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A USER - ORIENTED DESCRIPTION OF SCHEDULER

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ABSTRACT

A user-oriented description of a program which formulates university timetables is given. This program takes into account each student's choice of courses and each instructor's choice of instruction times. Directions on how to use the program and samples of input and output are included.

TABLE OF CONTENTS

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I. General Description

A program has been written in Fortran 63 for the CDC 1604 which forms timetables by assigning courses to times on the basis of professor preference of times and student preference of courses. First the professors choose the times at which they would like to teach and the students choose the courses they would like to take. Then the computer assigns each professor as high a preference of times as possible, subject to a concurrent attempt to prevent any one of a student's courses from being put into a time period which would cause it to conflict with any other of that student's courses.

This program took 5 minutes and 7 seconds, (including compile time but without trace) to find suitable time arrangements for 26 courses and 75 students for the Computer Sciences spring 1967 timetable. If each course had been given at its professors highest time preference, there would have been 34 student conflicts. One of the best schedules found had 20 professors at 1st preference, 6 at 2nd preference, and 5 student conflicts.

The program has undergone some improvements since this run, in particular one allowing it to handle up to 50 time periods, 210 courses, and 750 students. It is not claimed that this program will find the best timetable possible; instead it merely attempts to find timetables which can definitely be classified as good; and it has been successful on all data given it to date.

II. Particular Features

A. Professor preferences

It is assumed that the courses and their corresponding professors are known beforehand. The possible times must also be known. Each professor is allowed to pick up to four 1st choices (very highly acceptable times), up to four 2nd choices (highly acceptable times), and up to four 3rd choices (acceptable times). For ease of keypunching, code numbers representing times are used rather than the times themselves. It is suggested that each professor be required to place at least one time period in each of the above-named categories. If a professor desires a time which is not listed, he can write in the time itself rather than a code number. A course can be pre-fixed into a certain time slot by listing that time slot as first preference and listing no others. This is often desirable, for example, in the case of the 2nd semester of a 2-semester course.

If a professor is to teach more than 1 course, then he must choose pairs or triples of times rather than single times. For example, his top preference might be: Course A at time 1 and Course B at time 2.

NOTE: A professor will not be given any time period he does not list.

B. Student preferences and weights

Each student must list the courses he expects to take, together with the probability with which he expects to take each one. If, for example, a student is sure of taking Course A and Course B and will also take either Course C or Course D, then he might assign a probability of 1 to Course A and to Course B and a probability of .5 to Course C and to Course D.

In cases where a professor deems it highly important that a particular student be able to take a particular course, the names of the student, professor, and course should be noted; the student's weight for that course will be increased (manually).

Extreme care should be taken that course names and professor names are spelled the same throughout the input (including location of blanks).

C. Sections

Quiz sections are not handled by this program. It is presumed that the student will have room in his schedule for at least one of the quiz sections offered for a course.

A course which is divided into sections will be indicated by a 1, 2, etc., in the name of that course (see IV C). A student who requests a particular section will be assigned to that section. A student who submits an unsectioned request for a sectioned course will be placed in the emptiest section.

When the different sections of a course cover different material (e.g., the sections of topics courses), they are each treated as separate courses.

D. Output

In all cases the best five schedules found for each run are printed out. Each schedule lists for each course the course name, the professor, the professor's preference level (1- very highly acceptable; 2- highly acceptable; 3- acceptable), the time, the code number of the time in the Table of Times (see Appendix B), the number of students, and the number of conflicts.

The number of students for each course is allowed to be non-integral because of the non-integral nature of the weight (probability) which the student assigns to each course he chooses. If a student assigns .5 as a weight for course G, then he is counted as one half of a student for course G. In like manner, if, in a particular schedule, a student has a conflict between course C (weight .4) and course D (weight .9), there will be .36 of a conflict (the product of the weights) assigned to each of those courses. This explains the non-integral values in the conflicts column of the output.

Also associated with each schedule output is a "conflict ratio sum" which is a measure of how good the schedule is in terms of professor preferences and student conflicts. The smaller the conflict ratio sum, the better the schedule.

An itemized list of exactly which student has which conflict is also given with each schedule which is output.

A trace option is provided which, if selected, will print out the results of each attempt to move a course from one time period to another.

III. Directions for Users

(Please refer any questions concerning this program or its operation to Eric Timmreck, Computer Sciences Department, University of Wisconsin,262-5879. Your comments, suggestions for improvement, etc. are welcomed.)

1. Compose the list of courses to be offered together with professors who will teach them. (See example in Appendix A.)

2. Compose a list of times from which professors can choose. (See example in Appendix B.)

3. Compose a letter to the professors informing them that the computer will be used to assist in timetable formation. (See example in Appendix C.)

4. Compose a form for professors to fill out in order to indicate their preferences of times. (See example in Appendix D.)

5. Compose a letter to the students informing them that the computer will be used in timetable formation and asking for courses and weights from them. (See example in Appendix E.)

6. Mail to each professor: (for courses which are not pre-fixed)

    a. List of courses

    b. List of times

    c. Form

    d. Letter

7. Mail to each student:

    a. List of courses

    b. Letter

8. Receive completed forms from professors and data from students.

9. Update the list of times to include times which were chosen by professors but which were not on the original list.

10. For each time period list all other time periods which overlap it or are immediately adjacent to it (e.g., one ending at 11:15, another starting at 11:15).

11. Wherever a professor has said that it is particularly important for a particular student to take a particular course, quadruple the student's weight for that course.

12. Punch data according to IV.

13. Run program. (For the moment this can be done by giving your set of data to Eric Timmreck who will run the program for you.)

14. Evaluate results and any error messages and rerun if necessary.

IV. Data Arrangement Directions

A. IPREF card

1st card: Columns 1-5: IPREF

Col 6-9: Blank

Col 10: 0 if trace not desired

1 if trace desired (Trace will print out the results of each attempt to move a course from one time period to another.)

B. COURSINF card

2nd card: Columns 1-8: COURSINF

Col 9-11: number of courses, counting sections separately (right justified)

C. Card for each course:

Columns 1-8: Course name

(Column 8 should contain 1,2, etc. for sections of a course which are basically the same. Column 8 must be blank otherwise. The maximum number of sections allowable is the number of distinct symbols which can be placed in Column 8. In the case of sections of a course which are basically different, it is recommended that they be represented, for example, as

Col. 1 2 3 4 5 6 7 8
C S b 8 3 8 A b
C S b 8 3 8 A b

where the symbol b represents a blank.)

Column 9: Blank

Column 10-17: Professor's name (abbreviated if too long). Each professor's name must be punched identically on all cards which refer to him. Also, the content of these columns must be different for different professors.

Column 18: Blank

Column 19-21:
22-24:
25-27:
28-30:
} Code numbers for 1st choices - very highly acceptable times (each code right justified within its 3-character field). For any course which is to be pre-fixed, whether or not the instructor is teaching other courses as well, put the code for the desired time in Cols. 19-21 (right justified) and leave blank all columns to the right of Col. 21.

Note: Cols. 19-21 must in all cases contain a time code.

Column 31-35: Blank

Column 36-38:
39-41:
42-44:
45-47:
} Code numbers for 2nd choices - highly acceptable times (each code right justified within its 3-character field).

Column 48-52: Blank

Column 53-55:
56-58:
59-61:
62-64:
} Code numbers for 3rd choices - acceptable times (each code right justified within its 3-character field).

Note: Corresponding time period codes for professors who teach more than one course must be punched in corresponding columns. (For example, suppose Professor X is to teach Course A and Course B; and suppose that one of his choice pairs listed under '2nd' choice is time 16 for Course A and time 22 for Course B. Then the code '16' on the card for Course A must be in the same columns as the code '22' on the card for Course B.)

D. TIMESLAP card

Next card (after last course card):

Column 1-8: TIMESLAP

Column 9-11: The number of time periods involved (right justified)

E. Card for each time period:

Column 1-3: Time period number (right justified) - number the first time period "1", the second "2", etc.

Column 4: Blank

Column 5-20: Time period description (e.g., MWF 1100-1150) - used for output purposes only.

Column 21-23:
24-26:
27-29:
30-32:
33-35:
36-38:
39-41:
42-44:

These fields contain from left to right the numbers of other time periods (right justified within each field) which the present time period overlaps or is immediately adjacent to.

F. STUPREF card

Next card (after cards for time periods):

Column 1-7:	STUPREF
Column 8:	Blank
Column 9-11:	Number of students (right justified)
Column 12-15:	Lower bound for an individual weighting of a course by a student. Suggested value: .001 .
Column 16-19:	Upper bound for an individual weighting of a course by a student. Suggested value: 1.00 .
Column 20-23:	Lower bound for the sum of the weights of the courses of an individual student. Suggested value: .001 .
Column 24-27:	Upper bound for the sum of the weights of the courses of an individual student. Suggested value: 4.00 .

G. Card for each student:

Column 1-8:	Name of 1st course
Column 9-12:	Weight for 1st course (punch the decimal point)
Column 13-20:	Name of 2nd course
Column 21-24:	Weight for 2nd course (punch the decimal point)
Column 25-32:	Name of 3rd course
Column 33-36:	Weight of 3rd course (punch the decimal point)
Column 37-44:	Name of 4th course

Column 45-48: Weight of 4th course (punch the decimal point)

Column 49-56: Name of 5th course

Column 57-60: Weight of 5th course (punch the decimal point)

(Note: Fill in only as many courses as are desired, but from the left. If a course is divided into sections which are basically the same, the section number may be omitted from Column 8 on the student cards).

Then:

Column 61-80: Name of student

H. MAXTRIES card

Next card (after all student cards):

Column 1-8: MAXTRIES

Column 9-13: Number of iterations to be performed (right justified).
Suggested value: Two to four times the number of courses. (An iteration involves one attempt to move a course from one time period to another.)

I. FACTRI card

Next card:

Column 1-6: FACTRI

Column 7-8: Blank

Column 9-16: Multiplicative factor
Suggested value: .2 .
To favor students more: .1 .
To favor professors more: .3 .
(See Appendix H.)

Column 17-19: Blank

Column 20: Trial type
Suggested value: 2
(See Appendix I.)

This previous card may be repeated with different trial types or factors. Each card present will initiate a new run of the program.

J. Last card

Column 1-6: FACTRI

Column 7-18: Blank

Column 19-20: -1

APPENDIX A. List of Courses used for Computer Sciences run for Spring 1967 Timetable

Course	Instructor	Title
CS 132	Davidson	Introduction to computing machines
CS 204	Travis	Basic computer sciences II
CS 301	Purdom	Computer programming in the physical sciences
CS 315	Williams	Computer programming in the behavioral sciences
CS 412	R. E. Moore	Introduction to numerical methods
CS 414 1	Cryer	Introduction to numerical analysis II
CS 414 2	Collins	Introduction to numerical analysis II
CS 415	Purdom	Theory and operation of computing machines
CS 467	Collins	Programming computers for non-numeric applications
CS 509	Travis	Logical foundations of computing theory
CS 510	Cudia	Introduction to computability and unsolvability
CS 536	Lovell	Introduction to systems programming
CS 540	London	Survey of artificial intelligence research
CS 545	Venezky	Natural language and computing
CS 718	R. E. Moore	Advanced numerical analysis II
CS 726	Ritter	Nonlinear programming methods
CS 732	Gregg	Artificial intelligence and models of thinking II
CS 737	Robinson	Advanced systems programming II
CS 741	Wyllys	Information retrieval
CS 761	Robinson	Deduction and problem solving by computer I
CS 765	Uhr	Pattern recognition and adaptive systems I
CS 837A	Rosen	Numerical methods for optimal control
CS 837B	Hu	Network theory and combinatorial methods
CS 837C	Halton	Monte Carlo methods
CS 838A	E. F. Moore	Binary codes
CS 882	Russell	Numerical methods for ordinary differential equations II
CS 884	Parter	Numerical methods for partial differential equations II

APPENDIX B. Table of Times used in Computer Sciences run for Spring 1967 Timetable

(More were added when professors chose times which were not listed here.)

TABLE OF TIMES

CODE	TIME	
1	MWF	7:45 - 8:35
2	MWF	8:50 - 9:40
3	MWF	9:55 - 10:45
4	MWF	11:00 - 11:50
5	MWF	12:05 - 12:55
6	MWF	1:20 - 2:10
7	MWF	2:25 - 3:15
8	MWF	3:30 - 4:20
9	TT	8:50 - 10:30
10	TT	11:00 - 12:30
11	TT	1:20 - 3:00

APPENDIX C. Suggested Letter to Professors

(As mentioned in the recent staff meeting) we are going to use a computer program to help make out next semester's timetable.

Assuming the attached schedule is correct would you indicate on the form provided your preferences for the time your course(s) should be offered.

One minor constraint is that both semesters of a two-semester sequence should be offered (if possible) at the same time.

Please understand that this will be a tentative assignment both of instructors to courses and courses to times.

If possible please return the filled out form to (person) by (deadline date).

APPENDIX D. Suggested Form for Professors.

INSTRUCTOR _____

1. Fill the blanks in the following with codes from the enclosed Table of Times. Indicate at least one first choice, at least one second choice, and at least one third choice for each course you are to teach. Please do not list the same time more than once for the same course.

2. If you are teaching more than one course, then your preferences will be considered pairwise (triplewise, etc). That is, your highest preference might be: Course 101 at 9:55 and Course 203 at 11:00. Therefore for each blank in which you put a time in the leftmost column, you are also requested to put a time in the corresponding blank for each other course you are teaching. (Exception: If a course is to be pre-fixed into a certain time slot, simply fill in the first blank for that course with the time desired.)

3. If a time that you would like to list is not in the Table of Times, please write the time itself in the blank.

	Course _____	Course _____	Course _____	
1st choices	_____	_____	_____	very highly acceptable times
	_____	_____	_____	
	_____	_____	_____	
	_____	_____	_____	
2nd choices	_____	_____	_____	highly acceptable times
	_____	_____	_____	
	_____	_____	_____	
	_____	_____	_____	
3rd choices	_____	_____	_____	acceptable times
	_____	_____	_____	
	_____	_____	_____	
	_____	_____	_____	

If there are any cases in which you feel that it is very important that a particular student be able to take a particular course, please list below the names of the students and the courses involved.

APPENDIX E. Suggested Letter to Students.

In order that your desires may be taken into account in the formation of the timetable for next (fall, spring), you are requested to do the following:

1. Determine (as best you can at this early date) from the enclosed list the courses you expect to take next (fall, spring). A maximum of five courses is allowed. For each course chosen, decide with what probability you will take that course. For example, if you are fairly certain that you will take course A and course B and either course C or course D, you might decide on weight 1.0 for courses A and B and weight .5 for courses C and D. Each individual probability must be > 0.0 and ≤ 1.0 .

2. Punch this information on a card as follows: In the first 8 columns put the designation of one course; in the next 4 columns put the probability for that course (punch the decimal point). Use the next 12 columns for the designation and probability of the next course. Continue until all chosen courses are listed with their corresponding probabilities (maximum of 5). Then punch your name, starting in column 61. (This card will be read by a (5(A8,F4.0),4A5) format.) The course designations must be punched <u>exactly</u> as they are given in the list of courses, including the location of blanks, except that you need not indicate which section of a sectioned course you would prefer.

Example:

COL	1 2 3 4 5 6 7 8	9 10 11 12	13 14 15 16 17 18 19 20	21 22 23 24	25 26 27
	C S 7 1 7	1 . 0	C S 4 1 4 1 (Optional)	1 . 0	C S

COL	28 29 30 31 32	33 34 35 36	37 38 39 . . . . 61 62 63 64 . . . .
	8 3 8 A	0 . 5	(blank) N A M E

(If a keypunch is not available to you just write your name, courses, and probabilities on a sheet of paper.)

3. Turn this preference card (or sheet of paper) in to <u>(person)</u> by <u>(deadline date)</u> .

Thank you very much for your cooperation in this matter.

APPENDIX F. Sample Input

```
IPREF     1
COURSINF 26
CS 132    DAVIDSON  17                16                14
CS 204    TRAVIS    12
CS 301    WILLIAMS   4                 3                 6
CS 412    R MOORE    2                 3                 4
CS 414 1  CRYER      2
CS 414 2  COLLINS    8  7  9           6                 4  3
CS 415    PURDOM     2  3              4  6              7  8
CS 467    COLLINS    7  8  6           4                 2  1
CS 509    TRAVIS     9 11             10  2              3
CS 536    LOVELL    11  9              7 10              8  4
CS 540    LONDON     7  6  4
CS 545    VENEZKY    7  8
CS 718    R MOORE    3                 4                 2
CS 726    RITTER    10  4              3  2              9
CS 732    GREGG      7 11              4  6              3
CS 737    ROBINSON  11 10              9  5              6
CS 741    WYLLYS    11  9                                2
CS 761    ROBINSON   9 11             10  6              5
CS 765    UHR       11 21             22
CS 837A   ROSEN      20 10             11
CS 837B   HU        10  9              4  3              2
CS 837C   HALTON     2  3              4  9             10
CS 838A   E MOORE     2                8                 1
CS 838B   PURDOM      3  4             6  7              8  9
CS 882    RUSSELL    6
CS 884    PARTER     7                 2                 8
TIMESLAP 22
   1 MWF 745-835
   2 MWF 850-940
   3 MWF 955-1045      13 15
   4 MWF 11-1150       12 20
   5 MWF 1205-1255     20
   6 MWF 120-210       22
   7 MWF 225-315       22
   8 MWF 330-420
   9 TT 850-1030       14 15 16
  10 TT 11-1230        12 17
  11 TT 120-300        18 19 21
  12 MTWT 11-1150       4 10 17 20
  13 MW 955-1045        3 15
  14 TT 955-1045        9 15
  15 M TH 955-1045      3  9 13 14
  16 TT 850-940         9
  17 TT 11-1150        10 12
  18 TT 120-210        11
  19 TT 225-315        11 21
  20 MW 11-1230         4  5 12
  21 TT 225-345        11 19
  22 MW 120-300         6  7
STUPREF  75.001  1..001  4.
CS 882    1. CS 887    1.                                          BW
CS 737    1. CS 741    1. CS 412    1.                             A
CS 737    .5 CS 838A   .7 CS 741    1. CS 838B   .8                B
CS 732    1. CS 765    1.                                          C
CS 737    1.                                                       D
CS 732    1. CS 774    1.                                          E
CS 718    1. CS 467    1.                                          F
CS 414 1  1. CS 732    .5 CS 741    .5 CS 838A   .5 CS 737    .5G
CS 414 2  1. CS 536    1.                                          H
```

CS 718	1.	CS 467	1.	CS 536	1.							I
CS 510	.5	CS 536	.5	CS 737	.5	CS 741	.5					J
CS 718	1.	CS 837A	.3	CS 837B	.3	CS 837C	.4					K
CS 414 2	1.	CS 741	1.	CS 737	1.							L
CS 718	1.	CS 732	1.	CS 737	1.							M
CS 732	1.	CS 737	1.	CS 414	1.							N
CS 718	1.	CS 726	1.	CS 837A	.4	CS 837B	.3	CS 882	.3			O
CS 414 2	1.	CS 540	.5	CS 718	1.	CS 837A	.5					P
CS 837C	1.											Q
CS 414 1	1.	CS 726	1.	CS 741	.5	CS 837A	.5					R
CS 414 1	1.	CS 467	1.	CS 509	.2	CS 536	.8					S
CS 737	1.	CS 741	1.	CS 837C	1.							T
CS 545	1.	CS 732	1.	CS 737	.5	CS 765	.5					U
CS 737	1.	CS 741	1.									V
CS 414 2	1.	CS 415	1.	CS 456	.7	CS 726	.3					W
CS 737	1.	CS 741	1.	CS 765	1.							X
CS 414 1	1.	CS 536	1.	CS 726	.8	CS 741	.2					Y
CS 737	1.	CS 765	1.									Z
CS 726	1.	CS 732	1.	CS 737	1.							AA
CS 414 1	1.	CS 732	1.	CS 737	1.							AB
CS 732	1.	CS 414 1	1.	CS 509	.4	CS 467	.3	CS 718	.3			AC
CS 509	1.	CS 726	1.									AD
CS 761	1.											AE
CS 510	1.	CS 887	1.									AF
CS 414 1	1.	CS 467	1.	CS 509	.5	CS 732	.5					AG
CS 467	1.											AAH
CS 467	.6	CS 718	.6	CS 726	.6	CS 741	.6	CS 838A	.6			AI
CS 510	1.	CS 536	1.	CS 838A	1.							AJ
CS 414 2	1.	CS 732	1.	CS 765	1.							AK
CS 414 1	1.	CS 467	1.	CS 737	.5	CS 838A	.5					AL
CS 741	1.	CS 765	1.	CS 837C	1.							AM
CS 414 2	1.	CS 536	1.	CS 741	1.							AN
CS 467	1.	CS 536	1.	CS 761	.5	CS 838A	.5					AO
CS 414 1	.6	CS 509	.6	CS 536	.6	CS 540	.6	CS 741	.6			AP
CS 414 1	1.	CS 536	1.									AQ
CS 509	1.	CS 718	1.	CS 732	1.							AR
CS 732	1.											AS
CS 2[illegible]4	1.											AT
CS 884	.8	CS 837A	.8	CS 737	.7	CS 545	.4	CS 732	.3			AU
CS 990	1.											AV
CS 726	1.	CS 741	1.	CS 765	.5	CS 837C	.5					AW
CS 765	1.	CS 545	1.	CS 761	1.							AX
CS 737	1.	CS 761	1.	CS 765	1.							AY
CS 761	1.	CS 765	1.	CS 737	.2	CS 837C	.8					AZ
CS 718	1.	CS 837A	1.	CS 837B	1.							BA
CS 718	1.	CS 732	1.	CS 737	1.							BB
CS 732	1.	CS 737	1.	CS 741	.5	CS 765	.5					BC
CS 536	1.	CS 732	1.									BD
CS 467	.6	CS 540	.6	CS 737	.6	CS 761	.6	CS 765	.6			BE
CS 737	1.	CS 741	1.	CS 837B	1.							BF
CS 414 1	1.	CS 726	.6	CS 741	.7	CS 837A	.4	CS 838A	.3			BG
CS 718	1.	CS 837A	1.	CS 881	1.							BH
CS 414 1	1.	CS 545	1.	CS 732	.5	CS 765	.5					BI
CS 737	1.	CS 761	1.	CS 838A	.5	CS 509	.5					BJ
CS 837A	1.	CS 837C	1.	CS 882	.5	CS 884	.5					BK
CS 467	1.	CS 732	1.	CS 882	1.							BL
CS 414 1	1.	CS 761	1.	CS 838A	1.							BM
CS 732	1.	CS 741	1.									BN
CS 718	1.	CS 726	1.	CS 741	1.							BO
CS 732	1.	CS 737	1.	CS 509	1.							BP
CS 510	.6	CS 732	.6	CS 761	.6	CS 765	.6	CS 838A	.6			BQ

APPENDIX G: Sample Output

Example of trace output:

COMPUTE CONFLICT INFORMATION AFTER MOVING COURSE CS 545 FROM TIME PERIOD 7 TO TIME PERIOD 8.
THIS IS TRY NUMBER 24.

	COURSE	TIME	NO. OF CONFLICTS
1	CS 132	17	0
2	CS 204	12	0
3	CS 301	4	0
4	CS 412	2	0
5	CS 414 1	2	0
6	CS 414 2	7	0
7	CS 415	2	0
8	CS 467	8	0
9	CS 509	9	.3600
10	CS 536	11	0
11	CS 540	4	0
12	CS 545	8	0
13	CS 718	3	0
14	CS 726	10	.3000
15	CS 732	4	0
16	CS 737	5	0
17	CS 741	9	.3600
18	CS 761	6	0
19	CS 765	11	0
20	CS 837A	11	0
21	CS 837B	10	.3000
22	CS 837C	2	0
23	CS 838A	1	0
24	CS 838B	3	0
25	CS 882	6	0
26	CS 884	7	0

```
CS 414 1 1. CS 536    1. CS 726    1.                                  BR
CS 718   1. CS 726    1. CS 467    1.                                  BS
CS 718   1. CS 837A   1.                                              BT
CS 540   1. CS 718    1. CS 726    .5 CS 741    .5                     BU
CS 414 1 1. CS 467    1. CS 536    .8 CS 540    .2                     BV
MAXTRIES   50
FACTRI          .2     2
FACTRI                -1
```

15 CS 732	GREGG	2	MWF 11-1150	4	19.40	0
16 CS 737	ROBINSON	2	MWF 1205-1255	5	20.50	0
17 CS 741	WYLLYS	1	TT 850-1030	9	16.60	.3600
18 CS 761	ROBINSON	2	MWF 120-210	6	7.70	0
19 CS 765	UHR	1	TT 120-300	11	11.20	0
20 CS 837A	ROSEN	2	TT 120-300	11	6.90	0
21 CS 837B	HU	1	TT 11-1230	10	2.60	.3000
22 CS 837C	HALTON	1	MWF 850-940	2	5.70	0
23 CS 838A	E MOORE	2	MWF 330-420	8	6.20	0
24 CS 838B	PURDOM	1	MWF 955-1045	3	.80	0
25 CS 882	RUSSELL	1	MWF 120-210	6	2.80	0
26 CS 884	PARTER	1	MWF 225-315	7	1.30	.3200

CONFLICTS IN THE PREVIOUS SCHEDULE ARE AS FOLLOWS.

D	HAS A CONFLICT BETWEEN CS 726	AND CS 837B	OF WEIGHT	.3000.	
AP	HAS A CONFLICT BETWEEN CS 509	AND CS 741	OF WEIGHT	.3600.	
AU	HAS A CONFLICT BETWEEN CS 884	AND CS 545	OF WEIGHT	.3200.	

Example of standard output:

THE 1ST RANKED SCHEDULE FOUND IS AS FOLLOWS.

CONFLICT RATIO SUM = 1.25153
NUMBER OF STUDENT CONFLICTS = .9800

TRIALTYP = 2 FACTOR = .20000

COURSE	PROF	PREF LEV	TIME	TIMECODE	STUDENTS	CONFLICT
1 CS 132	DAVIDSON	1	TT 11-1150	17	0	0
2 CS 204	TRAVIS	1	MTWT 11-1150	12	1.00	0
3 CS 301	WILLIAMS	1	MWF 11-1150	4	0	0
4 CS 412	R MOORE	1	MWF 850-940	2	1.00	0
5 CS 414 1	CRYER	1	MWF 850-940	2	14.60	0
6 CS 414 2	COLLINS	1	MWF 330-420	8	6.00	0
7 CS 415	PURDOM	1	MWF 850-940	2	1.00	0
8 CS 467	COLLINS	1	MWF 225-315	7	11.50	0
9 CS 509	TRAVIS	1	TT 850-1030	9	5.20	.3600
10 CS 536	LOVELL	1	TT 120-300	11	11.70	0
11 CS 540	LONDON	1	MWF 11-1150	4	2.90	0
12 CS 545	VENEZKY	1	MWF 225-315	7	3.40	.3200
13 CS 718	R MOORE	1	MWF 955-1045	3	14.90	0
14 CS 726	RITTER	1	TT 11-1230	10	10.80	.3000

	TIME	NO. OF CONFLICTS
1	MWF 745-835	0
2	MWF 850-940	0
3	MWF 955-1045	0
4	MWF 11-1150	0
5	MWF 1205-1255	0
6	MWF 120-210	0
7	MWF 225-315	0
8	MWF 330-420	0
9	TT 850-1030	.3600
10	TT 11-1230	.3000
11	TT 120-300	0
12	MTWT 11-1150	0
13	MW 955-1045	0
14	TT 955-1045	0
15	M TH 955-1045	0
16	TT 850-940	0
17	TT 11-1150	0
18	TT 120-210	0
19	TT 225-315	0
20	MW 11-1230	0
21	TT 225-345	0
22	MW 120-300	0

TOTAL NUMBER OF CONFLICTS IS .6600.

CONFLICT RATIO SUM = 1.25495

IMPROVEMENT.

APPENDIX H. Factor Specifics.

The conflict ratio sum is computed from the following formula.

$$\text{Conflict Ratio Sum} = \frac{\sum_{\text{courses}} \text{professor preference levels}}{\text{\# of courses}} * \text{factor} + \frac{\text{\# of students} + \text{\# of conflicts}}{\text{\# students}}$$

A factor of .2 has been found to weight students and professors more or less equally. Decreasing the factor weights the students more heavily and vice versa.

APPENDIX I. Trial Type Specifics.

Courses are attempted to be moved from one time period to another in one of 5 ways:

1. Start with the course contributing the second highest number of conflicts.
2. Start with the course contributing the highest number of conflicts.
3. Start with the course with the second largest number of students.
4. Start with the course with the largest number of students.
5. Start with the course with the smallest number of students.

Trial type 2 has been found to be reliable, but any integer from 1 to 5 can be used.