SIS - Answerer:
An Interactive Program to Use PQI functions

Version 2.0

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About This Manual

The Programmatic Query Interface as described in "SIS - Programmatic Query Interface - Reference Manual", is a set of functions that can be used in programs to express queries to a SIS base. *Answerer* is a program that uses PQI to access a SIS base and gives a user the capability to call any of the PQI functions interactively. In this way the user can express queries to the SIS base and test query scenarios which can then be used in programs. *Answerer* 's input can be redirected so query macros can be written in files and then be redirected to *answerer* for execution. Apart from that, *answerer* can be used inside programs as an interpreter for batch execution of queries. It is used as a configuration language for Data Entry Forms.

When someone starts *answerer*, has to define an object existing in the SIS base as *current* and then call any of the query commands to apply on this object. The answer to a query command is stored in a set of objects and the unique identifier of this set is returned. When someone calls a query command, he can specify this query to apply on every object existing in a set of objects which was created by previous calls to query commands. The answer to a query can be viewed by projecting the contents of a set using one of the projection commands.

PQI functions are renamed to four-character commands and with these names they can by called within *answerer* as well as some other help commands.

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1. How to run *answerer*

In directory `bin` the following executables exist: `qserver`, `answerer.client` and `answerer`.

If you want to run *answerer* as a client process according to the client-server model of PQI you should do the following steps:

1. Set environment variable `DB_DIR` to represent the path where the SIS base is located.
2. Run `qserver` *[socket_port]*. The default socket port is 1201.
3. Run `answerer.client` *<hostname> <socket_port>*.

If you want to run *answerer* as an independent process which accesses the SIS base directly, you should do the following steps:

1. Set environment variable `DB_DIR` to represent the path where the SIS base is located.
2. Run `answerer`.

If everything is OK you should get the following on your screen:

```
***************************************************************
*                      A N S W E R E R                        *
*                                                             *
*  An interactive query processor for the Telos language.     *
*                                                             *
*  Most queries apply on a current node that has to be set    *
*  at the beginning of a query session and return a set       *
*  identifier. This set id can be used by other commands      *
*  that print out the contents of the set or by the query     *
*  commands which apply on each object in the set.            *
*                                                             *
*  Since the number of the temporary sets that can be used    *
*  is fixed (about 50), you should use the free commands      *
*  that clear a set (or all sets) for reuse.                  *
*                                                             *
*  Type '?' for a list of commands.                           *
*  Type 'help' or 'HELP' for help on a certain command.       *
*                                                             *
***************************************************************

(answerer) _
```

You are now in *answerer*'s interactive mode.

2. Using *answerer*

In the next sections you can find all the *answerer* commands, what they stand for and a sort description for each of them. For more information about a command that represends a specific PQI function you can refer to the "SIS - Programmatic Query Interface Reference Manual".

When you start *answerer* you have to set an object existing in the SIS base as *current* with the `scn` (Section 2.2) or `scni` (Section 2.2) commands. You can then call any of the query commands. The answer to a query command is stored in a set of objects and what you get is the unique identifier of this set. When you call a query command you can specify this query to apply on every object existing in a set of objects which was created by previous calls to query commands.

You can see the answer to a query by projecting the contents of a set using a projection command from group of commands that are presented in a following section.

2.1. Miscellaneous commands

Use the following commands to end or reset a query session or ask for help on some commands.

`q` (**Q**uit)

Exit from answerer.

`rq` (**R**eset **Q**uery)

Resets all global parameters as if the query session has just started. Resets name scope and categories, frees all temporary sets, resets all traverse and filter conditions and disables depth control in traverse queries.

`?` Get a list of groups of commands. You select the number of a group and then get a list of all the commands of this group.

`help` Similar to the `?` command but after selecting a group, you can ask for some sort help on a certain command simply typing it.

`HELP` Same as help.

2.2. Commands to set global parameters

With the following commands you can set some global parameters that affect the query processing and the behaviour of some query commands.

`rns` (**R**eset **N**ame **S**cope)

Empty the name stack. The next attempt to set a current node will expect to be given the name a node in the semantic net.

See help on `scn` below.

`pns` (**P**op **N**ame **S**cope)

Pop the name stack.

See help on `scn` below.

`scn` (**S**et **C**urrent **N**ode)

You are prompted to enter the logical name of an object which object is then tried to be set as *current* so that next calls of query commands can apply on it.

When first setting a current node you have to enter the name of a node in the semantic network but when a current node has already been set, an attempt to set a current node will expect you to give the name of an attribute of the current node. For this reason a name stack is used and the first item in stack is a node object and each next item is a link pointing from the previous object. The top item of stack is the current node and there are commands for manipulating the name stack. The name stack has to be empty before setting as *current* an object that is node in the semantic network.

See help on `pns` and `rns` below.

`sncn` (**S**et **N**ew **C**urrent **N**ode)

Reset name stack (see help on `rns` above) and prompt to enter the logical name of an object which object is then tried to be set as *current* so that next calls of query commands can apply on it. The object has to be a node in the semantic network.

`scni` (**S**et **C**urrent **N**ode by system **I**dentifier)

You are prompted to enter an integer (the system identifier of an object) and this object then is tried to be set as *current* so that next calls of query commands will apply on.

The name stack is changed properly even if the new current node is a link object.

`sc` (**S**et **C**ategories)

Define a group of categories (link classes) that can be used later by other commands such as `rf` (Section 2.8) , `tc` (Section 2.5) and `tmc` (Section 2.5).

Each category is a link node, so not only the name of the link must be given but the name of the object it is pointing from. You are also prompted to set a direction for each category. The use of the defined direction is explained in the description of each of the above commands that uses those categories defines with the `sc` command.

`stvc` (**S**et **T**o-**V**alue **C**ondition)

You are prompted to define a logical expression that must by true for the to-value of links traversed forward by `tall` (Section 2.5) command.

Commands used to construct logical expressions are presented in section 2.6.

`sfvc` (**S**et **F**rom-**V**alue **C**ondition)

You are prompted to define a logical expression that must by true for the from-value of links traversed backwards by `tall` (Section 2.5) command.

Commands used to construct logical expressions are presented in section 2.6.

`stlc` (**S**et **T**o-**L**ink **C**ondition)

You are prompted to define a logical expression that must by true for the link traversed backwards by `tall` (Section 2.5) command.

Commands used to construct logical expressions are presented in section 2.6.

`sflc` (**S**et **F**rom-**L**ink **C**ondition)

You are prompted to define a logical expression that must by true for the link traversed forward by `tall` (Section 2.5) command.

Commands used to construct logical expressions are presented in section 2.6.

`sfc` (**S**et **F**ilter **C**ondition)

You are prompted to define a logical expression that is used by `gf` (Section 2.4) command.

Commands used to construct logical expressions are presented in section 2.6.

`spc` (**S**et **P**rojection **C**ondition)

You are prompted to define an expression that defines a query to be executed for each object projected with `rp` (Section 2.8) command.

Commands used to construct logical expressions are presented in section 2.6.

`sdep` (**S**et **Dep**th)

Set the depth where transitive queries will stop while traversing. Depth is used in the same way as in graph traversing. If **Depth** < 0 there will be depth control on transitive queries.

2.3. Commands for low level queries

With the following commands you can retrieve low-level information about specific objects in the SIS base.

`gln` (**G**et **L**ogical **N**ame)

You are prompted to enter the system identifier of an object (an integer) and get the logical name of this object.

`gcid` (**G**et **C**lass system **ID**entifier)

You are prompted to enter the logical name of an object which is node in the semantic network, and get its system identifier.

`glid` (**G**et **L**ink system **ID**entifier)

With this command you can get the system identifier of a link object. Since the logical name of a link object is not unique in the SIS base you have to enter the logical name of the object from which the link is pointing from as well as the logical name of the link itself.

2.4. Commands for simple queries

The following query commands have the same functionality. After calling each of them, you are prompted to enter an integer which is the identifier of the set of object on which you want the query to apply on. If you enter "0", the query applies on current node previously set with `scn` (Section 2.2) or `scni` (Section 2.2) commands. If you enter a positive integer then the query is applied on each object in set with this identifier.

What you get after a call to these functions is the identifier of the set where the answer is stored. You can use this identifier in next calls to query functions or use projection commands to read the contents of the set.

`gf` (**G**et **F**iltered)

Get a set that contains the objects for which the logical expression previously set with `sfc` (Section 2.2) is true.

`gm` (**G**et **M**atched)

You are prompted to enter a set that will be searched for string matches on the logical names of its objects and a set that contains matching-patterns (Telos_String's). Pattern types are i) left matching (word*), ii) right matching (*word), and iii) any sub-string matching (word).

`gc` (**G**et **C**lasses)

Get a set that contains the classes that the current object is instance of.

`gac` (**G**et **A**ll **C**lasses)

Get a set that contains all classes that the current object is instance of and also the classes that all superclasses of the current object are instance of.

`gSc` (**G**et **S**ystem **C**lass)

Get a set that contains the system class that the current object is instance of.

`gaSc` (**G**et **A**ll **S**ystem **C**lasses)

Get a set that contains all the system classes that the current object is instance of.

`gi` (**G**et **I**nstances)

Get a set that contains the instances of the current object.

`gai` (**G**et **A**ll **I**nstances)

Get a set that contains the instances of the current object and the instances of all subclasses of the current object too.

`gI` (**G**et Class Attr**I**butes Of)

Get a set that contains the class attributes that are instances of the current category.

`gaI` (**Get All** Class Attr**I**butes Of)

Get a set that contains the class attributes that are instances of the current category and the instances of all subclasses of the current category too.

`gsc` (**Get SuperClasses**)

Get a set that contains the classes that the current object is 'isA' of.

`gasc` (**Get All SuperClasses**)

Get a set that contains all superclasses (isA closure) of the current object: superclasses of its superclasses etc.

`gSsc` (**Get** all **System SuperClasses**)

Get a set that contains all system superclasses of the current object.

`gsbc` (**Get SuBClasses**)

Get a set that contains the classes that are isA of the current object.

`gasb` (**Get All SuB**classes)

Get a set that contains all subclasses (inverse isA closure) of the current object: subclasses of its subclasses etc.

`glf` (**Get Link From**)

Get a set that contains all links that are pointing from the current object.

`gLf` (**Get** c**L**ass Attributes **From**)

Get a set that contains all class attributes that are pointing from the current object.

`glfc` (**Get Link From** by **Category**)

Get a set that contains all links pointing from the node and are instances of the category you are prompted to define. The category is defined by giving not only the name of the link but also the name of the object it is pointing from.

`glfm` (**Get Link From** by **Metacategory**)

Get a set that contains all links pointing from the current object and are of meta category you are prompted to define. The category is defined by giving not only the name of the link but also the name of the object it is pointing from.

`gilf` (**Get Inherited Link From**)

Get a set that contains all links that are pointing from the current object and the links inherited from all its superclasses.

`giLf` (**Get Inherited** c**L**ass Attributes **From**)

Get a set that contains all class attributes that are pointing from the current object and the class attributes inherited from all its superclasses.

`glt` (**Get Link To**)

Get a set that contains all links that are pointing to the current object.

`gltc` (**Get Link To** by **Category**)

Get a set that contains all links pointing to the current object and are instances of the category you are prompted to define. The category is defined by giving not only the name of the link but also the name of the object it is pointing from.

`gltm` (**Get Link To** by **Metacategory**)

Get a set that contains all links pointing to the current object and are of meta category you are prompted to define. The category is defined by giving not only the name of the link but also the name of the object it is pointing from.

`gcf` (**Get Category From**)

Get a set that contains all classes of the links that are pointing from the current object.

`gct` (**Get Category To**)

Get a set that contains all classes of the links that are pointing to the current object.

`gclf` (**G**et **C**ategory of **L**ink **F**rom)

Get a set that contains all the classes of the link (the categories of the link), pointing from the current object and the logical name of which is the one you are prompted to enter.

`gtn` (**G**et **T**o-**N**ode)

Get a set that contains all objects that are pointed to by links that are pointing from the current object.

`gtnc` (**G**et **T**o-**N**ode by **C**ategory)

Get a set that contains all objects that are pointed to by links that are pointing from the current object and are instances of the category you are prompted to define. The category is defined by giving not only the name of the link but also the name of the object it is pointing from.

`gtnm` (**G**et **T**o-**N**ode by **M**etacategory)

Get a set that contains all objects that are pointed to by links that are pointing from the current object and are instances of the meta category you are prompted to define. The category is defined by giving not only the name of the link but also the name of the object it is pointing from.

`gfn` (**G**et **F**rom-**N**ode)

Get a set that contains all objects that have links pointing to the current object.

`gfnc` (**G**et **F**rom-**N**ode by **C**ategory)

Get a set that contains all objects that have links pointing to the current object and are instances of the category you are prompted to define. The category is defined by giving not only the name of the link but also the name of the object it is pointing from. In the case of class attributes the returned objects are the computed instance set.

`gfnm` (**G**et **F**rom-**N**ode by **M**etacategory)

Get a set that contains all objects that have links pointing to the current object and are instances of the meta category you are prompted to define. The category is defined by giving not only the name of the link but also the name of the object it is pointing from.

`gfv` (**Get From-Value**)

Get a set that contains the node that the current object points from, supposing this object is a link.

`gtv` (**Get To-Value**)

Get a set that contains the value (object or primitive value) that the current object points to, supposing this object is a link.

2.5. Commands for transitive queries

This section describes the commands that can be used to express traverse queries. Except the set identifier to apply on the query, they ask some more parameters for the traverse.

`tal` (**T**raverse **A**ll **L**inks)

Get a set that contains all the links traversed, starting from the current object and traversing all links in the direction you are prompted to provide.

After entering the set identifier you are asked if you want during the traverse, for each node visited, to visit also all its superclasses, all its subclasses, both superclasses or none of these.

Then you are prompted to enter the direction of the traverse. You can define the directions :

(1) FORWARD meaning to traverse all links pointing from each node.

(2) BACKWARD meaning to traverse all links pointing to each node.

(3) BOTH DIR. meaning to traverse all links pointing from and to each node.

CAUTION : The setting of previous calls of `stvc`, `sfvc`, `stlc` and `sflc` (Section 2.2) commands will be reset, that is the corresponding expressions will be true for any object they are evaluated for.

You can limit the depth of the traverse by setting a maximum depth with the `sdep` (Section 2.2) command.

Cycle detection is performed.

`tall` (conditionally **T**raverse **ALL** links)

Get a set that contains all the links traversed, starting from the current object and traversing all links according to conditions previously set with : `sdep`, `stvc`, `sfvc` , `stlc` and `sflc` (Section 2.2) commands.

After entering the set identifier, you are asked if you want during the traverse, for each node visited, to visit also all its superclasses, all its subclasses, both superclasses or none of these.

Cycle detection is performed.

`tc` (**T**raverse by **C**ategory)

Get a set that contains all the links traversed, starting from the current object and traversing all links which are instances of the categories previously defined with the `sc` (Section 2.2) command.

For each category, if the direction was set to FORWARD only the links pointing from each node are checked, if the direction was set to BACKWARD only the links pointing to each node are checked and if direction was set to BOTH DIR all links are checked.

You can limit the depth of the traverse by setting a maximum depth with the `sdep` (Section 2.2) command.

Cycle detection is performed.

`tmc` (**T**raverse by **M**eta**C**ategory)

Get a set that contains all the links traversed, starting from the current object and traversing all links which are instances of some instance of the categories previously defined with the `sc` (Section 2.2) command. That is traversing links that are of some Metacategory defined with the `sc` command.

For each category, if the direction was set to FORWARD only the links pointing from the node are checked, if the direction was set to BACKWARD only the links pointing to the node are checked and if direction was set to BOTH DIR all links are checked.

You can limit the depth of the traverse by setting a maximum depth with the `sdep` (Section 2.2) command.

Cycle detection is performed.

2.6. Commands to construct logical expressions

This section describes the commands that can be used to construct logical expressions.

The commands that require a logical expression prompt you to enter some of the commands that are presented in this section. While constructing the logical expression, you are prompted to enter commands of a specific group of commands which are: LOGICAL, OBJECT, SET_EXPR and INT_VAL. If you type "?" you get a list of the commands you can use.

The logical expressions are constructed in prefix notation so you have to enter the function name first and then its arguments.

2.6.1. LOGICAL group of commands

When you are prompted to enter a LOGICAL command you can use any of the following commands that return a logical value.

`succ` Equivalent to TRUE in logical expressions.

`fail` Equivalent to FALSE in logical expressions.

`and` Logical AND between the next two logical expression that you will be prompted to enter.

`or` Logical OR between the next two logical expression that you will be prompted to enter.

`not` Logical negation of the next logical expression that you will be prompted to enter.

`blng` (BeLoNGs)

True if the object that you will by prompted to describe (OBJECT group of commands) exists in the set of objects that you will be also prompted to describe (SET_EXPR group of commands).

`mtch` (MaTCH)

True if there is an object name in the set of objects that you will be prompted to describe (SET_EXPR group of commands) matches (partialy) any pattern in the set of Telos_Strings that you will also be prompted to describe (SET_EXPR group of commands).

`eq` (EQual)

You will be prompted to enter two INT_VAL commands. True if the first of them is equal to the second one.

`gt` (Greater Than)

You will be prompted to enter two INT_VAL commands. True if the first of them is greater than the second one.

`gte` (Greater Than of Equal)

You will be prompted to enter two INT_VAL commands. True if the first of them is greater than or equal to the second one.

`lt` (Less Than)

You will be prompted to enter two INT_VAL commands. True if the first of them is less than the second one.

`lte` (Less Than of Equal)

You will be prompted to enter two INT_VAL commands. True if the first of them is less than or equal to the second one.

`bfr` (BeFoRe)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)). True if at least one of the time values pointed by the links of the first set ends before the time value included in the second set starts

`aftr` (AFTeR)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)). This operand is the inverse operand of bfr. True if at least one of the time values pointed by the links of the first set starts after the time value included in the second set finishes.

`tmeq` (TiMe EQual)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)). True at least one of the time values pointed by the links of the first set starts where the time value (tm2) included in the second set starts and finishes where tm2 finishes.

`mts` (MeeTS)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)). True at least one of the time values pointed by the links of the first set ends where the time value included in the second set starts

`mtb` (MeT By)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)). This operand is the inverse operand of mts. True if at least one of the time values pointed by the links of the first set starts where the time value included in the second set ends.

`ovl` (OVerLaps)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)). True if at least one of the time values pointed by the links of the first set starts before the ending of the time value included in the second set (tm2) and ends after the begining of tm2.

`ovlb` (OVerLaPped By)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)). This operand is the inverse operand of ovl. True if at least one of the time values pointed by the links of the first set starts before the ending of the time value included in the second set (tm2) and ends after the begining of tm2.

`drng` (DuRiNG)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)). True if at least one of the time values pointed by the links of the first set starts after the begining of the time value included in the second set (tm2) and ends before the ending of tm2.

`ctns` (ConTaiNS)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)). This operand is the inverse operand of drng. True if at least one of the time values pointed by the links of the first set starts before the begining of the time value included in the second set (tm2) and ends after the ending of tm2.

`srts` (StaRTS)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)). True if at least one of the time values pointed by the links of the first set starts where the time value included in the second set (tm2) starts and ends before the ending of tm2.

`srtb` (StaRTed By)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)) This operand is the inverse operand of srts. True if at least one of the time values pointed by the links of the first set starts where the time value included in the second set (tm2) starts and ends before the ending of tm2.

`fshs` (FiniSHeS)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)) True if at least one of the time values pointed by the links of the first set starts after the begining of the time value included in the second set (tm2) and ends where tm2 ends.

`fshb` (FiniSHed By)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)) This operand is the inverse operand of fshs. True if at least one of the time values pointed by the links of the first set starts before the begining of the time value included in the second set (tm2) and ends where tm2 ends.

`cbeq` (Can Be EQual)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)) True if at least one of the time values pointed by the links of the first set (lets say tm1) fullfills the following condition in comparison to the time value included in the second set (tm2) : *There exist t1* $\in$ *tm1, t2* $\in$ *tm2: t1 = t2* This means that there exists at least one element into time interval (value) tm1 that is equal to at least one element that belongs to time interval tm2. Lets remind here that Telos adopts an interval-based time model.

`cblt` (Can Be Less Than)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)) True if at least one of the time values pointed by the links of the first set (lets say tm1) fullfills the following condition in comparison to the time value included in the second set (tm2) : *There exist t1 ∈ tm1, t2 ∈ tm2: t1 < t2* This means that there exists at least one element into time interval (value) tm1 that is less than at least one element that belongs to time interval tm2. Lets remind here that Telos adopts an interval-based time model.

`cble` (Can Be Less or Equal)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)) True if at least one of the time values pointed by the links of the first set (lets say tm1) fullfills the following condition in comparison to the time value included in the second set (tm2) : *There exist t1 ∈ tm1, t2 ∈ tm2: t1 <= t2* This means that there exists at least one element into time interval (value) tm1 that is less than or equal to at least one element that belongs to time interval tm2. Lets remind here that Telos adopts an interval-based time model.

`cbgt` (Can Be Greater Than)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)) True if at least one of the time values pointed by the links of the first set (lets say tm1) fullfills the following condition in comparison to the time value included in the second set (tm2) : *There exist t1 ∈ tm1, t2 ∈ tm2: t1 > t2* This means that there exists at least one element into time interval (value) tm1 that is greater than at least one element that belongs to time interval tm2. Lets remind here that Telos adopts an interval-based time model.

`cbge` (Can Be Greater or Equal)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)) True if at least one of the time values pointed by the links of the first set (lets say tm1) fullfills the following condition in comparison to the time value included in the second set (tm2) : *There exist* $t1 \in tm1, t2 \in tm2: t1 >= t2$ This means that there exists at least one element into time interval (value) tm1 that is greater than or equal to at least one element that belongs to time interval tm2. Lets remind here that Telos adopts an interval-based time model.

`mbeq` (Must Be EQual)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)) True if at least one of the time values pointed by the links of the first set (lets say tm1) fullfills the following condition in comparison to the time value included in the second set (tm2) : *Forevery* $t1 \in tm1, t2 \in tm2: t1 = t2$ This means that every element into time interval (time value) tm1 must be equal to every element that belongs to time interval (time value) tm2. Lets remind here that Telos adopts an interval-based time model.

`mblt` (Must Be Less Than)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)) True if at least one of the time values pointed by the links of the first set (lets say tm1) fullfills the following condition in comparison to the time value included in the second set (tm2) : *Forevery* $t1 \in tm1, t2 \in tm2: t1 < t2$ This means that every element into time interval (time value) tm1 must be less that every element that belongs to time interval (time value) tm2. Lets remind here that Telos adopts an interval-based time model.

`mble` (Must Be Less or Equal)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)) True if at least one of the time values pointed by the links of the first set (lets say tm1) fullfills the following condition in comparison to the time value included in the second set (tm2) : *Forevery t1 ∈ tm1, t2 ∈ tm2: t1 <= t2* This means that every element into time interval (time value) tm1 must be less than or equal to every element that belongs to time interval (time value) tm2. Lets remind here that Telos adopts an interval-based time model.

`mbgt` (Must Be Greater Than)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)) True if at least one of the time values pointed by the links of the first set (lets say tm1) fullfills the following condition in comparison to the time value included in the second set (tm2) : *Forevery t1 ∈ tm1, t2 ∈ tm2: t1 > t2* This means that every element into time interval (time value) tm1 must be greater that every element that belongs to time interval (time value) tm2. Lets remind here that Telos adopts an interval-based time model.

`mbge` (Must Be Greater or Equal)

You will be prompted to enter two SET_EXPR commands. The first one must be a set that contains links that points to time primitives (their to value is time value). The second one must be a set that contains a specific time value, which is used as the condition for the comparison (this set is created using sppr (Section 2.7)) True if at least one of the time values pointed by the links of the first set (lets say tm1) fullfills the following condition in comparison to the time value included in the second set (tm2) : *Forevery t1 ∈ tm1, t2 ∈ tm2: t1 >= t2* This means that for every element into time interval (time value) tm1 must be greater than or equal to every element that belongs to time interval (time value) tm2. Lets remind here that Telos adopts an interval-based time model.

2.6.2. INT_VAL group of commands

When you are prompted to enter a INT_VAL command you can use any of the following commands that describe an integer value.

`val` With this command you can describe a specific integer that you will by prompted to enter.

`card` With this command you can describe an integer which is the cardinality of the set that you will by prompted to enter (SET_EXPR group of commands).

2.6.3. OBJECT group of commands

When you are prompted to enter a OBJECT command you can use any of the following commands that describe an object.

`sys` With this command you can describe an object by its system identifier which you are prompted to enter. If you enter system identifier 0 represents the object that the logical expressions is evaluated for.

`node` With this command you can describe an object which is a node in the semantic network in the data base, by its logical name which you are prompted to enter.

`link` With this command you can describe an object which is a link in the semantic network in the data base, with the combination of the logical name of the object it is pointing from and its logical name which you are prompted to enter.

2.6.4. SET_EXPR group of commands

When you are prompted to enter a SET_EXPR command you can use any of the following commands that are describing a set of objects.

If you want query commands to apply on the object that the logical expression is evaluated for, you should use `set` command of this group with argument "0".

`set` With this command you can describe a set by its unique identifier which you are prompted to enter. If you enter system identifier 0 means the object that the logical expressions is evaluated for.

`su` The set union of the two sets you are prompted to enter.

`si` The set intersection of the two sets you are prompted to enter.

`sd` The set difference of the two sets you are prompted to enter.

`gc` The answer set of `gc` (Section 2.4) command applied on set that you are prompted to enter.

`gac` The answer set of `gac` (Section 2.4) command applied on set that you are prompted to enter.

`gSc` The answer set of `gSc` (Section 2.4) command applied on set that you are prompted to enter.

`gaSc` The answer set of `gaSc` (Section 2.4) command applied on set that you are prompted to enter.

`gi` The answer set of `gi` (Section 2.4) command applied on set that you are prompted to enter.

`gai` The answer set of `gai` (Section 2.4) command applied on set that you are prompted to enter.

`gI` The answer set of `gI` (Section 2.4) command applied on set that you are prompted to enter.

`gaI` The answer set of `gaI` (Section 2.4) command applied on set that you are prompted to enter.

`gsc` The answer set of `gsc` (Section 2.4) command applied on set that you are prompted to enter.

`gasc` The answer set of `gasc` (Section 2.4) command applied on set that you are prompted to enter.

`gSsc` The answer set of `gSsc` (Section 2.4) command applied on set that you are prompted to enter.

`gsbc` The answer set of `gsbc` (Section 2.4) command applied on set that you are prompted to enter.

`gasb` The answer set of `gasb` (Section 2.4) command applied on set that you are prompted to enter.

`glf` The answer set of `glf` (Section 2.4) command applied on set that you are prompted to enter.

`gLf` The answer set of `gLf` (Section 2.4) command applied on set that you are prompted to enter.

`glt` The answer set of `glt` (Section 2.4) command applied on set that you are prompted to enter.

`gfv` The answer set of `gfv` (Section 2.4) command applied on set that you are prompted to enter.

`gtv` The answer set of `gtv` (Section 2.4) command applied on set that you are prompted to enter.

`glfc` The answer set of `glfc` (Section 2.4) command applied on set that you are prompted to enter.

`gltc` The answer set of `gltc` (Section 2.4) command applied on set that you are prompted to enter.

2.7. Commands to manipulate sets of objects

This section describes the commands that can be used to manipulate sets of objects.

`fs` (**F**ree **S**et)

Free the set with identifier the one you are prompted to enter, for later reuse.

`fas` (**F**ree **A**ll **S**ets)

Free all sets allocated since now,, for later reuse.

`sgn` (**S**et **G**et **N**ew)

Get a new, empty set of objects.

`sgc` (**S**et **G**et **C**ardinality)

Get the number of the objects containing in the set with identifier the one you are prompted to enter.

`su` (**S**et **U**nion)

You are prompted to give two set identifiers , a set union operation is performed and the result is stored in the first of the two sets.

`si` (**S**et **I**ntersection)

You are prompted to give two set identifiers , a set intersection operation is performed and the result is stored in the first of the two sets.

`sd` (**S**et **D**ifference)

You are prompted to give two set identifiers , a set difference operation is performed and the result is stored in the first of the two sets.

`sput` (**S**et **PUT**)

You are prompted to give a set identifier and current node is put into this set.

`sppr` (**S**et **PUT PR**imitive)

You are prompted to give a primitive value and a set identifier in which the primitive value will be put in.

`sdel` (**S**et **DEL**ete)

You are prompted to give a set identifier and current node is deleted from this set, if it exists in it.

`smo` (**S**et **M**ember **O**f)

You are prompted to give a set identifier and get an answer whether current node exists in this set or not.

2.8. Commands to project objects

This section describes the commands that can be used to project the objects that exist in a specific set. After calling any of these commands you are prompted to enter the identifier of the set whose objects you want to project. Then you are asked if you want output on screen (enter "`s`") or redirected in a file (enter "`f`"). If you select "`f`" you are prompted to enter the name of the file where the output is going to be redirected.

The difference among the following commands is in the amount of information presented for each object in the set.

`rn` (**R**eturn **N**odes)

Print out a list of the logical names of the objects contained in a set.

`rfn` (**R**eturn **F**ull **N**odes)

Print out a list of the system identifier, the logical name and the system class of the objects contained in a set.

`ren` (**R**eturn **E**dge **N**odes)

Print out a list of the logical names of the objects, where the traverse query stopped because of the depth control, but the traversing should continue from these objects.

`rprs` (**R**eturn **PRS** values)

Print out a list of the objects contained in a set. If the object is a node or a class the logical name of it, is printed, if it is a primitive value (integer, real or string) the actual value of it is printed. Usually sets contain only objects but some commands, like `gtv` (Section 2.4) may create a set that contains primitive values as well. In this case the `rn` (Same section) and `rfn` (Same section) will return only the objects contained in the set.

`rc` (**R**eturn **C**ategories)

Suppose that objects contained in a set are links and print out the logical name of the class the object is pointing from and the logical name of the object.

`rl` (**R**eturn **L**inks)

Suppose that objects contained in a set are links and print out the logical name of the class the object is pointing from, the logical name of the object and the object/value the object is pointing to.

`rli` (**R**eturn **L**ink **I**dentifiers)

Suppose that objects contained in a set are links and print out the logical name of the object and also the system identifier of the object it is pointing from, the system identifier of the link object and the system identifier of the object or primitive value it is pointing to. If the link object is pointing to a primitive value, system identifier 0 is printed.

`rfl` (**R**eturn **F**ull **L**inks)

Suppose that objects contained in a set are links and for each of them print out :

- A flag "F" or "B" denoting that the link was traversed forward of backward by a traverse query. If link object was not retrieved by a traverse query "F" is printed.
- The logical name of the class the object is pointing from.
- The logical name of the link object.
- In parenthesis the category of the link object.
- A flag "UNIQUE" or "NOT UNIQUE" denoting that the category is or not unique for this link object, since link object may be instance of more than one category.
- The object or primitive value the link object is pointing to.

`risa` (**R**eturn **ISA** related objects)

Return pairs of objects A and B, contained in an answer set and A isA B.

`rins` (**R**eturn **INS**tance pairs)

Return pairs of objects A and B, contained in an answer set and A is instance of B.

`rf` (**R**eturn **F**ields)

Print a list of tuples where first field is the logical name of an objects existing in an answer set and next fields vary according to categories previously set with `sc` (Section 2.2) command. For each category, there is a field in the tuple, and the value of the field is the to-value of the link of this category if the category was set FORWARD, or the from-value of the link of this category, if the category was set BACKWARD.

For each object in set, its links are checked to be instances of each category or of some superclass or subclass of this category.

`rhl` (**R**eturn **H**idden **L**inks)

Suppose that objects contained in a set are links and print out the logical name of the class the object is pointing from, the logical name of the object and the object/value the object is pointing to.

If the from-object is linked with an inverse link of category previously set with `sc` (Section 2.2) command with an object A then object A is returned in the position of from-class since this object is supposed to be some kind of member of object A. Recursively the same happens if A has an inverse links of this specific category.

With this mechanism we can get an abstraction of some information hidding the information of links that are instances of a specific category.

`rp` (**R**eturn **P**rojection)

Print a list of tuples where first field is the logical name of an object existing in an answer set and next fields contains the logical names of objects that are retrieved by current on this object a previously defined query with the `spc` (Section 2.2) command.

2.9. Update Commands

The Programmatic Query Interface (PQI) was designed to support simple queries in the data base. These queries actually retrieve information from the data base and never changed the contents of the data base.

PQI simple query functions are used for the implementation of the built-in queries of the SIS Graphical Analysis Interface and Entry Forms. Recently, there has been a request for updating the data base contents using PQI functions. To achieve that, a new version of PQI supports update functions that change the contents of the data base in a predefined manner. The update functions implemented so far correspond to requests from the use of both STA and Entry Forms. There have been implemented two groups of update functions. The first group updates the data base by deleting objects and the second group updates the data base by relocating the referred object in the Isa hierarchy it is defined. An object can be deleted if it has no instances and no links originating from it or pointing to it.

`rmv` (**R**e**M**o**V**e **Object)**

If the first argument is the current node, it tries to delete it, initiating a transaction. If the object can be deleted the transaction is commit, otherwise it is aborted. If the first argument is a set of objects, tries to delete as many as possible objects in that set, initiating a transaction. If an object can be deleted it is removed from set that set. After the first check for the deletion, a second pass of the objects that have remained in the Sysids set is done, just in case any other object can be deleted. Finally, the objects that can not be deleted are returned in the second argument. If the second argument is the current node, tries to delete all objects referred int the set originated by the first argument, initiating a transaction. If at least one object can not be deleted the transaction is aborted.

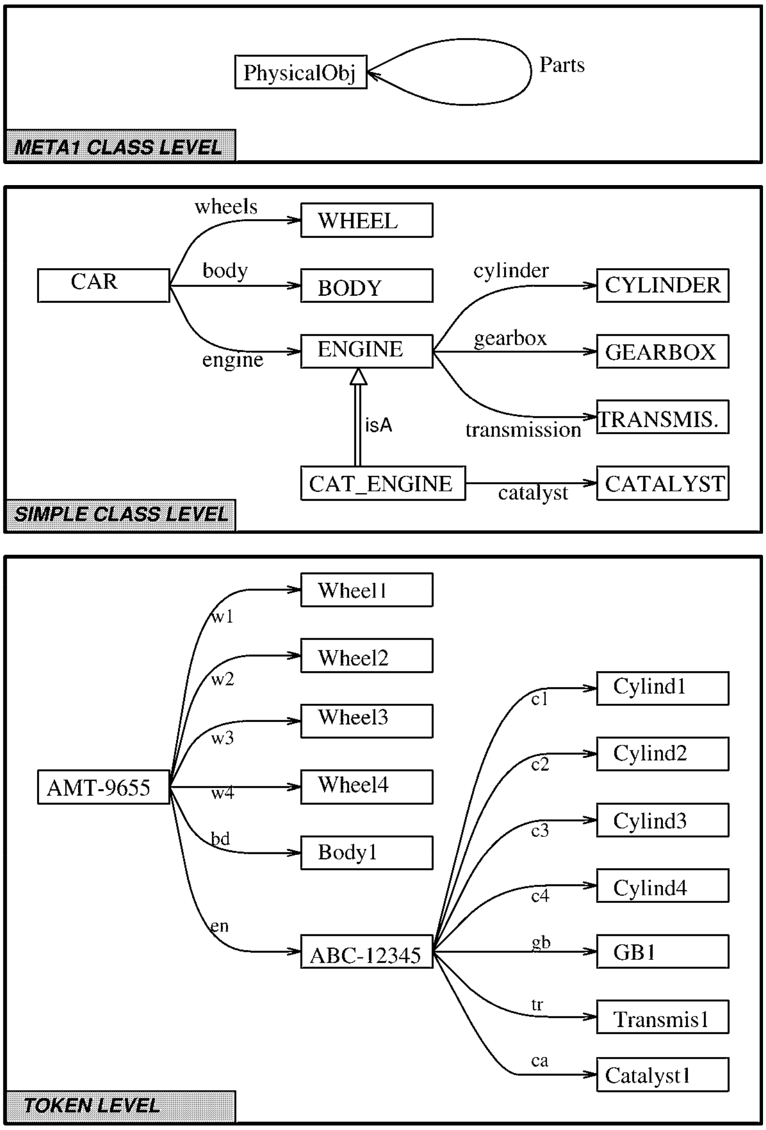
cisa (**C**hange **ISA** Hierarchy)

Initiates a transaction and checks if each object in set *rmved_set* can be deleted from the set of superclasses of object with SYSID *Sysid*. Then, checks if each object in the set *added_set* can be added in the set of superclasses of the referred object. The transaction is committed if all updates can be done safely in the data base, otherwise the transaction is aborted. If the referred object is not the current node, but a set, initiates a transaction and checks for every object in that set, if each object in set *rmved_set* can be deleted from the set of superclasses of that object. Then, checks if each object in the set *added_set* can be added in the set of

superclasses of that object. If all changes can be done safely in the data base the transaction is committed, otherwise it is aborted.

3. Appendix A - An example

Let's see an example of the use of *answerer* for querying a SIS base that contains the description of the following model:



A TELOS model

A model from the real world that can be easily described with the TELOS language. The instance relationship is not shown in the picture in order not to be too complicated. The instance relationships that hold are the obvious. *CAR, WHEEL, BODY, ENGINE, CAT_ENGINE, CYLINDER, GEARBOX, TRANSMIS* and *CATALYST* are all instances of *PlysicalObj* and *wheels, body, engine, cylinder, gearbox, transmission* and *catalyst* link objects are instances of *Parts* attribute of *PlysicalObj*. Similarly there are instance relations between the objects at Token Level and objects at Simple Class Level. Object *ABC-12345* is instance of *CAT_ENGINE* simple class object.

In the following examples, highlighted is what we type.

We can find instances of class *PhysicalObj* by:

```
(answerer) scn

    SET CURRENT NODE
    Enter logical name of node : PhysicalObj

    CURRENT NODE IS NOW: PhysicalObj (SYSID 33)

(answerer) gi

    GET INSTANCES
    Enter set id or 0 for current node  : 0
    The answer is located into set number 1


(answerer) rn

    RETURN NODES
    Enter the set number       : 1
    Output to (f)ile  (s)creen : s

    SET No  1 CONTAINS :
-------------------------------
  No |  Object name
-------------------------------
   1 | CAR
   2 | WHEEL
   3 | BODY
   4 | ENGINE
   5 | CYLINDER
   6 | GEARBOX
   7 | TRANSMIS
   8 | CAT_ENGINE
   9 | CATALYST
-------------------------------
```

And then all instances of these objects by:

```
(answerer) gi

    GET INSTANCES
    Enter set id or 0 for current node  : 1
    The answer is located into set number 2
```

```
(answerer) rn

    RETURN NODES
    Enter the set number       : 2
    Output to (f)ile  (s)creen : s

    SET No  2 CONTAINS :
-------------------------------
  No |  Object name
-------------------------------
   1 | AMT-9655
   2 | Wheel1
   3 | Wheel2
   4 | Wheel3
   5 | Wheel4
   6 | Body1
   7 | ABC-12345
   8 | Cylind1
   9 | Cylind2
  10 | Cylind3
  11 | Cylind4
  12 | GB1
  13 | Transmis1
  14 | Catalyst1
-------------------------------
```

After this, we can free set 1 which we don't need any more and ask for all wheels of car *AMT-9655* by:

```
(answerer) fs

    FREE SET
    Enter the set number       : 1


(answerer) sncn

    SET CURRENT NODE
    Enter logical name of node : AMT-9655

    CURRENT NODE IS NOW: AMT-9655 (SYSID 51)


(answerer) glfc

    GET LINK FROM BY CATEGORY

    Enter Class and category            : CAR wheels
    Enter set id or 0 for current node  : 0
    The answer is located into set number 1
```

```
(answerer) rl

    RETURN LINK
    Enter the set number       : 1
    Output to (f)ile  (s)creen : s


    SET No  1 CONTAINS :
----------------------------------------------------------------------------
  No |               Class |      Label Name |            To value ( Type )
----------------------------------------------------------------------------
   1 |            AMT-9655 |              w1 |              Wheel1 ( NODE )
   2 |            AMT-9655 |              w2 |              Wheel2 ( NODE )
   3 |            AMT-9655 |              w3 |              Wheel3 ( NODE )
   4 |            AMT-9655 |              w4 |              Wheel4 ( NODE )
----------------------------------------------------------------------------
```

Set 2 contains the instances of instances of metaclass *PhysicalObj* and we can filter this set to get only those object that have more that 5 attributes (there are 5 link objects pointing from them) by:

```
(answerer) sfc

    SET FILTER CONDITION
    (LOGICAL  ) : gt
        (INT_VAL  ) : card
            (SET EXPR) : glf
                (SET EXPR) : set
                    (INTEGER  ) : 0
        (INT_VAL  ) : val
            (INTEGER  ) : 5

(answerer) gf

    GET FILTERED
    Enter set id or 0 for current node  : 2
    The answer is located into set number 3
```

We can see the objects selected after filtering by:

```
(answerer) rn

    RETURN NODES
    Enter the set number       : 3
    Output to (f)ile  (s)creen : s

    SET No  3 CONTAINS :
-------------------------------
  No |  Object name
-------------------------------
   1 | AMT-9655
   2 | ABC-12345
-------------------------------
```

But we can ask to see not only the name of these objects but also the names of their attributes.

```
(answerer) spc

    SET PROJECTION CONDITION
    (SET EXPR) : gtv
        (SET EXPR) : glf
            (SET EXPR) : set
                (INTEGER  ) : 0

(answerer) rp

    RETURN PROJECTION
    Enter the set number       : 3
    Output to (f)ile  (s)creen : s

    SET No  3 CONTAINS :
AMT-9655 | Wheel1 , Wheel2 , Wheel3 , Wheel4 , Body1 , ABC-12345 >
ABC-12345 | Cylind1 , Cylind2 , Cylind3 , Cylind4 , GB1 , Transmis1 , Catalyst1 >
```

Finally, we can free all sets used till now and ask for all parts of a car by traversing all links of category <PhysicalObj, Parts>, starting from node CAR.

```
(answerer) fas

    FREE ALL SETS

(answerer) sncn

    SET NEW CURRENT NODE
    Enter logical name or sysid of node : CAR

    CURRENT NODE IS NOW: CAR (SYSID 35)


(answerer) sc

    SET CATEGORIES
    Enter category[0]     (From_class  Category)
    ('end end' to stop) : PhysicalObj Parts
    Enter traverse direction 1-FW  2-BW  3-Both : 1
    Enter category[1]     (From_class  Category)
    ('end end' to stop) : end end


(answerer) tc

    TRAVERSE BY CATEGORY
    Enter set id or 0 for current node  : 0
    For each node, visit also
    (1)superclasses(2)subclasses(3)both(0)none : 0
    The answer is located into set number 1
```

We could express the same query using the conditionally traverse query:

```
(answerer) sflc

    SET FROM LINK CONDITION
    (LOGICAL  ) : blng
        (OBJECT   ) : link
            (LINK NAME) : PhysicalObj Parts
        (SET EXPR) : gc
            (SET EXPR) : set
                (INTEGER  ) : 0

(answerer) stvc

    SET TO VALUE CONDITION
    (LOGICAL  ) : succ

(answerer) stlc

    SET TO LINK CONDITION
    (LOGICAL  ) : fail

(answerer) tall

    GENERAL TRAVERSE BY ALL LINKS
    Enter set id or 0 for current node  : 0
    For each node, visit also
    (1)superclasses(2)subclasses(3)both(0)none : 0
    The answer is located into set number 2
```

The answer to the last two queries is the same and contains the following link objects:

```
(answerer) rl

    RETURN LINK
    Enter the set number       : 1
    Output to (f)ile  (s)creen : s

    SET No  1 CONTAINS :
----------------------------------------------------------------------------
  No |                Class |      Label Name |            To value ( Type )
----------------------------------------------------------------------------
   1 |                  CAR |          wheels |             WHEEL ( NODE )
   2 |                  CAR |            body |              BODY ( NODE )
   3 |                  CAR |          engine |            ENGINE ( NODE )
   4 |               ENGINE |        cylinder |          CYLINDER ( NODE )
   5 |               ENGINE |         gearbox |           GEARBOX ( NODE )
   6 |               ENGINE |    transmission |          TRANSMIS ( NODE )
----------------------------------------------------------------------------
```

4. Appendix B - User defined queries in the SIB Static Analyser

As mentioned above, *answerer* commands can be invoked inside a program, that is non-interactively. Here we shall present an example of non-interactive use of *answerer*: the queries written for the SIB Static Analyser (see also: SIB Static Analyser Graphical Analysis Interface - User's Manual). The queries offered by the SIS Graphical Analysis Interface can be defined by the user and stored in the SIS base. These queries consist of *answerer* commands that are executed at run-time in batch mode.

In order to write queries, the user has to include the following segments of TELOS code in the model he uses.

First, there must be a *Model* object with a category *uiMenus*:

```
TELL Individual Model in M1_Class with
    attribute
        ...
        uiMenus : MenuDescription
end
```

MenuDescription contains textual query submenus (*queryMenu*), graphical query submenus (*viewMenu*) and retrieval menus (*retrievalMenu*):

```
TELL Individual MenuDescription in S_Class with
    attribute
        queryMenu: SubMenu;
        viewMenu : SubMenu;
    retrievalMenu : RetrievalMenu
end
```

SubMenu contains other submenus (thus, it is recursively defined) and queries that will be executed by the user (*commands*):

```
TELL Individual SubMenu in S_Class with
    attribute
        subMenu : SubMenu;
        commands: QueryMacro
end SubMenu
```

The recursive definition of the *SubMenu* class allows to the query menus of the SIS Graphical Analysis Interface to have submenus at any depth.

RetrievalMenu is a subclass of *SubMenu* with one more category:

```
TELL Individual RetrievalMenu in S_Class isA SubMenu with
    attribute
        return_conditions: QueryMacro
end
```

This additional *QueryMacro* allows presenting results in formatted mode.

QueryMacro objects are the actual queries:

```
TELL Individual QueryMacro in S_Class with
    attribute
        code         : Telos_String;
        inputType    : Telos_String;
        outputType   : Telos_String;
        iterator     : Telos_String;
        outputHeader : Telos_String
end QueryMacro
```

Category *code* represents the actual answerer commands that will be executed, *inputType* and *outputType* are used for type checking, *iterator* is the return function used to retrieve parts of the answer set that are of interest to the user and *outputHeader* concerns the presentation of the results on the screen. All of these will be explained in detail later.

All identifiers presented here are keywords used by the SIS Graphical Analysis Interface to construct the query menus at startup. The entry point is the logical name of the instance of *Model*, given on the command line of the SIS Graphical Analysis Interface. Consequently, this code has to be written exactly in the way presented here. If some mistake occurs (e.g. a link does not exist or does not have the correct name), part of the query menus (or all of them) will not appear on screen when the user interface is created and the user will be appropriately warned.

Specifically, the keywords necessary for creation of the menus are the following: **Model**, **uiMenus**, **MenuDescription**, **queryMenu**, **viewMenu**, **SubMenu**, **subMenu**, **commands**, **QueryMacro**, **code,inputType**, **outputType**, **iterator**, **outputHeader**,.

4.1. Writing Queries - The CooL example

Queries presented under the *Views* and *Queries* menus of the SIS Graphical Analysis Interface are stored in the SIS base. The example presented here is based on the model for the CooL language; for each model used the user can define a different set of queries.
CooL (our model) has the following menu description:

```
{**********************************************************
**      The CooL Model                                    *
**********************************************************}

TELL IndividualClass CooL in S_Class, ImplementationModel with
      ...
    uiMenus
        : CooLMenus
end CooL
```

CooL is also the command line argument for the SIS Graphical Analysis Interface. The *CooLMenus* object contains the description of the menus.

```
TELL Individual CooLMenus in Token, MenuDescription with
    queryMenu
        Queries : CooLTextQuery
    viewMenu
        Views   : CooLGraphQuery
    retrievalMenu
        (Faceted_Retrieval) : CooLRetrievalQuery
end CooLMenus
```

The names of the links under the categories *queryMenu* and *viewMenu* (in this case the labels *Queries* and *Views*) are displayed on screen as button names of the respective menus; the user thus has the possibility of configuring the appearance of the menus. The name of the link under the category *retrievalMenu* (in this case the label *Faceted_Retrieval*)appears on the retrieval card of the SIS Graphical Analysis Interface.

The *CooLTextQuery* object describes textual queries and the *CooLGraphQuery* object describes the graphical queries. Let us now examine the contents of these objects:

```
TELL Individual CooLTextQuery in Token, SubMenu with
    subMenu
        (Classification_Queries) : ClassiQuery;
        (File_Queries)           : CooLFileQuery;
        (Variable_Queries)       : CooLVariableQuery;
        (Procedure_Queries)      : CooLProcedureQuery;
        (Method_Queries)         : CooLMethodQuery;
        (Refer_Queries)          : CooLReferQuery;
        (Class_Queries)          : CooLClassQuery
end
```

CooLTextQuery consists of some submenus while *CooLGraphQuery* below has no submenu and consists of some commands (mixing the two categories in one object is also possible).

```
TELL Individual CooLGraphQuery in Token, SubMenu with
    commands
        (Subtype_Tree)       : CooLSubtypeTree;
        (Supertype_Tree)     : CooLSupertypeTree;
        (Call_Tree)          : CooLCallTree;
        (Called_By_Tree)     : CooLCallByTree;
        (Reference_Tree)     : CooLreferTree;
        (Referenced_By_Tree) : CooLreferByTree
end
```

The labels of *subMenu* and *commands* links are used as labels of the menu buttons in the user interface (only '_' characters are omitted). In this way, the user can set the names of the options in the menu.

Each individual query is a *QueryMacro* object:

```
{-----------------------------------------------------------
    Display all the files that are referenced by the given
    file directly or indirectly. The query target must be
    of kind CooLFile.
-----------------------------------------------------------}
TELL Individual CooLreferTree in Token, QueryMacro with
    code
        (1) : "scn * CooLFileReference";
                {current node, instance of CooLFileReference, set 0}
        (2) : "sc CooLFile references 1 end end";
                {set category, look forward for references relation}
        (3) : "tc 0 0"
                {traverse by category,start from 0,don't visit super/subclasses, set 1}
    iterator
           : "flin" {show graph with full links}
end CooLreferTree
```

The *answerer* commands are read from the SIS database by the SIS Graphical Analysis Interface and stored internally. When the query is selected by the user, these commands are passed to the *answerer* for execution. Here are some remarks about this code segment:

- The *inputType* field shows that an object of type *CooLFileReference* must be Query Target so that the query can be executed correctly. The SIS Graphical Analysis Interface stores this type internally for every query and performs a check on the current Query Target each time the query menus are "pulled down". All queries having an *inputType* different than the classes where Query Target belongs become inactive and the user cannot execute them. If the *inputType* of the query matches one of the Query Target's classes, two actions are performed when the query is selected: a *scn* command is executed first with the current Query Target as parameter and then all *answerer* commands stored in the *QueryMacro* object are executed. Thus, the *inputType* field implicitly states that the query needs an external target found in the Query Target area of the SIS Graphical Analysis Interface. In case this target does not have to belong to a specified type, the inputType field should simply be: *"ALL_TYPES"*. If the query does not demand an external target at all, the *inputType* category should not be instantiated.
- The string *flin* instantiated under the category *iterator* is used by the SIS Graphical Analysis Interface as a function to retrieve the contents of the answer set which is created as answer to the query. It is an iterator that selects parts of the answer set, in order to present them to the user.

  Graphical queries like the one presented can use one of the following iterators:
  isa (corresponding to a return_isa command),
  Isa (corresponding to return_inverse_isa),
  flin (corresponding to return_full_link),
  flIs (corresponding to return_full_link_inverse_isa),
  hidl (corresponding to return_hidden_links),
  inst (corresponding to return_instances),
  Inst (corresponding to return_inverse_instances)
  and *sIn* (corresponding to return_inverse_isa_inverse_instances).

Textual queries can use one of the three following answerer commands as iterators:
rn (return_nodes),
rf (return_fields) and
rp (return_projection).

- The order of execution of the *answerer* commands is marked by their respective integer label. The first command should have a label "1" and no two labels can be identical.

With the two first remarks it becomes clear that each query can be associated with a particular class of objects and also with a specific return function.

The submenus of the textual queries look similar:

```
{********************************************************
    These are the queries concerning the objects that
    are of kind CooLVariable. None of them requires
    a query target.
********************************************************}
TELL Individual CooLVariableQuery in Token, SubMenu with
    commands
        (List_All_Variables) : CooLListVar
end CooLVariableQuery
```

A query from this submenu is the following:

```
{--------------------------------------------------------
    Display all objects of kind CooLVariable (namely
    parameters and global variables - local variables are
    not part of the analysis).
--------------------------------------------------------}
TELL Individual CooLListVar in Token, QueryMacro with
    code
        (1) : "scn CooLVariable";
                  {current node, CooLVariable, set 0}
        (2) : "gai 0";
                  {get all variables, set 1}
        (3) : "sc CooLObject type 1 CooLFile variables 2 end end"
                  {set category,look forward for types and inverse for variables}
    outputHeader
        : "Variable Type File"
end CooLListVar
```

There are some more features in this query that need explanation:

- The *outputHeader* is a string that contains labels to be displayed above the text window of the SIS Graphical Analysis Interface when the text output is in formatted state. The presence of the *outputHeader* link indicates to the SIS Graphical Analysis Interface that this query can have formatted output, that is, additional information for each object in the final answer set (for each variable, its type and the file it is defined in will be displayed). The part of the query that is responsible for retrieving that information is the last command (*sc..., Set Categories*), where the user indicates the categories that must be set in order to get the relevant information. A command like this should be the last one given in the *QueryMacro* object, so that additional processing can be performed after execution of the query.

- All queries are expected to leave their final answer in answer set 1. This is where the SIS Graphical Analysis Interface expects to find the answers to the queries that are requested by the user.

  To simplify the writing of queries in the database (in the form presented above) some additional processing is performed before executing the *answerer* commands. We internally free all temporary sets used so far by the answerer and also reset the name scope: thus, the user does not have to explicitly invoke the `fas` and `rns` commands in the *QueryMacro* object.

  After executing a query such as the one presented here, the SIS Graphical Analysis Interface displays the query answer set to the user.

The *CooLRetrievalQuery* object describes the retrieval queries. Let us now examine the contents of this object:

```
TELL Individual (CooLRetrievalQuery) in Token, RetrievalMenu with
     commands
        (1_Abstraction) : CooLAbstractionQuery;
        (2_Operation)   : CooLOperationQuery;
        (3_OperatesOn)  : CooLOperatesOnQuery
end (CooLRetrievalQuery)
```

The labels of the links instantiated under *commands*, must begin with a number and a '_' character. This number determines the order of appearance of the respective entry in the retrieval card of the SIS Graphical Analysis Interface. The rest of the label appears on the left of the respective field in the retrieval card.

Every time the user wants to perform a retrieval query, each sub-query instantiated under the *commands* category (that is, each *QueryMacro*) is performed on the query targets that the user has provided in the respective field. The results of each execution are then combined using the logical operators that the user has provided (logical AND, logical OR). Finally, all these partial results are combined (using the logical AND operator) to form the final query answer. Every *QueryMacro* corresponds to a field of the retrieval card, that is, the same *QueryMacro* code is executed for every query target entered in the same field of the retrieval card.

Because each of these sub-queries might be executed more than once, the condition functions of the *answerer* should be written in a separate object, so that they can be called only once at the end of the execution.

Each individual query is a *QueryMacro* object :

```
TELL Individual CooLAbstractionQuery in Token, QueryMacro with
    code
        (1) : "scn *";
                    {current node ,no type checking, set 0}
        (2) : "gai 0";
                    {get all instances under this term , set 1}
        (3) : "gfnc Facet synonym 0";
                    {get from synonym the thesaurus term , set 2}
        (4) : "gai 2";
                    {get all methods and types under this term , set 3}
        (5) : "su 1 2";
                    {union ,one of both sets should be empty ,results in set 1}
        (6) : "gfnc CooLObjectType supertype 1";
                    {get subtypes of this term, set 4}
        (7) : "su 1 4";
                    {union of objects and their subclesses, results in set 1}
        (8) : "fs 2";
                    {free set 2}
        (9) : "fs 3";
                    {free set 3}
        (10): "fs 4"
                    {free set 4}
end
```

Another useful remark about queries in general is the following:

- If a *answerer* command is too long to fit in one string of category *code*, it can be divided in to parts, that is, in to subsequent strings. A special character '@' is used as the last of the string in order to denote that the current string is continued into the next one. Thus, strings 12 through 17 in the previous example are in fact one single *answerer* command. This technique can be used in order to keep the query code readable.

All previous remarks about textual and graphical queries hold for retrieval queries as well.

5. Appendix C - Changes from previous versions

In the process of upgading the functionality of the Programmatic Query Interface some functions changed name in order to be more readable or to be in accordance with the PQI function naming conventions. Some other functions changed the number or the order of their arguments to be in accordance with the PQI function argument passing conventions.

Changes from version 1.3 to version 1.3.1

-- In **mtch** the order of the arguments is changed

-- In **gm** the order of the arguments is changed.

-- In section *2.6.1 LOGICAL group of commands* temporal expressions were added (e.g. **bfr**, **aftr** etc.).

-- The server `qserver` and the client `answerer.client` are now called with an additional argument: the socket port number.