

The Coral Language Specification

Kateřina Nikola Lisov

April 27, 2014

Contents

1	Lexical Syntax	3
1.1	Identifiers	4
1.2	Keywords	4
1.3	Newline Characters	5
1.4	Operators	6
1.5	Literals	6
1.5.1	Integer Literals	6
1.5.2	Floating Point Literals	6
1.5.3	Imaginary Number Literals	6
1.5.4	Units of Measure	6
1.5.5	Boolean Literals	6
1.5.6	String Literals	6
1.5.7	Symbol Literals	6
1.5.8	Type Parameters	6
1.5.9	Regular Expression Literals	6
1.5.10	Collection Literals	6
1.6	Whitespace & Comments	6
1.7	Preprocessor Macros	6
2	Identifiers, Names & Scopes	7
3	Types	9
3.1	Paths	10
3.2	Value Types	10
3.2.1	Value Type	10

3.2.2	Type Projection	10
3.2.3	Type Designators	10
3.2.4	Parametrized Types	10
3.2.5	Tuple Types	10
3.2.6	Annotated Types	10
3.2.7	Compound Types	10
3.2.8	Function Types	10
3.2.9	Existential Types	10
3.3	Non-Value Types	10
3.3.1	Method Types	10
3.3.2	Polymorphic Method Types	10
3.3.3	Type Constructors	10
3.4	Relations Between Types	10
3.4.1	Type Equivalence	10
3.4.2	Conformance	10
4	Basic Declarations & Definitions	11
4.1	Variable Declarations & Definitions	12
4.2	Property Declarations & Definitions	12
4.3	Instance Variable Definitions	12
4.4	Type Declarations & Aliases	12
4.5	Type Parameters	12
4.6	Variance of Type Parameters	12
4.7	Function Declarations & Definitions	12
4.7.1	Positional Parameters	12
4.7.2	Optional Parameters	12
4.7.3	Repeated Parameters	12
4.7.4	Named Parameters	12
4.7.5	Procedures	12
4.7.6	Method Return Type Inference	12
4.8	Use Clauses	12

5	Classes & Objects	13
5.1	Class Definitions	14
5.1.1	Class Linearization	14
5.1.2	Constructor & Destructor Definitions	14
5.1.3	Class Block	14
5.1.4	Class Members	14
5.1.5	Overriding	14
5.1.6	Inheritance Closure	14
5.1.7	Modifiers	14
5.2	Mixins	14
5.3	Unions	14
5.4	Enums	14
5.5	Compound Types	14
5.6	Range Types	14
5.7	Units of Measure	14
5.8	Record Types	14
5.9	Struct Types	14
5.10	Object Definitions	14
6	Expressions	15
6.1	Expression Typing	16
6.2	Literals	16
6.3	The Nil Value	16
6.4	Designators	16
6.5	Self, This & Super	16
6.6	Function Applications	16
6.6.1	Named and Optional Arguments	16
6.6.2	Input & Output Arguments	16
6.6.3	Function Compositions & Pipelines	16

6.7	Method Values	16
6.8	Type Applications	16
6.9	Tuples	16
6.10	Instance Creation Expressions	16
6.11	Blocks	16
6.12	Prefix & Infix Operations	16
6.12.1	Prefix Operations	16
6.12.2	Infix Operations	16
6.12.3	Assignment Operators	16
6.13	Typed Expressions	16
6.14	Annotated Expressions	16
6.15	Assignments	16
6.16	Conditional Expressions	16
6.17	Loop Expressions	16
6.17.1	Classic For Expressions	16
6.17.2	Iterable For Expressions	16
6.17.3	Basic Loop Expressions	16
6.17.4	While & Until Loop Expressions	16
6.17.5	Conditions in Loop Expressions	16
6.18	Collection Comprehensions	16
6.19	Return Expressions	16
6.19.1	Implicit Return Expressions	16
6.19.2	Explicit Return Expressions	16
6.19.3	Structured Return Expressions	16
6.20	Raise Expressions	16
6.21	Rescue & Ensure Expressions	16
6.22	Throw & Catch Expressions	16
6.23	Anonymous Functions	16
6.24	Conversions	16
6.24.1	Type Casting	16

7	Implicit Parameters & Views	17
8	Pattern Matching	19
8.1	Patterns	19
8.1.1	Variable Patterns	19
8.1.2	Typed Patterns	19
8.1.3	Literal Patterns	19
8.1.4	Constructor Patterns	19
8.1.5	Tuple Patterns	19
8.1.6	Extractor Patterns	19
8.1.7	Pattern Alternatives	19
8.1.8	Regular Expression Patterns	19
8.2	Type Patterns	19
8.3	Pattern Matching Expressions	19
8.4	Pattern Matching Anonymous Functions	19
9	Top-Level Definitions	21
9.1	Compilation Units	21
9.2	Modules	21
9.3	Module Objects	21
9.4	Module References	21
9.5	Top-Level Classes	21
9.6	Programs	21
10	Annotations	23
11	Naming Guidelines	25
12	The Coral Standard Library	27
12.1	Root Classes	27
12.1.1	The Object Class	27

12.1.2 The Nothing Class	27
12.2 Value Classes	27
12.3 Standard Reference Classes	27
A Coral Syntax Summary	29

Preface

Coral is a Ruby-like programming language which enhances advanced object-oriented programming with elements of functional programming. Every value is an object, in this sense it is a pure object-oriented language. Object blueprints are described by classes. Classes can be composed in multiple ways – classic inheritance and/or mixin composition, along with prototype-oriented inheritance.

Coral is also a functional language in the sense that every function is also an object. Therefore, function definitions can be nested and higher-order functions are supported out-of-the-box. Coral also has a limited support for pattern matching, which can emulate the algebraic types used in other functional languages.

Coral has been developed from 2012 in a home environment out of pure enthusiasm for programming and out of a desire for a truly versatile language. This document is a work in progress and will stay that way forever. It acts as a reference for the language definition and some core library classes.

Some of the languages that had major influence on the development of Coral, including syntax and behavior patterns, are Ruby, Ada, Scala, Java, C#, F# and Clojure. Coral tries to inherit their good parts and put them together in its own way.

The vast majority of Coral's syntax is inspired by *Ruby*. Coral uses keyword program parentheses in Ruby fashion. There is **class ... end**, **def ... end**, **do ... end**, **loop ... end**. Ruby itself is inspired by other languages, so this relation is transitive and Coral is inspired by those languages as well (for example, Ada).

Coral is inspired by *Ada* in the way that user identifiers are formatted: `Some_Constant_Name` and — unlike in Ada, but quite similar to it — `some_method_name`. Also, some control structures are inspired by Ada, such as loops, named loops, return expressions and record types. Pretty much like in Ada, Coral's control structures can be usually ended the same way: **class ... end class** etc.

Scala influenced the type system in Coral. Syntax for existential types comes almost directly from it. However, Coral is a rather dynamically typed language, so the type checks are made eventually in runtime (but some limited type checks can be made during compile time as well). Moreover, the structure of this mere specification is inspired by Scala's specification.

From *F#*, Coral borrows some functional syntax (like function composition) and F# also inspired the feature of Units of Measure.

Clojure inspired Coral in the way functions can get their names. Coral realizes that turning function names into sentences does not always work, so it is pos-

sible to use dashes, plus signs and slashes inside of function names. Therefore, `call/cc` is a legit function identifier. Indeed, binary operators are required to be properly surrounded by whitespace or other non-identifier characters.

Chapter 1

Lexical Syntax

Coral programs are written using the Unicode character set; Unicode supplementary characters are supported as well. Coral programs are preferably encoded with the UTF-8 character encoding. While every Unicode character is supported, usage of Unicode escapes is encouraged, since fonts that IDEs might use may not support the full Unicode character set.

1.1 Identifiers

Syntax:

```

simple_id    ::= lower [id_rest]
variable_id ::= simple_id | '_'
constant_id ::= upper [id_rest]
function_id ::= simple_id [id_rest_ext]
id_rest     ::= {letter | digit | '_'}
id_rest_ext ::= id_rest [id_rest_mid] ['?' | '!' | '=']
id_rest_mid ::= id_rest {'/' | '+' | '-'} id_rest

```

There are three kinds of identifiers.

First, *variable identifiers*, which are simply a lower-case letter followed by arbitrary sequence of letters (any-case), digits and underscores, or just one underscore (which has special meaning).

Second, *constant identifiers*, which are just like variable identifiers, but starting with an upper-case letter and never just an underscore.

And third, *function identifiers*, which are the most complicated ones. They can start as a variable identifier, then optionally followed by one of “/”, “+” and “-”, and then optionally ended with “?” or “!”.

Coral programs are parsed greedily, so that a longest match rule applies. Letters from the syntax may be any Unicode letters, but English alphabet letters are recommended, along with English names.

1.2 Keywords

A set of identifiers is reserved for language features instead of for user identifiers. However, unlike in most other languages, keywords are not being recognized inside of paths, except for a few specific cases.

The following names are the reserved words.

alias	annotation	as	begin	bitfield
break	case	cast	catch	class
clone	constant	constructor	declare	def
destructor	do	else	elsif	end
ensure	enum	for	for-some	function
goto	if	implements	in	include
interface	is	let	loop	match
memoize	message	method	mixin	module
native	next	nil	no	of

opaque	operator	out	prepend	property
protocol	raise	range	record	redo
refine	rescue	retry	return	self
skip	struct	super	template	test
then	this	throw	transparent	type
undef	unless	until	union	unit-of-measure
use	val	var	void	yes
when	while	with	yield	

Not every reserved word is a keyword in every context, this behavior will be further explained. For example, the `bitfield` reserved word is only recognized as a keyword inside an enumeration definition context, in a specific place. Every reserved word may be used as a function identifier, with a little work-around when used with an implicit receiver.

1.3 Newline Characters

Syntax:

```
semi ::= nl {nl} | ';' 
```

Coral is a line-oriented language, in which statements are expressions and may be terminated by newlines, as well as by semi-colon operator. A newline in a Coral source file is treated as the special separator token `nl` if the following criterion is satisfied:

1. The token immediately preceding the newline can terminate an expression.

Since Coral may be interpreted in a REPL¹ fashion, there are no other suitable criteria. Such a token that can terminate an expression is, for instance, not a binary operator or a message sending operator, which both require further tokens to create an expression. Keywords that expect any following tokens also can not terminate expressions. Coral interpreters and compilers do not look-ahead beyond newlines.

If the token immediately preceding the newline can not terminate an expression and is followed by more than one newline, Coral still sees that as only a one significant newline, to prevent any confusion.

Keywords that can terminate an expression are: **break**, **end**, **opaque**, **native**, **next**, **nil**, **no**, **redo**, **retry**, **return**, **self**, **skip**, **super**, **this**, **transparent**, **void**, **yes**, **yield**.

¹Read-Eval-Print Loop

1.4 Operators

1.5 Literals

1.5.1 Integer Literals

1.5.2 Floating Point Literals

1.5.3 Imaginary Number Literals

1.5.4 Units of Measure

1.5.5 Boolean Literals

1.5.6 String Literals

1.5.7 Symbol Literals

1.5.8 Type Parameters

1.5.9 Regular Expression Literals

1.5.10 Collection Literals

1.6 Whitespace & Comments

1.7 Preprocessor Macros

Chapter 2

Identifiers, Names & Scopes

Chapter 3

Types

3.1 Paths

3.2 Value Types

3.2.1 Value Type

3.2.2 Type Projection

3.2.3 Type Designators

3.2.4 Parametrized Types

3.2.5 Tuple Types

3.2.6 Annotated Types

3.2.7 Compound Types

3.2.8 Function Types

3.2.9 Existential Types

3.3 Non-Value Types

3.3.1 Method Types

3.3.2 Polymorphic Method Types

3.3.3 Type Constructors

3.4 Relations Between Types

Chapter 4

Basic Declarations & Definitions

4.1 Variable Declarations & Definitions

4.2 Property Declarations & Definitions

4.3 Instance Variable Definitions

4.4 Type Declarations & Aliases

4.5 Type Parameters

4.6 Variance of Type Parameters

4.7 Function Declarations & Definitions

4.7.1 Positional Parameters

4.7.2 Optional Parameters

4.7.3 Repeated Parameters

4.7.4 Named Parameters

4.7.5 Procedures

4.7.6 Method Return Type Inference

4.8 Use Clauses

Chapter 5

Classes & Objects

5.1 Class Definitions

5.1.1 Class Linearization

5.1.2 Constructor & Destructor Definitions

5.1.3 Class Block

5.1.4 Class Members

5.1.5 Overriding

5.1.6 Inheritance Closure

5.1.7 Modifiers

5.2 Mixins

5.3 Unions

5.4 Enums

5.5 Compound Types

5.6 Range Types

5.7 Units of Measure

5.8 Record Types

Chapter 6

Expressions

6.1 Expression Typing

6.2 Literals

6.3 The Nil Value

6.4 Designators

6.5 Self, This & Super

6.6 Function Applications

6.6.1 Named and Optional Arguments

6.6.2 Input & Output Arguments

6.6.3 Function Compositions & Pipelines

6.7 Method Values

6.8 Type Applications

6.9 Tuples

6.10 Instance Creation Expressions

6.11 Blocks

Chapter 7

Implicit Parameters & Views

Chapter 8

Pattern Matching

8.1 Patterns

8.1.1 Variable Patterns

8.1.2 Typed Patterns

8.1.3 Literal Patterns

8.1.4 Constructor Patterns

8.1.5 Tuple Patterns

8.1.6 Extractor Patterns

8.1.7 Pattern Alternatives

8.1.8 Regular Expression Patterns

8.2 Type Patterns

8.3 Pattern Matching Expressions

8.4 Pattern Matching Anonymous Functions

Chapter 9

Top-Level Definitions

9.1 Compilation Units

9.2 Modules

9.3 Module Objects

9.4 Module References

9.5 Top-Level Classes

9.6 Programs

Chapter 10

Annotations

Chapter 11

Naming Guidelines

Chapter 12

The Coral Standard Library

12.1 Root Classes

12.1.1 The Object Class

12.1.2 The Nothing Class

12.2 Value Classes

12.3 Standard Reference Classes

Chapter A

Coral Syntax Summary