Informatics II, Spring 2023, Exercise 1

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Task 1

For single choice questions (SC) exactly one of the alternatives is correct. For multiple choice (MC) questions each statement must be analyzed and assessed independently.

1.1 (SC): Consider the Hilbert curves of order 1, 2 and 3 in Figure 1. Assume the canvas that is used for drawing the Hilbert curve is a 5cm x 5cm square.

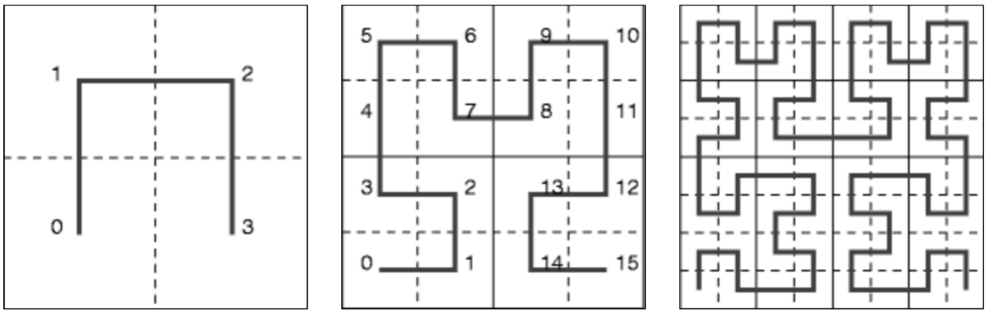

Figure 1: Hilbert curves of order 1, 2 and 3.

What is the length of the Hilbert curve of order 15?

- □ 79.6875 cm
- □ 1638.4 m
- □ 2048 m
- □ 5120.6875 m
- □ 53'687.09115 km

1.2 (MC): Consider the following sorting algorithms for answering the questions below. Assume the algorithms are used to sort an array A with n elements. For the analysis we only consider operations that compare array elements and operations that move array elements.

```
Algo: BubbleSort(A)

for $i = n$ to 2 do
    for $j = 2$ to $i$ do
        if $A[j] < A[j-1]$ then
            t = A[j];
            A[j] = A[j-1];
            A[j-1] = t;
```

```
Algo: SelectionSort(A)

for $i = 1$ to $n - 1$ do
    $k = i$;
    for $j = i + 1$ to $n$ do
        if $A[j] < A[k]$ then
            k=j;
    exchange A[i] and A[k];
```

```
Algo: InsertionSort(A)

for $i = 2$ to $n$ do
    j = i - 1;
    t = A[i];
    while $j \geq 1 \wedge t < A[j]$ do
        A[j+1] = A[j];
        j = j-1;
    A[j+1] = t;
```

True	False	
□	□	The best case runtime of BubbleSort is linear to n.
□	□	Whether an array is sorted or not does not impact the runtime of SelectionSort.
□	□	SelectionSort has the same best, average and worst case runtime.
□	□	InsertionSort achieves its best runtime if the input array is sorted in any order.

1.3 (SC) Consider the following sorting algorithm XSort:

```
Algo: XSort(A)

l = 1; r = n;
do
    for $j = r$ to $l + 1$ do
        if $A[j] < A[j-1]$ then
            exchange A[j] and A[j-1];
            m = j;
    l = m;
    for $j = l$ to $r - 1$ do
        if $A[j] > A[j+1]$ then
            exchange A[j] and A[j+1];
            m = j;
    r = m;
while $l < r$;
```

Assume the array $A = (4, 8, 8, 7, 7, 3, 5, 0, 5)$ is sorted with XSort. Which of the following arrays shows the state of array A after the second completion of the outermost loop?

- □ $A = (0, 3, 4, 7, 7, 5, 5, 8, 8)$
- □ $A = (4, 8, 7, 7, 3, 5, 0, 5, 8)$
- □ $A = (4, 7, 7, 3, 5, 0, 5, 8, 8)$
- □ $A = (0, 4, 8, 7, 3, 5, 5, 7, 8)$
- □ $A = (0, 3, 4, 8, 8, 7, 7, 5, 5)$

Task 2

Write a C program that takes four integer numbers as input values on the command line. The four numbers are the values that shall be used to populate a 2 × 2 matrix. Compute the square of the matrix and print the original and the squared matrix side by side on the terminal.

The input handling is specific for exactly four values and does not have to be generalized. The matrix multiplication and the printing shall be general for $n \times n$ matrices.

Hint: Use `sscanf` to process command line arguments.

Task 3

Assume an array A with n integer elements and an integer c. The goal is to develop an algorithm that checks if there exists a pair of elements in A such that the sum of the two elements is equal to c.

3.1 Develop and implement an algorithm `pairSum` that solves the problem in C.

3.2 Assume array A is sorted in non-decreasing order. Develop an algorithm `pairSumSorted` that exploits the sortedness and solves the problem faster than algorithm `pairSum`.

3.3 Measure and report the worst case runtime of algorithms `pairSum` and `pairSumSorted` for an array with half a million elements.