

Portugol IDE v3.x

A new environment to teach and learn computer programming

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Abstract— Teaching of programming is crucial in every engineering course and particularly in computer courses. Students failure in this domain has led to the development of Portugol IDE, a tool for teaching/learning algorithms. This tool allows algorithms to be coded in mother tongue of portuguese students (portugol) or in flow diagrammatic language (flowchart) and its automatic execution. This paper presents generation 3.x of this tool and describes the advancements therein.

Keywords— component; programming learning; portugol; flowchart; computer science education

I. INTRODUCTION

All courses in computer science related areas include in their curricula an introductory module on programming, which usually has high rates of failure. The concepts taught in this introductory module will be used in many other course disciplines and the rates of failure are deemed as one of the major reasons for student drop-out from these courses [1] [2] [3].

This serious drop-out rate has been a subject for research and several recommendations from computing professional associations (e. g. ACM e IEEE) [3]. Many different strategies and tools have been proposed to improve the teaching/learning process of programming basics [1]. With this in mind, faculty members and students of the School of Technology of the Polytechnic of Tomar have developed an innovative environment for teaching/learning algorithms - Portugol IDE.

This freeware and open source environment has been used in the Polytechnic of Tomar, in national and foreign higher education institutions and in high schools and professional schools.

Given its success and in order to broaden its scope of application in the teaching of programming, the authors have developed generation 3.x which features a more advanced language and a new environment.

This paper includes an overview of this tool (Portugol IDE) and the pedagogical characteristics that make generation 3.x an asset for the teaching of programming.

II. PORTUGOL IDE PROJECT

Portugol IDE is an environment for algorithm exploration designed for the teaching of programming created in the Polytechnic of Tomar in 2005 as the final project by finalist students of the degree in Computer Engineering. This

teaching/learning tool is available free of charge (<http://www.dei.estt.ipt.pt/portugol>) and its source code is accessed through the GPL licence. The tool has been developed using Java technology which makes it transferable to any computer platform that supports this technology.

Portugol IDE uses a Portuguese lexicon-based language for encoding algorithms (the portugol) and a graphic language (flowchart). These languages have been defined in a manner that allows their execution by the computer and are equivalent among them [4].

Flowcharts are a graphic language consisting of parameterized geometric shapes and arrows representing the flow of execution between those shapes. As it is a graphic language, the algorithm is designed and thus form parameters have a minimal syntax, thus being less prone to coding errors. This language is specially intended to teach the foundations of computer programming. Figure 1 shows the Euclid's algorithm coded in portugol and in flowchart.

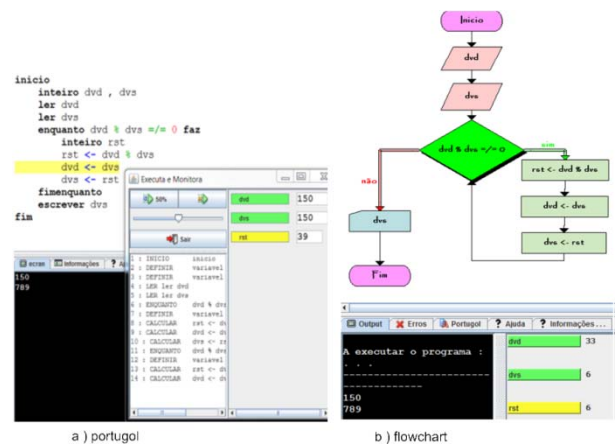


Figure 1. Euclid's algorithm in portugol (a) and flowchart (b) executed in the Portugol IDE environment.

Portugol has a small set of instructions and operators with a flexible syntax which make it easily understandable and powerful enough to perform complex reasoning. Although the flowchart is executed through portugol language, it is transparent by the student.

Portugol IDE also has some features that improve the efficiency of the programming learning process. Its environment allows the students to encode, execute and check

algorithm correction in an iterative way within a simple intuitive environment (Figure 1). These activities can be performed in both languages and the system allows the translation of the algorithm into the complementary form providing an alternative representation of it. The environment allows formal verification of the algorithm through step-by-step execution of computer instructions. Portugol IDE also allows visualization of the state of real-time memory variables and to control algorithm execution speed. By analyzing automatic execution of the algorithm the students can recognize algorithm correction or the instructions that make it incorrect. Thus students can execute, change, correct and test their theories to solve the problem contributing to an active experience-based learning.

III. PORTUGOL IDE V 3.X

Advancements in Portugol IDE have reflected the needs and suggestions from faculty and students regularly invited to contribute to its development both at the level of system encoding and at the level of introduction of new tool features. This symbiosis between the two parts of the teaching/learning process causes Portugol IDE to be a widely used and appreciated tool by the whole academic community in the Polytechnic of Tomar.

The first generation of Portugol IDE was developed in 2005. The second generation was launched in 2006 and was characterized by the introduction of the flowchart module and its inclusion in portugol language. The generation 3.x of Portugol IDE featuring an enhanced language and a new environment will soon be launched

Previous generation of Portugol IDE was designed to teach learning modules: data manipulation, decision structures and repetition structures. For this purpose basic data types and arrays have been defined.

A. Core Enhancements

New features of generation 3.x include the possibility of defining complex data for the tuition of algorithms involving the definition of the arrangement for conceptual data (structures).

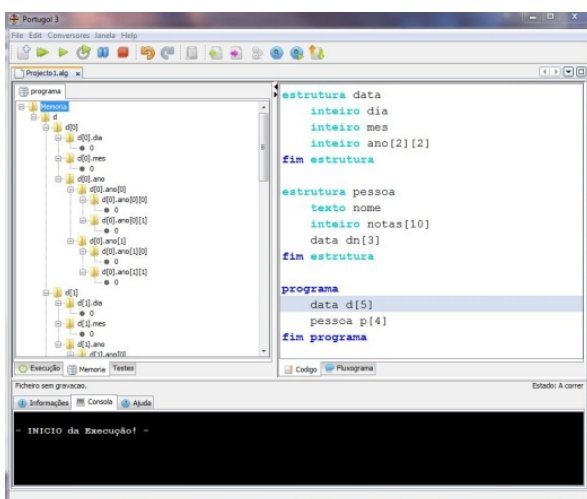


Figure 2. Complex data types in Portugol IDE v 3.x

The concept of reference is one of the most complex issues of computer programming [5]. Today this is introduced to students through complex computer languages such as C making learning of this subject even more difficult.

In order to illustrate this concept within the Portugol IDE environment, a new feature (&) has been introduced in variable definition to support values or addresses. Manipulation of the referenced variables follows a pattern that is similar to that of normal variables in which memory operations are displayed in the learning environment as can be observed in the referenced variable pb whose attribution value is like a normal variables (figure 3).

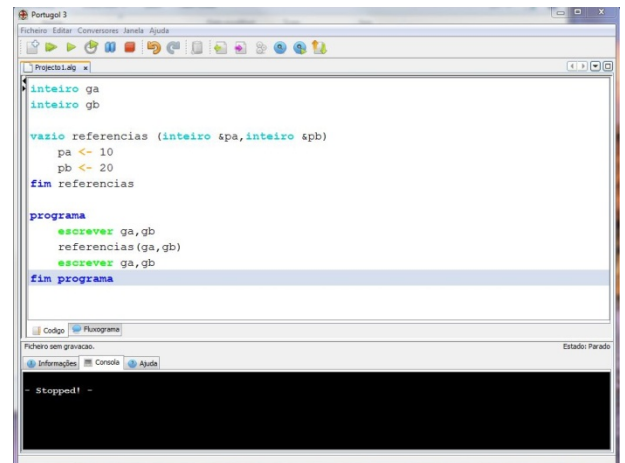


Figure 3. References in Portugol IDE v 3.x.

The new generation of Portugol IDE was equipped with a feature that allows the use and definition of iterative and recursive functions. Function definition enables problems to be divided into several modules that can be solved separately thus allowing new techniques for the development of algorithms to be learned such as top-down and divide-to-conquer.

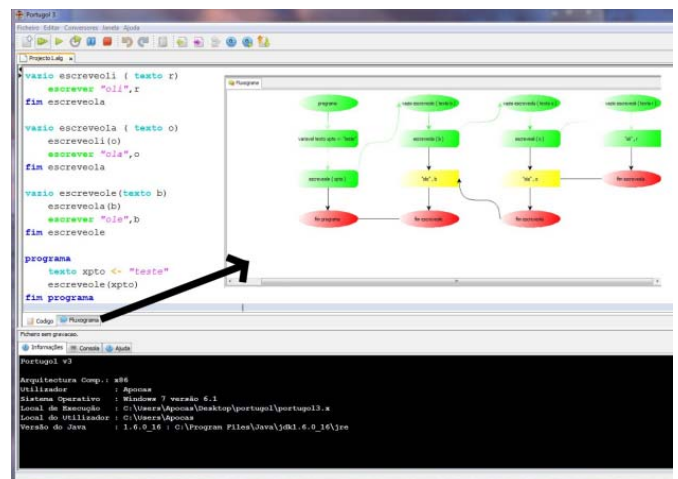


Figure 4. Functions in Portugol IDE v 3.x in the form of portugol and flowchart

The ability to include Java-compiled function libraries enables the utilisation of the learning environment in

pedagogical contexts which were not initially predicted. These libraries can be developed by the students and external contributors so as to increase the functionalities of Portugol IDE without putting at risk the stability of the tool.

B. Development Environment

Classroom context is hazardous to any software because there is, more than often, an intensive unpredicted use of it.

To equip the tool with a sound basis an RCP (Rich Client Platform) architecture has been used. This type of architecture is very powerful due to its modular structure which is constituted by a nucleus containing several modules surrounding it and provides different features. As nucleus the NetBeans Platform RCP by Sun has been used. The stability of Portugol IDE nucleus has thus been ensured through a platform whose code has repeatedly been tested for years in IDE NetBeans, that shares this same platform.

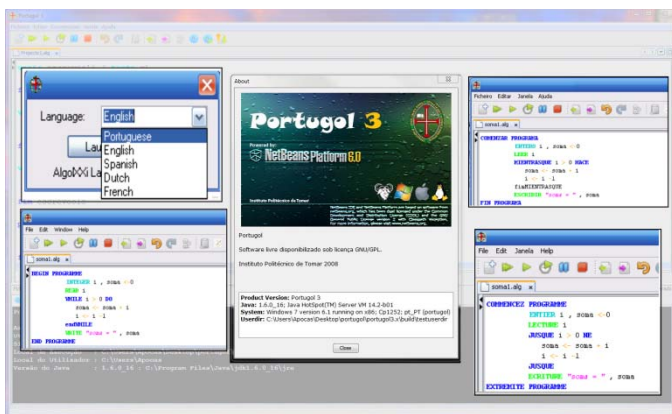


Figure 5. Multi-language support of the Portugol IDE v 3.x

Previous generations of Portugol IDE have only been made available in Portuguese, this feature being hardcoded in the source application code, which made implementation of a new language very difficult. In Portugol IDE v3.x the interface language can be changed in a dynamic way as well as the language used in the source code syntax written by the student. Thus the students with different mother tongues will always write in their natural language. The source code in all the languages is the same, and the tool have an intelligent module that identifies the language of the source code and translates it to the desired language. This feature allows the exchange algorithm regardless of the language they were written.

This feature allows the coexistence of different language-speaking students in the same classroom solving the same exercises and cooperating among them.

In order to implement functions and complex data types it was necessary to redesign the overall system used to represent both local and global memories. The tree layout has revealed to be the best way to represent complex data structures allowing the user to collapse and expand different memory levels, thus turning the representation more organised and understandable (Figure 2).

To represent the different memories (global and local) a tabbed interface has been used in which each memory has an independent tab with a tree layout in the inside as can be observed in Figure 7. Tabulations of local memories are added and removed according to program execution. Only active local memories and the global memory are visualised.

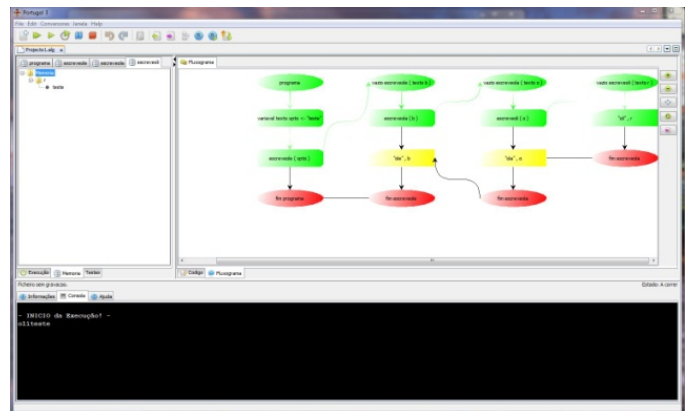


Figure 6. Running the algorithm in Portugol IDE v 3.x

To implement the new language features in flowchart no new graphic elements have been introduced, thus maintaining easiness. In function call, the process icon functionalities have been redefined in which execution of a function starts the construction of a new flowchart for the execution of the algorithm implemented therein. The transfer function parameters are now represented in the start icon and the return value in the end icon.

This new functionality generates a new local memory which in turn is generated by the start icon and destroyed by the end icon.

IV. EDUCATIONAL APPLICATION

Portugol IDE allows the student to be more active in the learning process, improves the effectiveness of development and verification of algorithms and promotes algorithmic reasoning.

Portugol IDE is currently being used in Engineering degrees and vocational programmes of the Polytechnic of Tomar, in various higher education institutions of the Portuguese-speaking community (e.g. Integrated Regional University and UDF – Brazil University Centre) and in several high schools (e.g. Sertã and Foz Côa High Schools).

In order to assess Portugol IDE's capacities, i.e. its utility and usability, a survey has been carried out involving students attending the 1st year of the Computer Engineering programme in the School of Technology of the Polytechnic of Tomar [1]. The participants have revealed to be very pleased with Portugol IDE viewing its innovations as extremely useful to learn programming. They also consider this learning environment as effective, user-friendly and easy remindable.

We believe that with launching of version 3.0 Portugol IDE has made great progress and advancements. This version allows the use of iterative and recursive structures and

functions. With this functionality students will be able to learn more complex study contents in a simpler way.

The easy change of interface application language and the language used in the source code syntax enables the students with different mother tongues to always write in their natural language. Portugol IDE generation 3.x promotes algorithm distribution through learning management systems and Web repositories.

With this enhanced version it will be necessary to know the behaviour of future users. We intend to collect students opinions about Portugol IDE 3.0 and also to assess the implications of this new version in learning by carrying out a quasi-experimental survey [6] involving two different groups: Group A (use of Portugol IDE 3.0) and Group B (use of traditional table tests)

V. CONCLUSIONS

Learning how to program is a complex task involving high levels of abstraction and logical thinking which, as a rule, has high rates of failure.

Portugol IDE has been designed in a manner as a support tool for teaching and learning the basic foundations of programming. The definition of a minimal set of instructions for portugol and flowchart languages facilitates the learning of commands and icons but they are also sufficiently powerful to construct complex algorithms.

Furthermore, generation 3.x. of Portugol IDE also allows to define complex data types, to use iterative and recursive functions, to include Java-compiled function libraries, to change the language of application interface and the syntax language, to represent different memories, among other functionalities.

We believe that Portugol IDE is a good option for all those who are involved in the teaching/learning of programming as it facilitates active learning inside and outside the classroom

environment while it validates algorithms, facilitates error depuration and supports two languages: portugol and flowchart [7]. Instructors are no longer the holders of the solution and become more available to their students.

New features are already being studied with the aim of promoting a virtual ecosystem in the framework of Portugol IDE, including its articulation with learning management systems, learning content management systems and learning objects repositories.

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