Using MAPLE in Teaching of Discrete Mathematics

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ABSTRACT

As we know the information technology and computer sciences (IT &CS) originated from mathematics and physics. Most of the research and analysis in these areas required strong mathematical background. Introduction and use of computational software has increased the speed and quality of research in academia, business, and industries. This paper elaborates some Maple lab activities, which seem to be appropriate for undergraduate discrete mathematics course and also found useful to form the foundation of students for numerous research and specialization paths of theoretical computer science and engineering. The students' interest increased and they visualized things easily and fast. New technologies not only bring facilities but also a lot of challenges for teachers. Here, we will focus on only few topics of discrete mathematics.

1. INTRODUCTION

Now-a-days the use of computer in class rooms is very common. And it is frequently used to reduce the load of students because the teachers of mathematics think that the students are unnecessarily overloaded with theory. Many well-known mathematicians and physicists founded Information technology and computer science as a data processing science. We found many departments of computer science that were started as mathematics department. There are many fields available in computer science for specialization and further research (http://www.ehow.com/about_5348276_computer-science-degree-information.html), (Hromkovic J., 2003). The degree of computer science is versatile and divides in theory and engineering both. The specialization of computer science in theory has many fields such as quantum computing, natural language processing, combinatory, number theory,

artificial intelligence and graph theory. Similarly, computer science has many engineering basis specialization program such as, network engineering, operating system, software engineering, programming languages, information security (http://www.ehow.com/about_5348276_computer-science-degree-information.html). Some of them are overlaps because a successful degree of computer science both involves theory and engineering aspects (http://en.wikipedia.org/wiki/Discrete_mathematics, 2012) (http://www.ehow.com/about_5348276_computer-science-degree-information.html).

These all areas have the strong foundation of mathematics. For this, the ideas of mathematics must be clear to student. This paper depicts some examples of discrete mathematics problems while teaching computer science student of BS by using Maple software. It is good program for mathematical calculation, modeling and discrete structure. Next section gives the importance of teaching of discrete mathematics.

2. Importance of Teaching Discrete Mathematics in Computer Sciences (CS)

Discrete Mathematics is the study of the discrete structures of mathematics, in contrast to continuous, such as graph, trees, and networks. The research and development in discrete mathematics increased in last fifty years. The mathematicians and physicists worked a lot on digital computers which store data in discrete bits and operate in discrete steps. That's why discrete mathematics notations and concepts were found very useful in co mputer science problems, objectives of cryptography, automated theorem proving and software engineering (http://medlibrary.org/medwiki/Discrete_mathematics).

 Moreover, it plays an essential role in modeling the natural world, e.g., modeling the genome, and the technological world, e.g., routing on the Internet. It is also applied in computer security, banking and auctions, coding theory, algorithms, telecommunication and search engines. There are many topics of discrete math use in IT & CS such as quantifier, logic, combinatory, graph theory, probability, number theory, algebra, discrete calculus and discrete analysis (Richard Johnsonbaugh, 2009). Section 3 now gives brief introduction to MAPLE.

3. Introduction to MAPLE

While using Maple we first make the students familiarized with basic statements by using the program. Secondly, improve their knowledge and skills step by step by small experimenting problems. Maple has well known features of modeling, experimentation, visualization and other tasks of mathematics. If this stage complete successfully, then they can easily solve their tasks at hand after learning a complete definition or theorem of mathematics. Now, we explain and elaborate the power of MAPLE by taking some examples in Section 4.

4. Some examples of Discrete mathematics using Maple

The discrete mathematics has topics like, sequence, sets, probability, logic, combinatory, Graph theory, number theory, algebra, etc. Some Maple results of discrete mathematics problems are following (mathworld.wolfram.com › ... › General Discrete Mathematics., 2012).

4.1. Sequence

We begin with an activity that invites students to investigate patterns. They are given Maple script that produces the first ten terms of a recursive sequence. Next they run the maple script and see if they can gauss the closed formula for the given sequence. The students

in this class work with both the closed and recursive forms of a sequence as well as gain experience in reading and writing loops.

Example

Consider the sequence $x_n = x_{n-1} + 2n + 1 > 1$ and $x_1 = 1$ using the following MAPLE script we can quickly see the first 12 terms of the sequence [4]..

```
> x:=array(1..12):
```
$$x:array(1..12,[])$$
```
> x[1]:=1:
```
$$x_1:=1$$
```
> print(1,x[1]);
```
$$1,1$$
```
>  for  j  from  2  to  10  do  x[j]:=x[j-1]+(2*j+1):
> print(j,X[j])
> od:
```

$$2,6$$

$$3,13$$

$$4,22$$

$$5,33$$

$$6,46$$

$$7,61$$

$$8,78$$

$$9,97$$

$$10,118$$

$$11,141$$

$$12,166$$

Check your conjecture by modifying the above script so that the closed form replaces the recursive form.

4.2. Introduction of Sets

To understand set and basic set operations we use following basic activity. It uses grammar of Maple.

Example

In this activity we will explore various set operations. Given the universal set U={1,2,3,4,5,6,7,8,9,10,11,12,13,14,15} and also use the following random subsets A, B and C of size 3, 5 and 7 respectively (http://webspace.ship.edu/deensley/DiscreteMath/ictcm03/MapleLabs.pdf).

```
> with(combinat,randcomb);
```
$$[randcomb]$$
Universal set can be state as,
```
>  U:={0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15};
```
$$U:=(0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15)$$

Selection of set A and B random of size 3 we use the following command.

```
> A:=randcomb(U,3);
```

$$A:=\{2,7,11\}$$

```
> B:=randcomb(U,5);
```

$$B:=\{5,6,11,12,14\}$$

The basic operations of sets like union, intersection, minus can be found by following commands.

```
> A union B;
```

$$\{2,5,6,7,11,12,14\}$$

```
> A intersect B;
```

$$\{11\}$$

```
> U minus A;
```

$$\{0,1,3,4,5,6,8,9,10,12,13,14,15\}$$

```
> U minus B;
```

$$\{0,1,3,4,5,7,8,9,10,13,15\}$$

```
> with(combinat,powerset);
```

$$[powerset]$$

The power set of set A can be found by typing the following command.

```
> powerset(A);
```

$$\{\{\},(2,7,11\}, \{2,11\}, \{2\}, \{7\}, \{2,7\}, (7,11\}, \{11\}\}$$

The Cartesian product of two sets, A and B, use the following MAPLE command.

```
> (op(map(y->map(x->[x,y],A),B)));
```

$$\{[2,5], [7,5], [11,5]\}, \{[2,11], [7,11], [11,11]\}, \{[2,12], [7,12], [11,12]\}, \{[2,14], [7,14], [11,14]\},$$

4.3. Binomial Theorem

The other important idea, throughout the course, is in understanding and possibilities of many answers of a single problem. It easily explains how different parts of the same questions are related to each other. For this, we use Maple command to explain the concepts of binomial terms and coefficient.

Examples

To find the coefficient of eighth binomial expansion the MAPLE command is

```
> binomial(8,4);
```

$$70$$

```
> binomial(4,1/2);
```

$$256$$
$$35p$$

The expansion of binomial expression can found by typing the following command

```
> expand((x+4)^8);
```
$$x^8+32x^7+448x^6+3584x^5+17920x^4+57344x^3+114688x^2+131072x+65536$$

5. Conclusion and Recommendation

Basic topics of discrete mathematics have been discussed with simple problems and power of MAPLE. We elaborated the mathematical concepts and ideas to students during teaching of discrete mathematics by using MAPLE commands. Following can be summarized:

- Student took more interest in class by visualizing the discrete mathematics theory and structure with the help of MAPLE.
- They can now understand the concept of computer algorithms. This in turn, has increased their learning power of different programming languages.
- They are now to use these mathematical techniques in different areas of IT & CS

After these results we will recommended all the teachers of under graduate to use different application software in teaching as an experimental tool for testing properties of discrete structures, etc. It is very helpful to develop the skills of students in major subjects of science and technology especially in mathematical sciences.

6. References

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