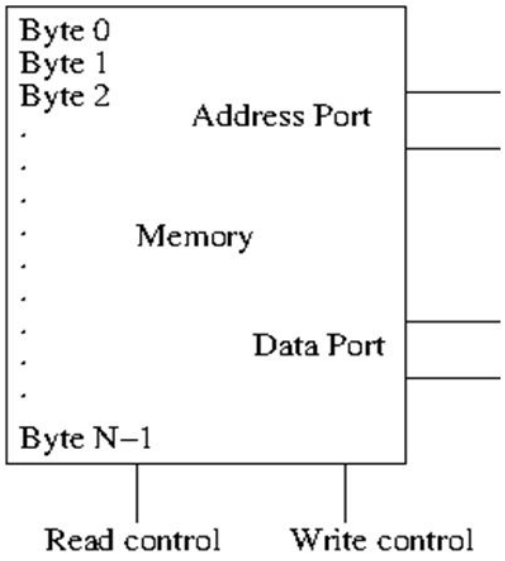
Chapter 2 problems

1. Suppose the representation of a picture is 1000x1000 grid, where each cell in the grid is a 1 if the cell is largely filled, and a 0 if it is largely empty. Show how we can recognize whether the picture is of the letter “T”. Make any assumptions.
2. ...recognize that the picture is symmetric along a vertical line
3. ...recognize that the picture is symmetric along a horizontal line.
4. Describe an algorithm which, given a paragraph (a stream of letters, punctuation and some spaces), will convert the first letter of a sentence into Capital.
5. The following computer is reading Memory location 100 in which the number 456 is stored. Complete the picture with appropriate labels (in binary).



6. A computer is executing the instruction 35 100, where 35 is code for “increment” and 100 is the memory location number. The instruction means increment the value in address 100 by one. Outline the steps that Control Unit does.
7. Convert the following decimal numbers to binary:
    a. 1212.871
    b. 0.8912
8. Convert the following binary numbers to decimal
    a. 11010.1001
    b. 10001010.0001

Programming practice

1. Write a program that reads a list of numbers (stops when number is negative, skips and reads the next one if a number is > 100) and counts the number of numbers greater than 40. It should print out this count.
2. Write a program that reads a list of numbers between 0 and 100 (stops when number is negative, skips and reads the next one if a number is > 100), and prints out a *histogram* of these numbers. The ranges for the histogram are: 0-20, 21-40, 41-60, 61-80, 81-100.
3. Write a program that reads a number *n*, and writes out all binomial coefficients of $(1+x)^n$.
4. Write a program which reads a number *n* and prints out the first *n* terms of the Fibonacci sequence. Fibonacci sequence is: 0, 1, 1, 2, 3, 5, 8, 13,...
5. Given $s_1 = 0$, $s_2 = 1$, $s_3 = 1$. Suppose the sequence s_n is defined as $s_{n+3} = s_n + s_{n+1} + s_{n+2}$. Write a program which reads a number *n* and generates the first *n* terms of this sequence.
6. Write a function **isFibonacci** which takes two numbers as arguments and returns true if they are consecutive numbers in a Fibonacci sequence, and false if not. Write a main program that reads two numbers and calls this function and prints the return value.
7. Write a program that takes as input a binary number and writes out its decimal equivalent.
8. Write a program that takes as input a quadral (base-4)number and writes out its decimal equivalent.
9. Write a program that reads a number and prints the sum of the digits of the number.
10. Write a function **areaRectangle** that takes three arguments: the length and breadth of the rectangle, and a boolean variable. The function returns the area of the rectangle, and sets the boolean variable to true if the rectangle is a square and false if not. Write a main program which calls this function.
11. Write a program that reads in a stream of characters (terminated by "."). It looks for two numbers in this stream, if it finds them, it prints out number 1 divided by number 2. E.g. if the stream is:

    thereare345twonumbersin982thisstream.

    It will print out 0.351324
12. Write a program that reads an integer *n* and prints out its smallest divisor other than 1.

Graphics Programming Problems

Problems 14, 15 from Prof Ranade's book Chapter 6

1. Modify the horizontal ball animation assuming that the box has mass equal to the ball and is free to move in x direction (say it is mounted on rails parallel to x direction). Note

that now in each collision the velocity of the box will also change. If the box has velocity v and the ball has velocity u parallel to the x axis at the time of the collision, then these velocities will be exchanged during the collision, i.e. will become u and v respectively. Show the animation of this system You may want to start off the system with the x component of the ball velocity equalling the negative of the velocity of the box. This will ensure that the box will not move out of the screen.

2. In the hardest version of the ball-in-a-box problem, the box is sitting on a frictionless surface, and is free to turn. Now, after a collision, the box will, in general start rotating as well as translating. Assume for simplicity that the mass of the box is uniformly distributed along its 4 edges.
3. Modify the projectile program so that the projectile is like a ball that falls to the ground and then bounces multiple times (each bounce shorter than the previous one)