Table of Contents

0 - Preface

1 - What is Jai?

- 1.1 Some context and history.
- 1.2 What type of language is Jai?

1B - What is Jai - more in depth

- 1.1 What type of language is Jai?
 - 1.1.1 Priorities
 - 1.1.2 Jai tries to be a better C/C++
- 1.2 Comparisons with other languages
- 1.3 Jai's performance
- 1.4 Some steps in Jai's history
- 1.5 Specific Jai features
- 1.6 Some wrong ideas in software development
- 1.7 Jai community and communication channels
- 1.8 Jai's popularity

2 - Setting up a Jai development environment

- 2.1 Opening up the Jai compiler toolkit
- 2.2 Setting up the Jai compiler
 - 2.2.1 Copying the compiler to its destination folder
 - 2.2.2 Making the jai command system-wide available
 - 2.2.3 Updating Jai and switching versions
 - 2.2.4 Prerequisite for Windows
 - 2.2.5 Windows as development platform
 - 2.2.6 Solution for install problem on Linux distros
 - 2.2.7 Working in WSL on Windows

2.3 Editor help for coding Jai

- 2.3.1 Overview of different editors
- 2.3.2 Using the Visual Studio Code plugin
- 2.3.3 How to edit, build and run a Jai program in VS-Code through CodeRunner
- 2.4 The compiler command

2B - Compiler command-line options

3 - Compiling and running your first program

- 3.1 Some preliminary remarks
- 3.2 The main entry point
- 3.3 Compiling our first program
 - 3.3.1 Compile-time
 - 3.3.2 Printing output
 - 3.3.3 Run-time
 - 3.3.4 Running code during compile-time
 - 3.3.5 Some remarks
 - 3.3.6 Errors
 - 3.3.7 Exiting a program

4 - More info about the compiler

- 4.1 General info
- 4.2 Internal byte-code interpreter
- 4.3 Front-end
- 4.4 Back-ends
- 4.5 Linking
- 4.6 Architectures
- 4.7 Debug and release build
- 4B_Options for giving code at the command-line
- 4C_The Preload module
- 4D_Memory management
- 4E_What happens when Jai starts up?

5 - Constants, variables, types and operations

- 5.1 Data, literals and types
 - 5.1.1 Data and types
 - 5.1.2 The primitive types: bool, int, float, string, void
 - 5.1.3 Using print to display a value
 - 5.1.4 type_of()
- 5.2 Constants
 - 5.2.1 Problem: What if we need the same literal many times in code?
 - 5.2.2 Solution: Constants
- 5.3 Variables
 - 5.3.1 How to declare variables

- 5.4 Errors when defining variables
- 5.5 Multiple assignment
- 5.6 Swapping values
- 5.7 More about printing
 - 5.7.1 Printing more than one value
 - 5.7.2 The write procedures
 - 5.7.3 Printing Unicode
- 5.8 General naming conventions

5B - Identifier backslashes

5C - ASCII table

6 – Bool and number types

- 6.1 Boolean values
 - 6.1.1 Equal values and boolean expressions
 - 6.1.2 Boolean operators
 - 6.1.3 The assert statement
- 6.2 Number types
 - 6.2.1 Comparison operators
 - 6.2.2 Arithmetic operators
 - 6.2.3 Mixing of different types
 - 6.2.4 Casting of values
 - 6.2.5 Autocasting with xx
 - 6.2.5.1 Cast of bool to int
 - 6.2.5.2 Cast of int to bool truthiness
 - 6.2.6 Complex expressions and precedence
 - 6.2.7 Bitwise operators
 - 6.2.7.1 Using bitwise operators
 - 6.2.7.2 Tests on numbers
 - 6.2.8 Formatting procs
 - 6.2.9 Random numbers
 - 6.2.10 The Math module

6B – Times and dates

- 6B.1 Getting the current time
- 6B.2 Measuring performance using get_time and current_time_monotonic
- 6B.3 Getting a random number from time

7 – Scope of Variables

- 7.1 Data scope and imperative scope
 - 7.1.1 Global constants and variables
 - 7.1.2 Local variables

7.2 - Shadowing of variables

8 - Structuring a project's code

- 8.1 Structuring with modules
- 8.2 Loading files with #load
- 8.3 Named imports
 - 8.3.1 Definition
 - 8.3.2 Handling naming conflicts
- 8.4 Import a file, a dir or a string
- 8.5 Structuring a project
 - 8.5.1 The folder structure
 - 8.5.2 The source code structure
- 8.6 -import_dir
- 8.7 Module and program parameters
 - 8.7.1 Definition and use
 - 8.7.2 Creating your own module parameters

8B – The #scope directives

- 8B.1 The #scope_file and #scope_export directives
- 8B.2 Scope in a module
- 8B.3 An example of using the #scope directives

9 - More about types

- 9.1 First class Types
- 9.2 Constants of type Type: Type alias
- 9.3 Variables of type Type
- 9.4 size_of
- 9.5 The Any type
- 9.6 Any and the print procedure
- 9.7 Type comparisons

10 – Working with pointers

- 10.1 What is a pointer?
- 10.2 Pointers to pointers
- 10.3 Dereferencing a null pointer
- 10.4 Dangling pointers
- 10.5 Casting to pointer types
- 10.6 Relative pointers *~snn

11 - Allocating and freeing memory

- 11.1 The defer keyword
- 11.2 Allocating and freeing primitive variables

12 - Basics of structs

- 12.1 Struct declarations
- 12.2 Making struct variables
- 12.3 Nested structs
- 12.4 Struct literals
- 12.5 Making structs on the heap
- 12.6 Recursive structs

12.6.1 Linked List

12.6.2 Double Linked List

12.6.3 Tree

12.6.4 Circular dependencies

- 12.7 A structs namespace
- 12.8 The #as directive
- 12.9 Using a structs namespace for better storage management
- 12.10 Pointer to struct
- 12.11 Struct alignment
- 12.12 Making definitions in an inner module visible with using
- 12.13 Struct parameters

12.13.1 Struct parameters of type Type

- 12.14 Structs with relative pointers
- 12.15 Anonymous structs
- 12.16 Member procs

13 - Unions and enums

- 13.1 Working with unions
- 13.2 Working with enums
- 13.3 Enum as a namespace
- 13.4 Enum as #specified
- 13.5 enum_flags and masking flags
- 13.6 Some useful enum methods

14 - Branching with if else

14.1 The if-else statement

14.1.1 One-liners

14.1.2 The classical C error

14.2 Ternary operator ifx

14.3 Case branching

14.3.1 What is the if-case construct?

14.3.2 Using if-case with enums and #complete

14.4 Test on empty variables

14.5 Other useful if tests

15 - Looping with while and for

15.1 While loop

15.1.1 Nested while loops

15.1.2 Named while-loops

15.1.3 Printing out a recursive list

15.2 For loop

15.3 Breaking out or continuing a loop

15.4 Looping over an enum's values

15.5 Runtime-reflection - Looping over a structs fields with type_info()

15.6 Serialization

15.7 Annotations or notes

16 - Types in depth

16.1 Definition of Any, .type and .type.type

16.2 Type_Info and Type_Info_Tag

16.3 The type_info() proc

16.4 Other useful ways to dig into type information

16.4.1 Checking whether an enum is #specified

16.4.2 Checking whether a struct a struct is a subclass of another struct

16.4.3 Type info available at runtime

17 - Basics of procedures

17.1 Declaring and calling a proc

17.1.1 Exiting from a proc with return

17.1.2 Getting the type and address of a proc

17.2 Local procs

17.3 Difference between passing a copy and passing a pointer

17.4 Default values for arguments

17.5 Named arguments

17.6 Multiple return values and #must

17.6.1 Named and default return values

17.6.2 The #must directive

17.6.3 Example proc: file_open

17.7 Overloading procedures

17.7.1 What are overloading procedures?

17.7.1 Overloading in global and local scope

17.8 Inlining procs

17.9 Recursive procs

17.9.1 The #this directive

17.9.2 Recursive structs and #this

17.10 Swapping values

- 17.11 A println procedure
- 17.12 Autocasting a parameter with xx
- 17.13 Structs and procs

17.13.1 Using the namespace of a struct in procedures

17.13.2 The #as directive in proc arguments

17.14 Reflection on procedures

17.14.1 Getting the argument and return types

17.14.2 The #procedure_name directive

17.15 The #deprecated directive

17.16 Anonymous procs

18 - Arrays

- 18.1. Array literals
- 18.2. For loop over arrays
- 18.3. Static arrays

18.3.1 Setting up an array with a for loop

18.3.2 Compile-time and run-time bounds check

18.3.3 Using an array as a boolean

18.3.4 Allocating an array on the heap

18.4. Dynamic arrays

18.4.1 Useful procs for dynamic arrays

18.4.2 Internal definition of a dynamic array

18.5. Array views

18.5.1 Changing the view and the base array

18.5.2 Misuse of array views with dynamic arrays

18.6. For-loops over arrays: more examples

18.6.1 Named index and value

18.6.2 Changing an array by iterating with a pointer

18.6.3 Reversing a for loop with <

18.7. Multidimensional arrays

- 18.8. Passing an array to a procedure
- 18.9. An array of pointers
- 18.10 Variable number of arguments (..) for a procedure

18.10.1 Passing an array as a variable argument 18.10.2 Named variable arguments proc

18.11 The print procedure

18.12 Array of structs

18B – Ordered remove in arrays

18C - Copying a struct with memcpy

19 - Working with strings

19.1 What are strings?

19.2 Some basic operations on bytes

19.3 Backslash codes, escape characters and Unicode characters

19.4 Some string characteristics

19.4.1 String literals are immutable and bounds-checked

19.4.2 Strings as boolean values

19.4.3 Multi-line strings

19.4.4 Looping over the characters in a string str with for

19.4.5 The sprint procedure

19.4.6 Releasing a string's memory

19.4.7 Storing code in strings

19.4.8 Strings as array views

19.4.9 Relative strings

19.5 String builder

19.6 String operations

19.6.1 Conversions to and from numbers

19.6.1.1 string to numbers

19.6.2 String comparisons

19.6.3 Joining and splitting

19.6.3.1 Looping over the result of a split

19.6.4 Searching

19.6.5 Changing

19.7 C strings

19B - Get command-line arguments

19C - Getting console input

19D - Comparing field names of structs

20 - Debugging

20.1 Some general strategies

20.1.1 Print debugging

20.1.2 Assert debugging

20.2 Debugging compile-time execution

20.2.1 #assert debugging

20.2.2 The compile-time interactive Jai debugger

20.2.3 The #dump directive

20.3 Debugging a run-time crash with an external debugger from Visual Studio

20.4 Debugging general code

20.5 Debugging with natvis

20.6 The WinDbg debugging tool

20.7 Some general info

21 - Memory Allocators and Temporary Storage

21.1 General remarks

21.1.1 Overview of allocation and freeing methods

21.1.2 User defer when possible

21.1.3 Different sorts of memory allocation

21.2 Allocators

21.3 Temporary storage

21.4 Examples of using Temporary Storage

21.4.1 Storing strings in temp with tprint

21.4.2 Storing arrays in temp

21.4.3 Using New with temp

21.4.4 Using Temporary Storage on the Stack

21.4.5 How much memory is allocated in temp?

21.5 Memory-leak detector

22 Polymorphic Procedures

22.1 What is polymorphism?

22.1.1 A first example

22.1.2 What is \$T?

22.2 Some other examples

22.2.1 T used more than once, and also used as a return type

22.2.2 T as the type of an arrays items

22.2.3 Example with pointers: swapping

22.2.4 Example with structs

22.2.5 Example with several polymorphic types

22.3 The lambda notation =>

22.4 A procedure as argument of another proc

22.5 A recursive lambda as argument of a polymorphic proc

22.6 #bake_arguments, \$ and \$\$

22.7 A map function

23 Polymorphic arrays and structs

- 23.1 Polymorphic arrays
- 23.2 A more general map procedure
- 23.3 Polymorphic structs
- 23.4 Restricting the type of polymorphic proc arguments
- 23.5 The \$T/Object syntax
- 23.6 The \$T/interface Object syntax
- 23.7 The #bake constants directive
- 23.8 Polymorphic struct using #this and #bake_constants
- 23.9 Implementing a simple interface
- 23.10 The broadcaster design pattern

23B. Document types: a showcase of inheritance using structs and #as

24 Operator overloading

- 24.1 Operators and operator overloading
- 24.2 Vector operators
- 24.3 Object operators
- 24.4 The #poke_name directive

25 Context

- 25.1 What is the context?
- 25.2 push_context
- 25.3 push_allocator
- 25.4 What does #no_context mean?
- 25.5 Logging
- 25.6 Temporary storage
- 25.7 The stack trace
- 25.8 The print style
- 25.9 Check if a variable is on the stack

26 Meta-programming and macros

- 26.1 The type table
- 26.2 Running code at compile time with #run
 - 26.2.1 The #compile_time directive
 - 26.2.2 The #no_reset directive
 - 26.2.3 Computing a struct at compile-time and retrieving at run-time

26.3 Compiling conditionally with #if

26.4 Inserting code with #insert

26.4.1 How does it work?

26.4.2 Type Code and #code

26.5 Basics of macros

26.5.1 Using a macro with #insert

26.5.2 Using a macro with #insert to unroll a for loop

26.5.3 Using a macro for an inner proc

26.5.4 Using a macro with #insert,scope()

26.5.5 Using a macro for swapping values

26.5.6 Measuring performance with a macro

26.6 Using a for-expansion macro to define a for loop

26.7 A for-expansion macro for a double linked-list

26.8 A for-expansion macro for an array

26.9 The #modify directive

26.10 SOA (Struct of Arrays)

26.10.1 Data-oriented design

26.10.2 Making a SOA struct using #insert

26.11 How to get the generated source files after the meta-program step?

26.12 How to get info on the nodes tree of a piece of code?

26.13 The #type directive and the VARIANT type

26.14 Getting the name of a variable at compile time

26.15 Converting code to string

26.16 Creating code for each member in a structure

26.17 A type-tagged union

27 Working with Files

27.1 Basic file operations

27.2 Working with CSV files

27.3 Deleting subfolders

28 Inline assembly

28.1 Inline assembly: what and why

28.2 How do Jai and inline assemby interact? - Declaring variables

28.3 Some background info

28.3.1 Overview of inline assembly instructions

28.3.2 List of size abbreviations

28.3.3 Assembly Language Data Types

28.3.4 Assembly Feature Flags

28.3.5 List of registers

28.3.6 The Machine X64 module

28.4 Immediate operands

28.5 Allocation and pinning

28.6 Feature flags

28.6.1 Global build level

28.6.2 Asm-block level

28.6.3 Checking on feature flags

28.7 Using AVX and AVX2 SIMD operations

28.7.1 Assembly memory operands: Loading memory into registers

28.7.2 Working with SIMD

28.8 Macros and asm

28.9 Compile-time execution

28.10 Other useful examples

28.10.1 Manipulating an array through pointers

28.10.2 Load Effective Address (LEA) and Load and Read Instruction Example

28.10.3 Fetch and add macro to increment a variable

28.10.4 Binary swap

28.10.5 Reset Lowest Set Bit (BLSR)

28.10.6 Reversing 64-bits integer

28.10.7 Broadcasting, rounding and masking with EVEX

29 Interacting with C

29.1 Why would you call C?

29.2 How to call C? The #foreign directives

29.3 Mapping a dynamic library

29.4 Converting a C header (.h) file

29.5 Examples on Linux

29.6 Examples on Windows

29.6.1 Calling system library functions

29.6.2 Calling user-defined library functions

29.7 Callbacks and the #c_call directive

29.8 Getting the computer name: using #if, OS and C interaction

30 Integrated build system

Intro: What is a metaprogram?

30.1 Workspaces

30.2 The source file location directives

30.3 A minimal build file

30.3.1 Compiling with add_build_file

30.3.2 Compiling with add_build_string

30.3.3 The #placeholder directive

30.4 The build options

30.4.1 The optimization level

30.4.2 The output type
30.4.3 The output executable name
30.4.3B The output path
30.4.3C The import path
30.4.4 The backend options
30.4.5 Info about runtime errors and crashes
30.4.6 Checks at runtime
30.4.7 runtime_storageless_type_info
30.4.7B Dead code elimination
30.4.8 Optimizing LLVM or X64 build
30.4.8B Setting machine-level asm options
30.4.9 Debug- and Release builds

30.4.10 Preventing the output of compiler messages 30.5 Changing the default metaprogram

30.6 Intercepting the compiler message loop

30.7 Building and running on successful compilation

30.8 Getting the file to compile from the command-line and inlining

30.9 Building and running with compiler command-line arguments

30.10 Choosing a debug / release build with compiler command-line arguments

30.11 Enforcing coding standards

30.12 Generating LLVM bitcode

30.13 Using notes to do special metaprogramming

30.14 Writing and loading dynamic libraries and #program_export

30.15 Adding binary data to the executable

31 Working with Threads

31.1 Basics of threads

31.2 Thread groups

31.2.1 Concept and basic example

31.2.2 Getting results from the thread group

31.2.3 Determining the number of threads to use

31.2.4 Periodically checking which portion of the work is completed

31.3 Mutexes

31.4 Building a program using OpenGL, macros and threads

31.5 Minimal implementation of Go-style channels

32 Working with processes

- 32.1 Running a process within a program
- 32.2 Creating a process
- 32.3 Writing to a process
- 32.4 Reading from a process

33 Graphical(GUI) modules

- 33.1 The GLFW module
- 33.2 The SDL module
- 33.3 The GL module
- 33.4 Direct3D
- 33.5 The Simp module

33.5.1 A simple window

33.5.2 A bouncing square

- 33.6 The Getrect module
- 33.7 The Window_Creation module

34 Other useful modules

- 34.1 The Sort module
- 34.2 The Hash_Table module
- 34.3 The Pool module

34.3.1 Using a Pool

34.3.2 Allocating a struct on a Pool

34.3.3 Using a pool with a macro

34.3.4 Using a flat pool

34.4 The Mail module

A description/discussion of some larger programs, in progressive difficulty:

50 The guessing game

50.1 Linux version

50.2 Windows version

51 The Game of Life

- 51.1 A console print version
- 51.2 A graphical version

Larger example programs:

23B. Document types: a showcase of inheritance using structs, as and polymorphism

27.2 Deleting subfolders

31.2 Building a program using OpenGL, macros and threads

§ 51