

# Bugs Detection Model With Human Computation

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**Abstract**— This paper proposes a model of creative peer-assisted learning based on the strategies of the Human Computation for the detection of errors of code in a programming language. In the model is presented a evaluative strategy of Human Computation of the type (Human Innovative - Human Selector) that allows to determine the possible errors generated by a user to solve a computer problem through the automatic review by a group of users that at the same time to review the code of another user, reinforce their own learning, this enables to detect each action user response in four dimensions: Use specific knowledge of these units, use of language, reasoning and ability to abstract, take perspective and make metacognition in processes that involve the design of computer programs. This is expected to facilitate the teaching-learning process through the active participation of the users through the transfer of knowledge between themselves.

**Index Terms**— Human Computation, Creative Learning, Peer-Assisted Learning, Knowledge Transference, Teaching – Learning.

## I. INTRODUCTION

During the decade of the 1970 the Artificial Intelligence (AI) began to get importance in the computational area, whereof objective is to mimic the human being or animal's behavior to solve complex problems [3]. However still exist functions that the intelligent systems can not realize as composing a song, programming a computer system, by what, the current trend is that the human being cooperate with the computers to solve a complex problem by the great participation of users which implies a collective intelligence. In addition to that activities that humans will solve, they will save a lot of time to compute the system solution. These strategies are established in a new area that it is known as Human Computation [2]. Given that humans design intelligent systems, it is vital to possess human resources trained in this area. However in the last years it is detected a low school achievement in the computation students especially in the programming languages learning, by what in this work is proposed a strategy by Human Computation that it is based in the models of peer-assisted learning, allow the collective participation of persons that fortify their learning.

## II. THEORETICAL FOUNDATIONS

This section show basic definitions about the problem development, considering the strategies and kind of Human Computation, learning for discovery and Peer-Assisted Learning.

### A. Human Computation

The Human Computation [2], [9] is a multi-disciplinary area that require of the Artificial Intelligence areas, machine learning, human-computer Interface, Psychology and Statistic, whose objective is make new models of collaboration human-computer allow to derive persons massive groups in that tasks that computers cannot perform[5], and then gather again that results in the data processing flow that programs execute with advanced effectiveness and efficiency. The Human Computation is located between the crowdsourcing and the computing social applications (social computing) [4]. The figure 1 show the Human Computation intersection, with the crowdsourcing that represents the applications where the computers or the humans can be replaced ones by others in the massive tasks. In the different projects of Human Computation the population is motivated for one or more of the following elements: curiosity, the desire to prove if it works, the desire of being amusing with the cooperative spirit of a computer game, of communicating and to share knowledge, of sharing user's innovation to see if someone else it can improve it, to play the system and to influence in the final result, the increase of the on-line reputation / recognition. The methods of computation based in humans [4] combine machines and human beings in different roles. Kosorukoff (2000) propose a way to describe the work division in computation, that it contains the methods based on human in three classes that they can be referred by abbreviations of two letters : HC, CH, HH. Here the first letter identify the type of agents that they carry out the innovation, the latter indicate the kind the type of agents of selection. In some implementations have:



(C) Alexander Quinn, A Human Computation: A Survey and Taxonomy of a Growing Field

Fig 1. Impact areas of Human Computation

### B. Learning

The essential strategy to learning without limits is the practice of three essential activities [8]:

**Cooperation:** it is necessary affirm internal our self in the interaction with others, through the practice of working in a group, solidarity, mutual respect and a permanent dialog.

**Creativity:** learning is not under go to molds, but live innovative. One who learns must always strive to give opening to his sensitivity, to work, to the flexibility and originality in thinking and in the act.

**Critical nature:** Develop reflection, critical spirit to understand the world and operate on it.

Within the learning more used is the Learning by Discovery that is that the student obtain knowledge by itself ( Bruner 1961), It is a type of inductive reasoning, because students spend time studying specific examples to formulate rules, general concepts and principles. Teaching for the discovery requires you to ask questions, problems, or complex solutions to resolve and encourage apprentices to formulate conjectures when they have doubts. To force the students to construct their own knowledge, in leading a class discussion teachers could ask questions without direct answers and tell them that are not being evaluated, in addition to raising structures in the questions and make suggestions on how to search for answers [8]. The Peer-Assisted Learning is the type of learning [6], [7] where the student get knowledge by itself ( Bruner 1961), it is a type of inductive reasoning, because students spend time studying specific examples to make rules, concepts and general principles. It is believed that the discovery is a way to solve problems. It is well suited to the constructivism as it consists in approaches to instruction in which the partners function as active agents in the learning process (Rohrbeck 2003). It has been shown that the peer assisted learning improves utilization, Rohrbeck found that this type of learning can increase the motivation for academic and social learning. Some of the methods that emphasizes this learning are the peer tutoring, the mutual learning and cooperative learning [1].

**Peer Tutoring:** Captures many of the principles of constructive teaching, students are active in the learning process; tutor and tutee freely participate. The one-to-one context may encourage tutees to ask questions that they might be reluctant to ask in a large class. There is evidence that peer tutoring can lead to greater achievement gains than traditional instruction (Fuchs, Fuchs, Mathes, & Simmons, 1997). Peer tutoring also encourages cooperation among students and helps to diversify the class structure.

**Reciprocal teaching:** it is a clustering strategy that relies on cooperative students so that they become the teacher and work as a group, to give meaning to a text. The main function proposed here involves trust to a student the observation of the execution of a particular task, in addition to providing him with information on the rights and wrongs. If the students know what to look for and how to correct the errors they are in a position to act cheerful and successfully in character of

observers and proofreaders.

**Cooperative Learning:** its objective is the ability of students to work in collaboration with other people. Must be implemented in a timely manner in tasks that are too extensive for a single student. The task at hand, in addition, must be adequate to stir and heat in group, As happens when students can carry out part of the work of individually and then combined in a final product.

### III. BUGS DETECTION MODEL

Given a computational problem and the proposed solution by a student, a review process takes place using Human Computation Strategies. In particular, a set of students is called reviewers who analyze the code, found bugs and report them. The set of bugs is reviewed, sorted and classified by the instructor in order to debug the types of errors that were reported by students reviewers. There is already a list of typical programming errors made by students, however this list can grow when new types of errors will be reported. The general scheme of model validation and code review is shown in Figure 2 where the problem solution is created by a student and another group of students find out the errors of kind  $E_1, E_2, \dots E_n$  in code. Errors are accumulated in order to get an average for each type of error. It is important to indicate to the student under the supervision of a teacher or tutor the most common errors committed by him. It keeps a history of the kind of mistakes he has made and this result is compared with the errors of last problem solved. If the number of errors of a type ( $E_k$ ) is given below its average then we could say that he is improving their learning, otherwise we will recommend him recheck certain topic and continues practicing. Another important factor in the model is the reliability of the reviewers; we have seen that some reviewers report errors that are not really considered as such so the tutor (teacher) assigned some degree of confidence for each of the reviewers according to reporting errors of a given solution.

### IV. RESULTS

This model has been applied to a group of students, the results obtained are shown in Table 1. Data in Table 1 are considered only four types of errors that are most common are denoted as:

- E1: Syntax Errors
- E2: programming logic errors
- E3: undeclared variables
- E4: Repetition Structures misused.

In Figure 3, the plot of the errors made by the Student 1 where the solid line shows the number of errors that were detected in the final solution proposed by the student and the dotted line indicates the average of the different types of mistakes made during the computer troubleshooting. In this case we have the type of error E2 is above average so it is necessary to recommend the student to go over a topic for this type of errors.

V. CONCLUSIONS AND PERSPECTIVES

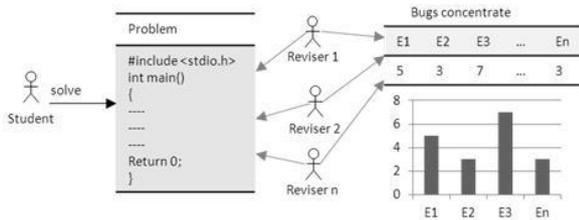


Fig 2. General Scheme of detection model

Table 1. Detected errors concentrate

	Average bugs rate				Current types of bugs			
	E1	E2	E3	E4	E1	E2	E3	E4
Prob_1	4.3	8	8.3	7	3	9	5	4
Prob_2	5.7	6.7	4	7.3	8	3	1	9
Prob_1	6.7	3.7	8	7	10	5	5	3
Prob_3	4.3	7	7	4	4	6	3	2
Prob_2	7.3	7.7	3.7	8.3	3	7	4	1

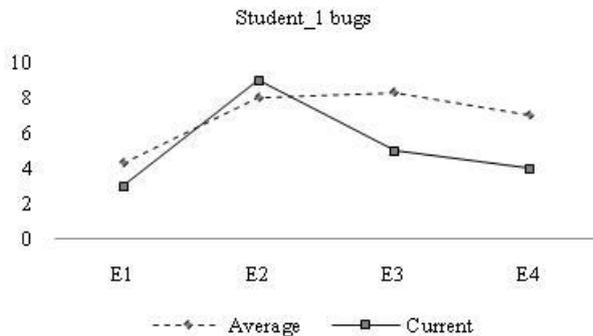


Fig 3. Chart of the errors made by the student\_1 and detected by the reviewers.

In Figure 4 shows the average errors concentrate generated by students where the overall average is indicated by the solid line, as can be seen would be ideal if the number of errors made by students was below the overall average however the majority at least some kind of errors is above average which indicates that still need more practice.

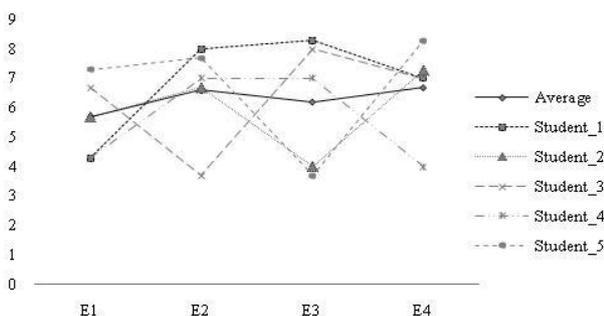


Fig 4. Chart of average errors students

The model developed allows reinforcing the ability of programming through the collaboration of students. We used the basic strategies of Human Computation to check the code in C Language without using a compiler, because the build process is done by the students themselves, where in addition to test their knowledge, the teacher is helped in the process of reviewing over student solutions. Having an automatic checker is difficult due to the complexity of the process and more so that compilers give little information on errors of a program, which is why this model is not only the review of syntax and semantics but also to offer better details of programming logic errors. In this sense the teacher plays an important role in reviewing and monitoring of the errors found by reviewers and solves more problems. The bug detection in C language model has been applied to a group of students who are starting their learning in that language and especially data took less outstanding students we find that produce more errors, however we believe that doing more reviews and solve programming problems more likely to re-make the same mistakes decreases. With this model it has been shown that new methods of peer assisted learning can be linked intrinsically to human computing strategies because this new computational area links human knowledge and skills to solve problems and if it applies to provide support among students we can perform that learning takes place in an environment where there is more reliance on their peers compared to the authority that the teacher projects and also I reinforced student learning both reviewers and reviewed. Among the prospects are working to achieve a web platform to automate part of this process, where you can save all the information collected and generate reports for each student or user of the system. It is also important to include more elements that are necessary to achieve meaningful learning in students also must keep track of users' levels and establish a classification of the reviewers that are more reliable.

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