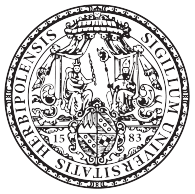


Introduction to Informatics
WiSe 2024/2025

Prof. Dr. Ingo Scholtes
Chair of Informatics XV
University of Würzburg

Exercise Sheet 10

1. **Multiple Choice**
   (a) What is the maximum number of steps required by the binary search algorithm to locate an element in a sorted array of length 16?
      A. 8
      B. 4
      C. 16
   (b) Which of the following statements about the Control Unit (CU) in a van Neumann architecture are correct
      A. The CU is responsible for performing arithmetic and logical operations.
      B. The Control Unit updates the Program Counter (PC) to point to the next instruction.
      C. The Control Unit loads the next instruction from memory into the Instruction Register
   (c) Which of the following IP addresses are valid?
      A. 192.168.0.256
      B. 2001:0db8:85a3:0000:0000:8a2e:0370:7334
      C. 10.0.0.1
   (d) What statements about an algorithm that has a time complexity of n^3 are true?
      A. It is a polynomial algorithm.
      B. If the input size doubles, the runtime will increase by a factor 8
      C. It is faster than an exponential algorithm with complexity 2^n
2. **Number Systems**
   (a) Convert the given decimal numbers into their binary and hexadecimal equivalents.
      (i) 34
      (ii) 255
   (b) Convert the given binary numbers into their decimal and hexadecimal equivalents.
      (i) 1101
      (ii) 10010010
   (c) Convert the following hexadicial numbers into their binary and decimal equivalents.
      (i) 0x2A
      (ii) 0x1E
3. **Logic Operators**
   (a) Give the truthtable for the formula

A **AND** (B **OR** ¬C)

(b) Give a formula for the Boolean function represented by the following truth table.

A	B	C	???
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

(c) Show that the logical operation **XOR** (with two inputs A and B) can be constructed as Boolean function that only uses **AND, OR and NOT** operations.

4. **Ciphers**

(a) The following cipher is encrypted with the Caesar cipher with shift key 3. Decrypt the cipher:
`hohskdqw`

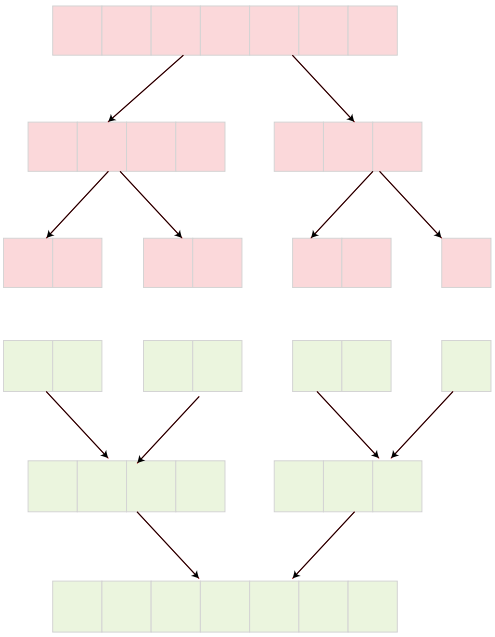
(b) Use the Vigenère cipher to encrypt the following message with the key `'ABC'`:
`Hello World!`

5. **Sorting Algorithms**

(a) Use the following algorithm on the list `[54,38,2,49,97]` and write down the result of each step in the for loop.

```
def function(arr):
    n = len(arr)
    for i in range(n):
        for j in range(0, n-i-1):
            if arr[j] > arr[j+1]:
                arr[j], arr[j+1] = arr[j+1], arr[j]
    return arr
```

(b) Perform a merge sort for the unsorted list `[7, 96, 81, 9, 22, 30, 56]` using the given diagram.



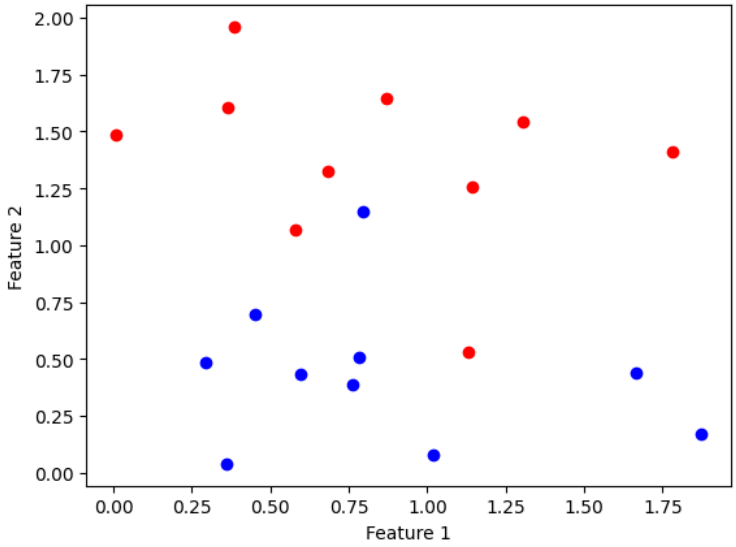
6. **Classification Problems**

   (a) You are given the ground truth labels and predicted labels for a binary classification problem.

   - Ground truth labels: `[1, 0, 1, 1, 0, 1, 0, 0, 1, 0]`
   - predicted labels: `[0, 0, 0, 1, 0, 1, 0, 0, 1, 0]`

   Calculate the confusion matrix, accuracy, precision, recall, and F1 score.

   (b) Given the following 2-dimensional dataset with two classes, what is the maximal accuracy that a logistic regression model can achieve?



7. **ER Diagrams**

   (a) Give an example for a N:M, a 1:N and a 1:1 relationship.

   (b) Create an Entity Relationship diagram for a library where you want to store information about the customers, books and authors. Think about useful attributes and relationships.

The following questions are only for the 10 ETCS students

1. **Understanding python code** For each of the following Python functions, describe what the algorithm does and how it works and provide the output for the given inputs.

   (a)
   ```
   def function1(lst):
       x = lst[0]
       for num in lst:
           if num < x:
               x = num
       return x

   # What is the result of
   function1([3, 1, 4, 1, 5, 9, 2, 6, 5])
   ```

   (b)
   ```
   def function2(lst, e):
       c = 0
       for i in lst:
           if i == e:
               c += 1
       return c

   # What is the result of
   function2([1, 2, 2, 3, 2, 4],2)
   ```

2. **KNN Algorithm**
   (a) Explain the basic idea of the KNN algorithm
   (b) What happens if k is small (k= 1) or large (k=n)?

3. **MLP**
   (a) Draw a Deep Neural Network with 6 input features, 2 hidden layers (2 and 3 neurons), and an output layer (1 neuron).
   (b) How many parameters does the above network have?

4. **RAID Configurations** You have 8 hard drives, each with a capacity of 10 TB, where one is used as hot spare. Your goal is to explore and compare different RAID configurations (RAID 0, RAID 1, RAID 5, and RAID 6)
   (a) For each RAID configuration (0, 1, 5, 6), calculate the **usable storage capacity**.
   (b) For each RAID level, describe how many disk failures the system can tolerate before data is lost.