

Intensive Computation – Homework 4

27 April 2020

Exercise 1

Write the **function binary-toRNS** that:

- takes a radix-10 number X and a natural number n as **input**
- computes the dynamic range M for the module set $\langle m_1=2^n - 1 ; m_2=2^n ; m_3= 2^{n+1} \rangle$
- computes the RNS representation $\langle x_1 x_2 x_3 \rangle$ of X for the module set $\langle m_1=2^n - 1 ; m_2=2^n ; m_3= 2^{n+1} \rangle$
- gives as **output** the dynamic range M and the triple $\langle x_1 x_2 x_3 \rangle$

Write the **function Radix10-toRB** that:

- takes radix-10 number D as **input**
- computes the RB representation of D in canonical form as two binary strings N and R , one for normal bits and one for redundant bits
- gives as **output** the two binary strings N and R representing D

Write the **function RB-toRadix10** that:

- takes two binary strings N and R representing an RB number as **input**
- computes the radix-10 associated value X
- gives as **output** either X or an error message if an overflow occurs (*with respect to the representation range corresponding to the number of bit considered*)

Write the **function RB-Sum** that:

- takes two RB numbers **A** and **B** as **input**
- computes the sum S applying the RB table
- gives as output S in RB representation

Write a script calling the functions above to compute the sum among a pairs of numbers randomly chosen in the range $[0, M-1]$, where M is the dynamic range for the RNS representation with respect to a given n and module set $\langle m_1=2^n - 1 ; m_2=2^n ; m_3= 2^{n+1} \rangle$.

The script shows: i) The two random values X_1 and X_2 , ii) the RNS representation of X_1 and X_2 and of the sum $S=X_1+X_2$, iii) the strings obtained with the two steps of the RB sum for the three digits of the RNS representation.

Exercise 2

Compute the **time** and **area speedup** with respect to a standard binary execution using a ripple-carry adder, when computing the sum among the K pairs of numbers randomly chosen in the range $[0, M-1]$, (where M is the dynamic range for the RNS representation with respect to a given n and module set $\langle m_1=2^n - 1 ; m_2=2^n ; m_3= 2^{n+1} \rangle$) in the following cases:

- Pipelined addition using an array adder for binary values
- RNS values with digits represented in binary and sum executed through ripple-carry adders for the single digits

- RNS values with digits represented in RB and sum executed through application of the RB table, taking into account that the application of the table corresponds to the circuit in the picture.

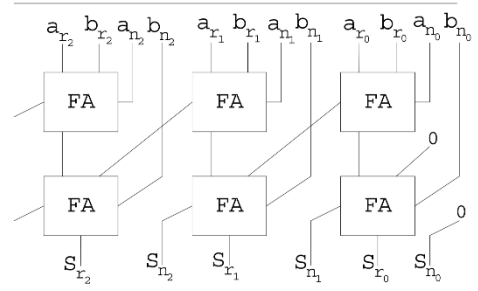


Figura 16: Addizionatore per numeri in binario ridondante

Show the results in two graphs: a first graph where n takes values 3, 4 and 5, and a second graph where K takes values 100, 500, 1000 (or more).

Remark This exercise requires only the computation of values, not the simulation of execution of the operations.