRYING VANADIUM ORE?  
WHEN WILL THE PHILADELPHIA REACH PORT?  
WHAT U. S. SHIPS ARE WITHIN 500 MILES OF GIBRALTAR?  
WHAT PORTS DO YOU KNOW ABOUT?  
WHAT IS THE STEAMING TIME FROM NORFOLK TO GIBRALTAR FOR THE STERETT?  
CAN THE JFK REACH NORFOLK WITHOUT REFUELING?  
NAPLES?  
WHAT SHIPS ARE WITHIN 24 HOURS STEAMING TIME OF GIBRALTAR?  
DEFINE (WHAT IS THE SHIPSTATUS OF JFK) LIKE (WHAT IS THE CURRENT POSITION,  
FUEL STATUS, STATE OF READINESS, AND COMMANDING OFFICER OF JFK)  
TELL ME THE SHIPSTATUS OF ALL US SHIPS IN THE NORTH ATLANTIC

Do you want to use two Data Computers? No  
Do you want to specify a current location (default = Norfolk)? No  
Do you wish distance/direction calculations to default to GREAT CIRCLE,  
or RHUMB LINE? (you can override by specifying in the query) Great Circle

1\_set verbosity to -2.  
-2

2\_what is the nationality, gross weight, dead weight, and current position  
of Tancred?

For SHIP equal to TANCREED, give the NAT and GWT and DWT and POSITION and  
DATE.

(NAT NORWAY GWT 12200 DWT 12200 POSITION 44-45N, 014-30E DATE  
17Jan76, 1200)

3\_list all ships within 500 miles of her.

For SHIP equal to TANCREED, give the POSITION and DATE.

For great-circle distance to 44-45N, 14-30E less than or equal to 500, give  
the SHIP and TYPE and NAT and POSITION and CRS and SPD and DATE.

I have 19 answers; do you want to see them? ...Yes

SHIP	TYPE	NAT	POSITION	CRS	SPD	DATE
CONSTELLATION	CV	U.S.	40-00N, 006-00E	100	20.0	17Jan76, 1200
KITTY HAWK	CV	U.S.	37-00N, 017-00E	100	20.0	17Jan76, 1200
OBRAZSTSOVY	DDG	USSR	40-00N, 006-10E	100	20.0	17Jan76, 1200

PROVORNY	DDG	USSR	37-00N, 017-10E	100	20.0	17Jan76, 1200
TANCRED	BULK	NORWAY	44-45N, 014-30E	0	0.0	17Jan76, 1200
HASSAYAMPA	AO	U.S.	40-00N, 006-00E	100	20.0	17Jan76, 1200
ASHTABULA	AO	U.S.	37-00N, 017-00E	100	20.0	17Jan76, 1200
CALIFORNIA	CGN	U.S.	40-00N, 006-00E	100	20.0	17Jan76, 1200
DANIELS J	CG	U.S.	37-00N, 017-00E	100	20.0	17Jan76, 1200
WAINWRIGHT	CG	U.S.	37-00N, 017-00E	100	20.0	17Jan76, 1200
JOUETT	CG	U.S.	37-00N, 017-00E	100	20.0	17Jan76, 1200
HORNE	CG	U.S.	37-00N, 017-00E	100	20.0	17Jan76, 1200
STERETT	CG	U.S.	37-00N, 017-00E	100	20.0	17Jan76, 1200
STANDLEY WH	CG	U.S.	37-00N, 017-00E	100	20.0	17Jan76, 1200
FOX	CG	U.S.	40-00N, 006-00E	100	20.0	17Jan76, 1200
BIDDLE	CG	U.S.	40-00N, 006-00E	100	20.0	17Jan76, 1200
LEAHY	CG	U.S.	40-00N, 006-00E	100	20.0	17Jan76, 1200
YARNELL HE	CG	U.S.	40-00N, 006-00E	100	20.0	17Jan76, 1200
WORDEN	CG	U.S.	40-00N, 006-00E	100	20.0	17Jan76, 1200

4 give the employment schedule, fuel status, readiness and reason of the US naval ships on the list.

LIST => (((GCDIST (PTPX , PTPNS , PTPY , PTPEW , 4445 , 'N' , 1430 , 'E') LE 500)))

For NAT equal to U.S. and TYPE not equal to BULK and TYPE not equal to CGO and TYPE not equal to PASS and TYPE not equal to TNKR and great circle distance to 44-45N, 14-30E less than or equal to 500, give the EMPLMNT and EMPBEG and EMPEND and PCFUEL and READY and REASN and SHIP.

I have 16 answers; do you want to see them? ...Yes

EMPLMNT	EMPBEG	EMPEND	PCFUEL	READY	REASN	SHIP
SURVOPS	10Jan76	28Feb76	89	C1	*	CONSTELLATION
SURVOPS	03Jan76	05Feb76	88	C2	AIR SEARCH RADAR	KITTY HAWK
CARESC	01Jan76	01Jun76	100	C1	*	CALIFORNIA
CARESC	31Dec75	15Jun76	76	C1	*	DANIELS J
CARESC	31Dec75	15Jun76	88	C1	*	WAINWRIGHT
CARESC	31Dec75	15Jun76	90	C1	*	JOUETT
CARESC	31Dec75	15Jun76	78	C1	*	HORNE
CARESC	31Dec75	15Jun76	91	C3	SONAR	STERETT
CARESC	31Dec75	15Jun76	98	C1	*	STANDLEY WH
CARESC	31Dec75	15Jun76	87	C1	*	FOX
CARESC	31Dec75	15Jun76	88	C1	*	BIDDLE
CARESC	31Dec75	15Jun76	96	C1	*	LEAHY
CARESC	31Dec75	15Jun76	78	C1	*	YARNELL HE
CARESC	31Dec75	15Jun76	88	C1	*	WORDEN
REPL	15Jan76	25Jan76	98	C1	*	HASSAYAMPA
REPL	09Jan76	19Jan76	75	C1	*	ASHTABULA

5 which of them has a doctor on board?

THEM => ((NAT EQ 'US') ((TYPE NE 'BULK') AND (TYPE NE 'CGO') AND (TYPE NE 'PASS') AND (TYPE NE 'TNKR'))) ((GCDIST (PTPX , PTPNS , PTPY , PTPEW , 4445 , 'N' , 1430 , 'E') LE 500)))

For NAT equal to U.S. and TYPE not equal to BULK and TYPE not equal to CGO and TYPE not equal to PASS and TYPE not equal to TNKR and great circle distance to 44-45N, 14-30E less than or equal to 500 and DOCTR equal to D, give the SHIP.

SHIP = CONSTELLATION, KITTY HAWK, WAINWRIGHT, JOUETT, HORNE, STERETT, STANDLEY WH, FOX, BIDDLE, LEAHY, YARNELL HE, WORDEN

6 define sar-1 like standley and wainwright.

STANDLEY AND WAINWRIGHT  
(SAR 1)

7 can sar-1 reach tancred without refueling?  
(CAN STANDLEY AND WAINWRIGHT REACH TANCREW WITHOUT REFUELING)

For SHIP equal to TANCREW, give the POSITION and DATE.

For SHIP equal to STANDLEY WH or SHIP equal to WAINWRIGHT, give the POSITION and DATE and PCFUEL and NORNG.

The shortest great-circle route  
from (POSITION 37-00N, 017-00E DATE 17Jan76, 1200 PCFUEL 88 PCF@DST 80)  
to (POSITION 44-45N, 014-30E DATE 17Jan76, 1200)  
is 479 nautical miles.

The shortest great-circle route  
from (POSITION 37-00N, 017-00E DATE 17Jan76, 1200 PCFUEL 98 PCF@DST 90)  
to (POSITION 44-45N, 014-30E DATE 17Jan76, 1200)  
is 479 nautical miles.

\* The PCFUEL@DST figure indicates the predicted percentage of fuel at the destination.

8 find the names of the cos of sar-1.  
(FIND THE NAME OF THE CO OF STANDLEY AND WAINWRIGHT)

For SHIP equal to STANDLEY WH or SHIP equal to WAINWRIGHT, give the NAME and RANK.

(NAME EVANS O RANK CAPT)  
(NAME MICHAELS C RANK CAPT)

\* Presuming that a standard procedure might be desirable to get basic information about candidates for a search and rescue operation, a user might use the macroparaphrase feature of LADDER to define a new command called SARCAND that would gather information about ships within a given distance from a given ship.



9\_define "sarcand 500 tancred" like "what is the nationality, gross weight, and current position of tancred? Give the employment schedule, fuel status, readiness, reason, and distance from Tancred of the US naval ships within 500 miles of her. What ships with a doctor aboard that are at readiness condition C1 are on the list?"

WHAT IS THE NATIONALITY GROSS WEIGHT AND CURRENT POSITION OF TANCREd

For SHIP equal to TANCREd, give the NAT and GWT and POSITION and DATE.

GIVE THE EMPLOYMENT SCHEDULE FUEL STATUS READINESS REASON AND DISTANCE FROM TANCREd OF THE US NAVAL SHIP WITHIN 500 MILE OF HER

For SHIP equal to TANCREd, give the POSITION and DATE.

For SHIP equal to TANCREd, give the POSITION and DATE.

For NAT equal to U.S. and TYPE not equal to BULK and TYPE not equal to CGO and TYPE not equal to PASS and TYPE not equal to TNKR and great-circle distance to 37-00N, 76-00W less than or equal to 500, give the EMPLMNT and EMPBEG and EMPEND and PCFUEL and READY and REASN and great-circle distance from 37-00N, 76-00W and SHIP.

WHAT SHIP WITH A DOCTOR ABOARD THAT ARE AT READINESS CONDITION C1 ARE ON THE LIST

```
LIST => ((NAT EQ 'US') ((TYPE NE 'BULK') AND (TYPE NE 'CGO') AND (TYPE NE 'PASS') AND (TYPE NE 'TNKR')) ((GCDIST (PTPX , PTPNS , PTPY , PTPEW , 3700 , 'N' , 7600 , 'W') LE 500)))
```

For DOCTR equal to D and READY equal to C1 and NAT equal to U.S. and TYPE not equal to BULK and TYPE not equal to CGO and TYPE not equal to PASS and TYPE not equal to TNKR and great-circle distance to 37-00N, 76-00W less than or equal to 500, give the SHIP.

```
LIFER.TOP.GRAMMAR => SARCAND <NUM> <SHIP>  
FO106 (SARCAND <NUM> <SHIP>)
```

\* The new command is now a part of the LADDER grammar. All of the capabilities of LADDER, including spelling correction, can be brought to bear on the new command.

10\_sarcnd 900 british bombardier.

```
SARCAND <--spelling
```

spelling--> BOMBARDIER

-- Macro expansion --

WHAT IS THE NATIONALITY GROSS WEIGHT AND CURRENT POSITION OF BRITISH BOMBARDIER

For SHIP equal to BRITISH BOMBARDIER, give the NAT and GWT and POSITION and DATE.

(NAT U.K. GWT 27500 POSITION 46-33N, 021-29W DATE 17Jan76, 1200)

GIVE THE EMPLOYMENT SCHEDULE FUEL STATUS READINESS REASON AND DISTANCE FROM BRITISH BOMBARDIER OF THE US NAVAL SHIP WITHIN 900 MILE OF HER

For SHIP equal to BRITISH BOMBARDIER, give the POSITION and DATE.

For NAT equal to U.S. and TYPE not equal to BULK and TYPE not equal to CGO and TYPE not equal to PASS and TYPE not equal to TNKR and great-circle distance to 46-33N, 21-29W less than or equal to 900, give the EMPLMNT and EMPBEG and EMPEND and PCFUEL and READY and REASN and great-circle distance from 46-33N, 21-29W and SHIP.

EMPLMNT	EMPBEG	EMPEND	PCFUEL	READY	REASN	GCDIST	SHIP
SURVOPS	15Dec75	15Feb76	90	C1	*	861	KENNEDY JF
CARESC	15Jan76	01Mar76	100	C1	*	861	SOUTH CAROLINA
CARESC	15Dec75	01Mar76	78	C1	*	861	DALE
CARESC	15Dec75	01Mar76	67	C1	*	861	TURNER RK
CARESC	15Dec75	01Mar76	77	C1	*	861	GRIDLEY
CARESC	15Dec75	01Mar76	66	C1	*	861	ENGLAND
CARESC	15Dec75	01Mar76	85	C1	*	861	HALSEY
CARESC	15Dec75	01Mar76	85	C3	AIR SEARCH RADAR	861	REEVES
REPL	10Jan76	20Jan76	87	C1	*	861	KAWISHIWI

WHAT SHIP WITH A DOCTOR ABOARD THAT ARE AT READINESS CONDITION C1 ARE ON THE LIST

LIST => ((NAT EQ 'US') ((TYPE NE 'BULK') AND (TYPE NE 'CGO') AND (TYPE NE 'PASS') AND (TYPE NE 'TNKR')) ((GCDIST (PTPX , PTPNS , PTPY , PTPEW , 4633 , 'N' , 2129 , 'W') LE 900)))

For DOCTR equal to D and READY equal to C1 and NAT equal to U.S. and TYPE not equal to BULK and TYPE not equal to CGO and TYPE not equal to PASS and TYPE not equal to TNKR and great-circle distance to 46-33N, 21-29W less than or equal to 900, give the SHIP.

SHIP = KENNEDY JF, TURNER RK, GRIDLEY, ENGLAND

Finished

11\_done

Thank you.

Appendix B  
THE BATCH PACKAGE FOR GUARD

Appendix B  
THE BATCH PACKAGE FOR GUARD

1. Introduction

The Batch package of LADDER was developed to satisfy the needs of the GUARD project. The ACCAT GUARD is to be a multi-level secure computer system that will interface a Top Secret computer network to a Secret computer network for the purpose of allowing the controlled interchange of information between the two networks.

The batch package enables a LADDER system instantiated on a low-security system to receive the name of a query file that has been transferred from one of any number of high-security system users, and to execute all the queries in it. The GUARD system then return the answers to the low side of the GUARD teletype, where they are copied by the surrounding software to the HIGH side, and transferred to the high-security user.

Multiple high-security users can submit queries that are to be processed by a single instantiation of LADDER, as they are received. There are a number of constraints ensuing from this--among them, in particular the undesirability of using ellipsis.

2. How these features are activated

To prepare LADDER for receiving GUARD commands, GUARD should start LADDER in the following manner.

The sanitization personnel start up LADDER, then issue the following commands:

```
[SET VERBOSITY TO -2.]  
[DO NOT USE EITHER ELLIPSIS OR SPELLING CORRECTION.]  
LISPX  
[(SET LADDER.ALWAYSPRINT# -1)]
```

The commands between brackets are not required by LADDER, but should be used for the benefit of GUARD.

Then, for each query or batch of queries issued by a HIGH user, GUARD will prepare a file--named <filename> for the sake of explanation, and transfer that file to the directory in which LADDER is connected. <filename> contains LADDER queries/commands, each expressed as a list of words, e.g.:

(WHERE IS THE FOX)  
(HOW LONG IS SHE)  
(WHO COMMANDS HER).

The physical end of the file indicates the end of the query list; there is no special delimiter.

Then, GUARD will send the following query to LADDER:

GUARD(<filename>)

LADDER will type each query, execute it, type the appropriate responses, then proceed in the same way with the next query.

When the last query processing is finished, LADDER will type:

\*\*\*GUARD-END\*\*\*

GUARD will then send all the text generated by those interactions to the HIGH user--after appropriate checks, if needed.

To stop LADDER, GUARD should just issue a conventional LADDER query, eg:

DONE

### 3. Miscellaneous considerations

ELLIPSIS should be turned off (via a special sentence--DO NOT USE EITHER ELLIPSIS OR SPELLING CORRECTION, or DO NOT USE EITHER). These features can be reactivated by typing: USE BOTH ELLIPSIS AND SPELLING CORRECTION or USE BOTH.

When appropriate, GUARD or the sanitization personnel will prevent the use of paraphrases and pronouns.

GUARD will "time-share" the LADDER programs among HIGH users, so that no single one of them will be in undivided possession of a LADDER system.

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