

Programming for Data Science (22/03/2024)

Upload the solutions to the programming exercises to the following link:

<https://evo.di.unipi.it/student/courses/16/exams/AvN2zAv>

Exercise 1. (Math, solve the exercise on paper)

- What is the decimal expansion of the number with octal expansion $(111)_8$?
- What is the binary expansion of integer $(32)_{10}$?
- Suppose you have a deck of 52 playing cards, each representing one of the four standard suits (hearts, diamonds, clubs, spades) and one of 13 values. You randomly select some cards from the deck.
 - How many cards should be selected so that there are at least two cards of the same suit?
 - How many cards should be selected so that there are at least two cards of the same value?
- Consider a set $A=\{1,2,3,4,5\}$ and relation R on $A \times A$ defined as follows: $R=\{(x,y) \mid x,y \in A \text{ and } x+y \text{ is even}\}$. Determine whether R is reflexive, symmetric, antisymmetric, transitive.

Exercise 2. (Python) Consider the itemset collection $D = \{ \{A,B,D,E\}, \{B,C,E\}, \dots \}$:

Tid	Itemset
1	ABDE
2	BCE
3	ABDE
4	ABCE
5	ABCDE
6	BCD

and the equivalence relation θ defined as follows: let X and Y itemsets, $X \theta Y$ iff $\text{cover}(X) = \text{cover}(Y)$, where $\text{cover}(X) = \{ t \in D \mid X \subseteq t \}$.

Implement the following functions:

- cover** function
- theta** equivalence relation θ
- longest** itemset in their class of equivalence

Examples:

- $\text{Cover}(\{A,C\}) = \{ \{A,B,C,E\}, \{A,B,C,D,E\} \}$
- $\{A,C\} \theta \{A,C,E\}$ and $\{A,C\} \theta \{A,B,C,E\}$.
- $\text{Longest}(\{A,C\}) = \{A,B,C,D,E\}$

Exercise 3. (C) Write a C program that implements basic operations on a single linked list using dynamic memory allocation. Implement the following functionalities:

- Node Structure:** Define a structure `Node` to represent a node in the linked list. Each node should contain an integer data value and a pointer to the next node.
- Linked List Creation:** Implement a function to create a linked list by adding nodes dynamically. Allow users to input the data values for each node until they choose to stop.
- Linked List Add Node:** Implement two functions to add a node in the linked list. The list should be sorted, i.e., a node should be added in the right position of the list.
 - Using an iterative approach
 - Using a recursive approach
- Linked List Length:** Implement two functions to calculate the length of the linked list (number of nodes):
 - Using an iterative approach
 - Using a recursive approach
- Linked List Print:** print the content of the nodes in the linked list.

Ensure proper memory management by freeing dynamically allocated memory after use.