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Using Color Coded Pattern Clustering Model Combined with Automated System for Courses Scheduling

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Abstract: Course scheduling is very important but complex task at universities. The complexity increases when a course includes lab hours in addition to the lecture hours. Course schedule often yields to dissatisfaction of students, instructors, and university administration. In this paper, I discuss a Color Coded Pattern Clustering Model that applies a reasoning approach to design the time table in the Computer Science Department at University of Bahrain. The model supports minimizing clashes between lectures and lab sessions and facilitate distributing the courses among the time blocks. The model, then has been implemented to automatically generate the time-table and support data mining. It supports minimizing clashes in students time table and preserves faculty preferences.

Keywords: Scheduling, Pattern Clustering Model, Reasoning Approach, Database, Data Mining

1. INTRODUCTION

Course Scheduling is a very important and serious administrative task at universities [1, 2]. Course scheduling is also known as timetabling. [1] defined the timetabling problem as "The problem of assigning a number of events into a limited number of time periods". It is very complex and time-consuming process [3, 4] and has been proven to be NP-hard problem [3]. [4] specified that "The problem of constructing course timetables for academic institutions consists of allocating the set of courses offered by the university to time periods and classrooms in such a way that no teacher, student or room is used more than once per period and that room capacities are not exceeded". Students and instructors cannot be at two different places at the same time which is called event-clash constraint by [5]. Event-clash is considered to be a hard constraint that cannot be violated because the solution will become not feasible [6, 7].

Various approaches in the literature have been applied to solve timetabling problems. According to [1], those approaches can be divided into four types, which are sequential methods, cluster methods, constraint-based methods, and meta-heuristic methods.

[1] created solutions to the timetabling problems using heuristic and meta-heuristic methods. This approach applies hybrid heuristic methods and genetic and memetic algorithms for timetabling. The meta-heuristic methods starts with one or more initial solutions. Then applies search algorithms to avoid local optima. The memetic algorithm tries to improve the performance of the genetic algorithm by integrating local neighborhood search [1].

[12] applied hierarchical mathematical model to address the priorities of the scheduling system through related mathematical models. Those are the capacity model, the distribution model, and the allocation model. The capacity model finds the number of course sections to be offered during a specific semester. It provides levels of coverage to courses so that expected demand of a course is met with high probability. The distributional model utilizes the output of the capacity model to schedule the sections in a way to avoid potential section conflicts for students. The allocation model allocates the sections to numerical frames and faculty to course sections [12].

[4] applied a timetabling integer programming model to assign courses to time periods and rooms. The model comprises of two different groupings which are the grouping of courses that is called the subject group and the grouping of time period. The courses in the subject group are followed by the same students, so those courses must be scheduled at different time periods.

This paper presents a reasoning approach that combines heuristic and analytical methods.

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2. THE COURSE SCHEDULING PROBLEM

Each department at university of Bahrain has a time-table committee that is responsible for preparing the course schedule of their courses every semester. At the college level, there is a time-table committee consists of the chairs of the departmental level committee to arrange for courses taken by students of different departments in the college. The chair of the college level committee is a member of the university time-table committee. This committee consists of members who represent all the university colleges to facilitate the communication across the colleges supporting students belong to a specific program. The department of computer science offers every semester around 27 courses, 22 of them are required courses and 5 elective courses. The total number of offered sections of the required courses is around 84 sections and around 5 sections of the elective courses. These figures are adjusted according to the number of students admitted every year. The college has 30 classrooms, 10 of them belong to department and can utilize other classrooms belong to other departments in the college. Classrooms vary to occupy from 40 to 45 students. The department has 10 computer laboratories, each occupy 30 students.

3. THE DISCRETE BLOCKS MODEL

The university registration system uses discrete blocks Model to allocate lectures' blocks. The period of the block is 1 hour for the lectures offered on Sunday (U), Tuesday (T), and Thursday (H) which is known by UTH. The lectures' blocks on Monday (M) and Wednesday (W) which are known by MW last for of 1 hour and 30 minutes. On UTH as shown in Table I and II, there are 8 non-overlapping blocks for the lectures starting from 8:00 to 15:00 that can be extended if needed depending on the number of students, sections, instructors, and available classrooms.

TABLE I. LECTURE BLOCKS ON UTH

Lecture Block		Time							
		8:00	*9:00*	*10:00*	*11:00*	*12:00*	*13:00*	*14:00*	*15:00*
Day	Sunday (U)								
	Tuesday (T)								
	Thursday (H)								

TABLE II. LAB BLOCKS ON UTH

Lab Block		Time			
		8:00	*10:00*	*12:00*	*14:00*
Day	Sunday (U)				
	Tuesday (T)				
	Thursday (H)				

For the same period there are only 4 non-overlapping labs' blocks since the labs lasts for 2 hours so two blocks are used to occupy one lab session. The lecture last for 1 hour and 30 minutes on MW. Thus, there are only 4 non-overlapping blocks for the lectures and for labs due to the students activities session on W from 11:00-13:00 where no lectures or labs are held. Because the block from 11:00-13:00 on Monday does not have counterpart on Wednesday, it is used only for labs as shown in Table III and IV.

TABLE III. LECTURE BLOCKS ON MW

Lecture Block		Time				
		8:00	*9:30*	*11:00*	*13:00*	*14:30*
Day	Monday (M)					
	Wednesday (W)					

TABLE IV. LAB BLOCKS ON MW

Lab Block		Time			
		8:00	*11:00*	*13:00*	*15:00*
Day	Monday (M)				
	Wednesday (W)				

4. THE ADVERSITY OF COURSE SCHEDULING

There are many difficulties faced during the development of the semester schedule which are:

- All major courses which are offered by the college has three hours for the lectures and one lab session consists of two hours each week which increased the possibility of clashes between the required major courses of any student enrolled in College of Information Technology. Thus, there might not be clashes between the lecture hours but there are clashes between the laboratory sessions. Each section of any course is treated as one package to be taught by one instructor and a lab assistant. The topics discussed in the lectures are highly related to laboratory activities which made it not possible to let the students register for the lectures and laboratory sessions separately.

- Satisfying the preferences of the instructors regarding the time to be offered [9, 10].
- Since faculty members teach the lecture and attend laboratory sessions. Laboratory sessions increase the chance of having clashes in instructors time table.
- A lab session can be taught only in a computer laboratory.
- Some courses with practical nature are taught in computer laboratories as well.
- Since the lab can occupy only up to 30 students at any time, the maximum number of students can register in a section is 30 students even that classrooms can occupy up to 40 or 45 according to the room size.
- No lectures or labs can be scheduled on the students' activity session which is on Wednesday from 11:00-13:00.
- The schedule need to be prepared long time before the start of the term with not complete initial information [8].
- Hard to communicate with many other departments to arrange for courses offered by them and taken by our students which are known as service courses in UOB [9].

There are three types of clashes that might occur in the students' time-table:

- Clashes between the lectures of two or more courses that occurs when the lectures of two or more courses are assigned to the same time block.
- Clashes between the laboratory sessions of two or more courses that occurs when the lectures of two or more courses are assigned to different time blocks but their lab sessions are assigned to the same time block.
- Clashes between the lectures and laboratory sessions of other courses that occurs when the lectures of two or more courses are assigned to different time blocks but the lab session of one of the courses assigned to the lecture block of the other course and vice versa.

5. THE SOLUTION

The solution in this paper maintains a mixture of action-driven approach and strategy-driven approach [4] which is mainly a reasoning approach [11]. It combines using of heuristic algorithm and analytical method, and emphasizing the development of suitable time-table that meets course instructors preferences [4, 11] to design the time-table . The design is then implemented using an automated time-table system to generate the time-table and facilitate data mining to support decision making . The solution focuses on overcoming the problem of clashes between the courses in students time-table and considering the nature of the courses that comprises of lecture and laboratory sessions. The relationships between the courses were determined as courses at the same level of the program plan can be registered simultaneously. Courses and their pre-requisite courses cannot be registered simultaneously in the same semester. The flowchart of the solution is shown in Fig. 1.

The courses of each level 100-level, 200-level, 300-level, and 400-level will be distributed among the blocks such that no clashes occur between the courses of the same level or even the 300-level and 400-level courses to speed students' graduation.

A. The Reasoning Approach

A course cluster consists of all courses of the same level that are offered at the same time block. Students can only register at any time one of the courses in the same course cluster to avoid clashes between courses. Since students are able only to register one of the courses in any course cluster, keeping the lab sessions of all courses in the same course cluster in one block to form a lab cluster will reduce lecture-lab and lab-lab clashes. The number of clashes will be reduced at least by the minimum number of courses in any time block.

A color coded pattern clusters distribution model [12] which applies a clustering method [1] have been used to allocate the labs of courses clusters together as a cluster to form pair clusters. The lab blocks can be one or more depend on the availability of labs to form one or more lab clusters. This have generated a pattern for lectures and labs clusters that helped in minimizing lecture-lab or lab-lab clashes. The same color code is used to specify the lecture cluster and its accompanied lab cluster. Most lecture clusters contain courses required in different semesters of the program plan. Table V shows a description of the color coded pattern clusters method.

B. Creating a color-coded cluster

Creating a color-coded cluster for each level or year in the program involves two steps:

1. Determine the courses to be offered in the same cluster: the courses to be offered in the same color-coded cluster for are determined according to the following constraints:
   - There are more than one section to be offered for a course.

- The courses should be registered at different semester of the program level such as a course should be taken at semester 1 and the other one at semester two.

2. Assign a cluster to the laboratory sessions of those courses. All courses within the same lecture cluster will be assigned to the same lab cluster according to Table V.

Tables VI and VII show the color coded pattern clusters for both UTH and MW blocks of 300 and 400 level courses. Clusters include sections of different courses of the same level have the same section number except for courses with one section. The sections are allocated across the available clusters so that the expected number of course conflicts for students are minimized per level. All clusters that involve a possible clash between the courses of the same level are among the multi-section courses. This provides other options to the students to solve the conflict and to choose other time slots according to their preference. The current number of clusters utilized in the model satisfies the current number of students and instructors. In case of an increase in the number of admitted students, then the number if clusters can be increased accordingly. Blocks for elective courses where specified regardless of the elective courses to be offered to minimize clashes between required and elective courses. It is recommended to increase the number of elective courses to be offered to give the student a variety of choices. Each semester the department offers four or more elective courses. Moreover, faculty preferences were implemented in the first lecture template to increase the instructors happiness level [13], shift the courses to avoid clashes for the students and keep the faculty preference as well. All courses are offered at the same building to speed students transfer from one room to another.

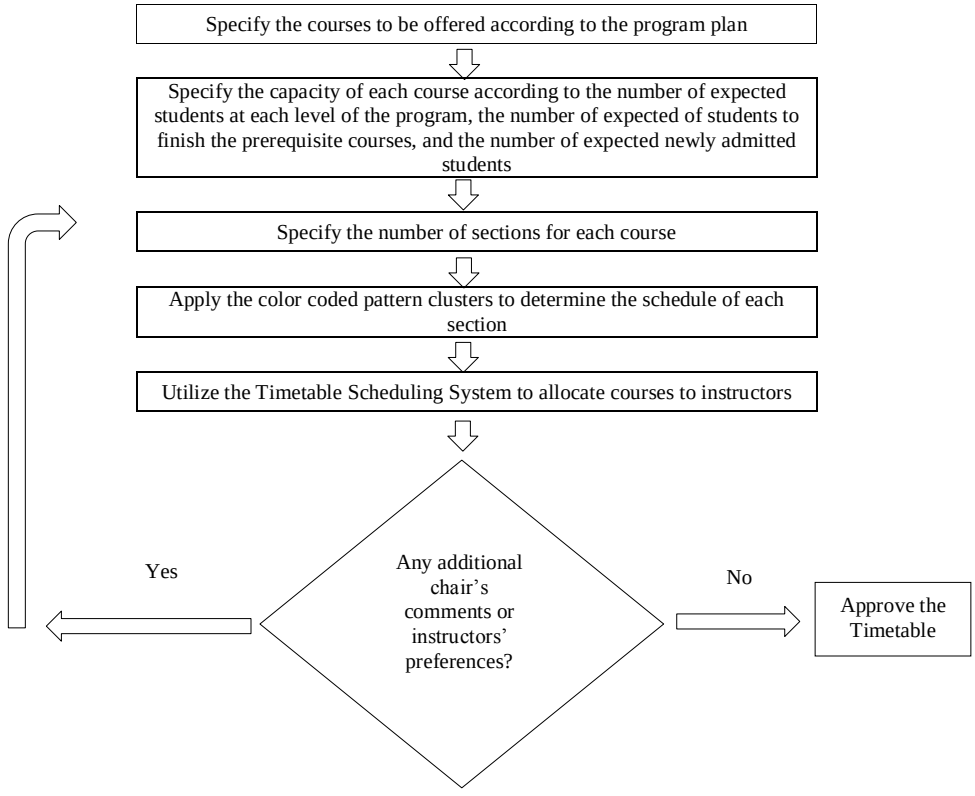

Figure 1. The flowchart of the solution

TABLE V. COLOR CODED PATTERN CLUSTERS

Color Coded Pattern Clusters		Pair Clusters				Color Coded Pattern Clusters		Pair Clusters			
		Lecture Clusters		Lab Clusters				Lecture Clusters		Lab Clusters	
Color Code	*Color Name*	*Days*	*Starting Time*	*Day*	*Starting Time*	*Color Code*	*Color Name*	*Days*	*Starting Time*	*Day*	*Starting Time*
	Dark Orange	UTH	8:00	M	11:00		Dark Blue	UTH	12:00	M	15:00
	Maroon	UTH	9:00	H	14:00		Light Orange	UTH	13:00	T	14:00
	Light Blue	UTH	10:00	U	14:00		Blue	MW	8:00	M	13:00
	Gray	UTH	11:00	W	15:00		Green	MW	9:30	W	13:00

TABLE VI. PARTIAL COLOR CODED CLUSTERS FOR UTH

Lectures -Labs Blocks	Time							
	8:00	*9:00*	*10:00*	*11:00*	*12:00*	*13:00*	*14:00*	*15:00*
Sunday (U)	Sem6-Lec. ITCS323/2	Sem5-Lec. ITCS385/1	Sem5-Lec. ITCE321/1	Sem5-Lec. ITCS399/1	Sem5-Lec. ITCS385/3	Sem5-Lec. ITCS346/2	Sem5-Lab ITCE321/1	Sem5- Lab ITCE321/1
	Sem6-Lec. ITCS390/1	Sem6-Lec. ITCS323/1	Sem5-Lec. ITCS385/2	Sem7-Lec. Elective 1	Sem6-Lec. ITCS332/1	Sem6-Lec. ITCE315/2	Sem5- Lab ITCS385/2	Sem5- Lab ITCS385/2
	Sem7-Lec. ITCS473/2	Sem6-Lec. ITCS341/2	Sem6-Lec. ITCS341/1		Sem8-Lec. ITCS412/2	Sem8-Lec. Elective 3	Sem6- Lab ITCS341/1	Sem6- Lab ITCS341/1
	Elective 5 Lec.	Sem7-Lec. ITCS473/1	Sem7-Lec. ITCS490/1				Sem7- Lab ITCS490/1	Sem7- Lab ITCS490/1
		Sem9-Lec. ITCS412/1	Sem8-Lec. Elective 4				Sem8- Lab Elective 4	Sem8- Lab Elective 4
Tuesday (T)	Sem6-Lec. ITCS323/2	Sem5-Lec. ITCS385/1	Sem5-Lec. ITCE321/1	Sem5-Lec. ITCS399/1	Sem5-Lec. ITCS385/3	Sem5-Lec. ITCS346/2	Sem5-Lab ITCS346/2	Sem5-Lab ITCS346/2
	Sem6-Lec. ITCS390/1	Sem6-Lec. ITCS323/1	Sem5-Lec. ITCS385/2	Sem7-Lec. Elective 1	Sem6-Lec. ITCS332/1	Sem6-Lec. ITCE315/2	Sem6-Lab ITCE315/2	Sem6-Lab ITCE315/2
	Sem7-Lec. ITCS473/2	Sem6-Lec. ITCS341/2	Sem6-Lec. ITCS341/1		Sem8-Lec. ITCS412/2	Sem8-Lec. Elective 3	Sem8-Lab Elective 3	Sem8-Lab Elective 3
	Elective 5 Lec.	Sem7-Lec. ITCS473/1	Sem7-Lec. ITCS490/1					
		Sem9-Lec. ITCS412/1	Sem8-Lec. Elective 4					
Thursday (H)	Sem6-Lec. ITCS323/2	Sem5-Lec. ITCS385/1	Sem5-Lec. ITCE321/1	Sem5-Lec. ITCS399/1	Sem5-Lec. ITCS385/3	Sem5-Lec. ITCS346/2	Sem5- Lab ITCS385/1	Sem5- Lab ITCS385/1
	Sem6-Lec. ITCS390/1	Sem6-Lec. ITCS323/1	Sem5-Lec. ITCS385/2	Sem7-Lec. Elective 1	Sem6-Lec. ITCS332/1	Sem6-Lec. ITCE315/2	Sem6- Lab ITCS323/1	Sem6- Lab ITCS323/1
	Sem7-Lec. ITCS473/2	Sem6-Lec. ITCS341/2	Sem6-Lec. ITCS341/1		Sem8-Lec. ITCS412/2	Sem8-Lec. Elective 3	Sem6- Lab ITCS341/2	Sem6- Lab ITCS341/2
	Elective 5 Lec.	Sem7-Lec. ITCS473/1	Sem7-Lec. ITCS490/1				Sem7- Lab ITCS473/1	Sem7- Lab ITCS473/1
		Sem9-Lec. ITCS412/1	Sem8-Lec. Elective 4				Sem9- Lab ITCS412/1	Sem9- Lab ITCS412/1

TABLE VII. PARTIAL COLOR CODED CLUSTERS FOR MW

Lectures-Labs Blocks	Time				
	8:00	*9:30*	*11:00*	*13:00*	*15:00*
Monday (M)	Sem4-Lec. ITCS315/1	Sem5-Lec. ITCE321/2	Sem6-Lab ITCS323/2	Sem4- Lab ITCS315/1	Sem5-Lab ITCS385/3
	Sem5-Lec. ITCS314/1	Sem5-Lec. ITCS346/1	Sem6- Lab ITCS390/1	Sem5- Lab ITCS314/1	Sem6-Lab ITCS332/1
	Sem6-Lec. ITCE315/1	Sem6-Lec. ITCS323/3	Sem7- Lab ITCS473/2	Sem6- Lab ITCE315/1	Sem8-Lab ITCS412/2
	Sem6-Lec. ITCS332/2	Sem6-Lec. ITCS390/2	Elective 5 Lab	Sem6- Lab ITCS332/2	
	Sem7-Lec. TCS490/2	Sem7-Lec. Elective 2		Sem7- Lab ITCS490/2	
Wednesday (W)	Sem4-Lec. ITCS315/1	Sem5-Lec. ITCE321/2		Sem5- ITCE321/2	Sem5- Lab ITCS399/1
	Sem5-Lec. ITCS314/1	Sem5-Lec. ITCS346/1		Sem5- ITCS346/1	Sem7- Lab Elective 1
	Sem6-Lec. ITCE315/1	Sem6-Lec. ITCS323/3		Sem6- ITCS323/3	
	Sem6-Lec. ITCS332/2	Sem6-Lec. ITCS390/2		Sem6- ITCS390/2	
	Sem7-Lec. TCS490/2	Sem7-Lec. Elective 2		Sem7- Elective 2	

C. A Scenario of Students Time-Table

Many scenarios can be determined of students time-table from the color coded clusters model. Tables VIII and IX show a typical scenario for semester 5 where all sections are of number 1.

D. Implementing the cluster design

The second stage of the solution is to implement the lecture-lab clusters design through an automated time-tabling system developed with Microsoft Access database management system to support data storage, management and mining. The system facilitates the distribution of courses among instructors, distribution of the courses on the classrooms and labs, and lab assistants.

The data mining reports produced by the time-table automated system supported in clarifying and solving the problem of offering all labs during the afternoon which caused to inefficient utilization of the labs and the classrooms. During the morning hours, class rooms are insufficient. Similarly, during the afternoon hours the labs where insufficient. To overcome this problem, labs were assigned during morning blocks, and on UTH, lab blocks shifted 1 hour earlier to start from 12:00 instead of 13:00.

The combined system have been used in the department of computer science at University of Bahrain since 2009 and implemented in the department of Information Systems since 2012. It has been noted that the average length of students at the program decreased which might be to the fact that having a schedule free of clashes.

The objective of the combined system is to minimize the number of clashes between the courses offered for the students at the same level [12], minimize number of clashes between the labs hours of those courses, efficiently distribute the courses among the faculty members, satisfy the faculty preferences [12], and efficiently utilize the classrooms and labs.

Data mining implemented by the system to support decision making such as providing information about the used labs and classrooms at any time-slot.

E. The Time –Table Scheduling System Features

To prepare the schedule of each semester. The system applies domain heuristic method [1] to create a higher quality initial schedule given as an input the schedule of the semester of the previous year such that the first semester will be generated from the first semester of previous year and second semester will be generated from previous second semester [1, 11]. The input schedule satisfies instructors' preferences. The number of sections is determined according to the capacity model [12]. Then the schedule is updated by adding or removing courses and sections. The instructor and lab assistant of each section are specified [12]. The classrooms or labs are updated as needed.

The system main functionality is to:

- Allocate courses to instructors.
- Generate a Report of all courses offered each semester shown in Fig. 2.
- Generate the schedule of each instructor shown in Fig. 3.
- Generate a report shown the lab assistants of each instructor shown in Fig. 4.
- Generate class rooms report showing the schedule of each class-room during each day in the week shown in Fig. 5.
- Generate labs report showing the schedule of each lab during each day in the week shown in Fig. 6.
- Generate lectures per time cluster report shown in Fig. 7.
- Generate the schedule of each lab assistant.

TABLE VIII. A SCENARIO OF STUDENT TIME-TABLE FOR SEMESTER 5

Lectures-Labs Blocks	Time							
	8:00	*9:00*	*10:00*	*11:00*	*12:00*	*13:00*	*14:00*	*15:00*
Sunday (U)		Sem5-Lec. ITCS385/1	Sem5-Lec. ITCE321/1	Sem5-Lec. ITCS399/1			Sem5-Lab ITCE321/1	Sem5-Lab ITCE321/1
Tuesday (T)		Sem5-Lec. ITCS385/1	Sem5-Lec. ITCE321/1	Sem5-Lec. ITCS399/1				
Thursday (H)		Sem5-Lec. ITCS385/1	Sem5-Lec. ITCE321/1	Sem5-Lec. ITCS399/1			Sem5-Lab ITCS385/1	Sem5-Lab ITCS385/1

TABLE IX. CONTINUE THE SCENARIO OF STUDENT TIME-TABLE FOR SEMESTER 5

Lectures-Labs Blocks	Time				
	8:00	*9:30*	*11:00*	*13:00*	*15:00*
Monday (M)	Sem5-ITCS314/1	Sem5-ITCS346/1		Sem4-Lab ITCS314/1	
Wednesday (W)	Sem5-ITCS314/1	Sem5-ITCS346/1		Sem5-Lab ITCS346/1	Sem5-Lab ITCS399/1

University of Bahrain
College of Information Technology
Computer Science Department
Class Schedule For Year 2014/2015 First Semester

Date: *22 October 2014* ***Page 9 of 10***

Course no	*Day*	*Time*	*Room*	*Instructor*
ITCS 385 03		DATA BASE MANAGEMENT SYSTEMS		**INSTRUCTOR NAME**
Lab	M	15:00 16:40	S40-051	***Exam:*** 10-Jun-14
Lecture:	UTH	12:00 12:50	S40-2049	***at*** 08:30
ITCS 390 01		SOFTWARE ENGINEERING I		**INSTRUCTOR NAME**
Lab:	M	11:00 12:40	S40-2053	***Exam:*** 14-Jun-14
Lecture:	UTH	08:00 08:50	S40-1048	***at*** 14:30
ITCS 390 02		SOFTWARE ENGINEERING I		**INSTRUCTOR NAME**
Lab:	M	13:00 14:40	S40-2045	***Exam:*** 14-Jun-14
Lecture:	MW	08:00 09:15	S40-057	***at*** 14:30
ITCS 395 01		ORACLE DATA BASE PROGRAMMING		**INSTRUCTOR NAME**
Lab:	T	14:00 15:40	S40-051	***Exam:*** 10-Jun-14
Lecture:	UTH	13:00 13:50	S40-051	***at*** 08:30

Figure 2. Partial Course Report

University of Bahrain
College of Information Technology
Computer Science Department

Class Schedule For Year 2014/2015 First Semester

Date: ***22 October 2014*** Page 2

	Course No.	***Day***		***Time***		***Room***	***Cr***	
Instructor: Dr. XXXX YYYY								
1)	ITCS 332	222	01	ORGANIZATION OF PROGRAMING LANGUAGES			3	
	Lab:	M		15:00	16:40	S40-2045		***Exam:*** 09/06/2014
	Lecture:	UTH		12:00	12:50	S40-1047		***at*** 14:30
2)	ITCS 242	222	01	ASSEMBLY LANGUAGE			3	
	Lab:	M		13:00	14:40	S40-1052		***Exam:*** 14/06/2014
	Lecture:	UTH		13:00	13:50	S40-1047		***at*** 08:30
3)	ITCS 242	222	02	ASSEMBLY LANGUAGE			3	
	Lab:	U		14:00	15:40	S40-2043		***Exam:*** 14/06/2014
	Lecture:	UTH		10:00	10:50	S40-1047		***at*** 08:30

Figure 3. Instructor's Schedule

University of Bahrain
College of Information Technology
Computer Science Department

Date: 22 October 2014 Page 2

	Course No.	***Day***		***Time***		***Room***	***Demo's Name and Ext.:***	
Instructor:	**INSTRUCTOR NAME**							
1)	ITCS 242	222	02	ASSEMBLY LANGUAGE				
	Lab:	U		14:00	15:40	S40-2043	**Assistance Name**	**0000**
	Lecture:	UTH		10:00	10:50	S40-1047		

Figure 4. Partial Instructor Schedule Including Lab Assistances Info

Lecture Room (First Semester 2014/2015)

LRoom	Days	From	To	Code	num	Sec	InstName
S40-056	**MW**						
		08:00	09:15	ITCS	215	04	INSTRUCTOR NAME
		09:30	10:45	ITCS	323	03	INSTRUCTOR NAME
		13:00	14:15	CSC	103	09	INSTRUCTOR NAME
	UTH						
		08:00	08:50	ITCS	323	02	INSTRUCTOR NAME
		09:00	09:50	ITCS	323	01	INSTRUCTOR NAME
		10:00	10:50	ITCS	490	01	INSTRUCTOR NAME
		11:00	11:50	ITCS	112	02	INSTRUCTOR NAME

Figure 5. Lecture Rooms Schedule

Lab (First Semester 2014/2015)

Day	Time		Course		Section	Instructor	Demonstrator
Lab: S40-051							
U	14:00	15:40	ITCS	385	02	INSTRUCTOR	DEMO
M	11:00	12:40	ITCS	393	01	INSTRUCTOR	DEMO
M	13:00	14:40	CSC	103	14	INSTRUCTOR	DEMO
M	15:00	16:40	ITCS	385	03	INSTRUCTOR	DEMO
T	14:00	15:40	ITCS	395	01	INSTRUCTOR	DEMO
W	13:00	14:40	ITCS	112	04	INSTRUCTOR	DEMO
Lab Use:	6						

Figure 6. Partial Labs Schedule

LECTURES PER Block

Lecture -Days	Time	Room	Code	num	Sec	LabDay	Lab Time	Instructor
MW	08:00	S40-049	CSC	103	04	W	13:00	INSTRUCTOR NAME
		S40-2050	ITCS	111	04	U	12:00	INSTRUCTOR NAME
		S40-2046	ITCS	111	10	T	12:00	INSTRUCTOR NAME
		S40-060	ITCS	112	06	M	11:00	INSTRUCTOR NAME
MW	09:30	S40-2048	CSC	103	05	W	13:00	INSTRUCTOR NAME
		S40-049	ITCS	252	05	W	13:00	INSTRUCTOR NAME
		S40-056	ITCS	323	03	W	13:00	INSTRUCTOR NAME
		S40-2049	ITCS	346	01	W	13:00	INSTRUCTOR NAME
UTH	08:00	S40-1047	ITCS	111	03	H	10:00	INSTRUCTOR NAME
		S40-2046	ITCS	112	08	U	14:00	INSTRUCTOR NAME
		S40-057	ITCS	215	03	U	12:00	INSTRUCTOR NAME

Figure 7. Partial Lectures Per Time Cluster Report

6. CONCLUSION

The color coded pattern clusters model combined with the automated system has been applied in the Department of Computer Science since 2009. On 2012, it has been implemented successfully in other departments within the college.

The color coded pattern clusters model has minimized the clashes between courses and eliminated the clashes between lectures and labs.

The model combined with the automated system has simplified the schedule preparation process. It has supported to have efficient distribution of the courses among the faculty members and efficient utilization of classrooms and labs. Faculty preferences are obtained and maintained.

In the future, the model combined with the system can be extended to have online distributed system to support the preparation of other programs schedule and support the collaboration between different departments offering service courses.

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