

Contents

Preface	v
I A++ - The Language	1
1 Educational Programming Languages	3
1.1 Introduction	3
1.2 Pascal	3
1.3 Scheme	3
1.4 Logo	4
1.5 A++	4
2 Introduction to A++	5
2.1 Purpose of A++ and Origin	5
2.1.1 Purpose	5
2.1.2 Origin	5
2.1.3 ARS — <i>Generalization of the Lambda-Calculus</i>	5
2.1.4 Name of the language	6
2.2 Motivations for the development of A++	6
2.2.1 To support an alternate method of teaching the principles of programming	6
2.2.2 To provide a learning tool for exploring the fundamentals of programming	7
2.2.3 To support a method teaching powerful programming patterns applicable to most languages	7
2.2.4 To open a new view of programming for many programmers:	7
2.3 Features of A++	7
2.3.1 Programming paradigms supported:	7
2.3.2 Constitutive Principles of A++	7
2.3.3 Closure	8
2.3.4 Basic abstractions derived from ARS	9
2.3.5 Development of Applications with A++	9
2.4 Internal Architecture of A++	10
2.4.1 Definition of A++ as Programming Language	10
2.4.2 Examples of A++ - Syntax	11
3 Linking Logic with the Physical World	13
3.1 Syntax of A++ including pre-defined primitive abstractions	14
3.2 Examples using pre-defined primitives of A++	14
3.2.1 Pre-defined primitive abstractions in A++	15
3.2.2 A++ including pre-defined primitives	16
3.2.3 A++ Overview	17
4 General Programming Patterns and A++	19

4.1	Closure Pattern	19
4.2	CLAM Pattern	20
4.3	List Pattern	20
4.4	Dictionary Pattern	21
4.5	Set Pattern	22
4.6	Recursion Pattern	22
4.7	Higher Order Function Pattern	23
4.8	Message Passing Pattern	23
4.8.1	Classes of objects	23
4.8.2	Instance of a class	24
4.8.3	Constructors	24
4.8.4	Creating instances of a class	25
4.8.5	Sending messages	26
4.8.6	Executing methods	27
4.8.7	Essential features of object oriented programming	28
4.8.8	Relation between classes	29
4.9	Meta Object Protocol Pattern	29
5	Discovering the Power of A++	31
5.1	Basic Abstractions	31
5.1.1	The IF- Abstraction	31
5.1.2	Extended Logical Abstractions	32
5.1.3	Application of extended logical abstractions	33
5.2	Numeric Abstractions	33
5.2.1	Natural Numbers	33
5.2.2	Arithmetic Operations	35
5.2.3	Application of numeric abstractions	36
5.3	Collections of Data	36
5.3.1	Basic abstractions for pairs	37
5.3.2	Basic utility abstractions for lists	38
5.4	Extended Numerical Abstractions	39
5.4.1	Abstraction ‘zeropair’	39
5.4.2	Decrementing a number: ‘pred’	39
5.4.3	Subtracting a number: ‘sub’	40
5.5	Relational Abstractions	40
5.5.1	Comparing two numbers: ‘equaln’	40
5.5.2	Comparing two numbers: ‘gtp’	40
5.5.3	Comparing two numbers: ‘ltp’	40
5.5.4	Comparing two numbers: ‘gep’	41
5.6	Examples for recursion	41
5.6.1	Calculating the faculty of a number	41
5.6.2	Calculating the sum of elements of a list	41
5.6.3	Insertion Sort	41
5.7	Higher Order Functions	42
5.7.1	Creating a new function by composition: ‘compose’	42
5.7.2	Changing the arity of a function:‘curry’	42
5.7.3	Converting all elements in a list: ‘map’	42
5.7.4	Converting the ‘map’ function: ‘mapc’	43
5.7.5	Selecting elements from a given list: ‘filter’	44
5.7.6	Searching for an element in a given list: ‘locate’	44
5.7.7	Iterating through all elements of a list: ‘for-each’	44
5.8	Set Operations	45

5.8.1	Checking for a member in a set: ‘memberp’	45
5.8.2	Adding an element to a set: ‘addelt’	45
5.8.3	Combining two sets: ‘union’	46
5.9	Associative Lists in A++	46
5.9.1	Abstractions for associative lists	47
5.9.2	Application of associative lists	47
5.10	Miscellaneous abstractions	48
5.10.1	Testing the basic abstractions	49
5.11	Object Oriented Programming in A++	50
5.11.1	First example of object oriented programming in A++	50
5.11.2	Second example of object oriented programming in A++	51
5.11.3	Third example of object oriented programming in A++	57
5.12	Imperative Programming in A++	65
6	Computer Resources for A++	67
6.1	Support Functions	67
6.1.1	Abstraction for displaying a number	67
6.1.2	Abstraction for displaying a boolean value	67
6.1.3	Abstraction for displaying lists	67
6.2	A++ Interpreters	67
6.2.1	A++ Interpreter written in Perl	68
6.2.2	A++ Interpreter written in C	72
6.3	Initializing the A++ Interpreter	74
6.3.1	Initializing the A++ Interpreter part 1	74
6.3.2	Initializing the A++ Interpreter part 2	74
6.3.3	Initializing the A++ Interpreter part 3	74
6.3.4	Initializing the A++ Interpreter part 4	75
6.3.5	Initializing the A++ Interpreter part 5	75
6.3.6	Initializing the A++ Interpreter part 6	76
6.3.7	Initializing the A++ Interpreter part 7	76
6.4	WWW Links	77
7	Extending A++	79
7.1	ARS++	79
7.2	ARSAPI	80

II	A++ - The Implementation	81
1	General Introduction	83
2	A++ Implementation in Perl	85
2.1	ARS and Perl	85
2.1.1	Syntax of Perl	85
2.1.2	Syntax of ARS	86
2.1.3	Basic Abstractions	86
2.1.4	Numeric Abstractions	88
2.1.5	Arithmetic Operations	88
2.1.6	Application of numeric abstractions	88
2.1.7	Collections of Data	88
2.1.8	Basic utility abstractions for lists	90
2.1.9	Relational Abstractions	92
2.1.10	Examples for recursion	92

2.1.11	Higher Order Functions	93
2.1.12	Set Operations	95
2.1.13	Associative lists	97
2.1.14	Object Oriented Programming in Perl	101
2.1.15	Regular expressions	104
2.2	A++ Interpreter	105
2.2.1	Main Program: Command Line Mode	105
2.2.2	Main Program: WEB-Based Application	105
2.2.3	Expression Definition Module (EXP)	107
2.2.4	List Module (PAIR)	108
2.2.5	Value Module (VALUE)	110
2.2.6	Name Management Module (NAME)	111
2.2.7	Environment Module (ENV)	112
2.2.8	Parser Module (ARSP)	116
2.2.9	Expression Evaluation Module (EVAL)	120
3	A++ Implementation in C	129
3.1	ARS and C	129
3.1.1	Mechanisms for Abstraction	129
3.1.2	Operations within functions	130
3.1.3	Simple and complex expressions	136
3.1.4	Modularization	136
3.1.5	Variables and pointers	137
3.1.6	Structures in C	139
3.1.7	Special control operations: setjmp/longjmp	140
3.2	A++ Interpreter in C	141
3.2.1	Introduction	141
3.2.2	ADT's used by the the interpreter	141
3.2.3	Functions used by the interpreter	146
3.2.4	Source code of the A++ Interpreter	156
3.3	ARS based programming in C	178
3.3.1	The 'clam' as a key for ARS based programming in C	178
3.3.2	Datatypes	179
3.3.3	Mapping ARS to C	185
3.3.4	Simple example	185
3.3.5	Basic demo of ARSAPI for C	186
3.3.6	Advanced demo of ARSAPI for C: menu system 'genfui'	187
3.3.7	Source code of 'ARSAPI for C' demos	187
3.4	External tools	207
Appendices	211	
A Detailed Discussion of Addition and Multiplication	211	
A.1	Addition of the numbers 'two' and 'three'	211
A.2	Multiplication of the numbers 'two' and 'three'	213
B The Lambda Calculus	217	
B.1	Introduction	217
B.1.1	Origin	217
B.1.2	Definition	217
B.1.3	Literature	217
B.2	Syntax of Lambda Expressions	217

B.3	Basic Rules for Lambda Conversions	218
B.3.1	Notation used in Conversion Rules	218
B.3.2	Alpha Conversion	218
B.3.3	Beta Conversion	219
B.3.4	Eta Conversion	220
B.3.5	Rules of Associativity	221
B.3.6	Y-Combinator	222
C	Testing the Y-Combinator in A++	227
C.1	A++ Source code of Y-Combinator test program	227
C.2	Running the Y-Combinator test program	227
C.3	Comments on the Y-Combinator test program	228
D	Background of the Author	229
Index		233