To compute the standard deviation for the distribution of the number of hashes needed, you need to use the standard deviation formula. I believe both population or sample standard deviation can be used.

I will explain based on population standard deviation.

Definition:

Standard deviation is a measure of how spread out numbers are. It is computed as the square root of the variance, that is,

Variance is the average of the square differences from the mean.

Mean is the simple average of a set of numbers.

For example, I have 10 numbers; 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10.

The mean is the average of these 10 numbers, which is obtained as (1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10) / 10 = 5.5.

The variance is then equals

= 8.25

In the puzzle problem, the average number of hashes needed is the mean (average) of the number of hashes needed.

Now we look at the assignment problem.

For puzzle A, we have one sub-puzzle with k = 6 bits.

With 6 bits, the worst expected hashes needed = where *m* is the number of sub-puzzle.

Hence we have,

Worst expected hashes = hashes.

For 64 hashes, what is the average number of hashes (mean)?

Average number of hashes = ; where . This is based on the definition of mean described above; that is,

We can calculate the average number of hashes using this formula:

Average number of hashes = hashes.

This should be the answer for part (ii) of 1.c.

Now look at how to compute standard deviation, that is the requirement for part (iii) of 1.c.

and

Variance is the average of the square differences from the mean.

Hence,

Square difference from mean = , that is, the square of the difference of the number from the mean. We have computed the mean to be 32.5, and we have 64 difference values (number of hashes), thus we need to find the average of these 64 different terms.

You can use a statistic calculator with variance function to compute it, otherwise, you need to do the long way of finding the difference of each value from the mean, square the result and add them all before divide the overall value by 64.

I used a MS Excel to calculate ☺, we the variance is:

Variance = 341.25.

The standard deviation is then the square of the variance; that is,

Standard deviation =

This should be the answer to part (iii) of 1c.

For puzzle with multiple sub-puzzles, the calculation should be similar. You just need to multiply each working with the number of sub-puzzles. For example, for Puzzle B, there are two sub-puzzle with k = 5.

First we need to compute the worst expected hash per sub-puzzle, that is, individual sub-puzzle =

Average number of hashes per sub-puzzle =

Since there are two sub-puzzle in the Puzzle B, hence the average number of hashes for puzzle B = 16.5 x 2 = 33.

This should be the answer to part (ii) of question 1.c(ii).

As for the standard deviation, it can be calculated as follows:

Since there are two sub-puzzle, the total variance = 170.5 x 2 = 341.

Hence the standard deviation =

I believe you should be able to do Puzzle C by now ☺

Okay now for your question related to the standard deviation from the lecture slide (SIM-2013-S3-CSCI262-S4b\_p6, slide 12), the standard deviation 2.2404 is obtained as follows:

Four puzzle, with k = 2 each.

Hence the worst expected hash per sub-puzzle =

Average number of hashes =

Since there are four sub-puzzles, hence the average number of hashes (expected hashes) = 2.5 x 4 = 10.

The variance =

Since there are 4 sub-puzzle, the total variance = 5

Hence the standard deviation =