CSE1301 Exercise Sheet 9
Software Engineering and Recursion

Exercise 1 (Structure charts)

Draw a structure chart (call structure) for each of the following algorithm examples. Add labelled arrows to show the data coupling between modules.

(a) Lecture 13: hello1.c

(b) Lecture 12: InviteToParty

(c) Exercise Sheet 4: Exercise 1

(d) Prac Session 5: Part 2

Exercise 2 (Structure charts)

Design a modular structure for an on-line inventory/customer records system for a mail-order business and represent it with a structure chart. Which module(s) in your system must be modified if there are changes in sales tax laws (for example, the introduction of the GST)? What if the length of the telephone system's phone numbers changes?

Exercise 3

Explain the similarities and differences between flowcharts and structure charts.

Exercise 4

Write a recursive algorithm for dealing a deck of cards. The parameters should be (i) the deck of undealt cards, and (ii) the person who is to receive the next card. Assume:

(a) the players are seated around a table;
(b) dealing begins with the player to the dealer's left;
(c) each dealing step involves dealing one card to a player, then the dealer's attention moves to the next player to the left;
(d) dealing continues until no cards are left in the deck.

Exercise 5

Consider the following function:

```
int func ( int n, int m )
{
  if ( n == 0 )
    return m;
  else
  {
    return 1+func( n-1, m );
  }
}
```

(a) What does `func(10,4)` return?

(b) Describe the objective of this function. What are its limitations?

(c) Extend the function with another recursive case to overcome the limitations.

Exercise 6

(a) Write a recursive function `void recurTriangle ( int n, char ch )` which prints out an upside-down triangle. The parameter *ch* is the character to be used for drawing the triangle, and *n* is the number of characters on the first row. For example, if *n* is 7 and *ch* is `'+'`, then the output of the function should be:

```
+++++++
++++++
+++++
++++
+++
++
+
```

(b) Modify the function you wrote in (a) so that the triangle is upright. For example, if *n* is 5 and *ch* is `'#'`, then the output of the function should now be:

```
#
##
###
####
#####
```

Exercise 7 (Coin Combination)

This problem involves finding the number of ways of making up a sum of money *s* cents using 5c, 10c and 20c coins, where we are given how many coins of each denomination we have available. Assume coins indistinguishable, so each possible solution simply specifies the *number* of coins of each denomination used.

For example, if *s* = 35, fives = 6, tens = 1, twenties = 2, then the number of combinations is 3:
20 + 10 + 5,
20 + 5 + 5 + 5,
10 + 5 + 5 + 5 + 5 + 5.

Hint: Deal with base cases first, then:

Total number of combinations =
number of combinations which use at least one 20c coin
+
number of combinations which use NO 20c coins and at least one 10c coin
+
number of combinations which use NO 20c or 10c coins and at least one 5c coin

Your solution should be a recursive one.

Exercise 8 (Additional)

A beetle stands at the base of a tree, and wants to visit every leaf of the tree. Write a recursive algorithm to guide the beetle to do this. Assume the leaves are only found at the end of branches.

Exercise 9 (Additional)

The Ackerman A function is defined as a function of two integer arguments:

A(0,y) = 1
A(1,0) = 2
A(x,0) = x+2 for x>=2
A(x+1, y+1) = A(A(x, y+1),y) otherwise

Implement the Ackerman function. What is the value of A(2,1)? Try to trace the execution manually. What is the value for A(4,3)? Extend your Implementation such that the program counts the number of recursive calls to A and investigate how this number grows for different values of the arguments. Explain your observation.

Exercise 10 (Additional)

Design a software system for a video rental store. Information to be stored includes a register of members, a database of the videos the stores carries, and all past and current video rentals. What different tasks must be done? What are the data structures? What are the modules and how are they connected?

Further Exercises

Do a selection of the following

Brookshear, Chapter 6. Chapter Review Problems: 6.5, 6.8,6.9, 6.10, 6.12, 6.14, 6.17