

Implementation Green Software Engineering Approach in University Course Timetabling Problem

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ABSTRACT

Rapid technological developments have an impact on resources. This allows resources to decrease gradually. Green Computing provides solutions to reduce the impact of technology on resources. One way is to apply green software to the lecture scheduling software that previously spent 45 minutes. Green software will optimize the software both in time and energy. This optimization can be done by choosing the right method, the reduction of looping and the use of data structure. Based on the results of the research found that by using these ways can make the software finish the program quickly which is in the range of 16-20 seconds with different databases. This can save the electrical energy generated from the computer so as to reduce damage to existing natural resources.

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1. INTRODUCTION

The rapid development of technology provides both positive and negative impacts. One of the negative impacts that occurs is the continuous exploitation of resources so that the earth as a source of energy will continue to diminish. Experts are concerned about the natural resource crisis that will lead to the world's energy crisis.

In reality, world of Information Technology (IT) have devices related to IT requires energy to be turned on. The use and utilization of IT devices conducted by the community resulted in increasing demands in energy use. As a solution to overcome the use of excessive energy, the term green computing or green IT is coming.

The term green computing or green IT or if translated into Indonesian is a term that describes the use of computers that are more environmentally friendly, effective, efficient, and energy efficient. Based on [1] *Green IT* is an umbrella term referring to environmentally sound information technologies and systems, applications and practices. It encompasses three complementary IT-enabled approaches to improving environmental sustainability:

- the efficient and effective design, manufacture, use and disposal of computer hardware, software and communication systems with no or minimal impact on the environment;
- the use of IT and information systems to empower – that is, support, assist and leverage – other enterprise-wide environmental initiatives and
- the harnessing of IT to help create awareness among stakeholders and promote the green agenda and green initiatives.

Green IT is not just about creating energy-efficient IT systems (hardware, software and applications), though this is an important component, especially as the use of IT proliferates. Green IT is also about the application of IT to create energy-efficient, environmentally sustainable business processes and practices, transportation and buildings.

Based on [2] The aim of Green IT is to produce as little waste as possible during the whole IT lifecycle (development, operation and disposal). The following factors play important role to achieve the target:

- Reducing harmful emissions.
- Proper treatment of electrical waste.

Other definition, [3] give definition. We require green software to fulfil three abstract requirements:

- a. The required software engineering processes of software development, maintenance, and disposal must save resources and reduce waste.
- b. Software execution must save resources and reduce waste
- c. Software must support sustainable development.

No	Activity	Benefit
1.	Choose faster Code over Future Hardware	Rapid Replacement of hardware is sinificantly less
2.	Include Environmental Costs in your cost analysis	Use of more servers is reduced by developing efficient algorithm
3.	Try to use optimum Memory of the computer	Old Computes with less memory can still be used
4.	Try to build in house when it is possible	Use of 3 rd party component is reduced and unnecessary resource utilization is reduced
5.	Go back and Solve it Again	Helps in developing more efficient and faster running code

2. RESEARCH METHOD

a. Preparing System Under Test (SUT)

1) Computation Platform

- a) Processor : Intel Pentium Dual CPU
- b) RAM : 504MB
- c) Operating System : Microsoft Windows XP Proffesional 2002 Service Pack 3

2) Software Test

- a) Java Language
- b) IDE Netbeans 8.0.1
- c) XAMPP 1.7.2
- d) ODBC Data Source Administrator
- e) SQLite 2009 Pro
- f) Mozilla Firefox
- g) Timetabling Software Automatic version 1.0

b. Test Plan

1) Timetabling Software Automatic Version 1.0

Test program will be using timetabling software automaric version 1.0 to get same comparison. This software needs to be equated with the source code for various DBMS that will be used so testing is not affected by the source code. After obtaining the general source code, this program code is used for the testing process.

2) Test for empty course schedule table

Empty schedule table is a table of lecture schedules that have not yet contained a college schedule. The test is done by recording the time of completion of the preparation of the lecture schedule for one semester. This data is used to get an idea of the effect of database access in the program. What is meant by the empty schedule table is a table of lecture schedules that have not yet contained a college schedule. The test is done by recording the time of completion of the preparation of the lecture schedule for one semester. This data is used to get an idea of the effect of database access in the program.

3) Test for filled course schedule table

Table of lecture schedule that has been filled is the schedule table that has been filled with lecture schedule in the semester and previous year. Software lecturing scheduling 1.0 time and schedule completion printed schedule for one semester.

c. Research Step

1) Collect data that is connected with Timetabling Software Automatic

The data required in lecturing scheduling process include subject data, lecturer data, lecture clock data, and space data for one semester. We get this data from the secretary of Informatics Engineering Department UIN Maulana Malik Ibrahim Malang. The data used as input data is teaching preference data and teaching plot data. Data of teaching preference is lecturer teaching option data. Lecturers can choose the schedule of teaching days, according to the time they have. While teaching plot data is the data of lecturer division in accordance with the subjects that he has, along with the number of classes to be taught.

2) Analyze soure code

By analyzing the program code, it can be done changing some source code related to the database. Changes can be made after the input data from the database and then stored and processed into memory to generate lecture schedules that will be stored back in the database.

3) Using data structure to manage data on memori with apply *arraylist*

Arraylist is one type of Collection that entered in the group List. Arraylist can hold a number of data dynamically, so that any amount will be accommodated regardless of the maximum number of elements that can be accommodated.

In this study, the arraylist is very useful for storing data dynamically and also includes one of the data structures capable of storing Objects in a Class.

Teaching plot data, teaching preferences, lecture schedule data and space data are stored into Object as they are used in the process of creating a schedule that will be stored into the arraylist.

4) Record time execution during application is running

5) Showing result comparison of time execution on the table

```
public class listPrefensi
{
    public Stringsemester,tahun_ajaran,kodedosen,hari;
    public listPrefensi(String semester,Stringtahun_ajaran, String kodedosen, String hari)
    {
        this.semester=semester;
        this.tahun_ajaran=tahun_ajaran;
        this.kodedosen=kodedosen;
        this.hari=hari;
    }
}
```

```
ArrayList<listRuang> lstRuang = new ArrayList<listRuang>();
```

```
ArrayList<listPM> lst_plot = new ArrayList<listPM>();
```

```
ArrayList<listPrefensi> lstPref = new ArrayList<listPrefensi>();
```

```
ArrayList<listJadwalKuliah> lst_jadwal_kuliah = new ArrayList<listJadwalKuliah>();
```

```
public void setPrefensi()
{
    ResultSet rs = null;
    try
    {
        String sql = "SELECT * FROM preferensimengajar order by Hari";
        rs = db.ambilData(sql);
        while (rs.next())
        {
            String Semester = rs.getString(1);
            String tahunAjaran = rs.getString(2);
            String kodeDosen = rs.getString(3);
            String hari = rs.getString(4);
            lstPref.add(new listPrefensi(Semester, tahunAjaran, kodeDosen, hari));
        }
    }
    catch (Exception ex)
    {
        System.out.println("Terjadi kesalahan ambil data : " + ex);
    }
}
```

3. RESULTS AND DISCUSSION

a. Result of time execution on Scheduling program

1) Time execution of Timetabling Software Automatic version 1.0 using DBMS

Time execution of Timetabling Software Automatic version 1.1 using data structure

No	DBMS	Execution Time (s)	
		Empty	Not Empty
1	MS Access	110	2605
2	SQLite	46	1027
3	MySql	51	991

No	DBMS	WaktuEksekusi (s)	
		Empty	Not Empty
1	MS Access	179	188
2	SQLite	22	24
3	MySql	19	19

b. Discussion

The execution time of processing the lecture schedule using the DBMS will look very different results between the scheduling with the data in the empty lecture schedule table with the data in the filled lecture schedule table. In this case, the amount of data in the table of lecture schedules filled as much as 2140 records. From the three DBMS used for comparison, there is no single program execution time that only has a small margin. This is because the processing of the schedule is done on the database, so much at least the data in the database will be very influential on the execution time of the program.

While the program execution time in the scheduling program version 1.1, the scheduling process uses the data structure as its storage. The results shown in Table 3 do not have a far-reaching outcome, even using MySQL's MySQL DBMS yields exactly the same time

CONCLUSION

Based on the results of the analysis, then some conclusions that can be obtained are as follows:

- Automatic lecture scheduling software version 1.0 underwent estimation time changes to run its task after computational efficiency. Time changes experienced before and after computing are very significant, so this is in accordance with the theory that the data structure can accelerate the process of task on a software
- After experiencing computational efficiency, how much data is in the database does not significantly affect the program's estimated time.

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