The University of British Columbia
The Faculty of Sciences
DATA 101
Assignment 3 Practice

1. Write out the binary representation of the following decimal numbers:

   (a) 1.0

   1.0_2

   (b) 1.5

   1.1_2

   (c) 7.0

   111_2

   (d) 0.625

   $.101_2$

   (e) 1/9

   $.000111000111000..._2$

2. Write out the decimal representation of the following binary numbers:

   (a) 1111_2

   15

   (b) 1010_2

   10

   (c) 1010.0101_2

   10.3125

   (d) $1.010101...(\text{repeated})_2$

   $4/3 = 1.3333...$

3. Assume 4 binary digit accuracy for the following computations.

   (a) Write out the binary representation for the approximate value of 6/7.

   $.1101_2$

   (b) Write out the binary representation for the approximate value of 1/7.

   $.001001_2$. *The first two digits here are not part of 4 digit expression.*

   (c) Add the two binary representations obtained above, and convert back to the decimal representation.

   $.1111_2$. *Note that we can only retain the first 4 digits of the result. In decimal notation, this is .9375. There is considerable error in this answer.*

   (d) Compare with the result that would be obtained if you add the binary representations of 6 and 1, followed by division by the binary representation of 7.

   $6 + 1 = 110.0_2 + 1.000_2 = 111.0_2$ *and* $7 = 111.0_2$, *so dividing* $6 + 1$ *in 4 digit binary by 7 in 4 digit binary is* 1.000_2, *which is correct.*

4. Calculate the following quantities using R, and then using algebra:

$$(101^6 + 97^6)(101^6 - 97^6) - (101^{12} - 97^{12})$$

$$(101^7 + 97^7)(101^7 - 97^7) - (101^{14} - 97^{14})$$

Briefly explain your results.

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(101^6 + 97^6)*(101^6 - 97^6) - (101^12 - 97^12)

## [1] 0

 (101^7 + 97^7)*(101^7 - 97^7) - (101^14 - 97^14)

## [1] 1.099512e+12
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In both cases, the mathematical result should be 0. In the second case, we see a big error, because a very large number is being subtracted from another very large number; there are not enough digits in the floating-point representations of these numbers. At least 28 places are needed, instead of the usual 16, leading to an error that contains 12 digits. In the first case, we are just lucky that number has an exact representation.