CS13002 Programming and Data Structures, Spring 2005

Class test 2 : Solutions

Total points: 30 | April 05, 2005 | Total time: 1 hour

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Write your answers in the question paper itself. You may use extra blank sheets for rough work, but your answers must fit in the respective spaces provided. Answer all questions.

1. Suppose that we have got a two-dimensional array $A = (a_{ij})$ with m rows and n columns. Let the one-dimensional row-major representation of A be stored in the array $B = (b_i)$ of size mn. Assume that indexing in the arrays is zero-based.

(a) Given a pair of indices i, j for the matrix A, the element a_{ij} is stored as b_k, where **(5)**

$k =$ $ni + j$ (in terms of i, j, m, n).

(b) Given an index k in the array B, the element b_k corresponds to the element a_{ij} in A, where **(5)**

$i =$ $\lfloor k/n \rfloor$ and $j =$ $k \operatorname{rem} n = k - n \lfloor k/n \rfloor$ (in terms of k, m, n).

In terms of C syntax, we have $i = k \ / \ n$ (integer division) and $j = k \ \% \ n$ (integer remainder).

2. Let A be a square $(n \times n)$ matrix. We want to compute the matrix $B = A - A^{\mathrm{t}}$ and store this matrix in A itself. Here A^{t} denotes the transpose of the matrix A. Write a function that accepts A and computes B without using an additional array. You are not allowed to use any extra variables other than two indices i and j. Assume that **ROWDIM** and **COLDIM** are the storage dimensions and $n \times n$ is the actual dimension of A. Note that if $A = (a_{ij})$ and $B = (b_{ij})$, then $b_{ij} = a_{ij} - a_{ji}$ and $b_{ji} = a_{ji} - a_{ij}$ for all indices i, j. **(10)**

```
void matFunc ( int A[ROWDIM][COLDIM] , int n )
{
   int i,j;

   for (i=0; i<n; ++i) {
      A[i][i] = 0;
      for (j=0; j<i; ++j) {
         A[i][j] -= A[j][i];
         A[j][i] = -A[i][j];
      }
   }
}
```

3. You are given a linked list. Your task is to create two new linked lists, the first of which should contain the 1st, 3rd, 5th, ... elements and the second the 2nd, 4th, 6th, ... elements of the input list. The following code segment provides a solution. Fill in the blanks to complete the segment. Evaluation of your answer will depend on overall correctness.

The function **createLists** assumes that there is a dummy node at the beginning of each list (input as well as output). The input list is headed by the pointer **head**. Odd-numbered elements are to be stored in the list headed by the pointer **oddhead**, and the even-numbered elements are to be stored in the list headed by the pointer **evenhead**. Assume that the input pointer **head** already points to a properly allocated list with a dummy node at the beginning. Assume also that both **oddhead** and **evenhead** are already allocated memory only for the dummy nodes. We number the elements of the input list from 1. **(10)**

```
/* First define a structure for a node in the list */
typedef struct nodeTag {
   int data;
   /* Declare the self-referencing pointer */

      struct nodeTag *     next;
} node;

void createLists ( node *head , node *oddhead , node *evenhead )
{
   node *src, *dest1, *dest2;
   int flag = 1;

   /* Initialize the source and destination pointers to point to the dummy nodes */
   src = head; dest1 = oddhead; dest2 = evenhead;

   /* As long as the source list is not fully traversed */

   while (        src -> next != NULL          ) {
      if (flag == 1) {                                    /* Insert in the odd list */
         /* Allocate memory for a new node */

            dest1 -> next = (node *) malloc(sizeof(node));
         /* Advance the destination pointer by one node */

            dest1 = dest1 -> next;
         /* Copy data from source */

            dest1 -> data = src -> next -> data;
      } else {                                           /* Insert in the even list */
         /* Allocate memory for a new node */

            dest2 -> next = (node *) malloc(sizeof(node));
         /* Advance the destination pointer by one node */

            dest2 = dest2 -> next;
         /* Copy data from source */

            dest2 -> data = src -> next -> data;
      }
      src = src -> next;                        /* Look at the next node in the input */
      if (flag == 1) flag = 2; else flag = 1;             /* Switch the destination */
   }
   dest1 -> next = dest2 -> next = NULL;          /* Terminate the destination lists */
}
```