A Developmental Approach to the Examination Timetabling Problem

1 Introduction

This report describes the developmental approach applied to the examination timetabling problem for the 2nd International Timetabling Competition. This method is a heuristic-based method which attempts to mimic the processes of cell biology. The method presented begins with the creation of a single cell, which through the processes of cell division, cell interaction and cell migration develops into a well-developed organism. The overall process is described in the sections that follow.

2 The Developmental Approach

The overall process begins with the creation of a single cell. The position of the cell in the timetable is randomly chosen. The examinations are sorted according to the cell options currently available, i.e. saturation degree. The examinations are allocated sequentially to the available cell/s. If there is more than one cell available, i.e. cell division has occurred, the examination is allocated to the cell which will not result in hard constraint violations and which produces a minimum soft constraint cost. If there is more than one option the period is randomly chosen from the options. In each case the choice of a cell also depends on room availability of the correct capacity. Once a cell has been found a room is chosen. If more than one room is available, the options are sorted according to the minimum difference in remaining room capacity and number of the students that will be sitting the exam, as well as the soft constraint cost, and the room with the minimum joint value is chosen.

Cell division occurs if adding an examination to the cell results in a violation of a hard constraint. The cell divides into two with the examination causing the violation being placed in a new cell. The position of the cell in the timetable is chosen so as to reduce the soft constraint costs. If there is more than one position that produces the minimum soft constraint cost, the position is randomly chosen from these. If the maximum number of cells has been reached, cell interaction occurs. This involves finding an examination in another cell with which the examination causing the violation can be swapped, so as to remove the violation. If such a swap is not possible the examination is randomly allocated. Cell division can also take place if the maximum capacity, i.e. maximum number of examinations permitted, of the cell has been reached. However, this was found to be unnecessary in this study.

The developmental process continues until all the examinations are scheduled, i.e. a complete organism has been formed. If the timetable represented by the organism is not feasible, further organisms are created until a feasible timetable is produced. Once a feasible timetable is formed, the organism goes through a process of

maturation involving cell migration. Cell migration involves changing the structure of the timetable by changing the position of each cell in the timetable. This involves swapping the positions of cells that have the same period duration. Two types of cell migration have been tested, namely, random migration and stimulus-driven migration. Random migration randomly chooses two cells of the same period duration and swaps their positions. Stimulus-driven migration is a hill-climber which only performs a swap if there is a reduction in the soft constraint cost of the timetable. Stimulus-driven migration was found to perform better than random migration and hence has been implemented in this study.

3 Experimental Setup

The system was implemented in Java and all simulations were run on a Windows XP machine with an Intel Pentium M processor with 512 MB of RAM. The system was tested with fifty different seeds, i.e. fifty different runs, for each problem. Each run was completed within 495 seconds.

4 Future Extensions

The process of migration needs to be studied further. The reshuffling of examinations during migration needs to be investigated. In addition to this the inclusion of migration at each stage of the development of the organism into a feasible solution needs to be examined.