

Labs - ordinary call - may (extra)

May 26, 2025

Surname, name _____ UO: _____

Gray Codes

Gray codes, also known as reflected binary codes, are a binary numeral system with a particular property: two successive values differ in only one bit. This characteristic makes them very useful in various applications, such as error correction in digital systems, Karnaugh maps, rotary encoders, and in state sequencing where minimizing transition errors is desired.

For example, the Gray code sequence for 1 bit is: [0, 1].

Another example, the standard Gray code sequence for 2 bits is: [00, 01, 11, 10]. If we observe the transition between successive values:

- 00 -> 01 (the least significant bit changes).
- 01 -> 11 (the most significant bit changes).
- 11 -> 10 (the least significant bit changes).

One last example, the standard Gray code sequence for 3 bits is: [000, 001, 011, 010, 110, 111, 101, 100].

In summary:

- For n bits, the elements of the output sequence will be in the range of $[0, 2^n - 1]$ when we represent them using the decimal number system.
- The first number will always be the binary representation of 0.
- A number will never appear more than once.
- The binary representation of each adjacent element will always differ by only one bit.
- The binary representation of the first and last elements will differ by only one bit.

The objective will be to implement a program that, for an input number of bits, generates all possible valid Gray code sequences (the order does not matter), showing both the binary codes and their decimal representation.

Below are examples of the input and expected output type of the program to be made.

java Gray 1

[0, 1] --> [0, 1]

java Gray 2

[00, 01, 11, 10] --> [0, 1, 3, 2]

[00, 10, 11, 01] --> [0, 2, 3, 1]

java Gray 3

[000, 001, 011, 010, 110, 111, 101, 100] --> [0, 1, 3, 2, 6, 7, 5, 4]

[000, 100, 101, 111, 110, 010, 011, 001] --> [0, 4, 5, 7, 6, 2, 3, 1]

[000, 001, 101, 100, 110, 111, 011, 010] --> [0, 1, 5, 4, 6, 7, 3, 2]

[000, 010, 011, 111, 110, 100, 101, 001] --> [0, 2, 3, 7, 6, 4, 5, 1]

[000, 001, 011, 111, 101, 100, 110, 010] --> [0, 1, 3, 7, 5, 4, 6, 2]

...

Please, when you finish, call your lab teacher to fill in the following table with the execution times obtained for the different test cases:

Case	How many Gray code sequences have been generated?	Time in milliseconds
Gray 1		
Gray 2		
Gray 3		
Gray 4		

Exercise completion time: