Σ
A Library for Ansi Common Lisp

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Chapter 2

Introduction

The Σ library is a generic library of mostly random useful code for Ansi Common Lisp. It is currently only really focused on Sbcl, but patches to add support for other systems are more than welcome.

This library started out as a single file, `utilities.lisp`, that I personally used for shared generic code for all of my Lisp code. Most lispers have a similar file of some name, `utilities.lisp`, `misc.lisp`, `shared.lisp`, or even `stuff.lisp`, that is just a random collection of useful little generic macros and functions. Mine has grown over the years, and in 2012 I decided that I should try to make it useful to people other than myself.

You can download the library from GitHub at:
`https://github.com/cgore/sigma`
and I have some other information on it at my own website at:
`http://cgore.com/programming/lisp/sigma/`

2.1 Getting Lisp

Before using this library you need a working Lisp. I use and recommend Sbcl, Steel Bank Common Lisp, which is available at:
`http://www.sbcl.org`
This is derived from CMUCL, Carnegie Mellon University Common Lisp, which is still under active development and is: available at:
`http://www.cons.org/cmucl/`

SBCL has information on getting started at:
`http://www.sbcl.org/getting.html`
If you are using Debian or a similar Linux distribution (including Ubuntu), you can just run as root:

```
apt-get install sbcl sbcl-doc sbcl-source
```

2.2 Getting Emacs and Slime

After installing, the best way to interact with any Common Lisp is via SLIME, the Superior Lisp Interaction Mode for EMACS, which is available at:
`http://common-lisp.net/project/slime/`
This can be installed on Debian by:
`apt-get install slime emacs emacs-goodies-el`

2.3 Using the Library

First we need to clone the utilities.

```
mkdir -p  /programming/lisp
cd  /programming/lisp
git clone git@github.com:cgore/sigma.git
```

Now we need to make a directory for our project and symlink to the ASDF definition. There are other ways to load ASDF libraries, especially if you want to have them available globally; I strongly recommend you read the documentation to ASDF.

```
mkdir our-new-project
cd our-new-project
ln -s  /programming/lisp/sigma/sigma.asd
```

Now we need to start up our Lisp REPL. The best way to do this for perfonal use is SLIME from within Emacs, but I will demonstrate using the shell itself here.

```
sbcl
```

Now we are in SBCL.

```
(require :asdf) ; Require ASDF
(require :sigma) ; Require the system via ASDF.
(sigma:use-all-sigma) ; This will pollute COMMON-LISP-USER
(sum (loop for i from 1 to 100 collect i)) ; Returns 5050 and makes Euler sad.
```

Have fun!

Chapter 3

The `Sigma/Behave` Package

The `sigma/behave` package contains some useful code for confirming behavior of code, supporting a very basic form of *behavior-driven development*, BDD. The basic flow is to define the *behavior* of something, with multiple *specs* specified within that behavior specification, each consisting of various assertions, such as `should=`, `should-equal`, `should-not-equal`, and many others. If the behavior of the thing doesn't match the specified behavior, then there is some error.

3.1 Macros

3.1.1 The `Behavior` Macro

The `behavior` macro is used to specify a block of expected behavior for a `thing`. It specifies an example group, loosely similar to the `describe` blocks in Ruby's RSpec. It takes a single argument, the `thing` we are trying to describe, and then a body of code to evaluate that is evaluated in an implicit `progn`. It is to be used around a set of examples, or around a set of assertions directly.

Syntax

`(behavior` *thing* `&body` *body*`)`

Examples

```
(behavior 'float
          (spec "is an Abelian group"
                (let ((a (random 10.0))
                      (b (random 10.0))
                      (c (random 10.0))
                      (e 1.0))
                  (spec "closure"
                        (should-be-a 'float (* a b)))
```

```
(spec "associativity"
      (should= (* (* a b) c)
               (* a (* b c))))
(spec "identity element"
      (should= a (* e a)))
(spec "inverse element"
      (let ((1/a (/ 1 a)))
        (should= (* 1/a a)
                 (* a 1/a)
                 1.0)))
(spec "commutitativity"
      (should= (* a b) (* b a))))))
```

3.1.2 The `Spec` Macro

The `spec` macro is used to indicate a specification for a desired behavior. It will normally serve as a grouping for assertions or nested `spec`s.

Syntax

`(spec` *description* `&body` *body*`)`

Examples

```
(spec "should pass some tests"
      (should= 12 (foo 3.5))
      (should= 14 (foo 4.22)))
```

3.1.3 The `Should` Macro

The `should` macro is the basic building block for most of the behavior checking. It asserts that `test` returns truthfully for the arguments. Typically you will want to use one of the macros defined on top of `should` instead of using it directly, such as `should=`.

Syntax

`(should` *test* `&rest` *arguments*`)`

Examples

```
(should #'= 12 (* 3 4)) ; Passes
(should #'< 4 (* 2 3))  ; Passes
(should #'< 4 5 6 7)    ; Passes
```

3.1.4 The `Should-Not` Macro

The `should-not` macro is identical to the `should` macro, except that it inverts the result of the call with `not`.

Syntax

`(should-not` *test* `&rest` *arguments*`)`

Examples

```
(should-not #'< 12 4)  ; Passes
(should-not #'= 12 44) ; Passes
```

3.1.5 The `Should-Be-Null` Macro

The `should-be-null` macro is a short-hand method for `(should #'null ...)`.

Syntax

`(should-be-null &rest` *arguments*`)`

Examples

```
(should-be-null ())            ; Passes
(should-be-null nil)           ; Passes
(should-be-null (not 12))      ; Passes
(should-be-null (and t t nil)) ; Passes
```

3.1.6 The `Should-Be-True` Macro

The `should-be-true` macro is a short-hand method for `(should #'identity ...)`.

Syntax

`(should-be-true &rest` *arguments*`)`

Examples

```
(should-be-true t)               ; Passes
(should-be-true (not nil))       ; Passes
(should-be-true (or nil nil 12)) ; Passes
```

3.1.7 The `Should-Be-False` Macro

The `should-be-false` macro is a short-hand method for `(should #'not ...)`.

Syntax

`(should-be-false &rest` *arguments*`)`

Examples

```
(should-be-false nil)
(should-be-false (not t))
(should-be-false (< 44 2))
```

3.1.8 The `Should-Be-A` Macro

The `should-be-a` macro specifies that one or more `things` should be of the type specified by `type`.

```
(should-be-a 'integer 1)                ; Passes
(should-be-a 'float 1)                  ; Passes
(should-be-a 'integer 1 2 3 4 5 6 7 8 9) ; Passes
(should-be-a 'integer 1.0)              ; Fails
```

3.1.9 The `Should=` Macro

The `should=` macro is a short-hand method for `(should #'= ...)`.

Syntax

`(should= &rest` *arguments*`)`

Examples

```
(should= 12 12)   ; Passes
(should= 12 12.0) ; Passes
```

3.1.10 The `Should-Not=` Macro

The `should-not=` macro is a short-hand method for `(should-not #'= ...)`.

Syntax

`(should-not= &rest` *arguments*`)`

Examples

```
(should-not= 12 12)   ; Fails
(should-not= 12 12.0) ; Fails
(should-not= 12 14)   ; Passes
```

3.1.11 The `Should/=` Macro

The `should/=` macro is a short-hand method for `(should #'/= ...)`.

Syntax

`(should/= &rest` *arguments*`)`

Examples

```
(should/= 12 13) ; Passes
(should/= 12 12) ; Fails
(should/= 12 12.0) ; Fails
```

3.1.12 The `Should-Not/=` Macro

The `should-not/=` macro is a short-hand method for `(should-not #'/= ...)`.

Syntax

`(should-not/= &rest` *arguments*`)`

Examples

```
(should-not/= 12 13) ; Fails
(should-not/= 12 12) ; Passes
(should-not/= 12 12.0) ; Passes
```

3.1.13 The `Should<` Macro

The `should<` macro is a short-hand method for `(should #'< ...)`.

Syntax

`(should< &rest` *arguments*`)`

Examples

```
(should< 12 13) ; Passes
(should< 13 12) ; Fails
(should< 12 12) ; Fails
```

3.1.14 The `Should-Not<` Macro

The `should-not<` macro is a short-hand method for `(should-not #'< ...)`.

Syntax

`(should-not< &rest` *arguments*`)`

Examples

```
(should-not< 12 13) ; Passes
(should-not< 13 12) ; Fails
(should-not< 12 12) ; Fails
```

3.1.15 The Should> Macro

The `should<` macro is a short-hand method for `(should #'> ...)`.

Syntax

`(should> &rest` *arguments*`)`

Examples

```
(should> 12 13) ; Fails
(should> 13 12) ; Passes
(should> 12 12) ; Fails
```

3.1.16 The Should-Not> Macro

The `should-not<` macro is a short-hand method for `(should-not #'> ...)`.

Syntax

`(should-not> &rest` *arguments*`)`

Examples

```
(should-not> 12 13) ; Passes
(should-not> 13 12) ; Fails
(should-not> 12 12) ; Passes
```

3.1.17 The Should<= Macro

The `should<=` macro is a short-hand method for `(should #'<= ...)`.

Syntax

`(should<= &rest` *arguments*`)`

Examples

```
(should<= 12 13) ; Passes
(should<= 13 12) ; Fails
(should<= 12 12) ; Passes
```

3.1.18 The `Should-Not<=` Macro

The `should-not<=` macro is a short-hand method for `(should-not #'<= ...)`.

Syntax

`(should-not<= &rest` *arguments*`)`

Examples

```
(should-not<= 12 13) ; Fails
(should-not<= 13 12) ; Passes
(should-not<= 12 12) ; Fails
```

3.1.19 The `Should>=` Macro

The `should>=` macro is a short-hand method for `(should #'>= ...)`.

Syntax

`(should>= &rest` *arguments*`)`

Examples

```
(should>= 12 13) ; Fails
(should>= 13 12) ; Passes
(should>= 12 12) ; Passes
```

3.1.20 The `Should-Not>=` Macro

The `should-not>=` macro is a short-hand method for `(should-not #'>= ...)`.

Syntax

`(should-not>= &rest` *arguments*`)`

Examples

```
(should-not>= 12 13) ; Passes
(should-not>= 13 12) ; Fails
(should-not>= 12 12) ; Fails
```

3.1.21 The `Should-Eq` Macro

The `should-eq` macro is a short-hand method for `(should #'eq ...)`.

Syntax

`(should-eq &rest` *arguments*`)`

Examples

```
(should-eq 12 12)       ; Probably passes
(should-eq 13 12)       ; Fails
(should-eq "foo" "foo") ; May pass, may fail.
```

3.1.22 The Should-Not-Eq Macro

The `should-not-eq` macro is a short-hand method for `(should-not #'eq ...)`.

Syntax

`(should-not-eq &rest` *arguments*`)`

Examples

```
(should-not-eq 12 12)       ; Probably fails
(should-not-eq 13 12)       ; Passes
(should-not-eq "foo" "foo") ; May pass, may fail.
```

3.1.23 The Should-Eql Macro

The `should-eql` macro is a short-hand method for `(should #'eql ...)`.

Syntax

`(should-eql &rest` *arguments*`)`

Examples

```
(should-eql 12 12)       ; Passes
(should-eql 13 12)       ; Fails
(should-eql "foo" "foo") ; May pass, may fail.
```

3.1.24 The Should-Not-Eql Macro

The `should-not-eql` macro is a short-hand method for `(should-not #'eql ...)`.

Syntax

`(should-not-eql &rest` *arguments*`)`

Examples

```
(should-not-eql 12 12)       ; Fails
(should-not-eql 13 12)       ; Passes
(should-not-eql "foo" "foo") ; May pass, may fail.
```

3.1.25 The `Should-Equal` Macro

The `should-equal` macro is a short-hand method for `(should #'equal ...)`.

Syntax

`(should-equal &rest` *arguments*`)`

Examples

```
(should-equal 12 12)       ; Passes
(should-equal 13 12)       ; Fails
(should-equal "foo" "foo") ; Passes
(should-equal "FOO" "foo") ; Fails
```

3.1.26 The `Should-Not-Equal` Macro

The `should-not-equal` macro is a short-hand method for `(should-not #'equal ...)`.

Syntax

`(should-not-equal &rest` *arguments*`)`

Examples

```
(should-not-equal 12 12)       ; Passes
(should-not-equal 13 12)       ; Fails
(should-not-equal "foo" "foo") ; Fails
(should-not-equal "FOO" "foo") ; Passes
```

3.1.27 The `Should-EqualP` Macro

The `should-equalp` macro is a short-hand method for `(should #'equalp ...)`.

Syntax

`(should-equalp &rest` *arguments*`)`

Examples

```
(should-equalp 12 12)       ; Passes
(should-equalp 13 12)       ; Fails
(should-equalp "foo" "foo") ; Passes
(should-equalp "FOO" "foo") ; Passes
```

3.1.28 The Should-Not-EqualP Macro

The `should-not-equalp` macro is a short-hand method for `(should-not #'equalp ...)`.

Syntax

`(should-not-equalp &rest` *arguments*`)`

Examples

```
(should-not-equalp 12 12)       ; Passes
(should-not-equalp 13 12)       ; Fails
(should-not-equalp "foo" "foo") ; Passes
(should-not-equalp "FOO" "foo") ; Fails
```

3.1.29 The Should-String= Macro

The `should-string=` macro is a short-hand method for `(should #'string= ...)`.

Syntax

`(should-string= &rest` *arguments*`)`

Examples

```
(should-string= "foo" "foo") ; Passes
(should-string= "FOO" "foo") ; Fails
```

3.1.30 The Should-Not-String= Macro

The `should-not-string=` macro is a short-hand method for `(should-not #'string= ...)`.

Syntax

`(should-not-string= &rest` *arguments*`)`

Examples

```
(should-not-string= "foo" "foo") ; Fails
(should-not-string= "FOO" "foo") ; Passes
```

3.1.31 The Should-String/= Macro

The `should-string/=` macro is a short-hand method for `(should #'string/= ...)`.

Syntax

`(should-string/= &rest` *arguments*`)`

Examples

```
(should-string/= "foo" "foo") ; Fails
(should-string/= "FOO" "foo") ; Passes
```

3.1.32 The `Should-Not-String/=` Macro

The `should-not-string/=` macro is a short-hand method for `(should-not #'string/= ...)`.

Syntax

`(should-not-string/= &rest` *arguments*`)`

Examples

```
(should-not-string/= "foo" "foo") ; Passes
(should-not-string/= "FOO" "foo") ; Fails
```

3.1.33 The `Should-String<` Macro

The `should-string<` macro is a short-hand method for `(should #'string< ...)`.

Syntax

`(should-string< &rest` *arguments*`)`

Examples

```
(should-string< "foo" "f")      ; Fails
(should-string< "foo" "foo")    ; Fails
(should-string< "foo" "FOOBAR") ; Fails
(should-string< "foo" "foobar") ; Passes
```

3.1.34 The `Should-Not-String<` Macro

The `should-not-string<` macro is a short-hand method for `(should-not #'string< ...)`.

Syntax

`(should-not-string< &rest` *arguments*`)`

Examples

```
(should-not-string< "foo" "f")      ; Passes
(should-not-string< "foo" "foo")    ; Passes
(should-not-string< "foo" "foobar") ; Fails
```

3.1.35 The Should-String> Macro

The should-string> macro is a short-hand method for (should #'string> ...).

Syntax

(should-string> &rest *arguments*)

Examples

```
(should-string> "foo" "f")      ; Passes
(should-string> "foo" "foo")    ; Fails
(should-string> "foo" "FOO")    ; Passes
(should-string> "foo" "foobar") ; Fails
```

3.1.36 The Should-Not-String> Macro

The should-not-string> macro is a short-hand method for (should-not #'string> ...).

Syntax

(should-not-string> &rest *arguments*)

Examples

```
(should-not-string> "foo" "f")      ; Fails
(should-not-string> "foo" "foo")    ; Passes
(should-not-string> "foo" "foobar") ; Passes
```

3.1.37 The Should-String<= Macro

The should-string<= macro is a short-hand method for (should #'string<= ...).

Syntax

(should-string<= &rest *arguments*)

Examples

```
(should-string<= "foo" "f")      ; Fails
(should-string<= "foo" "foo")    ; Passes
(should-string<= "foo" "foobar") ; Passes
```

3.1.38 The Should-Not-String<= Macro

The `should-not-string<=` macro is a short-hand method for `(should-not #'string<= ...)`.

Syntax

`(should-not-string<= &rest` *arguments*`)`

Examples

```
(should-not-string<= "foo" "f")      ; Passes
(should-not-string<= "foo" "foo")    ; Fails
(should-not-string<= "foo" "foobar") ; Fails
```

3.1.39 The Should-String>= Macro

The `should-string>=` macro is a short-hand method for `(should #'string>= ...)`.

Syntax

`(should-string>= &rest` *arguments*`)`

Examples

```
(should-string>= "foo" "f")      ; Passes
(should-string>= "foo" "foo")    ; Passes
(should-string>= "foo" "foobar") ; Fails
```

3.1.40 The Should-Not-String>= Macro

The `should-not-string>=` macro is a short-hand method for `(should-not #'string>= ...)`.

Syntax

`(should-not-string>= &rest` *arguments*`)`

Examples

```
(should-not-string>= "foo" "f")      ; Fails
(should-not-string>= "foo" "foo")    ; Fails
(should-not-string>= "foo" "foobar") ; Passes
```

3.1.41 The Should-String-Equal Macro

The `should-string-equal` macro is a short-hand method for `(should #'string-equal ...)`.

Syntax

`(should-string-equal &rest` *arguments*`)`

Examples

```
(should-string-equal "foo" "foo")    ; Passes
(should-string-equal "FOO" "foo")    ; Passes
(should-string-equal "foo" "foobar") ; Fails
```

3.1.42 The Should-Not-String-Equal Macro

The `should-not-string-equal` macro is a short-hand method for `(should-not #'string-equal ...)`.

Syntax

`(should-not-string-equal &rest` *arguments*`)`

Examples

```
(should-not-string-equal "foo" "foo")    ; Fails
(should-not-string-equal "FOO" "foo")    ; Fails
(should-not-string-equal "foo" "foobar") ; Passes
```

3.1.43 The Should-String-Not-Equal Macro

The `should-string-not-equal` macro is a short-hand method for `(should #'string-not-equal ...)`.

Syntax

`(should-string-not-equal &rest` *arguments*`)`

Examples

```
(should-string-not-equal "foo" "foo")    ; Fails
(should-string-not-equal "FOO" "foo")    ; Fails
(should-string-not-equal "foo" "foobar") ; Passes
```

3.1.44 The Should-Not-String-Not-Equal Macro

The `should-not-string-not-equal` macro is a short-hand method for `(should-not #'string-not-equal ...)`.

Syntax

`(should-not-string-not-equal &rest` *arguments*`)`

Examples

```
(should-not-string-not-equal "foo" "foo")    ; Passes
(should-not-string-not-equal "FOO" "foo")    ; Passes
(should-not-string-not-equal "foo" "foobar") ; Fails
```

3.1.45 The `Should-String-LessP` Macro

The `should-string-lessp` macro is a short-hand method for `(should #'string-lessp ...)`.

Syntax

`(should-string-lessp &rest` *arguments*`)`

Examples

```
(should-string-lessp "foo" "f")      ; Fails
(should-string-lessp "foo" "foo")    ; Fails
(should-string-lessp "foo" "FOOBAR") ; Passes
(should-string-lessp "foo" "foobar") ; Passes
```

3.1.46 The `Should-Not-String-LessP` Macro

The `should-not-string-lessp` macro is a short-hand method for `(should-not #'string-lessp ...)`.

Syntax

`(should-not-string-lessp &rest` *arguments*`)`

Examples

```
(should-not-string-lessp "foo" "f")      ; Passes
(should-not-string-lessp "foo" "foo")    ; Passes
(should-not-string-lessp "foo" "FOOBAR") ; Fails
(should-not-string-lessp "foo" "foobar") ; Fails
```

3.1.47 The `Should-String-GreaterP` Macro

The `should-string-greaterp` macro is a short-hand method for `(should #'string-greaterp ...)`.

Syntax

`(should-string-greaterp &rest` *arguments*`)`

Examples

```
(should-string-greaterp "foo" "f")      ; Passes
(should-string-greaterp "foo" "foo")    ; Fails
(should-string-greaterp "foo" "FOO")    ; Fails
(should-string-greaterp "foo" "foobar") ; Fails
```

3.1.48 The `Should-Not-String-GreaterP` Macro

The `should-not-string-greaterp` macro is a short-hand method for `(should-not #'string-greaterp ...)`.

Syntax

`(should-not-string-greaterp &rest` *arguments*`)`

Examples

```
(should-not-string-greaterp "foo" "f")      ; Fails
(should-not-string-greaterp "foo" "foo")    ; Passes
(should-not-string-greaterp "foo" "FOO")    ; Passes
(should-not-string-greaterp "foo" "foobar") ; Passes
```

3.1.49 The `Should-String-Not-GreaterP` Macro

The `should-string-not-greaterp` macro is a short-hand method for `(should #'string-not-greaterp ...)`.

Syntax

`(should-string-not-greaterp &rest` *arguments*`)`

Examples

```
(should-string-not-greaterp "foo" "f")      ; Fails
(should-string-not-greaterp "foo" "foo")    ; Passes
(should-string-not-greaterp "foo" "FOO")    ; Passes
(should-string-not-greaterp "foo" "foobar") ; Passes
```

3.1.50 The `Should-Not-String-Not-GreaterP` Macro

The `should-string-greaterp` macro is a short-hand method for `(should #'string-greaterp ...)`.

Syntax

```
(should-string-greaterp &rest arguments)
```

Examples

```
(should-string-greaterp "foo" "f")      ; Passes
(should-string-greaterp "foo" "foo")    ; Fails
(should-string-greaterp "foo" "FOO")    ; Fails
(should-string-greaterp "foo" "foobar") ; Fails
```

3.1.51 The `Should-String-Not-LessP` Macro

The `should-string-not-lessp` macro is a short-hand method for `(should #'string-not-lessp ...)`.

Syntax

```
(should-string-not-lessp &rest arguments)
```

Examples

```
(should-string-not-lessp "foo" "f")      ; Passes
(should-string-not-lessp "foo" "foo")    ; Passes
(should-string-not-lessp "foo" "FOOBAR") ; Fails
(should-string-not-lessp "foo" "foobar") ; Fails
```

3.1.52 The `Should-Not-String-Not-LessP` Macro

The `should-not-string-not-lessp` macro is a short-hand method for `(should-not #'string-not-lessp ...)`.

Syntax

```
(should-not-string-not-lessp &rest arguments)
```

Examples

```
(should-not-string-not-lessp "foo" "f")      ; Fails
(should-not-string-not-lessp "foo" "foo")    ; Fails
(should-not-string-not-lessp "foo" "FOOBAR") ; Passes
(should-not-string-not-lessp "foo" "foobar") ; Passes
```

Chapter 4

The `Sigma/Control` Package

The `sigma/control` package contains code for basic program control systems. These are mostly basic macros to add more complicated looping, conditionals, or similar. These are typically extensions to Common Lisp that are inspired by other programming languages. Thanks to the power of Common Lisp and its macro system, we can typically implement most features of any other language with little trouble.

4.1 Macros

4.1.1 The `AIf` Macro

The `aif` macro is an anaphoric variation of the built-in `if` control structure. This is based on [1, p. 190]. The basic idea is to provide an anaphor (such as pronouns in English) for the conditional so that it can easily be referred to within the body of the conditional expression. The most natural pronoun in the English language for a thing is "it", so that is what is used. If you need or want to use a different anaphor, use `a?if`. The most common use of `aif` is for when you want to do some additional computation with some time-consuming calculation, but only if it returned successfully.

Syntax

`(aif` *conditional t-action* `&optional` *nil-action*`)`

Examples

```
(aif (big-long-calculation)
     (foo it)
     (format t "The big-long-calculation failed!~%"))
```

This is similar to the following, but with less typing:

```
(let ((it (big-long-calculation)))
  (if it
      (foo it)
      (format t "The big-long-calculation failed!~%")))
```

4.1.2 The A?If Macro

The a?if macro is a variation of aif that allows for the specification of the anaphor to use, instead of being restricted to just it, the fefault with aif. This is most often useful when you need to nest calls to anaphoric macros.

Syntax

(a?if *anaphor conditional t-action* &optional *nil-action*)

Examples

```
(a?if foo 'outer
  (a?if bar 'inner
    `(,foo ,bar))) ; Returns '(outer inner)
```

4.1.3 The AAnd Macro

The aand macro is an anaphoric variation of the built-in and. This is based on [1, p. 191]. It works in a similar manner to aif, defining it as the current argument for use in the next argument, reassigning it with each argument.

Syntax

(aand &rest arguments)

Examples

```
(aand 2         ; Sets 'it' to 2.
      (* 3 it)  ; Sets 'it' to 6.
      (* 4 it)) ; Returns 24.
```

4.1.4 The A?And Macro

The a?and macro is a variant of aand that allows for the specification of the anaphor to use, instead of being restricted to just it, the default with aand. This is most often useful when you need to nest calls to anaphoric macros.

Examples

```
(a?and foo 12 (* 2 foo) (* 3 foo)) ; Returns 72.

(a?and foo 1 2 3 'outer
  (a?and bar 4 5 6 'inner `(,foo ,bar))) ; Returns '(outer inner)
```

4.1.5 The `ALambda` Macro

The `alambda` macro is an anaphoric variant of the built-in `lambda`. This is based on [1, p. 193]. It works in a similar manner to `aif` and `aand`, except it defines `self` instead of `it` as the default anaphor. This is useful so that you can write recursive lambdas.

```
(funcall (alambda (x) ; Simple recursive factorial example.
           (if (<= x 0)
               1
               (* x (self (1- x)))))
         10))) ; Calculates 10!, inefficently.
```

4.1.6 The `A?Lambda` Macro

The `a?lambda` macro is an variant of `alambda` that allows you to specify the anaphor to use.

```
(funcall (a?lambda ! (x) ; Simple recursive factorial example.
           (if (<= x 0)
               1
               (* x (! (1- x)))))
         10))) ; Calculates 10!, inefficently.
```

Chapter 5

The `Hash` Package

5.1 Functions

5.1.1 The `IncHash` Function

The `IncHash` function will increment the value in *key* of the *hash*, initializing it to 1 if it isn't currently defined.

5.1.2 The `DecHash` Function

The `DecHash` function will decrement the value in *key* of the *hash*, initializing it to -1 if it isn't currently defined.

Chapter 6

The `Numeric` Package

6.1 Macros

6.1.1 The `DivF` Macro

6.1.2 The `MultF` Macro

6.2 Functions

6.2.1 The `Bit?` Function

6.2.2 The `Choose` Function

The *Choose* function computes the binomial coefficient for n and k, typically spoken as n *choose* k, and usually written mathematically as $\binom{n}{k}$.

6.2.3 The `Factorial` Function

The *Factorial* function computes $n!$ for positive integers. NB, this isn't intelligent, and uses a loop instead of better approaches.

Chapter 7

The OS Package

7.1 Functions

7.1.1 The Perl Function

7.1.2 The Python Function

7.1.3 The Read-File Function

7.1.4 The Read-Lines Function

7.1.5 The Ruby Function

7.2 Parameters

7.2.1 The *Perl-Path* Parameter

7.2.2 The *Python-Path* Parameter

7.2.3 The *Ruby-Path* Parameter

Chapter 8

The `Probability` Package

8.1 Macros

8.1.1 The `Decaying-Probabiliity?` Macro

8.2 Functions

8.2.1 The `Probability?` Function

8.3 Types

8.3.1 The `Probability` Type

Chapter 9

The `Random` Package

9.1 Macros

9.1.1 The `NShuffle` Macro

9.2 Functions

9.2.1 The `Gauss` Function

9.2.2 The `Random-Argument` Function

9.2.3 The `Coin-Toss` Function

9.2.4 The `Random-In-Range` Function

9.2.5 The `Random-In-Ranges` Function

9.2.6 The `Random-Range` Function

9.2.7 The `Randomize-Array` Function

9.2.8 The `Random-Array` Function

9.3 Generics

9.3.1 The `Random-Element` Generic

9.3.2 The `Shuffle` Generic

Chapter 10

The Sequence Package

10.1 Macros

10.1.1 The Arefable? Macro

10.1.2 The NConcF Macro

10.1.3 The Nthable? Macro

10.1.4 The Set-NthCdr Macro

10.2 Functions

10.2.1 The Array-Values Function

10.2.2 The Nth-From-End Function

10.2.3 The Sequence? Function

10.2.4 The Empty-Sequence? Function

10.2.5 The Join-Symbol-To-All-Following Function

10.2.6 The Join-Symbol-To-All-Preceeding Function

10.2.7 The List-To-Vector Function

10.2.8 The Set-Equal Function

10.2.9 The Simple-Vector-To-List Function

10.2.10 The Sort-Order Function

10.2.11 The The-Last Function

10.2.12 The Vector-To-List Function

10.3 Generics

10.3.1 The Best Generic

10.3.2 The Minimum Generic

10.3.3 The Minimum? Generic

10.3.4 The Maximum Generic

Chapter 11

The `String` Package

The `String` package contains useful tools for working with strings.

11.1 Functions

11.1.1 The `Character-Range` Function

The `character-range` function returns a list of characters from the *start* to the *end* character. Note that this is returning a list, not a string.

Syntax

`(character-range` *start end*`)` $\Longrightarrow$ `'(`*start ... end*`)`

Arguments and Values

Start The character to start the range with, inclusive.

End The character to end the range with, inclusive.

Examples

```
(character-range #\a #\e) ⟹ '(#\a #\b #\c #\d #\e)
(character-range #\e #\a) ⟹ '(#\a #\b #\c #\d #\e)
```

11.1.2 The `Character-Ranges` Function

The `character-ranges` function is a convenience wrapper for `character-range` function, concatenating several calls and making the resultant list contain only unique instances.

Syntax

`(character-ranges` $start_1$ end_1 ... $\Longrightarrow$ `'(`$character_1$ ...`)`

Arguments and Values

Start$_n$ The character to start the nth range with, inclusive.

End$_n$ The character to end the nth range with, inclusive.

Examples

```
(character-ranges #\a #\c #\x #\z) ⟹ '(#\a #\b #\c #\x #\y #\z)
(character-ranges #\a #\c #\a #\c) ⟹ '(#\a #\b #\c)
```

11.1.3 The `Escape-Tildes` Function

11.1.4 The `Replace-Char` Function

11.1.5 The `StrCat` Function

11.1.6 The `StrMult` Function

11.1.7 The `String-Join` Function

11.1.8 The `Stringify` Function

11.1.9 The `To-String` Function

11.2 Methods

11.2.1 The `Split` Methods

Chapter 12

The Time-Series Package

12.1 Macros

12.1.1 The Snap-Index Macro

12.2 Functions

12.2.1 The Array-Raster-Line Function

12.2.2 The Distance Function

12.2.3 The Norm Function

12.2.4 The Raster-Line Function

12.2.5 The Similar-Points? Function

12.2.6 The Time-Series? Function

12.2.7 The Time-Multiseries? Function

12.2.8 The TMSref Function

12.2.9 The TMS-Dimensions Function

12.2.10 The TMS-Raster-Line Function

12.2.11 The TMS-Values Function

12.3 Types

12.3.1 The Time-Multiseries Type

Chapter 13

The `Truth` Package

13.1 Functions

13.1.1 The `[?]` Function

13.1.2 The `Toggle` Function

13.2 Generics

13.2.1 The `?` Generic

Chapter 14

The `Sigma` Package

14.1 Variables

14.1.1 The `*Sigma-Packages*` Variable

14.2 Functions

14.2.1 The `Use-All-Sigma` Function

Bibliography

[1] Paul Graham, *On Lisp*. Prentice-Hall, 1993. ISBN 0130305529. Retrived PDF from `http://www.paulgraham.com/onlisp.html`.