NICTA Victoria Laboratories
Department of Computer Science and Software Engineering
The University of Melbourne
433-637 Constraint Programming
Second Semester, 2010

# Combinatorial Problem Examples

## Introduction

Try to solve each of the problems defined in this handout. Use any method you can. As you are solving the problems try to record something about the method you use to solve the problem.

## Assigning Tasks to Workers

There are four office tasks and four workers. The cost for the task when done by each worker is given by the table below. Find an assignment of tasks to workers which leads to the minimum total cost.

| | Sorting | Stapling | Mailing | Filing |
|---|---|---|---|---|
| Adam | 18 | 13 | 16 | 12 |
| Bob | 20 | 15 | 19 | 10 |
| Cath | 25 | 19 | 18 | 15 |
| Diane | 16 | 9 | 12 | 8 |

If you think you have solved that one optimally, then try this one. Note here that one task will remain undone.

| | a | b | c | d | e | f | g |
|---|---|---|---|---|---|---|---|
| A | 21 | 15 | 19 | 10 | 16 | 20 | 22 |
| B | 16 | 11 | 12 | 8 | 13 | 17 | 17 |
| C | 25 | 19 | 18 | 15 | 15 | 19 | 16 |
| D | 23 | 17 | 16 | 16 | 17 | 18 | 21 |
| E | 18 | 13 | 16 | 12 | 11 | 15 | 18 |
| F | 17 | 12 | 11 | 10 | 19 | 16 | 16 |

## Smuggling

As a smuggler you have to work out how much of each type of item to put in your knapsack to cross the border, in order to maximize profit.

A table of the weight of each item and the profit is shown below. Determine how many of each item you should take to maximize profit while making sure you dont exceed the weight capacity of the knapsack.

The simple data on the left is for a problem with a knapsack capacity of 9kg. The larger problem on the right is for a capacity of 23kg

| Item | weight | profit |
|---|---|---|
| Whiskey | 4 | 15 |
| Perfume | 3 | 10 |
| Cigarettes | 2 | 7 |

| Item | weight | profit |
|---|---|---|
| a | 4 | 15 |
| b | 3 | 10 |
| c | 2 | 7 |
| d | 1 | 1 |
| e | 5 | 18 |
| f | 9 | 34 |
| g | 16 | 57 |

## Sudoku

Fill in the numbers in this 9 x 9 grid so that each row and column and each 3 x 3 subsquare contains exactly the numbers 1 .. 9.

Try the left one first its simple. Can you solve the one on the right?

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6 | | 1 | 9 | | | | | 2 |
| | | | 6 | | | 3 | 1 | |
| 9 | 3 | | 2 | 5 | | 8 | | |
| | 4 | 7 | | | 8 | | | 5 |
| | 8 | | 1 | | 9 | | 6 | |
| 3 | | | 7 | | | 1 | 4 | |
| | | 9 | | 3 | 6 | | 2 | 4 |
| | 5 | 8 | | | 7 | | | |
| 4 | | | | | 2 | 9 | | 7 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5 | 4 | | 2 | | | | |
| 7 | 3 | | 5 | | | | | |
| | 9 | | | | | | | |
| 4 | | | | | 7 | 6 | | |
| | | 3 | | | | 1 | | |
| | | 2 | 9 | | | | | 7 |
| | | | | | | | 9 | |
| | | | | | 4 | | 8 | 3 |
| | | | | 1 | | 4 | 7 | |

## Travelling Saleman

The travelling salesman must visit each city exactly once in a tour of all cities, starting and ending at the same place. The aim is to find a tour with minimum total length. What is the best tour you can find for the graph on the left? What about for the right?