ELKS-98/0

ELKS: THE EIFFEL LIBRARY KERNEL STANDARD

~~VINTAGE 95~~

(~~Also: vintage~~ Vintage 98, Revision 0)

Report identification

TR-EI-~~48~~64/KL: *The Eiffel Library Kernel Standard, Vintage 98.* ~~(Earlier title:~~ Based on TR-EI-48/KL, *The ~~Proposed~~ Eiffel Library ~~Kernel Standard~~Standard* (describing ELKS vintage 95). Prepared ~~for the Nonprofit International Consortium for Eiffel~~ by:

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Publication history

Based on ELKS Vintage 95 (see TR-EI-48/KL):

First published: 14 July 1994.

Version 5: 25 September 1994.

Version 6: 10 October 1994.

Version 7: 12 January 1995, integrating the result of the votes of the NICE library committee (December 1994) on classes *ANY*, *PLATFORM* and *GENERAL*..

Version 8, 4 June 1995, approved as the vintage 95 library standard.

For Vintage 98:

Revision 0: technical content identical to ELKS 95 document (TR-EI-48/KL) but adapted

The present text is version 9, 26 July 1998. It is not really a new version since the technical content is identical to version 8 . The purposes of this revision are:

- To provide a PDF version (earlier releases were available on paper and in Postscript).

- To perform text formating changes, taking advantage of color and circumventing a catastrophic bug of Adobe FrameMaker 5.5.

- To update addresses (mostly on the present page).

- Most importantly, to prepare for ELKS 98. As a working document this can thus be considered as revision 0 of ELKS 98.

~~Authors~~

~~The document was written by Bertrand Meyer and benefited from numerous discussions with Michael Schweitzer.~~

~~The substance (the kernel specification) is the result of a collective effort with contributions from:~~

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Document Comparison Summary

Documents

	Name	Modification Date
Newer Document:	TITLE	July 26, 1998 6:19 pm
Older Document:	TITLE	July 26, 1998 3:31 pm

Number of Changes

Type	Insertions	Deletions	Changes
Text Content	7	5	7
Tables	1	0	0

Flow A

Text Content Changes
Page Numbers

Composite	Newer	Older	Change	Text
1	1	1	Inserted:	"ELKS-98/0"
1	1	1	Deleted:	"VINTAGE 95"
1	1	1	Replaced:	" (Also: vintage " With: "Vintage "
1	1	1	Replaced:	")" With: " "
2	1	1	Replaced:	" " With: ""
3	2	2	Replaced:	"48" With: "64"
3	2	2	Inserted:	"Kernel "
3	2	2	Inserted:	", Vintage 98"
3	2	2	Replaced:	"(Earlier title: " With: "Based on TR-EI..."
3	2	2	Deleted:	"Proposed "
3	2	2	Replaced:	"Kernel Standard" With: "Standard (describing ELKS vintage ..."
3	2	2	Deleted:	"for the Nonprofit International Consortium ..."
3	2	2	Deleted:	"Interactive Software Engineering"
3	2	2	Inserted:	"Interactive Software Engineering ISE ... "
3	2	2	Inserted:	" http://..."
3	2	2	Deleted:	"http://..."
3	2	2	Inserted:	"Based on ELKS Vintage 95 ..."
3	2	2	Inserted:	"For Vintage 98:"
4	2	2	Replaced:	"Authors " With: "Authors"

Table Changes
Page Numbers

Composite	Newer	Older	Change	Table Title
1	1	1	Inserted:	No Title

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Documents

	Name	Modification Date
Newer Document:	FLATSHORTS	July 26, 1998 6:30 pm

Flow A

Text Content Changes
Page Numbers

Composite	Newer	Older	Change	Text
33	33	33	Inserted:	"ensure"
34	34	34	Inserted:	"require"

Contents

0 INTRODUCTION

[This introduction is not part of the Standard.]

0.1

To favor the interoperability between implementations of Eiffel, it is necessary, along with a precise definition of the language, to have a well-defined set of libraries covering needs that are likely to arise in most applications. This library is known in Eiffel as the Kernel Library.

0.2

The present document defines a standard for the Kernel Library. If an Eiffel implementation satisfies this Standard — under the precise definition of *Kernel Compatibility* given in section 2.2 — it will be able to handle properly any Eiffel system whose use of the Kernel Library only assumes the library properties defined in this Standard.

0.3

The Eiffel Library standardization process, as described in Appendix A of the present document, is based on a dynamic view which, in the spirit of Eiffel's own "feature obsolescence" mechanism, recognizes the need to support evolution while preserving the technology investment of Eiffel users. One of the consequences of this dynamic view is to define *vintages* corresponding to successive improvements of the Standard. The present document describes **Vintage 95**, valid for the calendar year 1995.

1 CONTENTS OF THIS STANDARD

1.1 Definition: this Standard

The Eiffel Kernel Library Standard, denoted in the present document by the phrase "this Standard", is made up of the contents of sections 1 to 5 of the present document, with the exception of elements appearing between square brackets [...] which are comments.

[As a result of the preceding definition the following elements are not part of this Standard: section 0, the table of contents, Appendix A in section 6 (the Kernel Library Standardization process), Appendix B in section 7 (list of differences), the Index in section 8, and elements playing a pure typesetting role such as page headers.]

1.2 Scope of this Standard

This Standard defines a number of library-related conditions that an Eiffel implementation must satisfy. These conditions affect a set of classes known as the kernel library. An implementation that satisfies the conditions described in this Standard will be said to be **kernel-compatible**, a phrase that is abbreviated in this Standard as just "compatible".

[In other contexts it may be preferable to use the full phrase, since the compatibility of an Eiffel implementation also involves other aspects, such as language compatibility.]

[The terms "compatibility" and "compatible" may be felt to be less clear than "conformance" and "conformant". The former are used here, however, since talking about conformance might cause confusions with the Eiffel notion of a type conforming to another.]

1.3 Other documents

The phrase *Eiffel: The Language* as used in this Standard refers to the second printing of the book *Eiffel: The Language*, Prentice Hall, 1992, ISBN 0-13-245-925-7.

For the purposes of this Standard, the definition of the Eiffel language is the definition given by *Eiffel: The Language*.

In case of contradictions between the library specifications given by *Eiffel: The Language* and those given in this Standard, the latter shall take precedence.

2 COMPATIBILITY CONDITIONS

2.1 Definitions

2.1.1 Required Classes

In this Standard, the phrase "Required Classes" denotes a set of classes whose names are those listed in section 3.

2.1.2 Required Flatshort Form

In this Standard, the phrase "Required Flatshort Forms" denotes the flatshort forms given for the Required Classes in section 3.

2.1.3 Flatshort Compatibility

In this Standard, a class is said to be Flatshort-Compatible with one of the short forms given in this Standard if it satisfies the conditions given in section 2 of this Standard.

2.1.4 Required Ancestry Links

In this Standard, the expression "Required Ancestry Links" denotes the inheritance links specified in section 4 of this Standard.

[The term "Ancestry" is used rather than "Inheritance" because the required links may be implemented by indirect rather than direct inheritance, except for which must be a direct heir of *GENERAL* as per rule 4.2, given on page 10.]

2.2 Kernel compatibility

2.2.1 Definition

An Eiffel implementation will be said to be kernel-compatible if and only if it includes a set of classes satisfying the following five conditions:

2.2.1.1
- For each of the Required Classes, the implementation includes a class with the same name.

2.2.1.2
- All the Required Ancestry Links are present between these classes.

2.2.1.3
- The flatshort form of each one of these classes is Flatshort-Compatible with the corresponding Required Flatshort Form.

2.2.1.4
- All the dependents of the Required Classes in the implementation are also included in the implementation.

2.2.1.5
- None of the features appearing in the Required Flatshort Forms appears in a Rename clause of any of the implementation's Required Classes.

[These conditions allow a kernel-compatible implementation to include inheritance links other than the ones described in this Standard; condition 2.2.1.4 indicates that for any such link the additional proper ancestors must also be provided by the implementors, since the dependents of a class include its parents.]

[Condition 2.2.1.4 guarantees that if a feature name appears in this Standard both in the Flatshort form of a Required Class and in the flatshort form of one of its proper ancestors, it corresponds to the same feature or to a redefinition of it.]

2.3 Flatshort Conventions

2.3.1 Definition

In the process of assessing for Flatshort Compatibility a class C from a candidate implementation, the following ten conventions, which have been applied to the Required Flatshort Forms as they appear in this Standard, shall be applied:

2.3.1.1
- No feature shall be included unless it is generally available (as defined in *Eiffel: The Language*, page 100) or is a general creation procedure (as defined in *Eiffel: The Language*, page 285).

2.3.1.2
- The Creation clause of the flatshort specification shall include the full specification of all general creation procedures of C.

2.3.1.3
- Any feature of C not inherited from *GENERAL* shall be included in one of the Feature clauses.

[As a consequence of the last two rules the specification of a creation procedure that is also generally exported will appear twice: in the Creation clause and in a Feature clause. Also note that the "features of a class" include inherited as well as immediate features, so that all features inherited from an ancestor other than *GENERAL* must appear in the flatshort form.]

2.3.1.4
- A feature f from *GENERAL* shall be included if and only if C redeclares f.

2.3.1.5
- The header comment of any inherited feature coming from a Required Class *A* and having the same name in *C* as in *A* shall end with a line of the form:

  -- (From *A*.)

2.3.1.6
- The header comment of any inherited feature coming from a Required Class *A* and having a name in *C* different from its name *x* in *A* shall end with a line of the form:

  -- (From *x* in *A*.)

  [The comments defined in the last two rules are applicable regardless of whether *C* redeclares the feature.]

2.3.1.7
- If deferred, *C* shall appear as **deferred class**.

2.3.1.8
- Any deferred feature of *C* shall be marked as **deferred**.

2.3.1.9
- In case of precondition redeclaration, the successive preconditions shall appear as a single Precondition clause, separated by semicolons.

2.3.1.10
- In case of postcondition redeclaration, the successive preconditions shall appear as a single Postcondition clause, separated by **and then**.

2.4 Flatshort Compatibility

2.4.1 Definition

A class appearing in an Eiffel implementation is said to be Flatshort-Compatible with a class of the same name listed in this Standard if and only if any difference that may exist between its flatshort form *ic* and the flatshort form *sc* of the corresponding class as it appears in section 5, where both flatshort forms follow the conventions of section 2.3, belongs to one of the following eleven categories:

2.4.1.1
- A feature that appears in *ic* but not in *sc*, whose Header_comment includes, as its last line, the mention:

  -- (Feature not in Kernel Library Standard.)

2.4.1.2
- An invariant clause that appears in *ic* but not in *sc*.

2.4.1.3
- For a feature that appears in both *ic* and *sc*, a postcondition clause that appears in *ic* but not in *sc*.

2.4.1.4
- For a feature that appears in both *ic* and *sc*, a precondition in *sc* that implies the precondition in *ic*, where the implication is readily provable using rules of mathematical logic.

2.4.1.5
- For a feature that appears in both *ic* and *sc*, a postcondition or invariant clause in *ic* that implies the corresponding clause in *sc*, where the implication is readily provable using rules of mathematical logic.

2.4.1.6
- A difference between the Tag_mark of an Assertion_clause in *ic* and its counterpart in *sc*.

2.4.1.7
- For a feature that appears in both *ic* and *sc*, an argument type in *sc* that is different from the corresponding type in *ic* but conforms to it.

2.4.1.8   • For a feature that appears in both *ic* and *sc*, an argument type in *ic* that is different from the corresponding type in *sc* but conforms to it.

2.4.1.9   • For a feature that appears in both *ic* and *sc*, a line that appears in the Header_ comment of *ic* but not in that of *sc*.

2.4.1.10   • An Index_clause that appears in *ic* but not in *sc*.

2.4.1.11   • A difference regarding the order in which a feature appears in *ic* and *sc*, the Feature_clause to which it belongs, the Header_comment of such a Feature_ clause, or the presence in *ic* of a Feature_clause that has no counterpart in *sc*.

> [As a consequence of section 2.4.1.11, the division of classes into one Feature_ clause or more, and the labels of these clauses, appear in this document for the sole purpose of readability and ease of opdreference, but are not part of this Standard.]

> [The goal pursued by the preceding definition is to make sure that an Eiffel system that follows this Standard will be correctly processed by any compatible implementation, without limiting the implementors' freedom to provide more ambitious facilities.]

3 REQUIRED CLASSES

The Required Classes are the following twenty classes [ordered from the general to the specific, as in section 5]:

3.1   • *GENERAL* [flatshort form in section 5.1].

3.2   • *ANY* [flatshort form in section 5.2].

3.3   • *COMPARABLE* [flatshort form in section 5.3].

3.4   • *HASHABLE* [flatshort form in section 5.4].

3.5   • *NUMERIC* [flatshort form in section 5.5].

3.6   • *BOOLEAN* [flatshort form in section 5.6].

3.7   • *CHARACTER* [flatshort form in section 5.7].

3.8   • *INTEGER* [flatshort form in section 5.8].

3.9   • *REAL* [flatshort form in section 5.9].

3.10   • *DOUBLE* [flatshort form in section 5.10].

3.11   • *POINTER* [flatshort form in section 5.10].

3.12   • *ARRAY* [flatshort form in section 5.12].

3.13   • *STRING* [flatshort form in section5.13).

3.14   • *STD_FILES* [flatshort form in section 5.14].

3.15   • *FILE* [flatshort form in section 5.15].

3.16   • *STORABLE* [flatshort form in section 5.16].

3.17	• *MEMORY* [flatshort form in section 5.17].
3.18	• *EXCEPTIONS* [flatshort form in section 5.18].
3.19	• *ARGUMENTS* [flatshort form in section 5.19].
3.20	• *PLATFORM* [flatshort form in section 5.20].
3.21	• *BOOLEAN_REF* [flatshort form in section 5.21].
3.22	• *CHARACTER_REF* [flatshort form in section 5.22].
3.23	• *DOUBLE_REF* [flatshort form in section 5.23].
3.24	• *INTEGER_REF* [flatshort form in section 5.24].
3.25	• *POINTER_REF* [flatshort form in section 5.25].
3.26	• *REAL_REF* [flatshort form in section 5.26].

[The classes appear in this section and section and section 5 in the following order: universal classes; deferred classes for basic classes; basic classes; arrays and strings; operating system interface; auxiliary reference classes for the definition of basic classes.]

4 REQUIRED ANCESTRY LINKS

The following constitute the required ancestry links [ordered alphabetically, after the first rule, by the name of the applicable descendant class]:

4.1	• Every Required Class except *GENERAL* is a descendant of *ANY*
4.2	• *ANY* is an heir of *GENERAL*.
4.3	• *BOOLEAN* is a proper descendant of *BOOLEAN_REF*.
4.4	• *BOOLEAN_REF* is a proper descendant of *HASHABLE*.
4.5	• *CHARACTER* is a proper descendant of *CHARACTER_REF*.
4.6	• *CHARACTER_REF* is a proper descendant of *COMPARABLE*.
4.7	• *CHARACTER_REF* is a proper descendant of *HASHABLE*.
4.8	• *DOUBLE* is a proper descendant of *DOUBLE_REF*.
4.9	• *DOUBLE_REF* is a proper descendant of *COMPARABLE*.
4.10	• *DOUBLE_REF* is a proper descendant of *HASHABLE*.
4.11	• *DOUBLE_REF* is a proper descendant of *NUMERIC*.
4.12	• *FILE* is a proper descendant of *MEMORY*.
4.13	• *INTEGER* is a proper descendant of *INTEGER_REF*.
4.14	• *INTEGER_REF* is a proper descendant of *COMPARABLE*.
4.15	• *INTEGER_REF* is a proper descendant of *HASHABLE*.
4.16	• *INTEGER_REF* is a proper descendant of *NUMERIC*.

4.17   • *POINTER* is a proper descendant of *POINTER_REF*.

4.18   • *POINTER_REF* is a proper descendant of *HASHABLE*.

4.19   • *REAL* is a proper descendant of *REAL_REF*.

4.20   • *REAL_REF* is a proper descendant of *COMPARABLE*.

4.21   • *REAL_REF* is a proper descendant of *HASHABLE*.

4.22   • *STRING* is a proper descendant of *COMPARABLE*.

4.23   • *STRING* is a proper descendant of *HASHABLE*.

4.24   • *STRING* is a proper descendant of *HASHABLE*.

[4.1 follows from *Eiffel: The Language*; the language description is considered to be amended in such a way that *PLATFORM* is a class without privileges, to be inherited explicitly by classes which need access to its features.]

5 SHORT FORMS OF REQUIRED CLASSES

5.1 Class *GENERAL*

indexing

> *description*: "Platform-independent universal
> properties. This class is an ancestor to all
> developer-written classes."

class interface

> *GENERAL*

feature -- Access

> *generating_type*: *STRING*
> > -- Name of current object's generating type
> > -- (type of which it is a direct instance)

> *generator*: *STRING*
> > -- Name of current object's generating class
> > -- (base class of the type of which it is a direct
> > instance)

> *id_object* (*id*: *INTEGER*): *ANY*
> > -- Object for which *object_id* has returned *id*;
> > -- void if none.

> *object_id*: *INTEGER*
> > -- Value identifying current object uniquely;
> > -- meaningful only for reference types.

> *stripped* (*other*: *GENERAL*): **like** *other*
> > -- New object with fields copied from current
> > object,
> > -- but limited to attributes of type of *other*.

> > **require**
> > > *conformance*: *conforms_to* (*other*)

> > **ensure**
> > > *stripped_to_other*: *Result*.*same_type* (*other*)

feature -- Status report

> **frozen** *conforms_to* (*other*: *GENERAL*): *BOOLEAN*
> > -- Does type of current object conform to type
> > -- of *other* (as per *Eiffel*: *The Language*,
> > chapter13)?

> > **require**
> > > *other_not_void*: *other* /= *Void*

> **frozen** *same_type* (*other*: *GENERAL*): *BOOLEAN*
> > -- Is type of current object identical to type of
> > *other*?

> > **require**
> > > *other_not_void*: *other* /= *Void*

> > **ensure**
> > > *definition*: *Result* = (*conforms_to* (*other*) **and**
> > > *other*.*conforms_to* (*Current*))

feature -- Comparison

> **frozen** *deep_equal* (*some*: *GENERAL*; *other*: **like** *some*):
> *BOOLEAN*
> > -- Are *some* and *other* either both void
> > -- or attached to isomorphic object structures?

> > **ensure**
> > > *shallow_implies_deep*: *standard_equal* (*some*,
> > > *other*) **implies** *Result*

> > > *same_type*: *Result* **implies** *some*.*same_type*
> > > (*other*)

> > > *symmetric*: *Result* **implies** *deep_equal* (*other*,
> > > *some*)

> **frozen** *equal* (*some*: *GENERAL*; *other*: **like** *some*):
> *BOOLEAN*
> > -- Are *some* and *other* either both void or attached
> > -- to objects considered equal?

> > **ensure**
> > > *definition*: *Result* = (*some* = *Void* **and** *other* =
> > > *Void*) **or else** ((*some* /= *Void* **and** *other* /= *Void*)
> > > **and then** *some*.*is_equal* (*other*))

> *is_equal* (*other*: **like** *Current*): *BOOLEAN*
> > -- Is *other* attached to an object considered equal
> > -- to current object?

> > **require**
> > > *other_not_void*: *other* /= *Void*

> > **ensure**
> > > *consistent*: *standard_is_equal* (*other*) **implies**
> > > *Result*

> > > *same_type*: *Result* implies *same_type* (*other*)

> > > *symmetric*: *Result* **implies** *other*.*is_equal*
> > > (*Current*)

frozen *standard_equal* (*some*: *GENERAL; other*: **like** *some*): *BOOLEAN*
-- Are *some* and *other* either both void or attached to
-- field-by-field identical objects of the same type?
-- Always uses the default object comparison criterion.
ensure
definition: *Result* = (*some* = *Void* **and** *other* = *Void*) **or else** ((*some* /= *Void* **and** *other* /= *Void*) **and then** *some*.*standard_is_equal* (*other*))

frozen *standard_is_equal* (*other*: **like** *Current*): *BOOLEAN*
-- Is *other* attached to an object of the same type as
-- current object, and field-by-field identical to it?
require
other_not_void: *other* /= *Void*
ensure
same_type: *Result* **implies** *same_type* (*other*)
symmetric: *Result* **implies** *other*.*standard_is_equal* (*Current*)

feature -- Duplication

frozen *clone* (*other*: *GENERAL*): **like** *other*
-- Void if *other* is void; otherwise new object
-- equal to *other*.
ensure
equal: *equal* (*Result*, *other*)

copy (*other*: **like** *Current*)
-- Update current object using fields of object attached
-- to *other*, so as to yield equal objects.
require
other_not_void: *other* /= *Void*;
type_identity: *same_type* (*other*)
ensure
is_equal: *is_equal* (*other*)

frozen *deep_clone* (*other*: *GENERAL*): **like** *other*
-- Void if *other* is void: otherwise, new object structure
-- recursively duplicated from the one attached to *other*
ensure
deep_equal: *deep_equal* (*other*, *Result*)

frozen *standard_clone* (*other*: *GENERAL*): **like** *other*
-- Void if *other* is void; otherwise new object
-- field-by-field identical to *other*.
-- Always uses the default copying semantics.
ensure
equal: *standard_equal* (*Result*, *other*)

frozen *standard_copy* (*other*: **like** *Current*)
-- Copy every field of *other* onto corresponding field
-- of current object.
require
other_not_void: *other* /= *Void*;
type_identity: *same_type* (*other*)
ensure
is_standard_equal: *standard_is_equal* (*other*)

feature -- Basic operations

frozen *default*: **like** *Current*
-- Default value of current type

frozen *default_pointer*: *POINTER*
-- Default value of type *POINTER*
-- (Avoid the need to write *p*.*default* for some *p*
-- of type *POINTER*.)
ensure
Result = *Result*.*default*

default_rescue
-- Handle exception if no Rescue clause.
-- (Default: do nothing.)

frozen *do_nothing*
-- Execute a null action.

frozen *Void*: *NONE*
-- Void reference

feature -- Output

io: *STD_FILES*
-- Handle to standard file setup

out: *STRING*
-- New string containing terse printable representation
-- of current object

print (*some*: *GENERAL*)
-- Write terse external representation of *some* on
-- standard output.

frozen *tagged_out*: *STRING*
-- New string containing printable representation of
-- current object, each field preceded by its attribute
-- name, a colon and a space.

invariant

reflexive_equality: *standard_is_equal* (*Current*)

reflexive_conformance: *conforms_to* (*Current*)

involutive_object_id: *id_object* (*object_id*) = *Current*

end

5.2 Class *ANY*

indexing

    description: "Project-wide universal properties. This
       class is an ancestor to all developer-written classes.
       ANY inherits from *GENERAL* and may be
       customized for individual projects or teams."

class interface

    ANY

end

5.3 Class *COMPARABLE*

indexing

description: "Objects that may be compared according to a total order relation"

note: "The basic operation is "<" (less than); others are defined in terms of this operation and *is_equal*."

deferred class interface

COMPARABLE

feature -- Comparison

infix "<" (*other*: **like** *Current*): *BOOLEAN*
-- Is current object less than *other*?

 require

  other_exists: *other* /= *Void*

 deferred

 ensure

  asymmetric: *Result* **implies not** (*other* < *Current*)

infix "<=" (*other*: **like** *Current*): *BOOLEAN*
-- Is current object less than or equal to *other*?

 require

  other_exists: *other* /= *Void*

 ensure

  definition: *Result* = (*Current* < *other*) **or** *is_equal* (*other*)

infix ">=" (*other*: **like** *Current*): *BOOLEAN*
-- Is current object greater than or equal to *other*?

 require

  other_exists: *other* /= *Void*

 ensure

  definition: *Result* = (*other* <= *Current*)

infix ">" (*other*: **like** *Current*): *BOOLEAN*
-- Is current object greater than *other*?

 require

  other_exists: *other* /= *Void*

 ensure

  definition: *Result* = (*other* < *Current*)

is_equal (*other*: **like** *Current*): *BOOLEAN*
-- Is *other* attached to an object considered equal
-- to current object?
-- (Redefined from *GENERAL*.)

 require

  other_not_void: *other* /= *Void*

 ensure

  symmetric: *Result* **implies** *other*.*is_equal* (*Current*)

  consistent: *standard_is_equal* (*other*) **implies** *Result*

  trichotomy: *Result* = (**not** (*Current* < *other*) **and not** (*other* < *Current*))

max (*other*: **like** *Current*): **like** *Current*
-- The greater of current object and *other*

 require

  other_exists: *other* /= *Void*

 ensure

  current_if_not_smaller: (*Current* >= *other*) **implies** (*Result* = *Current*)

  other_if_smaller: (*Current* < *other*) **implies** (*Result* = *other*)

min (*other*: **like** *Current*): **like** *Current*
-- The smaller of current object and *other*

 require

  other_exists: *other* /= *Void*

 ensure

  current_if_not_greater: (*Current* <= *other*) **implies** (*Result* = *Current*)

  other_if_greater: (*Current* > *other*) **implies** (*Result* = *other*)

three_way_comparison (*other*: **like** *Current*): *INTEGER*)
-- If current object equal to *other*, 0; if smaller,
-- −1; if greater, 1.

 require

  other_exists: *other* /= *Void*

 ensure

  equal_zero: (*Result* = 0) = *is_equal* (*other*)

  smaller_negative: (*Result* = −1) = (*Current* < *other*)

  greater_positive: (*Result* = 1) = (*Current* > *other*)

invariant

irreflexive_comparison: **not** (*Current* < *Current*)

end

5.4 Class *HASHABLE*

indexing

   description: "Values that may be hashed into an integer
      index, for use as keys in hash tables."

deferred class interface

   HASHABLE

feature -- Access

   hash_code: *INTEGER*
            -- Hash code value
      deferred

      ensure
         good_hash_value: *Result >= 0*

end

5.5 Class *NUMERIC*

indexing

    description: "Objects to which numerical operations are
      applicable"

    note: "The model is that of a commutative ring."

deferred class interface

    NUMERIC

feature -- Access

    one: **like** *Current*
        -- Neutral element for "*" and "/"

      deferred

      ensure
        Result_exists: *Result* /= *Void*

    zero: **like** *Current*
        -- Neutral element for "+" and "−"

      deferred

      ensure
        Result_exists: *Result* /= *Void*

feature -- Status report

    divisible (*other*: **like** *Current*): *BOOLEAN*
        -- May current object be divided by *other*?

      require
        other_exists: *other* /= *Void*

      deferred

    exponentiable (*other*: *NUMERIC*): *BOOLEAN*
        -- May current object be elevated to the power *other*?

      require
        other_exists: *other* /= *Void*

      deferred

feature -- Basic operations

    infix "+" (*other*: **like** *Current*): **like** *Current*
        -- Sum with *other* (commutative).

      require
        other_exists: *other* /= *Void*

      deferred

      ensure
        result_exists: *Result* /= *Void*
        commutative: *equal* (*Result*, *other* + *Current*)

infix "−" (*other*: **like** *Current*): **like** *Current*
        -- Result of subtracting *other*

    require
      other_exists: *other* /= *Void*

    deferred

    ensure
      result_exists: *Result* /= *Void*

infix "*" (*other*: **like** *Current*): **like** *Current*
        -- Product by *other*

    require
      other_exists: *other* /= *Void*

    deferred

    ensure
      result_exists: *Result* /= *Void*

infix "/" (*other*: **like** *Current*): **like** *Current*
        -- Division by *other*

    require
      other_exists: *other* /= *Void*
      good_divisor: *divisible* (*other*)

    deferred

    ensure
      result_exists: *Result* /= *Void*

infix "^" (*other*: *NUMERIC*): *NUMERIC*
        -- Current object to the power *other*

    require
      other_exists: *other* /= *Void*
      good_exponent: *exponentiable* (*other*)

    deferred

    ensure
      result_exists: *Result* /= *Void*

prefix "+": **like** *Current*
        -- Unary plus

    deferred

    ensure
      result_exists: *Result* /= *Void*

prefix "−": **like** *Current*
        -- Unary minus

    deferred

    ensure
      result_exists: *Result* /= *Void*

invariant

    neutral_addition: *equal* (*Current* + *zero*, *Current*)
    self_subtraction: *equal* (*Current* – *Current*, *zero*)

    neutral_multiplication: *equal* (*Current* * *one*, *Current*)

    self_division: *divisible* (*Current*) **implies** *equal* (*Current* /
      Current, *one*)

end

5.6 Class *BOOLEAN*

indexing

>   *description*: "Truth values, with the boolean
>   operations"

expanded class interface

>   *BOOLEAN*

feature -- Access

>   *hash_code*: *INTEGER*
>   -- Hash code value
>   -- (From *HASHABLE*.)
>   **ensure**
>   *good_hash_value*: *Result* >= *0*

feature -- Basic operations

>   **infix** "**and**" (*other*: *BOOLEAN*): *BOOLEAN*
>   -- Boolean conjunction with *other*
>   **require**
>   *other_exists*: *other* /= *Void*
>   **ensure**
>   *Result_exists*: *Result* /= *Void*
>   *de_morgan*: *Result* = **not** (**not** *Current* **or** (**not**
>   *other*))
>   *commutative*: *Result* = (*other* **and** *Current*)
>   *consistent_with_semi_strict*: *Result* **implies**
>   (*Current* **and then** *other*)

>   **infix** "**and then**" (*other*: *BOOLEAN*): *BOOLEAN*
>   -- Boolean semi-strict conjunction with *other*
>   **require**
>   *other_exists*: *other* /= *Void*
>   **ensure**
>   *Result_exists*: *Result* /= *Void*
>   *de_morgan*: *Result* = **not** (**not** *Current* **or else** (**not**
>   *other*))

>   **infix** "**implies**" (*other*: *BOOLEAN*): *BOOLEAN*
>   -- Boolean implication of *other*
>   -- (semi-strict)
>   **require**
>   *other_exists*: *other* /= *Void*
>   **ensure**
>   *definition*: *Result* = (**not** *Current* **or else** *other*)

>   **prefix** "**not**": *BOOLEAN*
>   -- Negation.

infix "**or**" (*other*: *BOOLEAN*): *BOOLEAN*
>   -- Boolean disjunction with *other*
>   **require**
>   *other_exists*: *other* /= *Void*
>   **ensure**
>   *Result_exists*: *Result* /= *Void*
>   *de_morgan*: *Result* = **not** (**not** *Current* **and** (**not**
>   *other*))
>   *commutative*: *Result* = (*other* **or** *Current*)
>   *consistent_with_semi_strict*: *Result* **implies**
>   (*Current* **or else** *other*)

infix "**or else**" (*other*: *BOOLEAN*): *BOOLEAN*
>   -- Boolean semi-strict disjunction with *other*
>   **require**
>   *other_exists*: *other* /= *Void*
>   **ensure**
>   *Result_exists*: *Result* /= *Void*
>   *de_morgan*: *Result* = **not** (**not** *Current* **and then**
>   (**not** *other*))

infix "**xor**" (*other*: *BOOLEAN*): *BOOLEAN*
>   -- Boolean exclusive or with *other*
>   **require**
>   *other_exists*: *other* /= *Void*
>   **ensure**
>   *definition*: *Result* = ((*Current* **or** *other*) **and not**
>   (*Current* **and** *other*))

feature -- Output

>   *out*: *STRING*
>   -- Printable representation of boolean

invariant

>   *involutive_negation*: *is_equal* (**not** (**not** *Current*))

>   *non_contradiction*: **not** (*Current* **and** (**not** *Current*))

>   *completeness*: *Current* **or** (**not** *Current*)

end

5.7 Class *CHARACTER*

indexing

   description: "Characters, with comparison operations
     and an ASCII code"

expanded class interface

   CHARACTER

feature -- Access

   code: *INTEGER*
       -- Associated integer value

   hash_code: *INTEGER*
       -- Hash code value
       -- (From *HASHABLE*.)
     ensure
       good_hash_value: *Result* >= *0*

feature -- Comparison

   infix "<" (*other*: **like** *Current*): *BOOLEAN*
       -- Is *other* greater than current character?
       -- (From *COMPARABLE*.)
     require
       other_exists: *other* /= *Void*

     ensure
       asymmetric: *Result* **implies not** (*other* < *Current*)

   infix "<=" (*other*:**like** *Current*): *BOOLEAN*
       -- Is current character less than or equal to *other*?
       -- (From *COMPARABLE*.)
     require
       other_exists: *other* /= *Void*

     ensure
       definition: *Result* = (*Current* < *other*) **or** *is_equal*
         (*other*)

   infix ">=" (*other*: **like** *Current*): *BOOLEAN*
       -- Is current object greater than or equal to *other*?
       -- (From *COMPARABLE*.)
     require
       other_exists: *other* /= *Void*

     ensure
       definition: *Result* = (*other* <= *Current*)

   infix ">" (*other*: **like** *Current*): *BOOLEAN*
       -- Is current object greater than *other*?
       -- (From *COMPARABLE*.)
     require
       other_exists: *other* /= *Void*

     ensure
       definition: *Result* = (*other* < *Current*)

   max (*other*: **like** *Current*): **like** *Current*
       -- The greater of current object and *other*
       -- (From *COMPARABLE*.)
     require
       other_exists: *other* /= *Void*

     ensure
       current_if_not_smaller: (*Current* >= *other*)
         implies (*Result* = *Current*)
       other_if_smaller: (*Current* < *other*) **implies**
         (*Result* = *other*)

   min (*other*: **like** *Current*): **like** *Current*
       -- The smaller of current object and *other*
       -- (From *COMPARABLE*.)
     require
       other_exists: *other* /= *Void*

     ensure
       current_if_not_greater: (*Current* <= *other*)
         implies (*Result* = *Current*)
       other_if_greater: (*Current* > *other*) **implies**
         (*Result* = *other*)

   three_way_comparison (*other*: **like** *Current*): *INTEGER*
       -- If current object equal to *other*, 0; if smaller,
       -- −1; if greater, 1.
       -- (From *COMPARABLE*.)
     require
       other_exists: *other* /= *Void*

     ensure
       equal_zero: (*Result* = *0*) = *is_equal* (*other*)
       smaller: (*Result* = −1) = *Current* < *other*
       greater_positive: (*Result* = 1) = *Current* > *other*

feature -- Output

    out: *STRING*
            -- Printable representation of character
            -- (From *GENERAL.*)

invariant

    irreflexive_comparison: **not** (*Current* < *Current*)

end

5.8 Class *INTEGER*

indexing

   description: "Integer values"

expanded class interface

   INTEGER

feature -- Access

   hash_code: *INTEGER* **is**
         -- Hash code value
         -- (From *HASHABLE*.)
      ensure
         good_hash_value: *Result >= 0*

   one: **like** *Current*
         -- Neutral element for "∗" and "/"
         -- (From *NUMERIC*.)
      ensure
         Result_exists: *Result /= Void*

         value: *Result = 1*

   sign: *INTEGER*
         -- Sign value (0, –1 or 1)
      ensure
         three_way: *Result = three_way_comparison*
            (*zero*)

   zero: **like** *Current*
         -- Neutral element for "+" and "–"
         -- (From *NUMERIC*.)
      ensure
         Result_exists: *Result /= Void*

         value: *Result = 0*

feature -- Comparison

   infix "<" (*other*: **like** *Current*): *BOOLEAN*
         -- Is *other* greater than current integer?
         -- (From *COMPARABLE*.)
      require
         other_exists: *other /= Void*

      ensure
         asymmetric: *Result* **implies not** (*other < Current*)

   infix "<=" (*other*: **like** *Current*): *BOOLEAN*
         -- Is current object less than or equal to *other*?
         -- (From *COMPARABLE*.)
      require
         other_exists: *other /= Void*

      ensure
         definition: *Result = (Current < other)* **or** *is_equal*
            (*other*)

   infix ">=" (*other*: **like** *Current*): *BOOLEAN*
         -- Is current object greater than or equal to *other*?
         -- (From *COMPARABLE*.)
      require
         other_exists: *other /= Void*

      ensure
         definition: *Result = (other <= Current)*

   infix ">" (*other*: **like** *Current*): *BOOLEAN*
         -- Is current object greater than *other*?
         -- (From *COMPARABLE*.)
      require
         other_exists: *other /= Void*

      ensure
         definition: *Result = (other < Current)*

   max (*other*: **like** *Current*): **like** *Current*
         -- The greater of current object and *other*
         -- (From *COMPARABLE*.)
      require
         other_exists: *other /= Void*

      ensure
         current_if_not_smaller: (*Current >= other*)
            implies (*Result = Current*)
         other_if_smaller: (*Current < other*) **implies**
            (*Result = other*)

   min (*other*: **like** *Current*): **like** *Current*
         -- The smaller of current object and *other*
         -- (From *COMPARABLE*.)
      require
         other_exists: *other /= Void*

      ensure
         current_if_not_greater: (*Current <= other*)
            implies (*Result = Current*)
         other_if_greater: (*Current > other*) **implies**
            (*Result = other*)

three_way_comparison (*other*: **like** *Current*): *INTEGER*
      -- If current object equal to *other*, 0; if smaller,
      -- –1; if greater, 1.
      -- (From *COMPARABLE*.)
    require
        other_exists: *other* /= *Void*
    ensure
        equal_zero: (*Result = 0*) = *is_equal* (*other*)
        smaller: (*Result = 1*) = *Current < other*
        greater_positive: (*Result = –1*) = *Current > other*

feature -- Status report

divisible (*other*: **like** *Current*): *BOOLEAN*
      -- May current object be divided by *other*?
      -- (From *NUMERIC*.)
    require
        other_exists: *other* /= *Void*
    ensure
        value: *Result* = (*other* /= *0*)

exponentiable (*other*: *NUMERIC*): *BOOLEAN*
      -- May current object be elevated to the power
      other?
      -- (From *NUMERIC*.)
    require
        other_exists: *other* /= *Void*
    ensure
        safe_values: (*other*•*conforms_to* (*Current*) **or**
          (*other*•*conforms_to* (*0*•*0*) **and** (*Current* >= *0*)))
            implies *Result*

feature -- Basic operations

abs: **like** *Current*
      -- Absolute value
    ensure
        non_negative: *Result* >= *0*
        same_absolute_value: (*Result = Current*) **or**
          (*Result = –Current*)

infix "*" (*other*: **like** *Current*): **like** *Current*
      -- Product by *other*
      -- (From *NUMERIC*.)
    require
        other_exists: *other* /= *Void*

infix "+" (*other*: **like** *Current*): **like** *Current*
      -- Sum with *other*
      -- (From *NUMERIC*.)
    require
        other_exists: *other* /= *Void*
    ensure
        result_exists: *Result* /= *Void*
        commutative: *equal* (*Result*, *other* + *Current*)

infix "–" (*other*: **like** *Current*): **like** *Current*
      -- Result of subtracting *other*
      -- (From *NUMERIC*.)
    require
        other_exists: *other* /= *Void*
    ensure
        result_exists: *Result* /= *Void*

infix "/" (*other*: **like** *Current*): *DOUBLE*
      -- Division by *other*
    require
        other_exists: *other* /= *Void*
        good_divisor: *divisible* (*other*)
    ensure
        result_exists: *Result* /= *Void*

infix "//" (*other*: **like** *Current*): **like** *Current*
      -- Integer division of Current by *other*
      -- (From "/" in *NUMERIC*.)
    require
        other_exists: *other* /= *Void*
        good_divisor: *divisible* (*other*)
    ensure
        result_exists: *divisible* (*other*)

infix "\\" (*other*: **like** *Current*): **like** *Current*
      -- Remainder of the integer division of Current by
      other
    require
        other_exists: *other* /= *Void*
        good_divisor: *divisible* (*other*)
    ensure
        result_exists: *Result* /= *Void*

infix "^" (*other*: *NUMERIC*): *DOUBLE*
      -- Integer power of Current by *other*
      -- (From *NUMERIC*.)
    require
        other_exists: *other* /= *Void*
        good_exponent: *exponentiable* (*other*)
    ensure
        result_exists: *Result* /= *Void*

prefix "+": **like** *Current*
    -- Unary plus
    -- (From *NUMERIC*.)
  ensure
    result_exists: *Result* /= *Void*

prefix "−": **like** *Current*
    -- Unary minus
    -- (From *NUMERIC*.)
  ensure
    result_exists: *Result* /= *Void*

feature -- Output

out: *STRING*
    -- Printable representation of current object
    -- (From *GENERAL*.)

invariant

irreflexive_comparison: **not** (*Current* < *Current*)

neutral_addition: *equal* (*Current* + *zero*, *Current*)

self_subtraction: *equal* (*Current* − *Current*, *zero*)

neutral_multiplication: *equal* (*Current* * *one*, *Current*)

self_division: *divisible* (*Current*) **implies** *equal* (*Current* /
  Current, *one*)

sign_times_abs: *equal* (*sign*abs*, *Current)*

end

5.9 Class *REAL*

indexing

    description: "Real values, single precision"

expanded class interface

    REAL

feature -- Access

    hash_code: *INTEGER*
        -- Hash code value
        -- (From *HASHABLE*.)
    ensure
        good_hash_value: *Result >= 0*

    one: **like** *Current*
        -- Neutral element for "*" and "/"
        -- (From *NUMERIC*.)
    ensure
        Result_exists: *Result /= Void*
        value: *Result = 1.0*

    sign: *INTEGER*
        -- Sign value (0, –1 or 1)
    ensure
        three_way: *Result = three_way_comparison* (*zero*)

    zero: **like** *Current*
        -- Neutral element for "+" and "–"
        -- (From *NUMERIC*.)
    ensure
        Result_exists: *Result /= Void*
        value: *Result = 0.0*

feature -- Comparison

    infix "<" (*other*: **like** *Current*): *BOOLEAN*
        -- Is *other* greater than current real?
        -- (From *COMPARABLE*.)
    require
        other_exists: *other /= Void*
    ensure
        asymmetric: *Result* **implies not** (*other < Current*)

    infix "<=" (*other*: **like** *Current*): *BOOLEAN*
        -- Is current object less than or equal to *other*?
        -- (From *COMPARABLE*.)
    require
        other_exists: *other /= Void*
    ensure
        definition: *Result = (Current < other)* **or** *is_equal*
          (*other*)

    infix ">=" (*other*: **like** *Current*): *BOOLEAN*
        -- Is current object greater than or equal to *other*?
        -- (From *COMPARABLE*.)
    require
        other_exists: *other /= Void*
    ensure
        definition: *Result = (other <= Current)*

    infix ">" (*other*: **like** *Current*): *BOOLEAN*
        -- Is current object greater than *other*?
        -- (From *COMPARABLE*.)
    require
        other_exists: *other /= Void*
    ensure
        definition: *Result = (other < Current)*

    max (*other*: **like** *Current*): **like** *Current*
        -- The greater of current object and *other*
        -- (From *COMPARABLE*.)
    require
        other_exists: *other /= Void*
    ensure
        current_if_not_smaller: (*Current >= other*)
          implies (*Result = Current*)
        other_if_smaller: (*Current < other*) **implies**
          (*Result = other*)

    min (*other*: **like** *Current*): **like** *Current*
        -- The smaller of current object and *other*
        -- (From *COMPARABLE*.)
    require
        other_exists: *other /= Void*
    ensure
        current_if_not_greater: (*Current <= other*)
          implies (*Result = Current*)
        other_if_greater: (*Current > other*) **implies** (*Result*
          = other)

three_way_comparison (*other*: **like** *Current*): *INTEGER*
    -- If current object equal to *other*, 0; if smaller,
    -- –1; if greater, 1.
    -- (From *COMPARABLE*.)

require
    other_exists: *other* /= *Void*

ensure
    equal_zero: (*Result = 0*) = *is_equal* (*other*)
    smaller: (*Result = –1*) = *Current < other*
    greater_positive: (*Result = 1*) = *Current > other*

feature -- Status report

divisible (*other*: **like** *Current*): *BOOLEAN*
    -- May current object be divided by *other*?
    -- (From *NUMERIC*.)

require
    other_exists: *other* /= *Void*

ensure
    not_exact_zero: *Result* **implies** (*other* /= 0.0)

exponentiable (*other*: *NUMERIC*): *BOOLEAN*
    -- May current object be elevated to the power
    other?
    -- (From *NUMERIC*.)

require
    other_exists: *other* /= *Void*

ensure
    safe_values: (*other*.*conforms_to* (*0*) **or**
      (*other*.*conforms_to* (*Current*) **and** (*Current* >=
      0.0)))   **implies** *Result*

feature -- Conversion

ceiling: *INTEGER*
    -- Smallest integral value no smaller than current
    object

ensure
    result_no_smaller: *Result* >= *Current*
    close_enough: *Result – Current < one*

floor: *INTEGER*
    -- Greatest integral value no greater than current
    object

ensure
    result_no_greater: *Result* <= *Current*
    close_enough: *Current – Result < one*

rounded: *INTEGER*
    -- Rounded integral value

ensure
    definition: *Result* = *sign* * ((*abs* + 0.5).*floor*)

truncated_to_integer: *INTEGER*
    -- Integer part (same sign, largest absolute
    -- value no greater than current object's)

feature -- Basic operations

abs: **like** *Current*
    -- Absolute value

ensure
    non_negative: *Result* >= *0*
    same_absolute_value: (*Result = Current*) **or**
      (*Result = –Current*)

infix "*" (*other*: **like** *Current*): **like** *Current*
    -- Product by *other*
    -- (From *NUMERIC*.)

require
    other_exists: *other* /= *Void*

ensure
    result_exists: *Result* /= *Void*

infix "+" (*other*: **like** *Current*): **like** *Current*
    -- Sum with *other*
    -- (From *NUMERIC*.)

require
    other_exists: *other* /= *Void*

ensure
    result_exists: *Result* /= *Void*
    commutative: *equal* (*Result*, *other* + *Current*)

infix "–" (*other*: **like** *Current*): **like** *Current*
    -- Result of subtracting *other*
    -- (From *NUMERIC*.)

require
    other_exists: *other* /= *Void*

ensure
    result_exists: *Result* /= *Void*

infix "/" (*other*: **like** *Current*): **like** *Current*
    -- Division by *other*
    -- (From *NUMERIC*.)

require
    other_exists: *other* /= *Void*
    good_divisor: *divisible* (*other*)

ensure
    result_exists: *Result* /= *Void*

infix "^" (*other*: *NUMERIC*): *DOUBLE*
    -- Current real to the power *other*
    -- (From *NUMERIC*.)

  require
    other_exists: *other* /= *Void*
    good_exponent: *exponentiable* (*other*)

  ensure
    result_exists: *Result* /= *Void*

prefix "+": **like** *Current*
    -- Unary plus
    -- (From *NUMERIC*.)

  ensure
    result_exists: *Result* /= *Void*

prefix "−": **like** *Current*
    -- Unary minus
    -- (From *NUMERIC*.)

  ensure
    result_exists: *Result* /= *Void*

feature -- Output

out: *STRING*
    -- Printable representation of real value
    -- (From *GENERAL*.)

invariant

irreflexive_comparison: **not** (*Current* < *Current*)

neutral_addition: *equal* (*Current* + *zero*, *Current*)

self_subtraction: *equal* (*Current* − *Current*, *zero*)

neutral_multiplication: *equal* (*Current* * *one*, *Current*)

self_division: *divisible* (*Current*) **implies** *equal* (*Current* / *Current*, *one*)

sign_times_abs: *equal* (*sign*∗*abs*, *Current*)

end

5.10 Class *DOUBLE*

indexing

  description: "Real values, double precision"

expanded class interface

  DOUBLE

feature -- Access

  hash_code: *INTEGER*
        -- Hash code value
        -- (From *HASHABLE*.)
    ensure
        good_hash_value: *Result* >= 0

  one: **like** *Current*
        -- Neutral element for "∗" and "/"
        -- (From *NUMERIC*.)
    ensure
        Result_exists: *Result* /= *Void*
        value: *Result* = 1.0

  sign: *INTEGER*
        -- Sign value (0, –1 or 1)
    ensure
        three_way: *Result* = *three_way_comparison*
          (*zero*)

  zero: **like** *Current*
        -- Neutral element for "+" and "–"
        -- (From *NUMERIC*.)
    ensure
        Result_exists: *Result* /= *Void*
        value: *Result* = 0.0

feature -- Comparison

  infix "<" (*other*: **like** *Current*): *BOOLEAN*
        -- Is *other* greater than current double?
        -- (From *COMPARABLE*.)
    require
        other_exists: *other* /= *Void*
    ensure
        asymmetric: *Result* **implies not** (*other* < *Current*)

  infix "<=" (*other*: **like** *Current*): *BOOLEAN*
        -- Is current object less than or equal to *other*?
        -- (From *COMPARABLE*.)
    require
        other_exists: *other* /= *Void*
    ensure
        definition: *Result* = (*Current* < *other*) **or** *is_equal*
          (*other*)

  infix ">=" (*other*: **like** *Current*): *BOOLEAN*
        -- Is current object greater than or equal to *other*?
        -- (From *COMPARABLE*.)
    require
        other_exists: *other* /= *Void*
    ensure
        definition: *Result* = (*other* <= *Current*)

  infix ">" (*other*: **like** *Current*): *BOOLEAN*
        -- Is current object greater than *other*?
        -- (From *COMPARABLE*.)
    require
        other_exists: *other* /= *Void*
    ensure
        definition: *Result* = (*other* < *Current*)

  max (*other*: **like** *Current*): **like** *Current*
        -- The greater of current object and *other*
        -- (From *COMPARABLE*.)
    require
        other_exists: *other* /= *Void*
    ensure
        current_if_not_smaller: (*Current* >= *other*)
          implies (*Result* = *Current*)
        other_if_smaller: (*Current* < *other*) **implies**
          (*Result* = *other*)

  min (*other*: **like** *Current*): **like** *Current*
        -- The smaller of current object and *other*
        -- (From *COMPARABLE*.)
    require
        other_exists: *other* /= *Void*
    ensure
        current_if_not_greater: (*Current* <= *other*)
          implies (*Result* = *Current*)
        other_if_greater: (*Current* > *other*) **implies**
          (*Result* = *other*)

three_way_comparison (*other*: **like** *Current*): *INTEGER*
    -- If current object equal to *other*, 0; if smaller,
    -- –1; if greater, 1.
  require
    other_exists: *other* /= *Void*
    -- (From *COMPARABLE*.)
  ensure
    equal_zero: (*Result = 0*) = *is_equal* (*other*)
    smaller: (*Result = –1*) = *Current < other*
    greater_positive: (*Result = 1*) = *Current > other*

feature -- Status report

divisible (*other*: **like** *Current*): *BOOLEAN*
    -- May current object be divided by *other*?
    -- (From *NUMERIC*.)
  require
    other_exists: *other* /= *Void*
  ensure
    not_exact_zero: *Result* **implies** (*other* /= *0.0*)

exponentiable (*other*: *NUMERIC*): *BOOLEAN*
    -- May current object be elevated to the power
    other?
    -- (From *NUMERIC*.)
  require
    other_exists: *other* /= *Void*
  ensure
    safe_values: (*other*.*conforms_to* (*0*) **or**
      (*other*.*conforms_to* (*Current*) **and** (*Current >=*
      0.0))) **implies** *Result*

feature -- Conversion

ceiling: *INTEGER*
    -- Smallest integral value no smaller than current
    object
  ensure
    result_no_smaller: *Result >= Current*
    close_enough: *Result – Current < one*

floor: *INTEGER*
    -- Greatest integral value no greater than current
    object
  ensure
    result_no_greater: *Result <= Current*
    close_enough: *Current – Result < one*

rounded: *INTEGER*
    -- Rounded integral value
  ensure
    definition: *Result = sign* * ((*abs + 0.5*).*floor*)

truncated_to_integer: *INTEGER*
    -- Integer part (same sign, largest absolute
    -- value no greater than current object's)

truncated_to_real: *REAL*
    -- Real part (same sign, largest absolute
    -- value no greater than current object's)

feature -- Basic operations

abs: **like** *Current*
    -- Absolute value
  ensure
    non_negative: *Result >= 0*
    same_absolute_value: (*Result = Current*) **or**
      (*Result = –Current*)

infix "*" (*other*: **like** *Current*): **like** *Current*
    -- Product by *other*
    -- (From *NUMERIC*.)
  require
    other_exists: *other* /= *Void*
  ensure
    result_exists: *Result* /= *Void*

infix "+" (*other*: **like** *Current*): **like** *Current*
    -- Sum with *other*
    -- (From *NUMERIC*.)
  require
    other_exists: *other* /= *Void*
  ensure
    result_exists: *Result* /= *Void*
    commutative: *equal* (*Result*, *other + Current*)

infix "–" (*other*: **like** *Current*): **like** *Current*
    -- Result of subtracting *other*
    -- (From *NUMERIC*.)
  require
    other_exists: *other* /= *Void*
  ensure
    result_exists: *Result* /= *Void*

infix "/" (*other*: **like** *Current*): **like** *Current*
    -- Division by *other*
    -- (From *NUMERIC*.)
  require
    other_exists: *other* /= *Void*
    good_divisor: *divisible* (*other*)
  ensure
    result_exists: *Result* /= *Void*

infix "^" (*other*: **like** *Current*): **like** *Current*
      -- Current double to the power *other*
      -- (From *NUMERIC*.)

   require
      other_exists: *other* /= *Void*
      good_exponent: *exponentiable* (*other*)

   ensure
      result_exists: *Result* /= *Void*

prefix "+": **like** *Current*
      -- Unary plus
      -- (From *NUMERIC*.)

   ensure
      result_exists: *Result* /= *Void*

prefix "−": **like** *Current*
      -- Unary minus
      -- (From *NUMERIC*.)

   ensure
      result_exists: *Result* /= *Void*

feature -- Output

   out: *STRING*
      -- Printable representation of double value
      -- (From *GENERAL*.)

invariant

   irreflexive_comparison: **not** (*Current* < *Current*)

   neutral_addition: *equal* (*Current* + *zero*, *Current*)

   self_subtraction: *equal* (*Current* − *Current*, *zero*)

   neutral_multiplication: *equal* (*Current* * *one*, *Current*)

   self_division: *divisible* (*Current*) **implies** *equal* (*Current* /
      Current, *one*)

   sign_times_abs: *equal* (*sign**abs, *Current*)

end

5.11 Class *POINTER*

indexing

description: "References to objects meant to be
exchanged with non-Eiffel software.*"*

expanded class interface

POINTER

feature -- Access

hash_code: *INTEGER*
-- Hash code value
-- (From *HASHABLE*.)
ensure
good_hash_value: *Result >= 0*

feature -- Output

out: *STRING*
-- Printable representation of pointer value
-- (From *GENERAL*.)

end

5.12 Class *ARRAY*

indexing

> *description*: "Sequences of values, all of the same type
>   or of a conforming one, accessible through integer
>   indices in a contiguous interval"

class interface

> *ARRAY* [*G*]

creation

> *make* (*minindex*, *maxindex*: *INTEGER*)
>> -- Allocate array; set index interval to
>> -- *minindex .. maxindex*; set all values to default.
>> -- (Make array empty if *minindex* > *maxindex*.)
>
>> **ensure**
>>> *no_count*: (*minindex* > *maxindex*) **implies** (*count* =
>>>   *0*);
>>>
>>> *count_constraint*: (*minindex* <= *maxindex*)
>>>   **implies** (*count* = *maxindex* – *minindex* + 1)
>
> *make_from_array* (*a*: *ARRAY* [*G*])
>> -- Initialize from the items of *a*.
>> -- (Useful in proper descendants of class *ARRAY,*
>> -- to initialize an array-like object from a manifest array.)

feature -- Initialization

> *make* (*minindex*, *maxindex*: *INTEGER*)
>> -- Set index interval to *minindex .. maxindex*
>> -- reallocate if necessary; set all values to default.
>> -- (Make array empty if *minindex* > *maxindex*.)
>
>> **ensure**
>>> *no_count*: (*minindex* > *maxindex*) **implies** (*count* = 0);
>>>
>>> *count_constraint*: (*minindex* <= *maxindex*)
>>>   **implies** (*count* = *maxindex* – *minindex* + 1)
>
> *make_from_array* (*a*: *ARRAY* [*G*])
>> -- Initialize from the items of *a*; reallocate if
>> -- necessary. (Useful in proper descendants of
>> -- class *ARRAY,* to initialize an array-like object
>> -- from a manifest array.)

feature -- Access

> *entry* (*i*: *INTEGER*): *G*
>> -- Entry at index *i*, if in index interval
>> -- (Redefinable synonym for *item* and *infix* "@".)
>
>> **require**
>>> *good_key*: *valid_index* (*i*)

frozen *item* (*i*: *INTEGER*): *G*
>> -- Entry at index *i*, if in index interval
>
>> **require**
>>> *good_key*: *valid_index* (*i*)

frozen infix "@" (*i*: *INTEGER*): *G*
>> -- Entry at index *i*, if in index interval
>
>> **require**
>>> *good_key*: *valid_index* (*i*)

feature -- Measurement

> *count*: *INTEGER*
>> -- Number of available indices
>
> *lower*: *INTEGER*
>> -- Minimum index
>
> *upper*: *INTEGER*
>> -- Maximum index

feature -- Comparison

> *is_equal* (*other*: **like** *Current*): *BOOLEAN*
>> -- Is array made of the same items as *other*?
>> -- (Redefined from *GENERAL*.)
>
>> **ensure**
>>> *same_lower*: *Result* **implies** (*lower* = *other* . *lower*)
>>>
>>> *same_upper*: *Result* **implies** (*upper* = *other* . *upper*)

feature -- Status report

> *valid_index* (*i*: *INTEGER*): *BOOLEAN*
>> -- Is *i* within the bounds of the array?

feature -- Element change

> *enter* (*v*: *G; i*: *INTEGER*)
>> -- Replace *i*-th entry, if in index interval, by *v*.
>> -- (Redefinable synonym for *put*.)
>
>> **require**
>>> *good_key*: *valid_index* (*i*)
>
>> **ensure**
>>> *inserted*: *item* (*i*) = *v*

force (*v*: **like** *item; i*: *INTEGER*)

>   -- Assign item *v* to *i*-th entry.
>   -- Always applicable: resize the array if *i* falls out of
>   -- currently defined bounds; preserve existing items.

>   **ensure**

>>   *inserted*: *item* (*i*) = *v;*

>>   *higher_count*: *count* >= **old** *count*

frozen *put* (*v*: **like** *item; i*: *INTEGER*)

>   -- Replace *i*-th entry, if in index interval, by *v*.

>   **require**

>>   *good_key*: *valid_index* (*i*)

>   **ensure**

>>   *inserted*: *item* (*i*) = *v*

feature -- Resizing

resize (*minindex*, *maxindex*: *INTEGER*)

>   -- Rearrange array so that it can accommodate
>   -- indices down to *minindex* and up to *maxindex*.
>   -- Do not lose any previously entered item.

>   **require**

>>   *good_indices*: *minindex* <= *maxindex*

>   **ensure**

>>   *no_low_lost*: *lower* = *minindex*.*min* (**old** *lower*)

>>   *no_high_lost*: *upper* = *maxindex*.*max* (**old** *upper*)

feature -- Conversion

to_c: *POINTER*

>   -- Address of actual sequence of values,
>   -- for passing to external (non-Eiffel) routines.

feature -- Duplication

copy (*other*: **like** *Current*)

>   -- Reinitialize by copying all the items of *other*.
>   -- (This is also used by *clone*.)
>   -- (From *GENERAL*.)

>   **require**

>>   *type_identity*: *same_type* (*other*)

invariant

>   *consistent_size*: *count* = *upper* – *lower* + *1;*

>   *non_negative_count*: *count* >= *0*

end

5.13 Class *STRING*

indexing

>   *description*: "Sequences of characters, accessible
>   through integer indices in a contiguous range."

class interface

>   *STRING*

creation

>   **frozen** *make* (*n*: *INTEGER*)
>   -- Allocate space for at least *n* characters.
>
>   **require**
>   *non_negative_size*: *n* >= *0*
>
>   **ensure**
>   *empty_string*: *count* = *0*
>
>   *make_from_string* (*s*: *STRING*)
>   -- Initialize from the characters of *s*.
>   -- (Useful in proper descendants of class *STRING*,
>   -- to initialize a string-like object from a manifest
>   string.)
>
>   **require**
>   *string_exists: s*/= *Void*

feature -- Initialization

>   *from_c* (*c_string*: *POINTER*)
>   -- Reset contents of string from contents of *c_
>   string*,
>   -- a string created by some external C function.
>
>   **require**
>   *C_string_exists: c_string* /= *Void*
>
>   **frozen** *remake* (*n*: *INTEGER*)
>   -- Allocate space for at least *n* characters.
>
>   **require**
>   *non_negative_size*: *n* >= *0*
>
>   **ensure**
>   *empty_string*: *count* = *0*
>
>   *make_from_string* (*s*: *STRING*)
>   -- Initialize from the characters of *s*.
>   -- (Useful in proper descendants of class *STRING*,
>   -- to initialize a string-like object from a manifest
>   string.)
>
>   **require**
>   *string_exists: s*/= *Void*

feature -- Access

>   *hash_code*: *INTEGER*
>   -- Hash code value
>   -- (From *HASHABLE*.)
>
>   **ensure**
>   *good_hash_value*: *Result* >= *0*
>
>   *index_of* (*c*: *CHARACTER; start*: *INTEGER*): *INTEGER*
>   -- Position of first occurrence of *c* at or after *start*;
>   -- 0 if none.
>
>   **require**
>   *start_large_enough*: *start* >= *1*
>   *start_small_enough*: *start* <= *count*
>
>   **ensure**
>   *non_negative_result*: *Result* >= *0*
>   *at_this_position*: *Result* > *0* **implies** *item* (*Result*)
>   = *c*
>   -- *none_before*: For every *i* in *start..Result*, *item* (*i*)
>   /= *c*
>   -- *zero_iff_absent*:
>   --   (*Result* = *0*) = For every *i* in *1..count*, *item* (*i*)
>   /= *c*
>
>   *item* (*i*: *INTEGER*): *CHARACTER*
>   -- Character at position *i*
>
>   **require**
>   *good_key*: *valid_index* (*i*)
>
>   *substring_index* (*other*: *STRING; start*: *INTEGER*):
>   *INTEGER*
>   -- Position of first occurrence of *other* at or after
>   *start*;
>   -- 0 if none.
>
>   **infix** "@" (*i*: *INTEGER*): *CHARACTER*
>   -- Character at position *i*
>
>   **require**
>   *good_key*: *valid_index* (*i*)

feature -- Measurement

>   *count*: *INTEGER*
>   -- Actual number of characters making up the
>   string
>
>   *occurrences* (*c*: *CHARACTER*): *INTEGER*
>   -- Number of times *c* appears in the string
>
>   **ensure**
>   *non_negative_occurrences*: *Result* >= *0*

feature -- Comparison

is_equal (*other*: **like** *Current*): *BOOLEAN*
-- Is string made of same character sequence as *other*?
-- (Redefined from *GENERAL*.)

require
other_exists: *other* /= *Void*

infix "<" (*other*: *STRING*): *BOOLEAN*
-- Is string lexicographically lower than *other*?
-- (False if *other* is void)
-- (From *COMPARABLE*.)

require
other_exists: *other* /= *Void*

ensure
asymmetric: *Result* **implies not** (*other* < *Current*)

infix "<=" (*other*: **like** *Current*): *BOOLEAN*
-- Is current object less than or equal to *other*?
-- (From *COMPARABLE*.)

require
other_exists: *other* /= *Void*

ensure
definition: *Result* = (*Current* < *other*) **or** *is_equal* (*other*)

infix ">=" (*other*: **like** *Current*): *BOOLEAN*
-- Is current object greater than or equal to *other*?
-- (From *COMPARABLE*.)

require
other_exists: *other* /= *Void*

ensure
definition: *Result* = (*other* <= *Current*)

infix ">" (*other*: **like** *Current*): *BOOLEAN*
-- Is current object greater than *other*?
-- (From *COMPARABLE*.)

require
other_exists: *other* /= *Void*

ensure
definition: *Result* = (*other* < *Current*)

max (*other*: **like** *Current*): **like** *Current*)
-- The greater of current object and *other*
-- (From *COMPARABLE*.)

require
other_exists: *other* /= *Void*

ensure
current_if_not_smaller: (*Current* >= *other*)
implies (*Result* = *Current*)
other_if_smaller: (*Current* < *other*) **implies**
(*Result* = *other*)

min (*other*: **like** *Current*): **like** *Current*)
-- The smaller of current object and *other*
-- (From *COMPARABLE*.)

require
other_exists: *other* /= *Void*

ensure
current_if_not_greater: (*Current* <= *other*)
implies (*Result* = *Current*)
other_if_greater: (*Current* > *other*) **implies**
(*Result* = *other*)

three_way_comparison (*other*: **like** *Current*): *INTEGER*)
-- If current object equal to *other*, 0; if smaller,
-- –1; if greater, 1.
-- (From *COMPARABLE*.)

require
other_exists: *other* /= *Void*

ensure
equal_zero: (*Result* = 0) = *is_equal* (*other*)
smaller: (*Result* = –1) = *Current* < *other*
greater_positive: (*Result* = 1) = *Current* > *other*

feature -- Status report

empty: *BOOLEAN*
-- Is string empty?

valid_index (*i*: *INTEGER*): *BOOLEAN*
-- Is *i* within the bounds of the string?

feature -- Element change

append_boolean (*b*: *BOOLEAN*)
-- Append the string representation of *b* at end.

append_character (*c*: *CHARACTER*)
-- Append *c* at end.

ensure
item_inserted: *item* (*count*) = *c*
one_more_occurrence: *occurrences* (*c*) = **old**
(*occurrences* (*c*)) + *1*
item_inserted: *has* (*c*)

append_double (*d*: *DOUBLE*)

    -- Append the string representation of *d* at end.

append_integer (*i*: *INTEGER*)

    -- Append the string representation of *i* at end.

append_real (*r*: *REAL*)

    -- Append the string representation of *r* at end.

append_string (*s*: *STRING*)

    -- Append a copy of *s*, if not void, at end.

    ensure

        new_count: *count* = **old** *count* + *s*•*count*

        -- *appended*: For every *i* in 1..*s*•*count*,

        --   *item* (*old count* + *i*) = *s*•*item* (*i*)

fill (*c*: *CHARACTER*)

    -- Replace every character with *c*.

    ensure

        -- *allblank*: For every *i* in 1..*count*, *item* (*i*) = *Blank*

head (*n*: *INTEGER*)

    -- Remove all characters except for the first *n*;

    -- do nothing if *n* >= *count*.

    require

        non_negative_argument: *n* >= *0*

    ensure

        new_count: *count* = *n*•*min* (**old** *count*)

        -- *first_kept*: For every *i* in 1..*n*, *item* (*i*) = *old item* (*i*)

insert (*s*: **like** *Current*; *i*: *INTEGER*)

    -- Add *s* to the left of position *i*.

    require

        string_exists: *s* /= *Void*;

        index_small_enough: *i* <= *count*;

        index_large_enough: *i* > *0*

    ensure

        new_count: *count* = **old** *count* + *s*•*count*

insert_character (*c*: *CHARACTER; i*: *INTEGER*)

    -- Add *c* to the left of position *i*.

    ensure

        new_count: *count* = **old** *count* + *1*

left_adjust

    -- Remove leading white space.

    ensure

        new_count: (*count* /= *0*) **implies** (*item* (*1*) /= ' ')

put (*c*: *CHARACTER; i*: *INTEGER*)

    -- Replace character at position *i* by *c*.

    require

        good_key: *valid_index* (*i*)

    ensure

        insertion_done: *item* (*i*) = *c*

put_substring (*s*: **like** *Current; start_pos*, *end_pos*: *INTEGER*)

    -- Copy the characters of *s* to positions

    -- *start_pos* .. *end_pos*.

    require

        string_exists: *s* /= *Void;*

        index_small_enough: *end_pos* <= *count;*

        order_respected: *start_pos* <= *end_pos;*

        index_large_enough: *start_pos* > *0*

    ensure

        new_count: *count* = **old** *count* + *s*•*count* − *end_pos* + *start_pos* − *1*

right_adjust

    -- Remove trailing white space.

    ensure

        new_count: (*count* /= *0*) **implies** (*item* (*count*) /= ' ')

tail (*n*: *INTEGER*)

    -- Remove all characters except for the last *n*;

    -- do nothing if *n* >= *count*.

    require

        non_negative_argument: *n* >= *0*

    ensure

        new_count: *count* = *n*•*min* (**old** *count*)

feature -- Removal

remove (*i*: *INTEGER*)

    -- Remove *i*-th character.

    require

        index_small_enough: *i* <= *count;*

        index_large_enough: *i* > *0*

    ensure

        new_count: *count* = **old** *count* − *1*

wipe_out

    -- Remove all characters.

    ensure

        empty_string: *count* = *0*

        wiped_out: *empty*

feature -- Resizing

    resize (*newsize*: *INTEGER*)
          -- Rearrange string so that it can accommodate
          -- at least *newsize* characters.
          -- Do not lose any previously entered character.
       require
          new_size_non_negative: *newsize* >= 0

feature -- Conversion

    to_boolean: *BOOLEAN*
          -- Boolean value;
          -- "true" yields *true*, "false" yields *false*
          -- (case-insensitive)

    to_double: *DOUBLE*
          -- "Double" value; for example, when applied to "123.0",
          -- will yield 123.0 (double)

    to_integer: *INTEGER*
          -- Integer value;
          -- for example, when applied to "123", will yield 123

    to_lower
          -- Convert to lower case.

    to_real: *REAL*
          -- Real value;
          -- for example, when applied to "123.0", will yield 123.0

    to_upper
          -- Convert to upper case.

feature -- Duplication

    copy (*other*: **like** *Current*)
          -- Reinitialize by copying the characters of *other*.
          -- (This is also used by *clone*.)
          -- (From *GENERAL*.)
       ensure
          new_result_count: *count* = *other*.*count*
          -- *same_characters*: For every *i* in 1..*count*,
          --   *item* (*i*) = *other*.*item* (*i*)

    substring (*n1*, *n2*: *INTEGER*): **like** *Current*
          -- Copy of substring containing all characters at indices
          -- between *n1* and *n2*
       require
          meaningful_origin: *1* <= *n1*;
          meaningful_interval: *n1* <= *n2*;
          meaningful_end: *n2* <= *count*
       ensure
          new_result_count: *Result*.*count* = *n2* – *n1* + *1*
          -- *original_characters*: For every *i* in 1..*n2*–*n1*,
          --   *Result*.*item* (*i*) = *item* (*n1*+*i*–1)

feature -- Output

    out: *STRING*
          -- Printable representation
          -- (From *GENERAL*.)
       ensure
          result_not_void: *Result* /= *Void*

invariant

    irreflexive_comparison: **not** (*Current* < *Current*)

    empty_definition: *empty* = (*count* = 0);

    non_negative_count: *count* >= 0

end

5.14 Class *STD_FILES*

indexing

 description: "Commonly used input and output
  mechanisms. This class may be used as either
  ancestor or supplier by classes needing its facilities."

class interface

 STD_FILES

feature -- Access

 default_output: *FILE*
   -- Default output.

 error: *FILE*
   -- Standard error file

 input: *FILE*
   -- Standard input file

 output: *FILE*
   -- Standard output file

 standard_default: *FILE*
   -- Return the *default_output* or *output*
   -- if *default_output* is Void.

feature -- Status report

 last_character: *CHARACTER*
   -- Last character read by *read_character*

 last_double: *DOUBLE*
   -- Last double read by *read_double*

 last_integer: *INTEGER*
   -- Last integer read by *read_integer*

 last_real: *REAL*
   -- Last real read by *read_real*

 last_string: *STRING*
   -- Last string read by *read_line*,
   -- *read_stream*, or *read_word*

feature -- Element change

 put_boolean (*b*: *BOOLEAN*)
   -- Write *b* at end of default output.

 put_character (*c*: *CHARACTER*)
   -- Write *c* at end of default output.

 put_double (*d*: *DOUBLE*)
   -- Write *d* at end of default output.

 put_integer (*i*: *INTEGER*)
   -- Write *i* at end of default output.

 put_new_line
   -- Write line feed at end of default output.

 put_real (*r*: *REAL*)
   -- Write *r* at end of default output.

 put_string (*s*: *STRING*)
   -- Write *s* at end of default output.

  require

   s /= *Void*

 set_error_default
   -- Use standard error as default output.

 set_output_default
   -- Use standard output as default output.

feature -- Input

 read_character
   -- Read a new character from standard input.
   -- Make result available in *last_character*.

 read_double
   -- Read a new double from standard input.
   -- Make result available in *last_double*.

 read_integer
   -- Read a new integer from standard input.
   -- Make result available in *last_integer*.

 read_line
   -- Read a line from standard input.
   -- Make result available in *last_string*.
   -- New line will be consumed but not part of *last_
   string*.

 read_real
   -- Read a new real from standard input.
   -- Make result available in *last_real*.

 read_stream (*nb_char*: *INTEGER*)
   -- Read a string of at most *nb_char* bound
   characters
   -- from standard input.
   -- Make result available in *last_string*.

 to_next_line
   -- Move to next input line on standard input.

end

5.15 Class *FILE*

indexing

   description: "Files viewed as persistent sequences of characters."

class interface

   FILE

creation

   make (*fn*: *STRING*)
           -- Create file object with *fn* as file name.

      require

         string_exists: *fn* /= *Void;*

         string_not_empty: **not** *fn*.*empty*

      ensure

         file_named: *name*.*is_equal* (*fn*);

         file_closed: *is_closed*

   make_create_read_write (*fn*: *STRING*)
           -- Create file object with *fn* as file name
           -- and open file for both reading and writing;
           -- create it if it does not exist.

      require

         string_exists: *fn* /= *Void;*

         string_not_empty: **not** *fn*.*empty*

      ensure

         exists: *exists;*

         open_read: *is_open_read;*

         open_write: *is_open_write*

   make_open_append (*fn*: *STRING*)
           -- Create file object with *fn* as file name
           -- and open file in append-only mode.

      require

         string_exists: *fn* /= *Void;*

         string_not_empty: **not** *fn*.*empty*

      ensure

         exists: *exists;*

         open_append: *is_open_append*

   make_open_read (*fn*: *STRING*)
           -- Create file object with *fn* as file name
           -- and open file in read mode.

      require

         string_exists: *fn* /= *Void;*

         string_not_empty: **not** *fn*.*empty*

      ensure

         exists: *exists;*

         open_read: *is_open_read*

   make_open_read_write (*fn*: *STRING*)
           -- Create file object with *fn* as file name
           -- and open file for both reading and writing.

      require

         string_exists: *fn* /= *Void;*

         string_not_empty: **not** *fn*.*empty*

      ensure

         exists: *exists;*

         open_read: *is_open_read;*

         open_write: *is_open_write*

   make_open_write (*fn*: *STRING*)
           -- Create file object with *fn* as file name
           -- and open file for writing;
           -- create it if it does not exist.

      require

         string_exists: *fn* /= *Void;*

         string_not_empty: **not** *fn*.*empty*

      ensure

         exists: *exists;*

         open_write: *is_open_write*

feature -- Access

   name: *STRING*
           -- File name

feature -- Measurement

   count: *INTEGER*
           -- Size in bytes (0 if no associated physical file)

feature -- Status report

   empty: *BOOLEAN*
           -- Is structure empty?

end_of_file: *BOOLEAN*
      -- Has an EOF been detected?
   require
      opened: **not** *is_closed*

exists: *BOOLEAN*
      -- Does physical file exist?

is_closed: *BOOLEAN*
      -- Is file closed?

is_open_read: *BOOLEAN*
      -- Is file open for reading?

is_open_write: *BOOLEAN*
      -- Is file open for writing?

is_plain_text: *BOOLEAN*
      -- Is file reserved for text (character sequences)?

is_readable: *BOOLEAN*
      -- Is file readable?
   require
      handle_exists: *exists*

is_writable: *BOOLEAN*
      -- Is file writable?
   require
      handle_exists: *exists*

last_character: *CHARACTER*
      -- Last character read by *read_character*

last_double: *DOUBLE*
      -- Last double read by *read_double*

last_integer: *INTEGER*
      -- Last integer read by *read_integer*

last_real: *REAL*
      -- Last real read by *read_real*

last_string: *STRING*
      -- Last string read by *read_line*,
      -- *read_stream*, or *read_word*

feature -- Status setting

close
      -- Close file.
   require
      medium_is_open: **not** *is_closed*
   ensure
      is_closed: *is_closed*

open_read
      -- Open file in read-only mode.
   require
      is_closed: *is_closed*
   ensure
      exists: *exists*
      open_read: *is_open_read*

open_read_append
      -- Open file in read and write-at-end mode;
      -- create it if it does not exist.
   require
      is_closed: *is_closed*
   ensure
      exists: *exists*
      open_read: *is_open_read*
      open_append: *is_open_append*

open_read_write
      -- Open file in read and write mode.
   require
      is_closed: *is_closed*
   ensure
      exists: *exists*
      open_read: *is_open_read*
      open_write: *is_open_write*

open_write
      -- Open file in write-only mode;
      -- create it if it does not exist.
   ensure
      exists: *exists*
      open_write: *is_open_write*

feature -- Cursor movement

to_next_line
      -- Move to next input line.
   require
      readable: *is_readable*

feature -- Element change

change_name (*new_name*: *STRING*)
      -- Change file name to *new_name*
   require
      not_new_name_void: *new_name* /= *Void*;
      file_exists: *exists*
   ensure
      name_changed: *name*•*is_equal* (*new_name*)

feature -- Removal

delete
>> -- Remove link with physical file; delete physical
>> -- file if no more link.
>
>> **require**
>>> *exists*: *exists*

dispose
>> -- Ensure this medium is closed when
>> garbage-collected.

feature -- Input

read_character
>> -- Read a new character.
>> -- Make result available in *last_character*.
>
>> **require**
>>> *readable*: *is_readable*

read_double
>> -- Read the ASCII representation of a new double
>> -- from file. Make result available in *last_double*.
>
>> **require**
>>> *readable*: *is_readable*

read_integer
>> -- Read the ASCII representation of a new integer
>> -- from file. Make result available in *last_integer*.
>
>> **require**
>>> *readable*: *is_readable*

read_line
>> -- Read a string until new line or end of file.
>> -- Make result available in *laststring*.
>> -- New line will be consumed but not part of *last_string*.
>
>> **require**
>>> *readable*: *is_readable*

read_real
>> -- Read the ASCII representation of a new real
>> -- from file. Make result available in *last_real*.
>
>> **require**
>>> *readable*: *is_readable*

read_stream (*nb_char*: *INTEGER*)
>> -- Read a string of at most *nb_char* bound
>> characters
>> -- or until end of file.
>> -- Make result available in *last_string*.
>
>> **require**
>>> *readable*: *is_readable*

read_word
>> -- Read a new word from standard input.
>> -- Make result available in *last_string*.

feature -- Output

put_boolean (*b*: *BOOLEAN*)
>> -- Write ASCII value of *b* at current position.
>
>> **require**
>>> *extendible*: *extendible*

put_character (*c*: *CHARACTER*)
>> -- Write *c* at current position.
>
>> **require**
>>> *extendible*: *extendible*

put_double (*d*: *DOUBLE*)
>> -- Write ASCII value of *d* at current position.
>
>> **require**
>>> *extendible*: *extendible*

put_integer (*i*: *INTEGER*)
>> -- Write ASCII value of *i* at current position.
>
>> **require**
>>> *extendible*: *extendible*

put_real (*r*: *REAL*)
>> -- Write ASCII value of *r* at current position.
>
>> **require**
>>> *extendible*: *extendible*

put_string (*s*: *STRING*)
>> -- Write *s* at current position.
>
>> **require**
>>> *extendible*: *extendible*

invariant

name_exists: *name* /= *Void*;

name_not_empty: **not** *name*•*empty*;

writable_if_extendible: *extendible* **implies** *is_writable*

end

5.16 Class *STORABLE*

indexing

> *description*: "Objects that may be stored and retrieved
>   along with all their dependents. This class may be
>   used as ancestor by classes needing its facilities."

class interface

> *STORABLE*

feature -- Access

> *retrieved* (*file*: *FILE*): *STORABLE*
>
> > -- Retrieved object structure, from external
> >
> > -- representation previously stored in *file*.
> >
> > -- To access resulting object under correct type,
> >
> > -- use assignment attempt.
> >
> > -- Will raise an exception (code *Retrieve_*
> > *exception*)
> >
> > -- if file content is not a *STORABLE* structure.
>
> > **require**
> >
> > > *file_not_void*: *file* /= *Void;*
> > >
> > > *file_exists*: *file* • *exists;*
> > >
> > > *file_is_open_read*: *file* • *is_open_read*
> > >
> > > *file_not_plain_text*: **not** *file* • *is_plain_text*
>
> > **ensure**
> >
> > > *result_exists*: *Result* /= *Void*

feature -- Element change

> *basic_store* (*file*: *FILE*)
>
> > -- Produce on *file* an external representation of the
> >
> > -- entire object structure reachable from current
> > object.
> >
> > -- Retrievable within current system only.
>
> > **require**
> >
> > > *file_not_void*: *file* /= *Void;*
> > >
> > > *file_exists*: *file* • *exists;*
> > >
> > > *file_is_open_write*: *file* • *is_open_write*
> > >
> > > *file_not_plain_text*: **not** *file* • *is_plain_text*

general_store (*file*: *FILE*)

> -- Produce on *file* an external representation of the
> -- entire object structure reachable from current
> object.
> -- Retrievable from other systems for same
> platform
> -- (machine architecture).

> **require**
>
> > *file_not_void*: *file* /= *Void;*
> >
> > *file_exists*: *file* • *exists;*
> >
> > *file_is_open_write*: *file* • *is_open_write*
> >
> > *file_not_plain_text*: **not** *file* • *is_plain_text*

independent_store (*file*: *FILE*)

> -- Produce on *file* an external representation of the
> -- entire object structure reachable from current
> object.
> -- Retrievable from other systems for the same or
> other
> -- platforms (machine architectures).

> **require**
>
> > *file_not_void*: *file* /= *Void;*
> >
> > *file_exists*: *file* • *exists;*
> >
> > *file_is_open_write*: *file* • *is_open_write*
> >
> > *file_not_plain_text*: **not** *file* • *is_plain_text*

end

5.17 Class *MEMORY*

indexing

description: "Facilities for tuning up the garbage
collection mechanism. This class may be used as
ancestor by classes needing its facilities."

class interface

MEMORY

feature -- Status report

collecting: *BOOLEAN*

-- Is garbage collection enabled?

feature -- Status setting

collection_off

-- Disable garbage collection.

collection_on

-- Enable garbage collection.

feature -- Removal

dispose

-- Action to be executed just before garbage
collection

-- reclaims an object.

-- Default version does nothing; redefine in
descendants

-- to perform specific dispose actions. Those
actions

-- should only take care of freeing external
resources

-- they should not perform remote calls on other
objects

-- since these may also be dead and reclaimed.

full_collect

-- Force a full collection cycle if garbage

-- collection is enabled; do nothing otherwise.

end

5.18 Class *EXCEPTIONS*

indexing

 description: "Facilities for adapting the exception
  handling mechanism. This class may be used as
  ancestor by classes needing its facilities."

class interface

 EXCEPTIONS

feature -- Access

 developer_exception_name: *STRING*
   -- Name of last developer-raised exception

  require
   applicable: *is_developer_exception*

feature -- Access

 Check_instruction: *INTEGER*
   -- Exception code for violated check

 Class_invariant: *INTEGER*
   -- Exception code for violated class invariant

 Incorrect_inspect_value: *INTEGER*
   -- Exception code for inspect value which is not
   one
   -- of the inspect constants, if there is no Else_part

 Loop_invariant: *INTEGER*
   -- Exception code for violated loop invariant

 Loop_variant: *INTEGER*
   -- Exception code for non-decreased loop variant

 No_more_memory: *INTEGER*
   -- Exception code for failed memory allocation

 Postcondition: *INTEGER*
   -- Exception code for violated postcondition

 Precondition: *INTEGER*
   -- Exception code for violated precondition

 Routine_failure: *INTEGER*
   -- Exception code for failed routine

 Void_attached_to_expanded: *INTEGER*
   -- Exception code for attachment of void value
   -- to expanded entity

 Void_call_target: *INTEGER*
   -- Exception code for violated check

feature -- Status report

 assertion_violation: *BOOLEAN*
   -- Is last exception originally due to a violated
   -- assertion or non-decreasing variant?

 exception: *INTEGER*
   -- Code of last exception that occurred

 is_developer_exception: *BOOLEAN*
   -- Is the last exception originally due to
   -- a developer exception?

 is_signal: *BOOLEAN*
   -- Is last exception originally due to an external
   -- event (operating system signal)?

feature -- Basic operations

 die (*code*: *INTEGER*)
   -- Terminate execution with exit status *code*,
   -- without triggering an exception.

 raise (*name*: *STRING*)
   -- Raise a developer exception of name *name*.

end

5.19 Class *ARGUMENTS*

indexing

description: "Access to command-line arguments. This
   class may be used as ancestor by classes needing its
   facilities."

class interface

ARGUMENTS

feature -- Access

argument (*i*: *INTEGER*): *STRING*
      -- *i*-th argument of command that started system
      execution
      -- (the command name if *i* = 0)

   require

      index_large_enough: *i* >= *0*
      index_small_enough: *i* <= *argument_count*

command_name: *STRING*
      -- Name of command that started system execution

   ensure

      definition: *Result* = *argument* (*0*)

feature -- Measurement

argument_count: *INTEGER*
      -- Number of arguments given to command that
      started
      -- system execution (command name does not
      count)

   ensure

      Result >= *0*

end

5.20 Class *PLATFORM*

indexing

description: "Platform-dependent properties. This class may be used as ancestor by classes needing its facilities."

class interface

PLATFORM

feature -- Access

Boolean_bits: *INTEGER*
-- Number of bits in a value of type *BOOLEAN*

ensure

meaningful: *Result >= 1*

Character_bits: *INTEGER*
-- Number of bits in a value of type *CHARACTER*

ensure

meaningful: *Result >= 1*

large_enough: $2 \wedge Result >= Maximum\_character\_code$

Double_bits: *INTEGER*
-- Number of bits in a value of type *DOUBLE*

ensure

meaningful: *Result >= 1*

meaningful: *Result >= Real_bits*

Integer_bits: *INTEGER*
-- Number of bits in a value of type *INTEGER*

ensure

meaningful: *Result >= 1*

large_enough: $2 \wedge Result >= Maximum\_integer$

large_enough_for_negative: $2 \wedge Result >= -Minimum\_integer$

Maximum_character_code: *INTEGER*
-- Largest supported code for *CHARACTER* values

ensure

meaningful: *Result >= 127*

Maximum_integer: *INTEGER*
-- Largest supported value of type *INTEGER*.

ensure

meaningful: *Result >= 0*

Minimum_character_code: *INTEGER*
-- Smallest supported code for *CHARACTER* values

ensure

meaningful: *Result <= 0*

Minimum_integer: *INTEGER*
-- Smallest supported value of type *INTEGER*

ensure

meaningful: *Result <= 0*

Pointer_bits: *INTEGER*
-- Number of bits in a value of type *POINTER*

ensure

meaningful: *Result >= 1*

Real_bits: *INTEGER*
-- Number of bits in a value of type *REAL*

ensure

meaningful: *Result >= 1*

end

5.21 Class *BOOLEAN_REF*

indexing

    description: "Reference class for *BOOLEAN*"

class interface

    BOOLEAN_REF

feature -- Access

    item: *BOOLEAN*
        -- Boolean value

    hash_code: *INTEGER*
        -- Hash code value
        -- (From *HASHABLE*.)
      ensure
        good_hash_value: $Result >= 0$

feature -- Element change

    set_item (*b*: *BOOLEAN*)
        -- Make *b* the associated boolean value.
      ensure
        item_set: $item = b$

end

5.22 Class *CHARACTER_REF*

indexing

  description: "Reference class for *CHARACTER*"

class interface

  CHARACTER_REF

feature -- Access

  item: *CHARACTER*
        -- Character value

  hash_code: *INTEGER*
        -- Hash code value
        -- (From *HASHABLE*.)
    ensure
        good_hash_value: *Result* >= *0*

feature -- Element change

  set_item (*c*: *CHARACTER*)
        -- Make *c* the associated character value.
    ensure
        item_set: *item* = *c*

end

5.23 Class *DOUBLE_REF*

indexing

   description: "Reference class for *DOUBLE*"

class interface

   DOUBLE_REF

feature -- Access

   item: *DOUBLE*
         -- Double value

   hash_code: *INTEGER*
         -- Hash code value
         -- (From *HASHABLE*.)
      ensure
         good_hash_value: *Result* >= *0*

feature -- Element change

   set_item (*d*: *DOUBLE*)
         -- Make *d* the associated double value.
      ensure
         item_set: *item* = *d*

end

5.24 Class *INTEGER_REF*

indexing

    description: "Reference class for *INTEGER*"

class interface

    INTEGER_REF

feature -- Access

    item: *INTEGER*
          -- Integer value

    hash_code: *INTEGER*
          -- Hash code value
          -- (From *HASHABLE*.)

       ensure

          good_hash_value: *Result >= 0*

feature -- Element change

    set_item (*i*: *INTEGER*)
          -- Make *i* the associated integer value.

       ensure

          item_set: *item = i*

end

5.25 Class *POINTER_REF*

indexing

description: "Reference class for *POINTER*"

class interface

POINTER_REF

feature -- Access

item: *POINTER*
-- Pointer value

hash_code: *INTEGER*
-- Hash code value
-- (From *HASHABLE*.)

ensure

good_hash_value: *Result* >= *0*

feature -- Element change

set_item (*p*: *POINTER*)
-- Make *p* the associated pointer value.

ensure

item_set: *item* = *p*

end

5.26 Class *REAL_REF*

indexing

   description: "Reference class for *REAL*"

class interface

   REAL_REF

feature -- Access

   item: *REAL*
          -- Real value

   hash_code: *INTEGER*
          -- Hash code value
          -- (From *HASHABLE*.)
      ensure
          good_hash_value: *Result >= 0*

feature -- Element change

   set_item (*r*: *REAL*)
          -- Make *r* the associated real value.
      ensure
          item_set: *item = r*

end

6 APPENDIX A: THE KERNEL STANDARDIZATION PROCESS

[This Appendix is not part of the Standard.]

6.1 Why plan a process?

The Eiffel Kernel Library cannot be specified for eternity. Ideas willcome up for new classes and features; ways will be found to do thingsbetter. The evolution process must be fast enough to enable Eiffel usersto benefit from this flow of ideas and avoid technical obsolescence, but orderly enough to protect their existing investments and modes of operation.

6.2 Cycle time

A revision every ten to fifteen years, as has occurred for programming language standards (Fortran, C and Ada are examples) is not appropriate for the Eiffel Kernel Library. It would foster complacency most of the time, and major upheavals when a revision is finally brought into effect. A yearly process, similar to the upgrading of wines, car models and stable software products, provides the right pace of change.

6.3 Vintages

Each revision of this Standard describes a **vintage** of theEiffel Library Kernel Standard. The present version is vintage 1995.

6.4 Yearly schedule

The following deadlines apply to year *year*:

6.4.1   • 1 January: Vintage *year* takes effect.

6.4.2   • 1 April: first permitted date for starting discussions on Vintage *year+1* in NICE's Library Committee. (1 January to 31 March is acooling-off period.)

6.4.3   • 1 May: first permitted date for submitting formal proposals to the Library Committee for Vintage *year + 1*.

6.4.4   • 1 July: last permitted date for submitting initial proposals for Vintage *year + 1*.

6.4.5   • 1 September: last permitted date for submitting final proposals (which may result from merging of several proposals) for Vintage *year + 1*.

6.4.6   • 1 October: last date by which the Committee may have defined Vintage *year +1*.

This schedule is applicable starting with vintage 96. For the present vintage (95), the first, the date of applicability is 1 July 1995.

6.5 Intermediate corrections

During the time when a vintage is in effect, minor corrections may prove necessary, due for example to typographical errors in the current version of this Standard or to inconsistencies discovered by users or implementors of Eiffel. In such a case the chairman of the Library Committee of NICE may, at his discretion, submit a motion covering one or more revisions. To be approved, such motions shall require a unanimous vote of the Library Committee, with the possible exception of any member who has notified the chairman of an absence of more than one month. If approved, such a revision shall receive a revision level and shall give rise to a modified Kernel Library Standard, identified as "Vintage *year* Level *revision_ level*". The modifications shall be integrated into the following year's vintage.

6.6 Eiffel Kernel Supplier requirements

Any provider of an Eiffel environment must make the following information available to any NICE member:

6.7   • Vintage and revision level currently supported.

6.8   • Any features not supported. (It is not permitted to have a non-supported class.)

6.9   • List of classes needed by kernel classes, but not in the kernel, hereafter referred to as para-kernel classes.

6.10   • Full inheritance hierarchy of kernel and para-kernel classes.

6.11   • List of names of features (immediate or inherited) that appear in the provider's kernel classes but not in this Standard.

7 APPENDIX B: DIFFERENCES UP TO ELKS 95

[This Appendix is not part of the Standard.]

The following differences exist between this Standard and earlierpresentations of the Kernel Library:

7.1
- Addition to *GENERAL* of a query *default* which returns the default value of the type of the current object. This also addresses the need to obtain the default value for type *POINTER* ; for convenience, since *POINTER* has no manifest constant, a query *default_pointer* has also been included. (See page 14.)

7.2
- Adaptation of the semantics of *copy* and equality features (*equal*, *is_equal* and their *standard_* versions) so that the result is true if and only if the objects are truly identical, and in particular have the same type. This implies a language change too; the previous definition was non-symmetric so that *a*.*copy* (*b*) and *equal* (*a, b*) only applied to the fields corresponding to the attributes of *a*'s type. The earlier effect can still be achieved through function *stripped,* as explained next in 7.5. (See page 13.)

7.3
- Addition to *GENERAL* of a frozen feature *same_type* which specifies conformance both ways. Addition of the requirement that *conforms_to* is frozen too. (See page 13.)

7.4
- Addition of a number of assertion clauses to the features of *GENERAL*, in particular to specify more precisely the semantics of equality, copying, cloning and conformance.

7.5
- Addition to *GENERAL* of a function *stripped* such that *stripped* (*a*) is a clone of the current object limited to the fields that apply to *a*'s dynamic type. As a result, the old semantics of copying and equality mentioned in 7.2 may now be achieved through calls such as *a*.*copy* (*b*.*stripped* (*a*)) and *equal* (*a, b*.*stripped* (*a*)). (See page 13.)

7.6
- Addition to *GENERAL* of *object_id* and *id_object* to allow unique identification of objects. (See page 13.)

7.7
- In class *PLATFORM*, removal of the assumption that *Character_bits*, *Integer_ bits*,*Real_bits* and *Double_bits* are constants. This does notintroduce any incompatibility with earlier uses except if they relied onthe specific numerical values. (See page 47.)

7.8
- Removal of *PLATFORM* from the universal inheritance hierarchy; *PLATFORM* is no longer a parent of *ANY* and hence an ancestor of every

class, and has no particular language-defined role; classes that need its facilities must name it explicitly among their proper ancestors. This is actually a language change. (See section 4.)

7.9   • Addition to *PLATFORM* of features *Maximum_integer*, *Minimum_integer*, *Maximum_character_code* and *Minimum_character_code*. (See page 47.)

7.10   • Addition to *COMPARABLE* of *min* and *max* functions and of a three-way comparison function, *three_way_comparison*, which returns 0, –1 or 1. (See page 16.)

7.11   • Addition to the arithmetic basic classes of functions *abs* and *sign* (the latter defined in terms of *three_way_comparison*). Addition to *REAL* and *DOUBLE* of *floor*, *ceiling*, *rounded* and *integer_part*. Addition to *DOUBLE* of *real_part*. (See page 24 and following.)

7.12   • Addition of inheritance links making all basic classes (*INTEGER* and so on) heirs of *HASHABLE*, so that it is now possible to hash any object. (See section 4.) Removal of function *is_hashable* and the corresponding preconditions.

7.13   • Addition to *ARRAY* of features *enter* and *entry* as redefinable synonyms to *put* and *item* (or **infix** "@"), the latter becoming frozen. (See page 33.)

7.14   • Addition to *STORABLE* of a procedure *independent_store* which produces machine-independent representations of object structures. (See page 43.)

7.15   • Addition of a few features to class *FILE* describing file opening and opening modes (such as read-only or read-write). In earlier presentations the corresponding class was *UNIX_FILE*. The new class is very similar but removes any Unix-specific aspect. (See section 5.15.)

7.16   • Changes of names in class *STD_FILES* and *FILE* : for consistency with the usual Eiffel naming style, underscores were added and abbrevations were expanded. In the following list (which uses the order of appearance of the features in *STD_FILES*), the added underscores appear as * and the added letters appear in ***bold italics***: *last*char**acter**, last*double, last*real, last*int**eger**, last*string, put*bool**ean**, put*char**acter**, put*double, put*int**eger**, **put**_new*line, put*real, put*string, read*char**acter**, read*double, read*int**eger**, read*line, read*real, read*stream, read*word, **to**_next*line.* (See sections 5.14 and 5.15.)

7.17   • Addition to *EXCEPTIONS* of a procedure *die* that terminates the execution cleanly with a given exit status, without triggering an exception. (See page 45.)

7.18   • In class *STRING*, replacement of the *adapt* function by a more convenient procedure *make_from_string* which descendants of the class can use to initialize a string-like object from a manifest string, as in !! *t*•*make_from_*

string (*"THIS STRING"*), where the type of *t* is a descendant of *STRING*. (See page 35.)

7.19

- Similarly, addition to *ARRAY* of a procedure *make_from_array* allowing initialization from a manifest array, as in !! *a***.***make_from_array* (*<<a, b, c, d>>*).

7.20

- Removal from *STRING* of a number of features which some committee members judged too specialized: *mirror*, *mirrored*, *share*, *shared_with*, *item_code*, *has*, *prepend*, *set*, *prune*, *prune_all*. Renaming of *replace_substring* to *put_substring*. Removal of *fill_blanks*, replaced by *fill* (applying to an arbitrary character). Change of the result type of *out* to *STRING* (rather than **like** *Current*).

8 INDEX

8.1

This Index indicates the page of definition of every class and feature appearing in the Required Flatshort Forms of section 5

8.2

Following the standard Eiffel conventions, feature names appear in lower-case italics and class names, when making up index entries, in **UPPER-CASE ITALICS**. Operator functions appear under **prefix** and **infix**; for example division appears under **infix** "/". This also applies to boolean operators, which appear under **infix** "**and**", **infix** "**and then**" and so on.

8.3

In a class entry, the class appears in *UPPER-CASE ITALICS*. Each reference to a feature name is followed by the name of the class or classes in which it is available, each with the corresponding page. To avoid any confusion with occurrences of the class name in its other role – as an index entry pointing to the beginning of the class specification – the class name in this case appears in UPPER-CASE ROMAN.

(ELKS 98 note: FrameMaker 5.5 acts so strange the font conventions don't hold any more. I have no idea what's going on and have written to Frame customer support in the hope it is not yet another bug of the new release but something stupid I am doing.)