Outline

1. midterm exam on Friday 26 February 2016
   - policies
2. questions
   - with some potential answers...

MCS 260 Lecture 19
Introduction to Computer Science
Jan Verschelde, 24 February 2016

review of the first 18 lectures

1. midterm exam on Friday 26 February 2016
   - policies

2. questions
   - with some potential answers...

policies

The exam will be closed book, no notes, and no computer.

The material on computer literacy breaks down in two parts:

1. computer science concepts: algorithms, computer architecture, functionality of operating systems, mass storage, formal languages, flowcharts and pseudocode, logic gates, transistors and flip flops, adder circuits, functional programming.
2. mathematical CS: binary and hexadecimal representations of numbers, precision and accuracy, boolean algebra, truth tables, simulation and Monte Carlo, histograms.

This review contains some preliminary examples of questions which may help you prepare for the first part of the midterm exam.

review of the first 18 lectures

1. midterm exam on Friday 26 February 2016
   - policies

2. questions
   - with some potential answers...

question 1

List the characteristics of an algorithm.

answer to question 1

The question: *List the characteristics of an algorithm.*

A potential answer: There are four characteristics:

1. ordered: steps in the execution come after each other;
2. unambiguous: the steps must be executable and clear;
3. correctness: must meet its specification, its intended goals;
4. terminating: must stop after a finite number of steps.

question 2

How many bytes are 15 terabytes?

answer to question 2

The question: *How many bytes are 15 terabytes?*

A potential answer: tera = 2^{40}.

So 15 terabytes are 15×2^{40} bytes,
or approximately 15 trillion bytes.

question 3

Explain the difference between 34//87 and 34.0/87.

answer to question 3

The question: *Explain the difference between 34//87 and 34.0/87.*

A potential answer:

- 34//87 represents the division of the integer 34 by the integer 87.

  The result of this integer division is zero.

- 34.0/87 represents the division of the *float* 34.0 by the integer 87.

  The result of this float division is a floating-point number
  which represents the rational number 34/87
  up to machine precision.

question 4

What is an interrupt?

answer to question 4

The question: *What is an interrupt?*

A potential answer:

An interrupt causes an executing process to go
in waiting (e.g.: wait for input from a device)
or ready state (e.g.: because the CPU is busy on another process).

question 5

Describe the differences between a compiler and an interpreter.

What are the advantages/disadvantages of using a compiler and an interpreter?

answer to question 5, part one

The first part of the question:
Describe the differences between a compiler and an interpreter.

A potential answer:

- A compiler translates an entire program into executable format.
  The program is not executed.
- An interpreter translates statements in a program one after the other and
  executes each statement as soon as its translation is done.

answer to question 5, part two

The second part of the question:
What are the advantages/disadvantages of using a compiler and an interpreter?

A potential (very short) answer:

- Compiled code executes faster than interpreted code.
- Code can be developed faster with an interpreter than with a compiler.

question 6

Convert 318 into hexadecimal notation.

answer to question 6

The question: *Convert 318 into hexadecimal notation.*
A potential answer:

n	$n/16$	$n \bmod 16$			
318	19	14	318	=	$19 \times 16 + 14$
19	1	3	19	=	$1 \times 16 + 3$
1	0	1	1	=	$0 \times 16 + 1$

Collecting the remainders gives 1, 3, 14 (or E).

So the decimal 318 equals 13E in hexadecimal.

An alternative method is to convert to binary
and group the bits in sequences of four.

question 7

Rank all memory elements we have seen twice:

1. use once its speed (memory that is fastest to access comes first); and
2. use once its capacity (memory that is largest in size comes first).

answer to question 7

The question: *Rank all memory elements we have seen twice:*

1. *use once its speed (memory that is fastest to access comes first); and*
2. *use once its capacity (memory that is largest in size comes first).*

A potential answer:

1. registers, cache, internal memory, disk, tape;
2. tape, disk, internal memory, cache, registers.

question 8

What is the kernel of an operating system?

answer to question 8

The question: *What is the kernel of an operating system?*

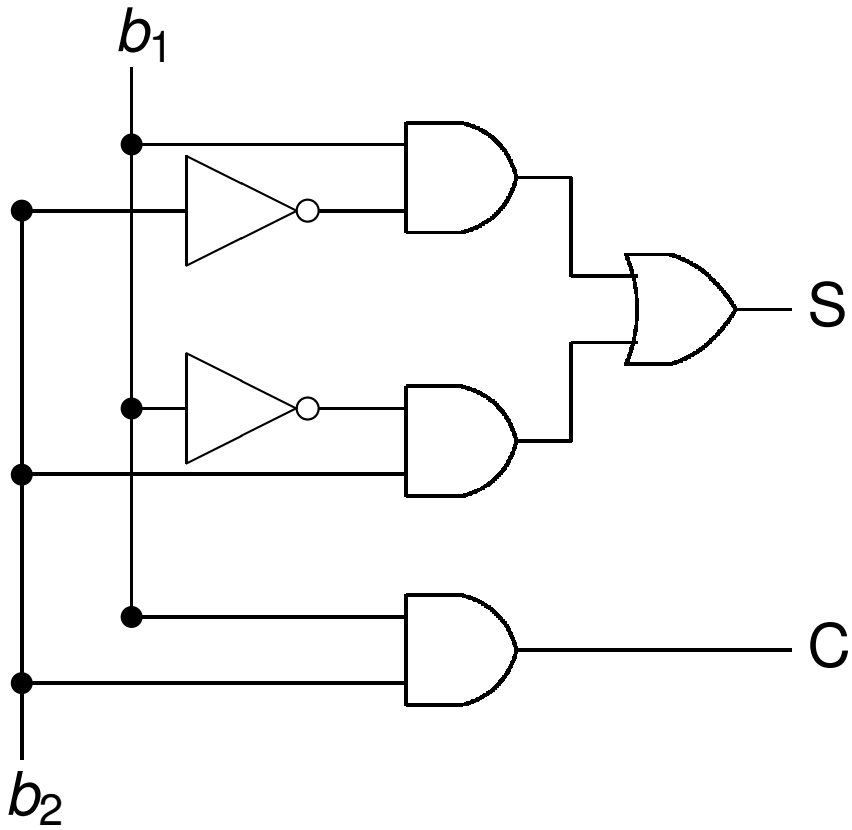
A potential answer:

The kernel of an operating system

1. controls the execution of programs;
2. allocates and frees internal memory;
3. manages the peripherals (i/o devices).

question 9

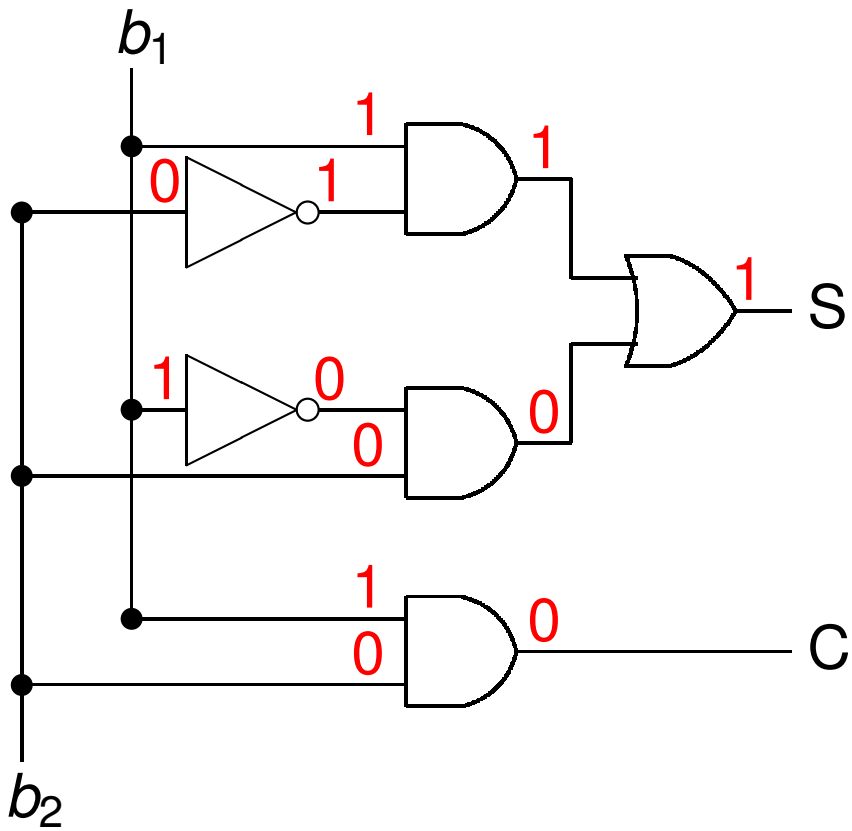
Consider the circuit shown below. For $b_1 = 1$ and $b_2 = 0$ as input, indicate on the picture below the input and output for every logical gate.



answer to question 9

Consider the circuit shown below. For $b_1 = 1$ and $b_2 = 0$ as input, indicate on the picture below the input and output for every logical gate.

The answer:



question 10

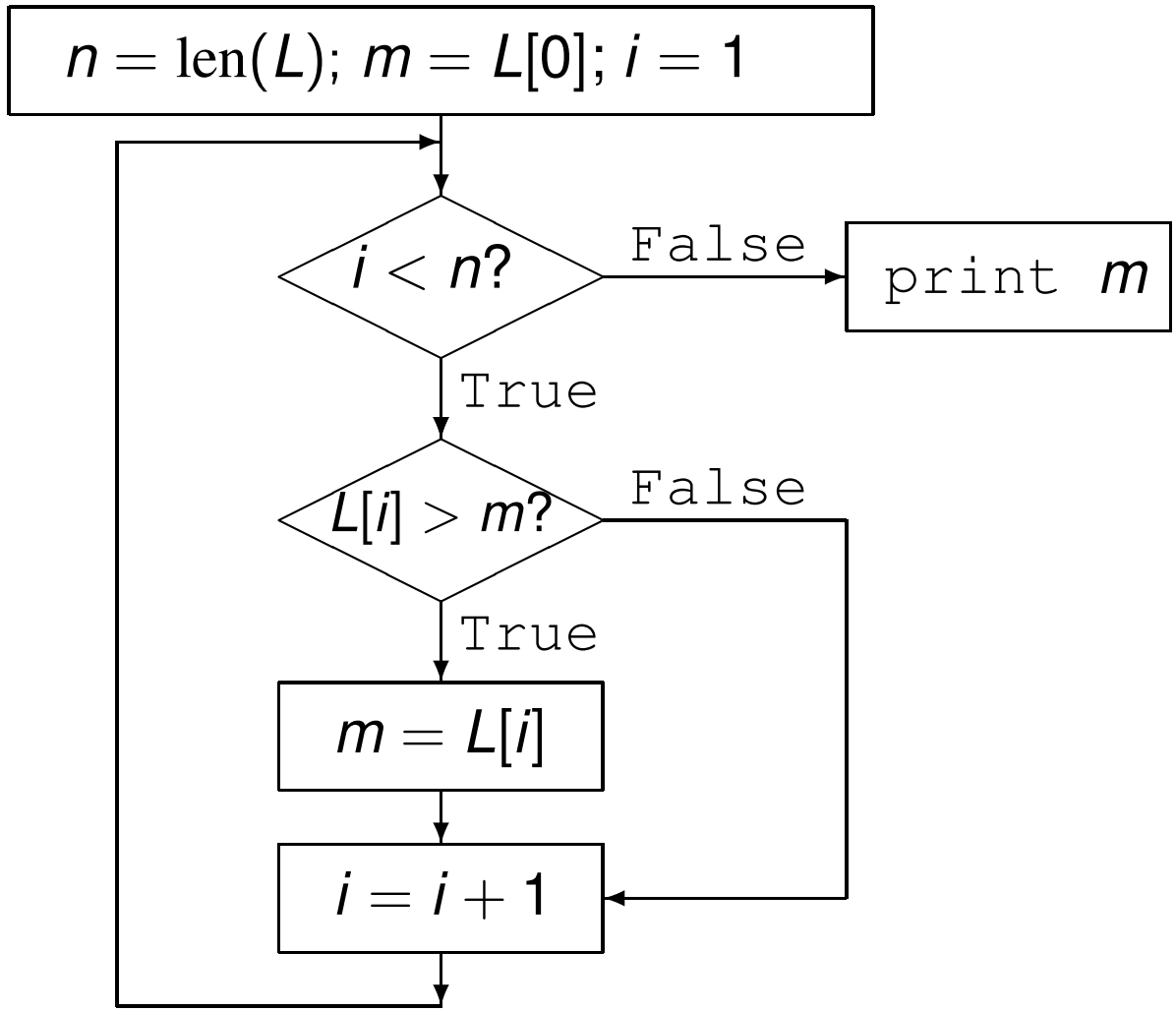
Draw the flowchart for the algorithm to search for the maximum in a list of unsorted numbers.

Write pseudo code for this algorithm as well.

answer to question 10: the flowchart

The question: *Draw the flowchart for the algorithm to search for the maximum in a list of unsorted numbers.*

A potential answer:



answer to question 10: the pseudocode

The question: *Draw the flowchart for the algorithm to search for the maximum in a list of unsorted numbers. Write pseudo code for this algorithm as well.*

A potential answer:

```
Input: L, a list of unsorted numbers.
Output: m, the maximum of the elements in L.

let m be L[0]
for i from 1 to the length of L do
    if L[i] > m then
        let m be L[i]
```

question 11

An exclusive or, denoted as XOR returns False only when the inputs are both the same, and True otherwise.

1. Give the truth table for the exclusive or.
2. Show how the XOR can be realized with NOT, OR, and AND by giving the logical expressions and their corresponding truth tables.
3. Draw the circuit for the XOR, using the symbols for the gates NOT, OR, and AND.

answer to question 11, item 1

The question: *An exclusive or, denoted as XOR returns False only when the inputs are both the same, and True otherwise.*

1. *Give the truth table for the exclusive or.*

The answer:

x	y	x XOR y
0	0	0
0	1	1
1	0	1
1	1	0

answer to question 11, item 2

The question: *An exclusive or, denoted as XOR returns False only when the inputs are both the same, and True otherwise.*

2. *Show how the XOR can be realized with NOT, OR, and AND by giving the logical expressions and their corresponding truth tables.*

The answer:

x	y	x OR y	x AND y	NOT (x AND y)	b
0	0	0	0	1	0
0	1	1	0	1	1
1	0	1	0	1	1
1	1	1	1	0	0

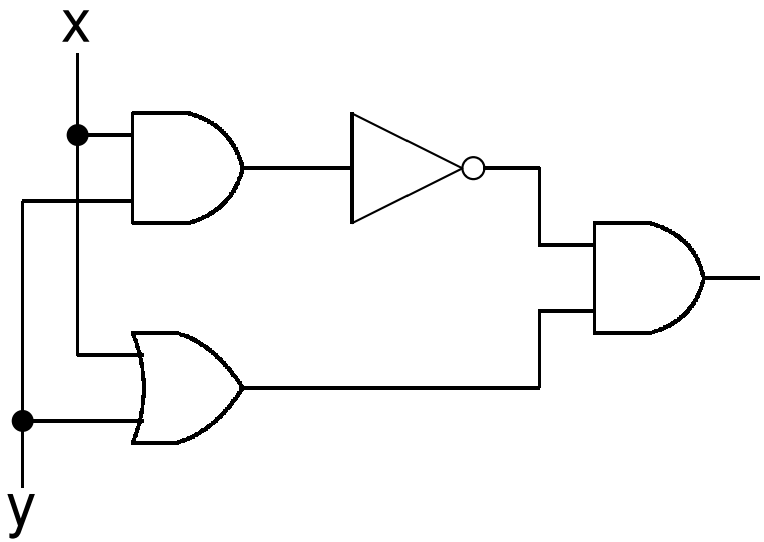
where b = (x OR y) AND (NOT (x AND y))

answer to question 11, item 3

The question: *An exclusive or, denoted as XOR returns False only when the inputs are both the same, and True otherwise.*

3. *Draw the circuit for the XOR, using the symbols for the gates NOT, OR, and AND.*

The answer:



question 12

Use truth tables to verify that

$$((\text{NOT } A) \text{ AND } B \text{ AND } C) \text{ OR } (A \text{ AND } (\text{NOT } B) \text{ AND } C) \\ \text{OR } (A \text{ AND } B \text{ AND } (\text{NOT } C)) \text{ OR } (A \text{ AND } B \text{ AND } C)$$

is equivalent to

$$(A \text{ AND } B) \text{ OR } (B \text{ AND } C) \text{ OR } (A \text{ AND } C).$$

Draw a realization of the second expression using the diagrams for the logic gates.

answer to question 12: first truth table

Give the truth table of

$$((\text{NOT } A) \text{ AND } B \text{ AND } C) \text{ OR } (A \text{ AND } (\text{NOT } B) \text{ AND } C) \\ \text{OR } (A \text{ AND } B \text{ AND } (\text{NOT } C)) \text{ OR } (A \text{ AND } B \text{ AND } C)$$

Let $D = \text{NOT } A$, $E = \text{NOT } B$, $F = \text{NOT } C$, $G = D \text{ AND } B \text{ AND } C$, $H = A \text{ AND } E \text{ AND } C$, $I = A \text{ AND } B \text{ AND } F$, $J = A \text{ AND } B \text{ AND } C$, $K = G \text{ OR } H \text{ OR } I \text{ OR } J$.

A	B	C	D	E	F	G	H	I	J	K
0	0	0	1	1	1	0	0	0	0	0
0	0	1	1	1	0	0	0	0	0	0
0	1	0	1	0	1	0	0	0	0	0
0	1	1	1	0	0	1	0	0	0	1
1	0	0	0	1	1	0	0	0	0	0
1	0	1	0	1	0	0	1	0	0	1
1	1	0	0	0	1	0	0	1	0	1
1	1	1	0	0	0	0	0	0	1	1

answer to question 12: second truth table

Give the truth table of

$$(A \text{ AND } B) \text{ OR } (B \text{ AND } C) \text{ OR } (A \text{ AND } C).$$

Let $D = A$ AND B, $E = B$ AND C, $F = A$ AND C, $G = D$ OR E OR F.

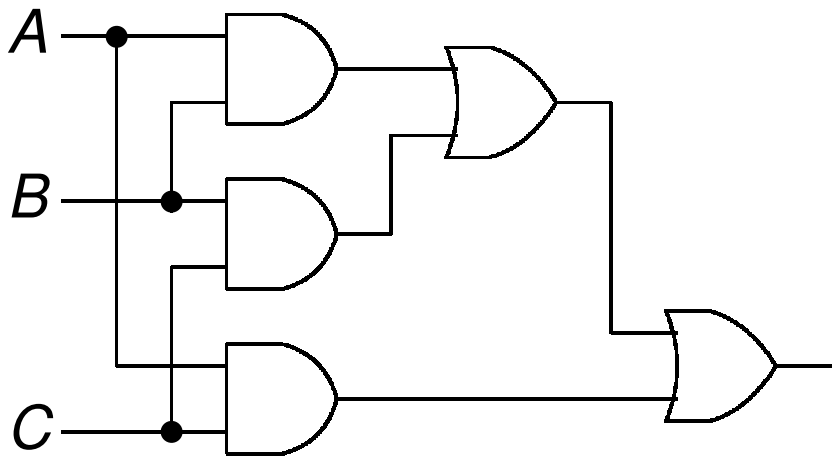
A	B	C	D	E	F	G
0	0	0	0	0	0	0
0	0	1	0	0	0	0
0	1	0	0	0	0	0
0	1	1	0	1	0	1
1	0	0	0	0	0	0
1	0	1	0	0	1	1
1	1	0	1	0	0	1
1	1	1	1	1	1	1

answer to question 12: the realization

Draw the realization of

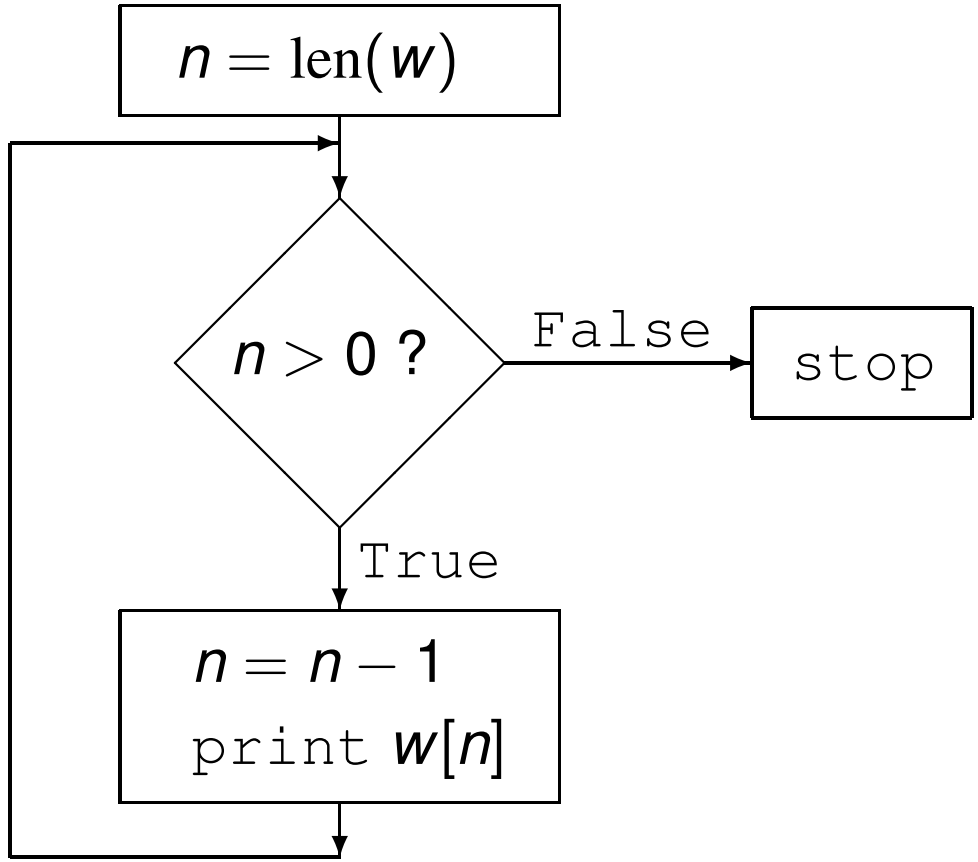
$$(A \text{ AND } B) \text{ OR } (B \text{ AND } C) \text{ OR } (A \text{ AND } C).$$

using the diagrams for the logic gates.
The answer:



question 13

Consider the flowchart, that takes on input the word w:



1. Explain what the algorithm defined by the flowchart does, that is: write pseudo code.
2. Redraw the flowchart that swaps the test with the body of the loop.

answer to question 13: the pseudocode

The question: *Explain what the algorithm defined by the flowchart does, that is: write pseudocode.*

A potential answer:

The algorithm writes a word backwards.

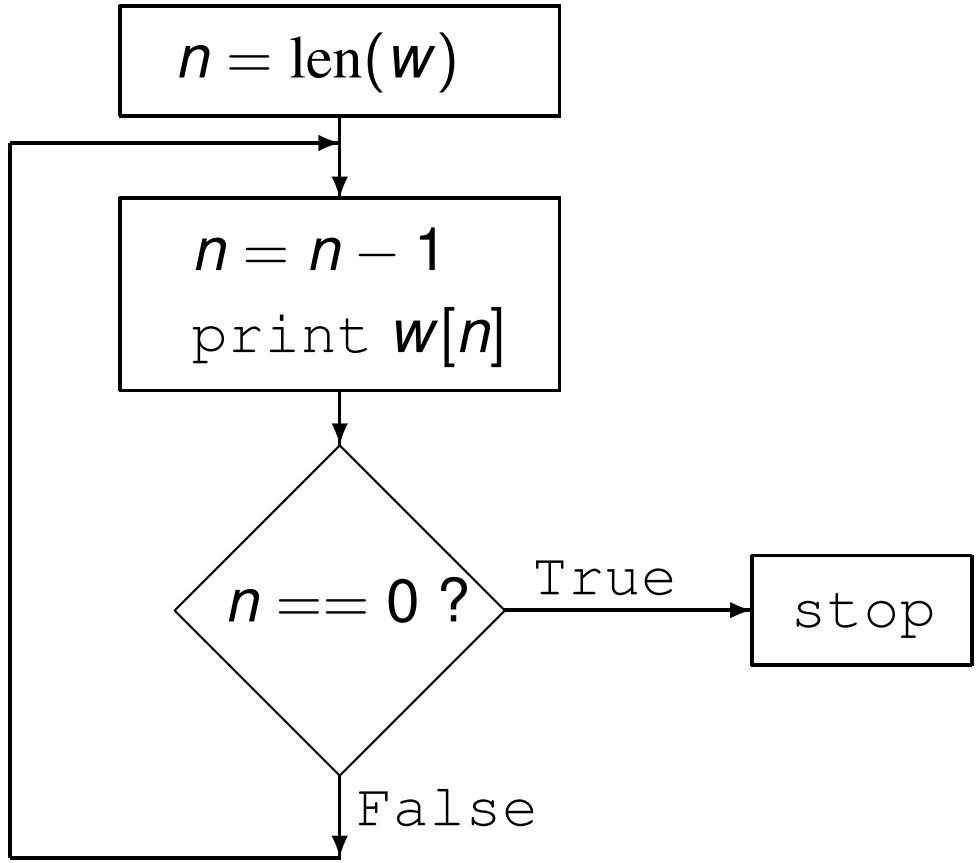
Pseudocode:

```
Input: w, a sequence of n characters.
Output: the sequence w written backwards.

for i from n-1 to 0 do
    print w[i]
```

answer to question 13: redraw the flowchart

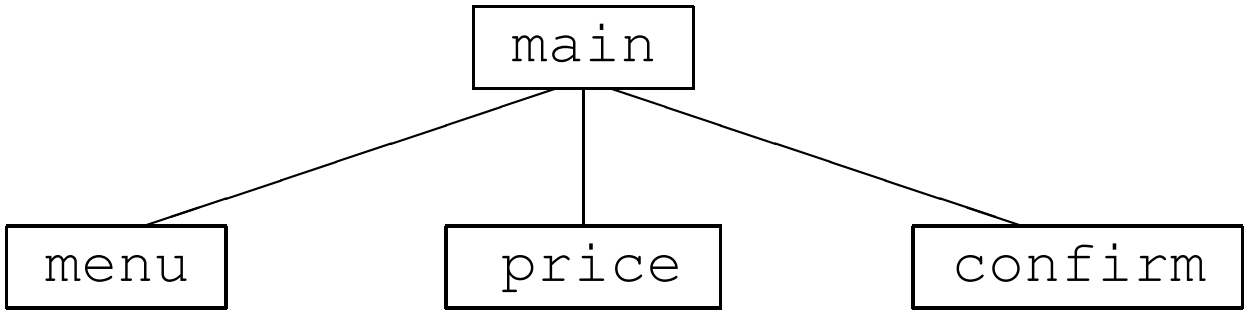
Redraw the flowchart that swaps the test with the body of the loop.



question 14

Describe the top down functional design for a program that takes orders in a fastfood restaurant.
The program should display a menu, prompt the customer to make a selection, calculate the price of the order, and then finally ask the customer to confirm the order.
Draw a hierarchy of the functions and for every function write a least one line for documentation string.

potential answer to question 14



Short description for each function:

- `main`: calls `menu`, `price`, and `confirm` (in that order).
- `menu`: displays the menu, prompts for a choice, returns the choice to the main function.
- `price`: given the choice, calculates the price, returns the price to the main function.
- `confirm`: given the choice and the price, prints a confirmation. Prompts the user to confirm (or cancel) the order.