Summary of Signed Numbers Arithmetic – any base

Note: This assumes that NO OVERFLOW for the operation

- **R's Complement Arithmetic**
  - If the operation to be performed is addition compute Z = X + Y, otherwise if it is subtraction, Z = X – Y, compute Z = X + Y' instead.
  - If the result has no end carry, the obtained value is the correct answer.
  - If the result has an end carry, discard it and the value in the remaining digits is the correct answer.

- **(R-1)'s Complement Arithmetic**
  - If the operation to be performed is addition compute Z = X + Y, otherwise if it is subtraction, Z = X – Y, compute Z = X + Y' instead.
  - If the result has no end carry, the obtained value is the correct answer.
  - If the result has an end carry, this end carry should be added to the **least significant digit** (ulp) to obtain the final correct answer.

Summary of Overflow Rules When Computing Z = X + Y

Basic Rule 1: Overflow occurs when the answer Z CANNOT be represented given the specified number system (r, n, signed/unsigned)

Note: a subtraction operation is changed to an addition using the complement system!

Unsigned numbers of n digits – How to tell?

Basic Rule 2: Overflow **occurs if** answer requires n+1 digits

signed numbers of n digits – How to tell?

Basic Rule 3: Overflow **may** occur if X & Y have the same sign

r = 2 (2's complement)

c_n and c_{n-1} are DIFFERENT – i.e. the sign of answer is DIFFERENT than sign of the two numbers

r > 2 ?

$$\begin{array}{cccccc} C_n & C_{n-1} & C_{n-2} & \dots & C_1 & C_0 \\ & X_{n-1} & X_{n-2} & \dots & X_1 & X_0 \\ & Y_{n-1} & Y_{n-2} & \dots & Y_1 & Y_0 \\ \hline & Z_{n-1} & Z_{n-2} & \dots & Z_1 & Z_0 \end{array}$$