Fine Tuning The Young Learners For Competitive Programming And Employability

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Abstract: Nowadays employability of graduating engineers has become very difficult. Most of the students go for a less paid job even which may not be in the proper field of study. Most of the high paying companies are looking for skilled people where the training that they have to provide is minimal no training have to be given. Most companies started recruiting people who scored best in competitive programming done through different media. This work studies the level of preparedness of students to face such competitive programing environment, where they need improvements and how this can be provided to the students through a unified platform. Competitive programming needs a lot of practice which is a key to success, and the components which are most required are discussed here.

Index Terms: Competitive programming, e-learning, logical programming, problem solving

1.INTRODUCTION

In the recent years competitive programming has become one of the most important part in employability of young engineers. A lot of competitive programming examinations are held throughout the year accessing the competitive programming skills. One of the first initiative in programming contest was started by International Collegiate Programming Contest (ICPC) during 1970s. From 1977 till 2017 Association for Computing Machinery (ACM) was hosting ICPC known as ACM-ICPC, which was one of the top contestant in competitive programming. After that it is being hosted by ICPC Foundation Factsheet (2017) [1], Factsheet (2020) [2]. All these programming competitions are set to have some logical and mathematical problems that need to solve with programming platforms with in a limited period of time Dagiene(2010) [3], Garcia-Mateos G and Fernandez-Aleman (2009) [4], Audrito et al.(2012) [5].

Mathematics has an important part in competitive programming. In order to understand the problem statement clearly and give solutions to it, a good knowledge in analysing the mathematical model of the problem and how to give solution it the problem is very important Laaksonen (2020) [18]. The next step towards this is to convert the problem solution to a programming model, which requires a good programming skill. Most of the online contest uses C++, java and python as platforms. Out of this most used platform was C++, then python and least used was Java. So it is a better way to learn one of these platform libraries well to do competitive programming.

In most of the current scenarios when students lean programming or solving problems, they tend to choose problems which are easy and less weight that can be solved using simple algorithms. The tough and tedious problems are mostly skipped by the students. But practicing the later can improve the skills better in programming. Competitive programming doesn't do anything with memorizing the complex algorithms. It purely looks on the approach used in solving the solutions.

All students are skilled in one or in the other way. Giving them a good training to project their skills to a right path is missing in most of the academic systems. A special platform to understand the need of the individual and make them trained in the right path is the need of the hour.

The rest of the paper is organised with study of similar initiatives in section 2, section 3 with actual requirement for such platform, section 4 with some observations from the student community with respect to competitive programming and some solutions and section 5 conclusion

2.BACKGROUND

As per the National Employability Report for Engineers (2019) [6] about 80% of the students still struggle to find a job in the country. Also as per the reports, the percentage of students who possess the next generation skills like artificial intelligence, data science is very less. Also the percentage of students who were able to write a good functional code without any error is only 4.6%. The report further specifies that the students entering the college or university level are underprepared. Many lack in the employability skills like mathematics, reasoning, reading skills and computer skills. There must be a rise and well defined policies need to be adapted to make the students employable.

IOI (2020) [7], Dagiene and Koivisto (2020)[8], International Olympiad in Informatics is the first organization to start a competitive programming contest among secondary school students in the year 1989 which was held at Bulgaria. They have divided their tasks to subtask depending on the difficulty level. Students must solve the given problem within the given time, five hours and have to write a computer program in C++ in the same time in the final round. Students are graded by analyzing the results by running the predefined sets of secret test data. The main idea behind this competitions is to inspire interest in computer programming and science. This also leads to great employability. IOI-syllabus (2019) [9] has the detailed syllabus of competitive programming contest. Mathematics and Logical reasoning plays a major role in the syllabus followed by Computer programming.

Alnahhas and Mourtada (2020) [10] addressed the problem in performance comparison and future prediction. They used a machine learning technique to analyze the performance with the historical ratings and projecting out useful information that requires training. This system can easily find out the students who may deviate from the track and such people can be provided with proper training.

Prashant (2020) [11] used the competitive programming methodology to learn and apply the skills in developing community needs. Lots of students were involved in doing such projects through experimental learning.

Dagiene and Skupiene (2004) [12] showed their concern about the education system where the students get a great information technology environment but the problem solving skills are very much lagging with the students. Similar to IOI (2020) [7] a large set of programs need to formularized for the students. Testing need to be put to the students to evaluate themselves and improve their skills. This must be made as a part of learning system.

Guerreiro and Georgouli (200) [13] done a research on individual score of students during introductory programming and competitive programming. When the tasks were done individual basis they found the improvements and participations were less satisfactory. They then introduced group activity and competitive learning platform and found significant improvement in the students. This shows the effectiveness of competitive programming in skill development.

Bátfai et al. (2016) [14] used the competitive programming model to make a best decision support for the continually changing behavior in the gaming model. The system used a strong mathematical model in the background which can go for optimization, implementation of this in different languages was a difficult task. They used competitive programming model for providing a solution to the same. This shows an application towards competitive programming mode.

Wasik et al. (2018) [15] made a survey on online judge systems which does the evaluation and analysis of examinations through an online system. They compared the majority platforms who provide competitive programming. They have taken Optil.io platform for the demonstration exercise. They have given a problem domain with time and space constraints. The aim of the exercise to find the optimal solution rather than finding the best performer. The problem was first given to a small group and further extended to larger group and found to arrive best solution when large group is working together. In competitive programming too, a small set of participation won't result in a good outcome, this requires a large group of learners and contributors.

Di Luigi et al. (2018) [16] introduced, the online analytics platform called the oii-web. Even though there are a large set of online platforms available for online training, these platforms that can take inputs and provide ranking based on global tasks that are solved. The oii-web is an analytic platform that can analyze the user submissions and provide proper suggestions in improved learning. Di Mascio et al. (2018) [17] also used the same oii-web framework for providing an analytical based results for the participants to learn further.

3.COMPONENTS OF COMPETITIVE PROGRAMMING

The core components of competitive programming includes problem identification and design of solutions or otherwise called algorithms and implementation of these designed solutions. These requires the skills shown in Fig.1 to be inbound with the students. As mentioned earlier, mathematics is a key for competitive programming. Even though there are number of comments from the competitors that many of the problems are too mathematical, it is a fact that mathematics and algorithms cannot exist without each other. Also analytical skills are very much important in analysing the problem and finding the right solution to it. Some of the most required mathematical skills are discussed here.
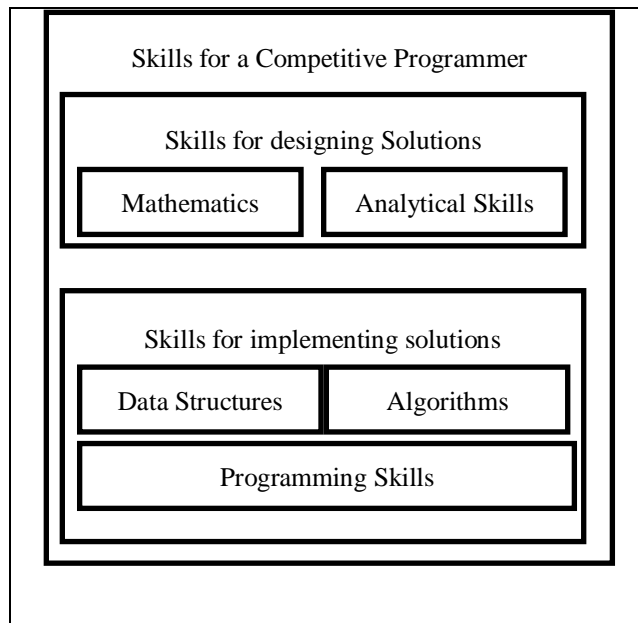
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Fig. 1 Skillset required for a competitive programmer

3.1. Primes Numbers

A number is said to be prime, if it is divisible by itself and one. Providing definitions and examples for every mathematical topics will go beyond the scope of this paper. But still this topic will be explained with example to make understand what competitive program requires. Suppose if this case is given as a question, to find all primes between 1 and 1000000, usually a programmer writes a for statement within which another for statement will be run to check whether the number 'n' is divisible from 2 to 'n' or 'n/2'. When this is run for large numbers as given here, it takes a lot of time to complete. But there is a fact with prime numbers that, once a prime is found, the multiple of that number cannot be a prime. This logic can be applied to remove the unnecessary checking with these numbers which are multiples of prime. For example, 2 is prime, so there is no necessary to check the multiples of 2, ie., 4,6,8,10,.. further. This technique is called Sieve of Eratosthenes. This considerably reduces the time to divide, the inner loop in the program. This is what required for competitive programming. Knowing the problem and providing a best solution to the system such that it can run faster and takes less memory. This requires a good understanding of mathematics.

3.2. Greatest Common Divisor (GCD)

GCD is the number which is largest among the group of numbers enough to divide all the numbers in the group. An even simpler method is available called Euclid's algorithm which takes less time compared to the regular division method.

3.3. Solving equations

Any equation of the form Ax+By=C is called Diophantine equations. This can be solved using extended Euclid's algorithm.

3.4. Combinatorics

This field deals with finding combinations of objects from a given set of inputs. There are large number of problems based on combinatorics and solutions for the same is also available in Laaksonen (2020) [19].

3.5. Matrices

Matrices plays an important role in programming. When it is in programming model, it is a two dimensional array. All the operations in matrix like addition, multiplication, transpose is important in programming also. Graph problems are usually represented with matrices.

3.6. Probability

Probability specifies the chances for an event to happen under a given situation. This usually takes a value from 0 which is less probable and 1 which is high probable. Combinatorics and events helps a lot in it.

Apart from this, basic mathematics on numbers, number system, geometry, functions, relations, sets, basic logic are requirement for competitive programming.

Most of all the mathematical foundations are available in Laaksonen (2020) [19].

3.7. Skills for implementing solutions

Once a mathematical solution is analyzed and found, now it is time to convert these solutions to programming models. For this one must be good in programming with C++/java/python. Since C++ is simple and has a large set of in-built libraries, and most used by competitive programmers, this can be a preferable choice. The following skill sets are required for any programming language.

The basic syntax and semantics of the language preferred. One should clearly know about variables, how it is stored in memory, data types, assignments and writing expressions. A good knowledge should also be there to deal with inputs and outputs. Since the input test cases are given by the automated system, one show know how to provide proper inputs and get desired outputs. Flow control statements, functions and passing parameters to functions are also important.

Writing algorithms are very important. Understand the problem statement and write the algorithms that will take minimal code, memory and time to execute. There are a lot of predefined libraries do certain tasks like sorting searching in most of the languages. So one should be very careful in not wasting the time for writing such kinds of search and sorting algorithms. A good idea on analysis of algorithms will help in finding the time complexity of algorithms which may help in writing code that takes less time and space.

4   OBSERVATIONS FROM THE COMMUNITY

A short survey with the student community has been done to understand the level of preparedness among the students. This included their experience in the field of programming, how often they practice code, the most widely used language among the students, how well they understood competitive programming, their experience in competitive programming platforms and how well are they trained to take this skills.
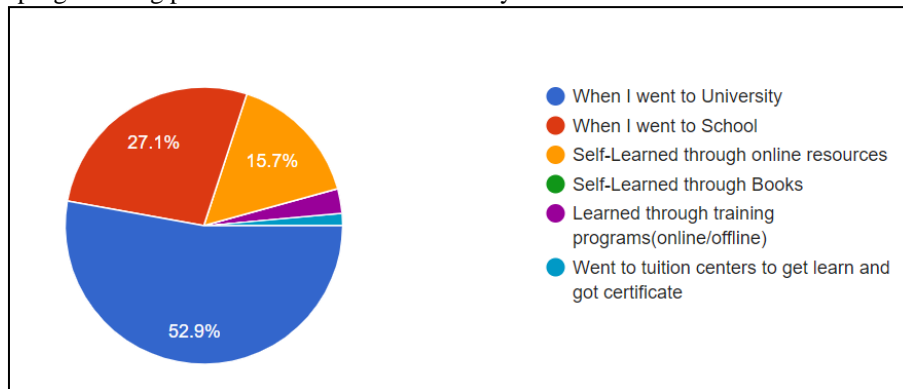

Fig. 2. When did the students start their coding?

As shown in the Fig. 2, Most of the students has a coding experience when they start their college or university and though the platform where they are learning. So it will be better option to add this as a part of their curriculum.

Next is the preferred language. As seen in the Fig. 3, most of the students are well with C. When it is coming to competitive programming, the speed of execution and library packages are very important. C, C++ has good execution speed, but in C, there is no standard template libraries and also it doesn't support object oriented programming. Due to this reason C++ is the best option. Compared with other languages like Java and Python, Python is very slow compared with C++ and Java. Java has features to support big-integers, but this is also slower than C++. Since speed of compilation is very important in competitive programming, C++is considered to be the best and most used by competitive programmers. So compared with Fig. 2, a good input to the students on the C++ features and standard template libraries will help them improve in doing the code easier.
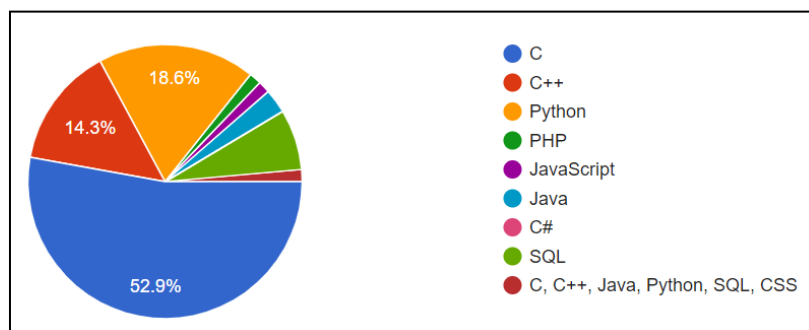

Fig. 3. What programming languages are students well with?

When analysed how the students view competitive programming, it is found that about 29% of students, Fig 3, thinks in right way, it deals with mathematical and logical skills in solving problems. Even though more than 80% of students, Fig. 4, have used competitive programming platforms one or in the other way, the importance given for mathematics and logical reasoning is less compared to other skills, shown in Fig. 5. But these are most required for competitive programming.
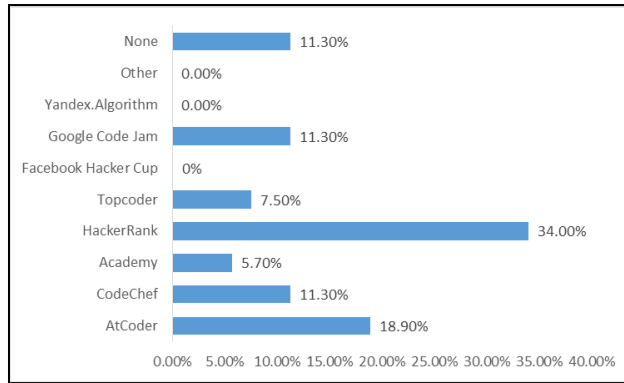
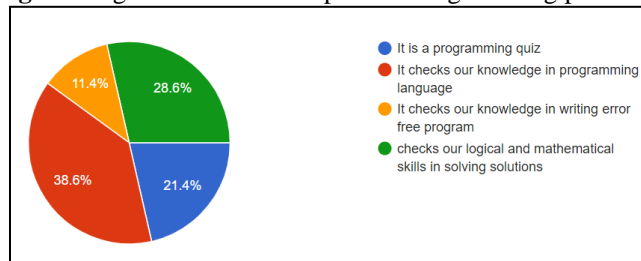**Fig. 4.** Usage statistics of Competitive Programming platforms

Fig. 5. Which skills are most required for competitive programming?

Further students are put on to a local platform created called "mychallenge" which was designed to test basic skills in programming and solving simple problems. It is found that about 50% students as shown in Fig. 6 need much practice in solving and understanding basic skills.

5. SOLUTIONS PROPOSED

The ultimate aim of this is to provide a learning platform for students to improve their problem solving skills and make them employable. The following Learning outcomes are designed for this platform:Understand the computational problems and device an appropriate and best computational logic.Work as individual and team to find solutions to complex computational problems.Implement the quick solutions with programming techniques that takes less time and space. Keeping this in mind, a learning platform is getting ready named "mychallenge" taking all components as discussed in Section 3. Initially a basic skill test environment is created and tested with students. The resultant of the same is shown in Fig. 6. The objective of this platform is more towards practice based learning rather than theoretical learning. Each blocks in the Fig. 1. Will be set as separate modules in learning platform with lots of practice questions. Once the complete process is done, "mychallenge" will be made publicly available for the other learners.
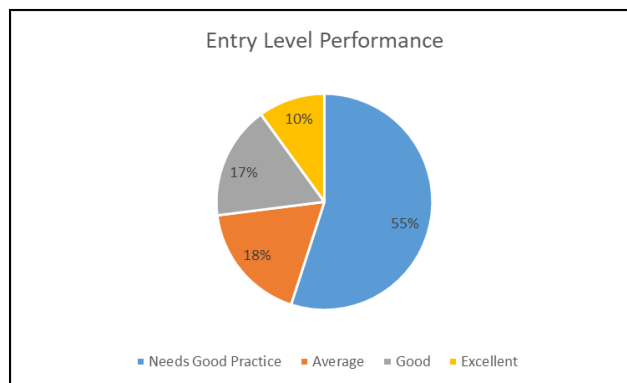

FIG. 6. ENTRY LEVEL PERFORMANCE BY "MYCHALLENGE

6. CONCLUSION AND FUTURE WORK

This work has deeply visited the current scenario in getting high paid jobs in dream companies like FAAGM (Facebook, Amazon, Apple, Google, and Microsoft). It is found that competitive programming plays a major role in getting in to such high paid jobs. Other companies also started following the same scenario. Learning the curriculum alone in the campus wont hemp students in getting succeeded. This requires and additional care with in the curriculum. Competitive programming majorly depends on practice than theory. A good guided practice

platform can hemp the students in achieving their goals. The platform proposed and which is under its developing phase can train the students with more tasks and inputs on where they lag and needs improvement. This will be made public available one all the process is complete and the test cases are good.

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