BABEŞ-BOLYAI UNIVERSITY CLUJ-NAPOCA
FACULTY OF MATHEMATICS AND COMPUTER SCIENCE
ENGLISH SPECIALIZATION

DIPLOMA THESIS

Design, implementation and comparision of different software emulating methods

Supervisor
Lect. dr. Mihai Andrei

Author
Oniga Andrei-Mihai

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ABSTRACT

Abstract: un rezumat în limba engleză cu prezentarea, pe scurt, a conținutului pe capitole, punând accent pe contribuțiile proprii și originalitate

Contents

1 Introduction

1.1 About

Introducere: obiectivele lucrării și descrierea succintă a capitolelor, prezentarea temei, prezentarea contribuției proprii, respectiv a rezultatelor originale și menționarea (dacă este cazul) a sesiunii de comunicări unde a fost prezentată sau a revistei unde a fost publicată.

1.2 Related work

CHIP8 Applications in engineering [1]. Brainfuck in reinforcement learning [5]. Esoteric languages list with BF in it [2]. Brainfuck conceptual [4]. Brainfuck hardware [3].

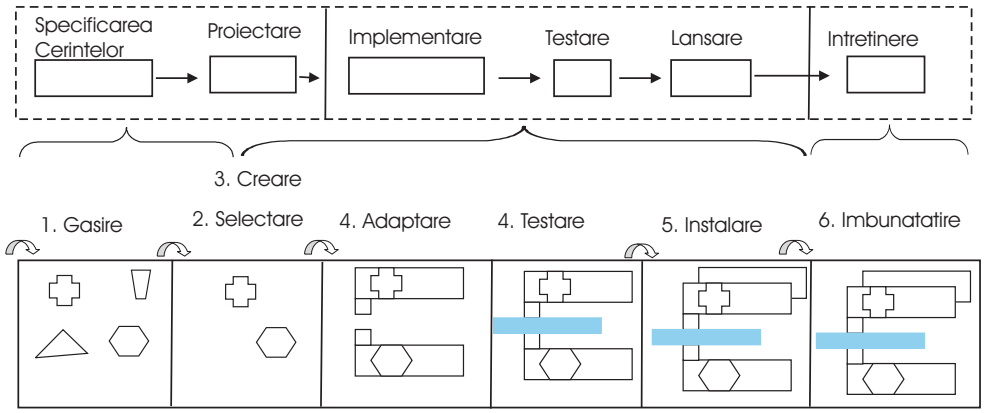

Figure 1.1: Ciclul de dezvoltare al sistemelor bazate pe componente adaptat modelului cascadã

Inserarea și Referirea la Tabelul 1.1.

Nume algoritm	Toate soluțiile	Soluția optimã
Nume 1	20	5
Nume 2	20	2

Table 1.1: Soluții obținute

Adaugarea și Referirea la o Ecuație 1.1.

$$ws_N4 = w_{14} * N1 + W_{24} + N2 + w_{34} * N3 \tag{1.1}$$

2 BF

Brainfuck, or as it is usually shortened for academical purposes, BF, is an esoteric programming language designed to be minimalistic and intentionally difficult to program in.

It was created in 1993 by Swiss student Urban Müller, primarily as a challenge for programmers.

Despite its simplicity, Brainfuck is Turing-complete, meaning it has the computational power to perform any calculation that can be computed by a modern computer, given sufficient resources.

The language operates on an array of memory cells, each initially set to zero, and uses a series of eight commands to manipulate the data and control program flow.

Brainfuck's syntax consists of only eight commands, these being instructions to move the data pointer, modify the value of the current memory cell, input or output data, and control loops.

The language's simplicity—combined with its deliberately difficult syntax—forces programmers to think creatively about how to implement basic operations like arithmetic or data manipulation.

As a result, Brainfuck is more often used in programming challenges and competitions rather than for practical software development.

The language has been made intentionally difficult to use for practical application, which has made it a popular subject of study within the community of esoteric programming languages (esolangs).

Brainfuck often serves as an example of the power of minimalism in programming, demonstrating that even with extremely limited resources, a fully functional computational system can be constructed.

It challenges conventional programming paradigms, as the programmer is forced to manage memory and control flow manually, akin to working in assembly or machine code.

2.1 Machine specification

There doesn't exist any well defined way in which a BF machine should behave, and, as such, programmers that want to emulate it are usually left to their own devices,

creating many variations of the same specification.

2.1.1 Programming in the language

Well known sample:

```
[ This program prints "Hello World!" and a newline to the screen,
  its length is 106 active command characters.

  This loop is an "initial comment loop", a simple way of adding
  a comment to a BF program such that you don't have to worry
  about any command characters. Any ".", ",", "+", "-", "<" and ">"
  characters are simply ignored, the "[" and "]" characters just
  have to be balanced. This loop and the commands it contains are
  ignored because the current cell defaults to a value of 0;
  the 0 value causes this loop to be skipped.
]
++++++++               Set Cell #0 to 8
[
    >++++               Add 4 to Cell #1; this will always set
                        Cell #1 to 4 as the cell will be cleared
                        by the loop
        >++             Add 2 to Cell #2
        >+++            Add 3 to Cell #3
        >+++            Add 3 to Cell #4
        >+              Add 1 to Cell #5
        <<<<-           Decrement the loop counter in Cell #1
    ]                   Loop till Cell #1 is zero; 4 iterations
    >+                  Add 1 to Cell #2
    >+                  Add 1 to Cell #3
    >-                  Subtract 1 from Cell #4
    >>+                 Add 1 to Cell #6
    [<]                 Move back to the first zero cell you find;
                        this will be Cell #1 which was cleared
                        by the previous loop
    <-                  Decrement the loop Counter in Cell #0
]                       Loop till Cell #0 is zero; 8 iterations

The result of this is:
Cell No :   0   1   2   3   4   5   6
```

```
Contents:   0   0  72 104  88  32   8
Pointer :   ^

>>.                     Cell #2 has value 72 which is 'H'
>---.                   Subtract 3 from Cell #3 to get 101 which is 'e'
+++++++..+++.           Likewise for 'llo' from Cell #3
>>.                     Cell #5 is 32 for the space
<-.                     Subtract 1 from Cell #4 for 87 to give a 'W'
<.                      Cell #3 was set to 'o' from the end of 'Hello'
+++.------.--------.    Cell #3 for 'rl' and 'd'
>>+.                    Add 1 to Cell #5 gives us an exclamation point
>++.                    And finally a newline from Cell #6
```

2.2 Emulator implementation

2.2.1 Interpreter

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2.2.2 Static compilation

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2.3 Applying optimizations

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2.3.1 Precalculating jumps

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2.3.2 Condensing operations

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2.3.3 Sequence matching

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2.4 Testing

3 CHIP8

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3.1 About

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3.2 Emulator implementation

3.2.1 Interpreter

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3.2.2 Just-in-time compiler

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3.3 Quirks and extensions

3.3.1 Super CHIP8 1.1

3.4 Testing

4 The application

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4.1 Design

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4.2 Implementation

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4.3 Usage

4.3.1 Command line

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4.3.2 GUI

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5 Conclusions

Concluzii ...

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