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SFWR ENG 2S03
Exercise Sheet 3

SFWR ENG 2S03 — Principles of Programming

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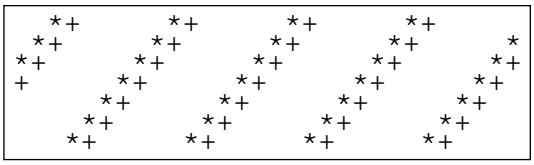
Exercise 3.1 — ASCII Art — Ribbons (60% of Midterm 2, 2003)

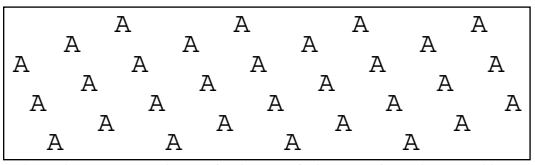
Throughout this question, the second dimension of the two-dimensional arrays will be some fixed WIDTH; in the examples this is 30.

(a) Implement a C function *printCharArray* that prints the contents of a two-dimensional character array to the screen, each row on a separate line.

(b) Implement a C function *putRibbon* that, given a two-dimensional character array, a start height *h* and a character *c*, will place a "ribbon" of *c* values into the array that starts at height *h* and then wind **upwards** diagonally around the array.
Below, the first box contains the result of putting a ribbon of asterisks from start height 2 into a 7×30 array filled with space characters; the second box contains the result of additionally inserting a ribbon of plus characters.

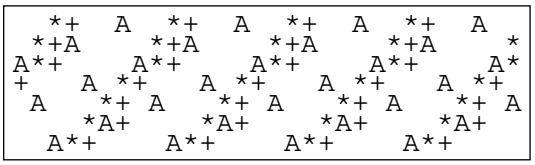


(c) Implement a C function *putSlantedRibbon* that in addition to the arguments of *putRibbon* also accepts an integral *slant* value that indicates the steepness of the ribbon's slant as it winds around the array. This allows one to produce the contents of the box to the right with a single call to *putSlantedRibbon* with a 7×30 array filled with space characters.



As an additional feature, this function **must not override non-space characters** in the array. Use an auxiliary function *squeeze* to squeeze a character into its target position, pushing right all non-space content encountered at the target position and at consecutive positions — the first space character encountered will be consumed.

The same call as for the previous box, when applied after the second box of (b), produces the box to the right — observe how the "A" characters sometimes push only a "+" to the right, sometimes the combination "*+"; at the end of the third line, a "+" has been "pushed off the board".



(d) Write a *main* program that uses the above (**and other**) functions to produce as screen output the contents of the four example boxes above **in the same sequence as above**, using a **single** array of size 7×30.

Do not forget design and documentation, in particular interface documentation for functions!

Exercise 3.2 — Simulation of C Program Execution (40% of Midterm 2, 2003)

Simulate execution of the following **correct ANSI C** program; show the intermeidiate steps and show which output is produced:

```
1   #include <stdio.h>
2   #define SIZE 5
3   int q[SIZE];
4
5   void printq() {
6     int i;
7     printf("[ ");
8     for ( i=0; i < SIZE; i++)
9       printf("%4d ", q[i]);
10    printf("]\n");
11  }
12
13  int s(int i, int j) {
14    int k = q[i];
15    q[i] = j;
16    return k;
17  }
18  int f(int m, int n) {
19    int h, r, mm = m + 1, nn = n – 1;
20    printf("f(%d,%d) --- ", m, n);
21    printq();
22    if (m >= n) return q[m];
23    h = s(mm, q[m]);
24    r = f(mm,nn);
25    q[m] = s(nn, q[n]);
26    q[n] = h;
27    return r;
28  }
29  int main() {
30    int i;
31    for ( i=0; i < SIZE; i++)
32      q[i] = 11 * (i + 1);
33    printf("%d\n", f(0,SIZE–1));
34    printq();
35    return 0;}
```

Exercise 3.3 — Compilation Phases (8% of Midterm 1, 2004)

Name the phases of compilation — **give a short description, too** — and the result of each phase.

Exercise 3.4 — Find Errors (16% of Midterm 1, 2004)

In each of the following programs or program segments,

- **Find and describe the error**. If the error can be corrected, explain how.
- Mark any unclear or unintuitive use of C features, **explain the problem**, and propose improvements.

(a)
```
int p=1, q=2.3;
p = q = 7;
printf( "q = %s\n", q );
```

(b)
```
int funny( int n, int k ) {
  return n ? k * funny (n–1) : 1;
}
```

(c)
```
int strange(int q, int r) {
  int m;
  if (q < r)
    m = r;       /* set m          */
  else           /* to minimum */
    m = q;       /* of q and r     */
  return m * m + q * r;
}
```

(d)
```
#include <stdio.h>
int main() {
  int i, count;
  printf("How often?\n");
  scanf("%d", count);
  for( i=1; i ≤ count; i++) {
    printf("Hello!\n");
    main();
  }
  return 0;
}
```