Functions with Parameters and Local Variables in Assembly
Bitwise Operations in C and Assembly

Luís Nogueira Paulo Ferreira Raquel Faria
André Andrade Carlos Gonçalves Marta Fernandes
Cláudio Maia Ricardo Severino

{lmn,pdf,arf,lao,cag,ald,crr,rar}@isep.ipp.pt

2019/2020

Notes:

- Each exercise should be solved in a modular fashion, organized in a set of files and with an associated Makefile.
- The source code must be commented and have a consistent indentation
- When there are subpoints in the exercises they should placed in different folders called `ex09a`, `ex09b` ...
- Unless clearly stated otherwise, there needed data structures for each exercise must be passed as parameters to the implemented functions and no global variables should be used, neither in C or Assembly

Implement the following functions in Assembly and test their behavior by using them in a C program:

1. Implement the function `int cube(int x)` that returns the cube of the integer number '`x`' passed as a parameter.
2. Implement the function `int sum_n(int n)` that returns the sum of the integers 1 to n ('`n`' is passed as a parameter).
3. Implement the function `int greatest(int a, int b, int c)` that returns the greatest of three integer numbers passed as parameters.
4. Implement in the function `int sum_smaller(int num1, int num2, int *smaller)` that returns the sum of the two numbers, `num1` and `num2`, and place the smaller of the two in the memory area pointed to by `smaller`.
5. Implement the function `int inc_and_square(int *v1, int v2)` that increases by one the value pointed to by `v1` and returns the square of `v2`.
6. Implement the function `int test_equal(char *a, char *b)` that detects if two strings are equal. If the strings are equal, the function should return 1, or 0 otherwise.

7. Implement the function `int count_even(short *vec, int n)` that given the start address of a vector of shorts with 'n' elements, returns the number of even numbers in the vector.

8. Implement in Assembly the function `int calc(int a, int * b, int c)` with the behaviour presented in Listing 1. Note: Use in Assembly the required local variables.

Listing 1: calc.c

```
int calc(int a, int *b, int c)
{
  int z=(*b)-a;
  return c*z-2;
}
```

9. The function `print_result(...)` in Listing 2 prints the result of an arithmetic operation. Place it on your C main module.

Listing 2: print_result.c

```
void print_result(char op, int o1, int o2, int res)
{
   printf("%d %c %d = %d\n", o1, op, o2, res);
}
```

Implement in Assembly the function `int calculate(int a, int b)` with the behaviour presented in Listing 3. Note: Use in Assembly the required local variables.

Listing 3: calculate.c

```
int calculate(int a, int b)
{
  int sum,product;
  sum=a+b;
  product=a*b;
  print_result('+', a, b, sum);
  print_result('*', a, b, product);
  return (a+b)-(a*b);
}
```

10. Implement the function `int count_bits_zero(int x)` that counts the number of inactive bits (with the value 0) in a number x.

    a) In C.

    b) In Assembly.

    c) Use the Assembly function developed in b) in another Assembly function `int vec_count_bits_zero(int * ptr, int num)` that counts the total number of inactive bits in a vector of integers.

11. Implement in C the functions:

    - `int rotate_left (int num, int nbits)` - this function rotates the value `num`, `nbits` to the left.
    - `rotate_right (int num, int nbits)` - this function rotates the value `num`, `nbits` to the right.

12. Implement the function `int activate_bit(int *ptr, int pos)` that, given a pointer to an integer, places '1' on the bit given by `pos` (a value within $0 \ldots 31$). The function should return 1 if the bit was altered or 0 if the bit was already one.

    a) In C.

b) In Assembly.

c) Use the Assembly function developed in b) in another Assembly function `void activate_2bits(int *ptr, int pos)` that activates two bits. The function should activate the bits n and $31 - n$.

13. Implement the function `int activate_bits(int a, int left, int right)` that should 'activate' all the bits to the left of `left` and to the right of `right` on the number `a` (excluding the bits `left` and `right`).

    a) In C.

    b) In Assembly.

    c) Use the Assembly function developed in b) in another Assembly function `int activate_invert_bits(int a, int left, int right )` that also inverts the result of the previous function.

14. Implement the function `int join_bits(int a, int b, int pos)` that has as a purpose to return a number composed by the bits $b_{31}b_{30}...b_{pos+1}a_{pos}...a_1a_0$

    a) In C.

    b) In Assembly.

    c) Use the Assembly function developed in b) in another Assembly function `int mixed_sum(int a, int b, int pos)`. The function should return the sum of `int join_bits(int a, int b, int pos)` with `int join_bits(int b, int a, int pos)`

15. Considering that the 32 bits on an unsigned integer represent a date like this:

    - Bits 0 to 7 are the day
    - Bits 8 to 23 are the year
    - Bits 24 to 31 are the month

    Implement the function `unsigned int greater_date(unsigned int date1, unsigned int date2)` that returns the greater of the two dates passed as parameters.

    a) In C.

    b) In Assembly.

16. Implement the function `void changes(int *ptr)` that inverts the 4 most significative bits of the third byte of an integer, but only when the value of those 4 bits is greater than 7.

    a) In C.

    b) In Assembly.

    c) Use the Assembly function developed in b) in another Assembly function `void changes_vec(int *ptrvec, int num)` that applies the operation to a vector of integers.

17. Implement the function `void add_byte(char x, int *vec1, int *vec2)` that has as parameters the addresses of two vectors, `vec1` and `vec2` and a byte `x`. The function should add `x` to the first byte of each element of `vec1` and store the result on `vec2`. All the other bytes should remain unchanged. It is assumed that on the first element of `vec1` is the number of integers on the vector (excluding the first element).

    a) In C.

    b) In Assembly.

18. Implement the function `int sum_multiples_x(char *vec, int x)` that given `vec`, the address of a zero terminated byte vector, and `x`, an integer, returns the sum of all the element of `vec` that are multiples of the second byte of `x`.

    a) In C.

    b) In Assembly.