Programing for computer technology
Hand-in Assignment Exercises

Week 04: Array data structures

Please make sure to submit your solutions by next **Monday** (22-09-2025).

At the beginning of each question, it is described what kind of answer you are expected to submit. If Text answer AND Code answer is stated, then you need to submit BOTH some argumentation/description and some code; if just Text answer OR Code answer, then just some argumentation/description OR code. From this week, we start using github classrooms; you have to submit using that

Note: the **Challenge** exercises are *optional*, the others mandatory (i.e. you **have** to hand them in).

Exercises

1)

Text answer Code answer When asking ChatGPT the following question *write a program that can print out a repayment plan for student loans* I got the following answer:

Quote

```c
#include <stdio.h>
#include <math.h>

int main() {
    double loanAmount;   // Loan principal amount
    double interestRate; // Annual interest rate (as a decimal)
    int loanDuration;    // Loan duration in months

    // Get user input
    printf("Enter the loan amount: ");
    scanf("%lf", &loanAmount);

    printf("Enter the annual interest rate (as a decimal): ");
    scanf("%lf", &interestRate);

    printf("Enter the loan duration in months: ");
    scanf("%d", &loanDuration);

    // Calculate monthly interest rate
    double monthlyInterestRate = interestRate / 12;

    // Calculate monthly payment
    double monthlyPayment = loanAmount * (monthlyInterestRate / (1 - pow(1 + monthlyInterestRate, -loanDuration)));

    // Display repayment plan
    printf("\nRepayment Plan:\n");
    printf("Month\tPrincipal\tInterest\tTotal Payment\n");

    double remainingBalance = loanAmount;
    int month = 1;

    while (1) {
        double interestPayment = remainingBalance * monthlyInterestRate;
        double principalPayment = monthlyPayment - interestPayment;

        remainingBalance -= principalPayment;

        printf("%d\t%.2lf\t\t%.2lf\t\t%.2lf\n", month, principalPayment, interestPayment, monthlyPayment);

        if (++month > loanDuration || remainingBalance <= 0.0) {
            // Break the loop when the loan is paid off or the loan term is exceeded
            break;
        }
    }
    return 0;
}
```

— ChatGPT v3.0

(a) Make at least four test cases for the program

(b) Use the test cases to ensure the the program works as expected.

(c) Add pre- and post conditions to the code and include them in your code as `assert`-statements

(d) Change the `while`-loop to a `for`-loop

(e) Refactor the program so that it has two functions: `calculateMonthlyPayment` (returns the monthly payment) and `displayRepaymentPlan` that prints out the repayment plan). Remember to make and include pre- and post-conditions for the functions

2)

Code answer Complete the following function (Listing 1) which returns the smallest number in an array:

```c
/*
 * Returns the smallest of the first n values in list
 * Pre: n>0, list[0...n-1] is defined
 */
int get_min( int list[], int n) {
  assert(n>0);
  ...
}
```

Listing 1: A C program for exercise 2

Tip

See listing 7.6 in the Book

3)

Old exam question Consider the following program fragment:

```c
int i = 5;
int b[] = {0, 1, 2, 3, 5, 8, 13, 21, 34, 55};
for (i = 1; i <=1; i = i*2)
  b[i] = b[i-1];}
```

Fill in the table below with the values stored in array `b` after the program fragment has been executed

Answer: `b =`

4)

Code answer Complete the following function that returns an array in reverse order:

```c
/*
 * Returns in rev_array the elements of list in reversed order
 * Pre: n>0, list[0...n-1] is defined
 */
void reverse( int list[], int rev_array[], int n) {
  assert(n>0);
  ...
}
```

For example, given the arrays:

```c
int a[5] = {1,2,3,4,5};
int b[5];
```

and calling the function in the following way:

```
reverse(a, b, 5);
```

you should end up with the array `b` that has the elements: `[5,4,3,2,1]`.

Notification

A function cannot return an array, that is why the second array (`rev_array`) is used as the output parameter (and `list` as the input parameter)

5)

Code answer Suppose I have a sequence of numbers such as:

1, 7, 43, 4, 67, 0, 3, 2, 0, 0, 3, 2, **0**, **0**, **0**, 3, 2, 6

The longest sequence of zeroes has 3 consecutive zeroes (in bold). Write a function that computes the start index of the longest sequence of zeros in an array. The function should have the following signature:

```c
/*
 * Returns the index in list of the logest sequence of zeros in list, -1 if no zeros in list
 * pre: n>0, list[0...n-1] is defined
 */
int longest_seq(int list[], int n){
  assert(n>0);
  ...
}
```

Given the following lines of code:

```c
int a[13] = { 0, 0, 0, 4, 5, 0, 0, 0, 0, 0, 11, 0, 0 };
int b[5] = {1, 2, 3, 4, 5};
printf ("The longest sequence of zeros start index is %d\n", longest_seq(a,13));
printf ("The longest sequence of zeros start index is %d\n", longest_seq(b,5));
```

the program shold print the following:

```
The longest sequence of zeros start index is 5
The longest sequence of zeros start index is -1
```

6)

Write a function that counts the occurrences of numbers between 1 to 20 in a two-dimensional array of size $100 * 150$, with the following signature:

```c
/*
* pre:  a contains numbers between 1..20
* post: count[i] is equal to the numers af i+1 in a
*/
void count_1_to_20(int a[100][150], int count[20]) {
   ...
   return ;
}
```

Notification

`count[i]` contains the number of `i+1` in `a`

7)

```c
int q = 0;
int r = m;
int b = n;
while (r >= b)
  b *= 2;
while (b != n)
{
  q *= 2;
  b /= 2;
  if (r >= b)
  {
    q += 1;
    r -= b;
  }
}
```

Listing 2: A C program for exercise 7

8)

Code answer Complete the following function that returns the average of an array of integers:

```c
/*
 * Returns the average of an array
 * Pre: n>0, list[0...n-1] is defined
 */
double average( int list[], int n) {
  assert(n>0);
  ...
}
```

Listing 3: A C program skeleton for exercise 7

Challenge

Write 1-2 sentences that answer the question: *What does the following program compute, that is, what problem does it solve?*

```c
int r = 0;
int n = 0;
int s = 0;
int h;
while (n != N) {
  h = n;
  while (h != s) {
    if (a[h - 1] != a[n])
      h--;
   else
      s = h;
  }
  r = max(r, n + 1 - s);
  n++;
 }
 printf("%d", r);
}
```

Listing 4: A C program for exercise *challenge*

where the function `max()` is given by:

```c
int max(int x, int y) {
  return (x >= y) ? x : y;
}
```

Tip

Experiment with different values for `a` and `N`, e.g.

```c
int a[11] = { 9,1,1,7,3,4,2,11,1,9,10 };
int N = 11;
```