CSNePS USER'S MANUAL[1]

Daniel R. Schlegel[1], Stuart C. Shapiro[2] and The SNePS Implementation Group

[1]Department of Computer Science
State University of New York at Oswego
464 Shineman Center
Oswego, NY 13126
[2]Department of Computer Science and Engineering
State University of New York at Buffalo
338 Davis Hall
Buffalo, NY 14260-2500

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Syed S. Ali
Michael J. Almeida
Charles W. Arnold
Robert J. Bechtel
Sudhaka Bharadwaj
Bharat Bhushan
Jonathan Bona
Jong S. Byoun
Alistair E. Campbell
Scott S. Campbell
Hans Chalupsky
Chung M. Chan
Robert G. Church
Joongmin Choi
Chi C. Choy
Soon Ae Chun
Maria R. Cravo
Zuzana Dobes
Gerard F. Donlon
Nicholas E. Eastridge
Elissa Feit
David Forster
Richard B. Fritzson
James Geller
Kate Gordon
Susan M. Haller
Richard G. Hull
Haythem Ismail
Frances L. Johnson
Steven D. Johnson
Darrel L. Joy
Sudha Kailar
Michael Kandefer
Sijun Kang
Deepak Kumar
Stanley C. Kwasny
John S. Lewocz
Naicong Li
John D. Lowrance
Christopher Lusardi
Anthony S. Maida
Mark D. Malamut
Nuno Mamede
João P. Martins
Pedro A. Matos
Donald P. McKay
James P. McKew
Ernesto J. Morgado
William A. Neagle
Jeannette G. Neal
Jane Terry Nutter
Rafail Ostrovsky
Sandra L. Peters
Anthony S. Petre
David R. Pierce
Carlos Pinto-Ferreira
William J. Rapaport
Victor H. Saks
John F. Santore
Daniel R. Schlegel
A. Patrice Seyed
Harold L. Shubin
Reid G. Simmons
Benjamin R. Spigle, Jr.
Rohini K. Srihari
William M. Stanton
Jennifer M. Suchin
Lynn M. Tranchell
Jason C. Van Blargan
Nicholas F. Vitulli
Diana K. Webster
Janyce M. Wiebe
Zhaomo Yang
Albert Hanyong Yuhan
Martin J. Zaidel

Stuart C. Shapiro

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Chapter 1

Syntax

1.1 Notation

The syntax is given in this chapter using Extended Backus-Naur Form (EBF). Terminal symbols are surrounded by the quotation marks "`" and "'". Sequences of items are separated by commas, ",". Parentheses "(" and ")" are used as grouping brackets. Alternatives are separated by "|". Optional symbols are surrounded by "[" and "]". Material that can be repeated zero or more times is followed by "*". Material that can be repeated one or more times is followed by "+". Each syntactic rule is terminated by ";". Material starting with "//" and extending to the end of the line is a comment. The symbol $\not{b}$ appearing instead of a comma indicates that the two surrounding items are to appear without whitespace separating them; otherwise consecutive items must be identifiable to the reader as separate tokens. Items in *italics* are expected to be understood without definition herein. The characters i, j, and k stand for any non-negative integers such that $i \leq j \leq k$. Material in red has not yet been implemented.

1.2 Syntax of Well-Formed Terms

The language in which CSNePS well-formed terms are expressed is a version of Common Logic Interchange Format (CLIF) (**?**).

```
wft               =  atomicwft
                     | 'wft' ♭ i
                     | '(' , function , argument+ , ')'
                     | '(' , binaryop , argument , argument , ')'
                     | '(' , naryop , wft* , ')'
                     | '(' , param2op , '(' , i , j , ')' wft+ , ')'
                     | '(' , 'thresh' , '(' , i , ')' wft+ , ')'
                     | '(', 'close' , (atomicname | ('(', atomicname+ , ')')) ,
                         wft , ')'
                     | '(', 'every' , atomicname , wft* , ')'
                     | '(', 'some' , atomicname , '(' , atomicname , ')' , wft* , ')'
                     | '(', '?' ♭ atomicname , wft* , ')'
                     | Generalized quantifiers to replace nexists ;

binaryop          =  'if' | i ♭ '=>' | 'v=>' ;

naryop            =  'and' | 'or' | 'not' | 'nor' | 'thnot' | 'thnor' | 'nand'
                     | 'xor' | 'iff' ;

param2op          =  'andor' | 'thresh' ;

atomicwft         =  atomicname | Lisp string | Lisp number ;

atomicname        =  Clojure symbol other than wfti ;

function          =  wft // other than reservedWord ;

argument          =  wft | 'nil' | '(' , argumentFunction , wft* , ')' ;

argumentFunction  =  'setof' ;

reservedWord      =  'every' | 'some' | 'close' | '?' ♭ atomicname
                     | binaryop | naryop | param2op ;
```

Every non-atomic `wft` (that is, a `wft` other than an `atomicwft`) is given a wft-name when it is stored into the SNePS knowledge base. The wft-name of every stored term may be seen by evaluating the user command `(list-terms)`. The user expression `wfti` is a syntactic abbreviation of the `wft` that was assigned `wfti` as its wft-name. If no `wft` has yet been assigned that wft-name, `wfti` is syntactically illegal.

1.3 Syntax of Paths

In this section is presented the syntax of path expressions used in `definePath` and `defineSlot`.

```
path  =  slotname
         | slotname ♭ '-'
         | '!'
         | '(' , 'converse' , path , ')'
         | '(' , 'kplus' , path , ')'
         | '(' , 'kstar' , path , ')'
         | '(' , 'compose' , path* , ')'
         | '(' , 'or' , path* , ')'
         | '(' , 'and' , path* , ')'
         | '(' , 'irreflexive-restrict' , path , ')'
         | '(' , 'domain-restrict' , '(' , path , wft , ')' , path , ')'
         | '(' , 'range-restrict' , path , '(' , path , wft , ')' , ')' ;
```

1.4 Rule Engine Syntax[1]

CSNePS implements a rule language loosely based on a subset of the syntax of CLIPS (**?**), and using concepts from the GLAIR Cognitve Architecture (**?**). A rule definition takes the following general form:

```
rule  =  `(defrule', rulename, LHS, `=>' RHS `)';
```

where `rulename` is a unique name for a rule, `LHS` is the Left Hand Side of the rule (the "pattern matching" component[2]), and `RHS` is the Right Hand Side of the rule (the firing component). The LHS and RHS are discussed in more detail in Sections 1.4.1 and 1.4.2.

1.4.1 The Left Hand Side

The LHS of a rule is a collection of generic terms that must be matched for the rule to fire. This portion of the rule is special in that the quantified terms used take wide scope over the entire rule. Continuing the formal definition of the rule language, the LHS is defined as follows:

```
LHS  =  genericterm+;
```

where is the definition of a generic term is a term containing an arbitrary term.

1.4.2 The Right Hand Side

The RHS of a rule may contain both Clojure forms and subrules. The set of Clojure forms will be executed in order, and the bindings from the LHS will be substituted in to them. Subrules are rules that are unnamed, and are only executed when the RHS of a rule fires. The subrule is provided the set of LHS bindings, which it may use in its own LHS/RHS. Subrules may themselves have subrules, with no constraint on depth.

Again continuing the formal definition of the rule language, the RHS is defined as follows:

```
RHS      =  RHSLine+;
RHSLine  =  clojureform | subrule;
subrule  =  `(:subrule', subrulename?, LHS, `=>', RHS `)';
```

[1] This section adapted from (**?**)

[2] Really, inference is performed to derive patterns.

Chapter 2

Getting and Running CSNePS

CSNePS is implemented in the Clojure programming language, a recently developed dialect of lisp which runs (primarily) on the Java Virtual Machine.

2.1 Pre-Requisites

- **git** is a versioning system which will be required. Install it by following the appropriate directions for your operating system at `http://git-scm.com/downloads`.
- **Leiningen** (aka **lein**) is a dependency manager for Clojure projects. To install Leiningen, follow the directions at `https://github.com/technomancy/leiningen`.

2.2 Getting CSNePS

CSNePS will be cloned from its repository using the `git` tool.

1. At the terminal, change directories into the directory which you would like to be the parent of the CSNePS directory.
2. Run the command `git clone https://github.com/SNePS/CSNePS.git`. This will copy CSNePS to your local machine.

2.3 Initial Configuration

1. At the command line, run `chmod 755 /path/of/csneps/csneps.sh`.
2. At the command line, run `chmod 755 /path/of/csneps/csnepsgui.sh`.

2.4 Running CSNePS at the Command Line

A script has been provided with the CSNePS distribution which loads CSNePS using leiningen.

1. At the command prompt, run the command `/path/of/csneps/csneps.sh`.
2. Clojure will load, and you will be presented a Clojure prompt, `csneps.core.snuser=>`, indicating that CSNePS has loaded and we are in the 'csneps.core.snuser' namespace.

2.5 Running the CSNePS GUI

The CSNePS GUI may be started with or without pre-loading CSNePS. If you choose to pre-load CSNePS you will also have access to the command prompt in your terminal window. This will not be available of you choose not to pre-load CNSePS.

2.5.1 By Pre-Loading CSNePS

1. Follow the directions from Section 2.4.
2. Type `(startGUI)` from the prompt and press enter. This will load the CSNePS GUI.

2.5.2 Without Pre-Loading CSNePS

1. At the command prompt, run the command `/path/of/csneps/csnepsgui.sh`.
2. CSNePS and its GUI will then load.

2.6 Using Eclipse to Run CSNePS

Before getting started with Eclipse, be sure to check out the Sneps3-Clojure project, change directories to that project, and run `lein deps` to be sure the project and its dependencies are up to date.

In order to run and develop CSNePS in Eclipse, you will require a version of Eclipse which includes Java support. The version on the CSE servers seems somehow incompatable with CounterClockwise, so I recommend installing the latest version from `http://www.eclipse.org` in your home directory.

First we must install the CounterClockwise plugin, which lets us run Clojure apps from Eclipse.

1. Click the Help menu, then ”Install New Software...”
2. In the “Work With:” field, enter `http://ccw.cgrand.net/updatesite/` and click the “Add...” button.
3. Enter ”CounterClockwise” (or whatever text you like) in the “Name” field and click “OK”.
4. Check the box next to ”Clojure Programming” in the list that appears, and click the “Next” button.
5. In the dialogs that follow click Next, agree to the license agreement, and click Finish.
6. Agree to any warnings about unsigned content, and agree to restart Eclipse when installation has finished.

Now we will import our project.

1. Choose ”Import...” from the File menu.
2. Cloose ”Existing Project or Workspace” under the ”General” node in the tree shown.
3. With the ”Select root directory” radio button selected, click browse and browse to the SNePS3-Clojure directory.
4. Click next and follow the dialogs until it is imported.

Now the project is imported into Eclipse and we can run it. In the project explorer on the left side of the workspace, expand the SNePS3-Clojure node and then the src node, right click on core.clj, and choose to run it as a Clojure Application. Once the repl loads, run `(loadsneps3)`.

2.7 Using Emacs to Run CSNePS

2.7.1 Configuring Emacs

There are multiple methods for configuring Emacs to run and edit Clojure code. The method described here is the most desirable as of the time of this writing. These instructions require emacs 24, as it has a package facility we will use.

First, add the following to your emacs initialization file (by default `/.emacs.d/init.el`).

```
(require 'package)
(add-to-list 'package-archives
  '("marmalade" . "http://marmalade-repo.org/packages/"))
(add-to-list 'package-archives
  '("melpa-stable" . "http://melpa-stable.milkbox.net/packages/"))

(package-initialize)
```

Evaluate the buffer with the initialization file, then run `M-x package-refresh-contents` to pull in the contents of the added package repositories.

Now, add the following to your initialization file after what you added above.

```
(defvar my-packages '(clojure-mode
                      clojure-test-mode
                      cider))

(dolist (p my-packages)
  (unless (package-installed-p p)
    (package-install p)))
```

Evaluate the buffer with the initialization file in order to download the required packages.

2.7.2 Loading and Running the Project in Emacs

1. Load Emacs and switch the current directory to the CSNePS directory. This is the directory containing the project.clj file which will be used to load the project.

2. Type `M-x cider-jack-in`. A Clojure REPL will be started in a new buffer, and you will be presented with a Clojure prompt, `csneps.core.snuser=>`, indicating we have started in the 'csneps.core.snuser' namespace.

3. CSNePS is now loaded and is ready to be used.

Chapter 3

User Commands

`(adopt-rule` *`rule-name`*`)` [*Function*]
Adopts the rule with the symbol rule-name as its name.

`(adopt-rules` *`rule-names`*`)` [*Function*]
Takes a list of symbolic rule names to be adopted in order, one after the other. Rows may take the form of a single rule name, or a vector of rule names. A vector of rule names will be adopted simultaneously.

`(allTerms )` [*Function*]
Returns a set of all the terms in the knowledge base.

`(ask` *`expr`*`)` [*Function*]
Attempts to derive the term `expr` or its negation. Returns the derived term, or nil if it is not derivable in the current context. If the term is not derivable, focused inference is left running until it is derived, or the task is canceled using *cancel-infer-of* or *cancel-focused-infer*.

`(askif` *`expr`*`)` [*Function*]
Attempts to derive the term `expr`. Returns the derived term, or nil if it is not derivable in the current context. If the term is not derivable, focused inference is left running until it is derived, or the task is canceled using *cancel-infer-of* or *cancel-focused-infer*.

`(askifnot` *`expr`*`)` [*Function*]
Attempts to derive the negation of the term `expr`. Returns the derived term, or nil if it is not derivable in the current context. If the term is not derivable, focused inference is left running until it is derived, or the task is canceled using *cancel-infer-of* or *cancel-focused-infer*.

`(askwh` *`exprpat`*`)` [*Function*]
Returns a set of substitutions for variable placeholders for the term pattern *`exprpat`* that are currently derivable in the current context; or the empty set if there are none. If no instances are derivable, focused inference is left running until an instance is derivable, or the task is canceled using *cancel-infer-of* or *cancel-focused-infer*.

`(assert` *`expr`*`)` [*Function*]
Asserts the term expressed by *`expr`* in the current context.

(assert! *expr*) [*Function*]
Asserts the term expressed by *expr* in the current context, and triggers forward inference.

(cancel-focused-infer) [*Function*]
Cancels all focused inference tasks.

(cancel-infer-from *exprpat*) [*Function*]
Cancels any forward focused reasoning tasks deriving from *exprpat*.

(cancel-infer-of *exprpat*) [*Function*]
Cancels any focused reasoning tasks attempting to derive *exprpat*.

(clearkb &optional (*clearall* nil)) [*Function*]
Reinitializes the SNePS knowledge base. If *clearall* is non-nil also reinitializes all slots, caseframes, and semantic types.

(currentContext) [*Function*]
Returns the current context.

(defineCaseframe *type frame* &key *docstring fsymbols*) [*Function*]
Defines a caseframe, where: *type* is the name of a SNePS semantic type; *frame* is either (*slot1 ... slotn*) or (*'function-symbol slot1 ... slotn*); *docstring* is a caseframe documentation string; *fsymbols* is a list of function symbols required if first of the *frame* is not quoted.

(defineContext *name* &key (*docstring* "") (*parents* '(BaseCT)) *hyps*) [*Function*]
Defines a new context with the given name, docstring, parent contexts, and initial hypotheses. If *dosctring* is omitted, it defaults to the empty string. If *parents* is omitted, it defaults to '(BaseCT). If *hyps* is omitted, it defaults to the empty list.

(definePath *slotname path*) [*Function*]
Given a slot name, *slotname*, and a path expression, *path* (*see* §1.3), generate the functions that will compute that path and its converse, and store them in the slot named *slotname*.

(defineSlot *name* &key *type docstring posadjust negadjust min max path*) [*Macro*]

Defines the slot named *name*. *type* must be a semantic type. It defaults to Entity. *docstring* must be a string. It defaults to the empty string. *posadjust* must be either reduce (default), expand, or none. *negadjust* must be either reduce, expand (default), or none. *min* must be a positive integer. It defaults to 1. *max* must be either nil (default) or an integer equal to or greater than *min*. *path* must be either nil (default) or a path (*see* §1.3).

(defineTerm *term &optional (semtype 'Entity)*) [*Function*]
If *term* is not already a term in the SNePS knowledge base, it is added to the KB with the semantic type *semtype*, which defaults to Entity. If *term* is already a term in the KB with semantic type *currenttype*:

- if *currenttype* is a subtype of *semtype*, the type of *term* is left as is;
- if *semtype* is a subtype of *currenttype*, the semantic type of *term* is lowered to *semtype*;

- if *currenttype* and *semtype* have one greatest common subtype, the semantic type of *term* is changed to that type;
- if *currenttype* and *semtype* have several greatest common subtypes, the user is asked which one (s)he wants *term* to be, and *term*'s semantic type is changed to that type;
- otherwise, an error is generated.

The term is returned.

(defineType *newtype supers* &optional *docstring*) [*Macro*]
Defines *newtype* to be a SNePS semantic type, and a subtype of the types listed in the list *supers*. Internally converts types to keywords, but accepts either keywords or symbols as arguments to maintain compatibility with SNePS 3. If *docstring* is given, it is set as the documentation string of the new type. Prints a message, either of success or what the problem was. Returns nil.

(demo &key file pause failonerror) [*Function*]
Echoes and evaluates the forms in the *file*. If *pause* is non-nil (the default is nil), will pause after echoing each form, but before evaluating it. If the *file* is omitted, a menu will be presented of available demos. By default, an erroneous form will not stop the demo from continuing, but this may be changed by setting *failonerror* to a non-nil value.

(defrule *rulename* &rest *body*) [*Macro*]
Defines a rule in the CSNePS rule engine, as described in Section 1.4.

(find *exprpat*) [*Function*]
Returns a list of vector pairs. In each pair, the first element is an instance of *exprpat* in the knowledge base, and the second is a substitution, which when applied to *exprpat* would give that instance. *exprpat* may be any wft with variables, symbols starting with a "?", in the place of any subterms.

(findTerm *name*) [*Function*]
Returns the term named *name*, or nil if there isn't one. The name of an atomic term is a symbol, string, or number. The name of a molecular term is its wftname.

(krnovice *boolean*) [*Function*]
If set to true (the default value is false), slots and caseframes will automatically be created whenever a function symbol is used that is not already associated with a caseframe. The slots will be named fn, arg1, arg2, *etc.*, and both slots and caseframes will have their default parameters. This should only be used by novices, or for very quick tests, as the careful modeling required by defining types, slots, and caseframes might be ignored.

(list-caseframes) [*Function*]
Prints all the caseframes.

(listContexts) [*Function*]
Prints a list of all the contexts.

(list-focused-reasoning-tasks) [*Function*]
Prints a list of all of the focused reasoning tasks, backward and forward.

`(list-slots )` [*Function*]
Prints a list of all the SNePS slots.

`(list-terms &key (:asserted nil) (:types nil) (:originsets nil) (:properties nil) (:ontology nil))` [*Function*]
Prints a list of all the terms in the KB, except ontological terms in the OntologyCT context. These may be seen by setting `:ontology` non-nil. If `:asserted` is non-nil, only asserted propositions will be printed. If `:types` is non-nil, the type of each term will also be printed. If `:originsets` is non-nil, the origin sets of each term will also be printed, and if `:properties` is non-nil, additional properties of the terms will be printed.

`(listkb )` [*Function*]
Prints the current context and all propositions asserted in it.

`(noverboserules )` [*Function*]
Disables verbose output for condition-action rules, as enabled through the *verboserules* function.

`(pathsfrom terms path)` [*Function*]
Returns the set of terms at the end of the given `path` (*see* §1.3) from `terms`, which must be a term, the name of a term, a list of terms or names of terms, or a set of terms.

`*PRECISION*` [*Variable*]
A positive integer: a floating point number will be rounded to this number of decimal places before being converted to a term.

`(remove-from-context term ctx)` [*Function*]
Removes the provided *term* from the context *ctx*. The term will still be asserted in contexts it isn't removed from.

`(sameFrame newf oldf)` [*Function*]
Associates the same frame associated with the function symbol `oldf` with the symbol, or list of symbols, `newf`.

`(setCurrentContext ctx)` [*Function*]
If `ctx` is a context name, makes the context named `ctx` the current context. If `ctx` is a context, makes it the current context. Else raises an error.

`(showTypes )` [*Function*]
Graphically displays all the defined semantic types.

`(startGUI &rest terms)` [*Macro*]
Starts the CSNePS GUI. Takes a variable number of `terms` to display on the graph. Each term is either found or defined using `defineTerm`. If no terms are given, the entire graph will be displayed.

`(unassert prop &optional (cntxt (currentContext)))` [*Function*]
Unasserts the proposition `prop` in the given context and all ancestor contexts. Currently there is no belief revision, so propositions derived using `prop` might still be asserted, and prop, itself, might be rederivable.

`(verboserules )` [*Function*]

When a condition-action rule fires, this function enables output of the rule name and set of substitutions sent to the RHS of the rule. It may be disabled with the *noverboserules* function.

`(writeKBToTextFile` *`file`* `&optional` *`headerfile`*`)` [*Function*]
Writes the KB to the given text *`file`*, so that when that file is loaded, all the propositions asserted in the current KB will be asserted in the new KB. If the *`headerfile`* is included, a load of that file will be written before any of the asserts.

Chapter 4

Debug Commands

The commands listed in this chapter may be useful if you experience issues with CSNePS and wish to attempt to resolve the problem.

`(build/print-all-trees )` [*Function*]
Prints all unification term trees to the terminal in a human-readable format.

`(build/print-channel-and-msgs` *`from to`*`)` [*Function*]
Given the names of two terms, *from* and *to*, prints the channel (if it exists) from the *from* term to the *to* term. Also prints all messages which are waiting in that channel.

`(snip/ig-status )` [*Function*]
Prints all channels in the Inference Graph, including their type, number of waiting messages, and any valve selectors.

`(snip/print-waiting-msgs &optional` *`term`*`)` [*Function*]
Prints messages waiting in channels incoming to *term*, or if *term* is not specified, prints all messages waiting in any channels in the IG.

`(snip/print-ptree` *`ptree`*`)` [*Function*]
Given a P-Tree, *ptree*, prints it to the terminal in a human readable form.

Chapter 5

Java API

CSNePS has a Java API, residing within the `csneps.api` package and used internally by the GUI, which allows a user to easily integrate CSNePS into a Java program.

5.1 The `CSNePS` class

The main class used for interacting with CSNePS is the `CSNePS` class in the `csneps.api` package.

`static void adoptRule(ITerm rule)` [*Method*]
Adopts the provided `Term` instance which is a rule.

`static ITerm assertTerm(String expr)` [*Method*]
Defines and asserts a term in the current context provided as a CSNePS expression.

`static ICaseframe defineCaseframe(String type, String name,`
`ArrayList<ISlot> slots)` [*Method*]
Defines a caseframe of the provided type, with the given name, and with the provided slots.

`static ICaseframe defineCaseframe(String type, ArrayList<Slot> slots`
`ArrayList<Slot> fsymbols)` [*Method*]
Defines a caseframe of the provided type, with the provided slots, and using the provided fsymbols.

`static IContext defineContext(String name, ArrayList<IContext> parents,`
`Set<Term> hyps)` [*Method*]
Define a new context with the provided name, inheriting hypotheses from parents, and having its own hypotheses (hyps).

`static void setCurrentContext(IContext c)` [*Method*]
Change the current context to *c*.

`static ISlot defineSlot(String name, ISemanticType type, Integer min,`
`Integer max, String posadjust, String negadjust)` [*Method*]

`static ITerm defineTerm(String expr)` [*Method*]
Defines (but does not assert) a term provided as a CSNePS expression.

`static ISemanticType defineType(String newtype, ArrayList<ISemanticType> parents)` [*Method*]
Define a new semantic type with the provided name and parents.

`static Set<ITerm> find(String pattern)` [*Method*]
Returns terms which match the provided pattern.

`static Boolean isAsserted(ITerm term, IContext context)` [*Method*]
Returns `true` if *term* is asserted in *context* and `false` otherwise.

`static void unadoptRule(ITerm rule)` [*Method*]
Unadopts the provided `Term` instance which is a rule.

`static ITerm assertTerm(ITerm term)` [*Method*]
Unasserts a term in the current context.

5.2 The `ICaseframe` interface

`Set<String> getFSymbols()` [*Method*]
Return this caseframe's fsymbols.

`String getName()` [*Method*]
Returns the name of a claseframe.

`ISemanticType getType()` [*Method*]
Returns the semantic type of the caseframe.

`List<ISlot> getSlots()` [*Method*]
Return the slots for this caseframe.

5.3 The `IContext` interface

`Set<ITerm> getHyps()` [*Method*]
Return the set of terms which are hypothesized in this context.

`String getName()` [*Method*]
; Return the name of the context.

`List<IContext> getParents()` [*Method*]
; Return the parents of the context.

5.4 The `ISemanticType` interface

`Set<ISemanticType> getAncestors()` [*Method*]
Return all of the ancestors of this semantic type.

`String getName()` [*Method*]
Return the name of this semantic type.

`List<ISemanticType> getParents()` [*Method*]
Return the parents of this semantic type.

`boolean hasAncestor(SemanticType type)` [*Method*]
Returns `true` if this semantic type has *`type`* as an ancestor, otherwise `false`.

`boolean hasParent(SemanticType type)` [*Method*]
Returns `true` if this semantic type has *`type`* as a parent, otherwise `false`.

5.5 The `ISlot` interface

`Long getMax()` [*Method*]
Returns the maximum number of fillers this slot can hold.

`Long getMin()` [*Method*]
Returns the minimum number of fillers this slot can hold.

`String getName()` [*Method*]
Returns the name of the slot.

`ISemanticType getType()` [*Method*]
Returns the semantic type of the slot.

5.6 The `ITerm` interface

`ICaseframe getCaseframe()` [*Method*]
Returns the caseframe this term is an instance of.

`Set<ITerm> getDependencies()` [*Method*]
Return the dependencies in this term (only if it is an indefinite).

`String getFSymbol()` [*Method*]
Return the function symbool (predicate or caseframe fsymbol) for this term.

`String getName()` [*Method*]
Return the name of the term (either the term itself, or if molecular, the `wft` name).

`Set<ITerm> getRestrictionset()` [*Method*]
Return the restriction set if this is an arbitrary or indefinite term.

`Map<ISlot, Set<ITerm>> getUpCableset()` [*Method*]
Return the up cableset for this term.

`List<ITerm> getUpCablesetTerms()` [*Method*]
Return the terms in the up cableset of this term.

`Boolean isMolecular()` [*Method*]
True if this term is molecular, otherwise false.

`Boolean isVariable()` [*Method*]
True if this term is a variable, otherwise false.

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