General

Read through the “Background” section below, then copy and paste the questions out of the “Assignment” section into your word processor and answer the questions. Turn in the questions using the instructions posted on the class web site.

At the top of the every document that you create (word processing or source files) include:

# **// Your name**

**// CS-160, Lab #X** (replace the X with the Lab #)

**// xxxx Term, 20xx** (i.e. Winter Term, 2007)

For ALL Word processing documents, you must submit your documents in one of the following formats: MS-Word (NOT Works), RTF (most word processors can save in this format), or Open Document (used by the freely available Open Office suite). They will be returned ungraded if submitted in any other format.

**Concepts**

This lab continues our coverage of problem solving techniques and the basic concepts in the structure and use of programming languages. We will continue to use the “Alice” tutorials for the programming part of this lab.

**Background**

*Note: Original source of the background contained below is from the “CS160 Worksheets” by Daniel Balls of the CS department at Oregon State University; updated and revised by Mitch Fry (CS, Chemeketa Community College).*

**Problem-Solving by Greedy Methods**

(local optimization approach)

The next problem-solving technique we will explore is called problem solving using *greedy methods*. A greedy method solves a problem by focusing on particular local aspects of the problem, making a choice that is best for the local sub-problem, and hoping that a series of locally optimal choices will lead to the best overall solution.

For example, suppose a department store clerk owes $17.68 in change to a customer who has just made a purchase. What is the fewest number of bills and coins (assuming the clerk has at his disposal only $20, $10, $5, and $1 bills and quarters, dimes, nickels and pennies) the clerk can give to the customer to provide proper change?

If we disregard the ‘fewest number of bills and coins’ phrase, there are a myriad of ways that this change-making process can be brought about. For example, the clerk could give the customer 1768 pennies, or 176 dimes and 8 pennies. However, if the greedy method is applied to this situation, the clerk will try to give the *greatest* monetary piece (bill or coin) at each ‘phase’ of the change-making process. First, he will place a $10 bill on the table, since that is the largest single piece that he can give without giving more than the amount owed. Next, a $5 bill will be given, followed by two $1 bills. At this point $17 of the customer’s change has been paid and bills can no longer be given. The clerk will then give two quarters, a dime, a nickel and three pennies. This solution of four bills ($10 + $5 + $1 + $1) and six coins ($0.25 + $0.25 + $0.10 + $0.01 + $0.01 + $0.01) is the optimal one—there is no way of combining less than 10 of the specified monetary pieces so that their sum is exactly $17.86.

While this rather mundane example is one we are all familiar with, it is indeed an example of the greedy technique at work—the next piece of money to be given was always the largest one that could be given at the time, and this series of ‘local’ optimal decisions led to a ‘global’ optimal solution.

However, there are situations—and some very similar to the one just described—in which the greedy method fails to provide the optimal global solution. For example, let’s imagine a society whose monetary system consisted of the following coins: 10-krunk, 8-krunk, 5-krunk and 1-krunk. If a sales clerk is obliged to give a customer 17 krunks in change, the greedy method would yield the following solution: one 10-krunk coin, one 5-krunk coin, and two 1-krunk coins. This global solution of four coins is not optimal. Rather, it is possible to provide 17 krunks with only three coins—two 8-krunk coins and one 1-krunk coin.

This example illustrates the fact that greedy methods should be used with caution; and importantly that “local optimization” does not always equate to “global optimization”. This lab should also help with your ability to understand why doing what is optimal or right for an individual does not always result in optimal or right answers for society; similarly why actions that produce the best short term results do not always produce the best long term results.

**Assignment Instructions**

*Answer the following questions. Please copy and paste the questions below into your editor (use the I-bar tool in Acrobat Reader to do this) and TYPE your answers below each question.*

**Part 1: Problem Solving**

***S****olve each of the following problems using the greedy method. Explain your reasoning in each case.* ***IMPORTANT NOTE: 2/3rds of the grade on these questions will be for showing that you understand the problem solving technique, only 1/3 of the grade is for correctness of you answer. So you MUST show your work in order to get most of the points on these questions; just listing the correct answer is only worth 1/3 of the points.***

***Q1:*** An international thief has gained entry to a high security medical laboratory and intends to steal valuable powdered chemicals from the lab. There are 8 different types of powder, and each type of powder is stored in a single large container. She plans to pour the precious powders from their containers into individual, thin plastic bags and then replace the containers. After putting the plastic bags containing the stolen powder in a brief case, the thief will attempt to bypass the lab’s security equipment again.

In order to successfully escape, she has calculated that, after accounting for the weight of the briefcase and the plastic bags, she can put no more than 25 kilograms of the stolen powder into the briefcase. Below is a table listing the powders, their ***total*** weight that is in the container, and the ***total*** value of the powder. If the thief wants to escape with the most valuable collection of powders in her briefcase, how much of each type of powder should she steal? *Note: The “Weight of Powder” column indicates the total available amount of each type of powder. For example, the thief can steal up to 3.25 kg of* ***IM2****, but no more.*

|  |  |  |
| --- | --- | --- |
| *Type of Powder* | *Weight of Powder* | *Value of Powder* |
| **IM2** | 3.25 kg | $1975 |
| **B24** | 9.50 kg | $2350 |
| **CP** | 1.25 kg | $3000 |
| **D+** | 7.50 kg | $1100 |
| **Rz** | 8.50 kg | $4800 |
| **Q32** | 8.00 kg | $3600 |
| **W07** | 9.50 kg | $2600 |
| **57/J** | 6.00 kg | $4320 |

***Q2:*** Chris has won a shopping spree at a gourmet donut wholesale bakery. The bakery owners have agreed to allow Chris to have 1 minute to gather as many boxes of donuts as possible, with two restrictions: all donuts must remain in their original bulk boxes (partial boxes are not allowed) and no more than ten pounds of donuts are to be chosen. Chris has created a list of the types of donuts the bakery sells, the weight of each box and the value per box (see table below). If Chris wants to end up with the most valuable ten pounds of donuts, which boxes of donuts would he choose by using a greedy method?

|  |  |  |
| --- | --- | --- |
| ***Donut Type*** | ***Package Weight*** | ***Value of Box*** |
| Jelly Filled Donuts | 2 lbs | $15.00 |
| Maple/Chocolate Bars | 5 lb | $86.25 |
| Chocolate-Covered Cake Donuts | 1 lbs | $12.50 |
| Custard Cream Filled Donuts | 6 lbs | $105.00 |
| Cinnamon Rolls | 5 lbs | $85.00 |
| Apple Fritters | 3 lb | $50.00 |

***Q3:*** “*In regional news, Blueneck County has decided to pave some of the roads connecting the cities in their county. County officials have decided that there must be at least one paved route between every pair of cities. Due to the economic shortfalls that have swept the region, the county also wants to minimize the cost of the project.”*

According to the map of Blueneck County shown on below, which roads should county officials have paved? (Hint: Start with the lowest mileage road).

***18 miles***

***11 miles***

***8 miles***

***10 miles***

***12 miles***

**Elberta**

**Fruit Heights**

**Durazno**

**Cider Canyon**

**Berry Hill**

**Appleton**

***11 miles***

***12 miles***

***10 miles***

***17 miles***

***Optional Challenge Question*:** The greedy method was successful at determining the optional solution in two of the three problems above. Which problems were they? What characteristic distinguishes the two problems that could be optimally solved by the greedy method from the other problem, which couldn’t be optimally solved by the greedy method?

**Part 2: Programming Language Structures (flow of control)**

***Q4:*** There are 4 common structures known as “flow of control” or “control structures”. They are:

1. sequential code
2. conditional code
3. iterative code
4. sub-program call.

Show an example of each from any of the “Scratch” examples or make up your own. You are to cut and paste images of Scratch Scripts from the IDE showing each type of control structure. Paste the pictures into your assignment document. Label each picture with the control structure that they demonstrate (you could do this very nicely by editing the pictures in a Paint program so that you can use circles and arrows to show specifically each control structure example).

**Part 3: Introduction to Programming (Alice Tutorial):**

***Q5:*** Now your own programming adventure begins. Your mission (should you decide to accept it), is to have fun with Scratch and implement a project of your choice subject only to the following requirements.

* Your project’s filename must be username.sb, where username is your CCC login username in all lowercase.
* Your project must have at least two sprites; each sprite must have at least one script.
* Your project must use at least one condition, one loop, and one variable.
* Your project must use at least one sound.

Feel free to browse the projects online at scratch.mit.edu or any of the example projects that come with Scratch for inspiration, but your project must be your own unique design. Try to think of an idea on your own, and then set out to implement it. If, along the way, you find it too difficult to implement some feature, don’t worry; alter your design or simplify the problem. If you set out to implement an idea that you find fun, you should not find it hard to satisfy this problem set’s requirements.

Take a few screen captures of your project showing it running and paste them into your assignment document. Also turn in your username.sb file (the scratch project file) in the same folder with your assignment document.

Alright, off you go and have fun Scratching! Oh, by the way, should you decide to not accept this mission, you will get 0 points for this question ☺.