

Individual Research - Time to compute square root of 2 to roughly 1 million significant digits

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Activity Kind

Individual Research

Purpose

The purpose of this activity is to learn how to gather performance data, identify a pattern, and leverage that information in order to answer questions.

Pre-requisite

Students are expected to have participated in the

- Individual Research - Rate of convergence to a square root
- Individual Research - Measure execution time using `System.nanoTime()`

Tasking

Continue working with the `UNumber` library and the small program you used to compute square root using the `UNumber` library. As you do the following, take notes in your ENB about what you did and any surprising results.

Start with a blank Excel spreadsheet and place the following values in Row 1, starting in Column B: 1000, 2000, 4000, 8000, 16000, with the last in Column F. Then, go to Column A, start in Row 2 and working down placing values into the cell to label the iteration number. Start with 1 and proceed down to 15.

To fill in the body of the table you have just labeled, compute the square root of 2 with varying number of significant digits and capture the resulting information about the execution time required by each iteration in the table's body.

Start by computing the square root of 2 with 1000 digits of accuracy and place the information about the execution time in Column B under that title in Row 1. This should require roughly 11 iterations and it will happen quickly.

Do the same thing, but for 2000 digits of accuracy and place the results in Column C. This too will happen quickly, but it will take longer. Proceed with 4000, 8000, and finish with 16000 digits of significance. As you move from one column to the next, the execution time will increase, and the number of iterations will as well.

When the table has been filled in, compute the average execution time for each iteration for that number of significant digits and place this average in Row 20. In Row 21 Column C, place the equation `=C20/B20`. Select the cells from C21 to F21 and select the menu item Edit/Fill/Right. This reveals the relative ratio of the execution times as we double the number of significant digits. Does this ratio begin to stabilize at a value between 4 and 5? What does this mean?

In Row 23 compute the sum of all of the iterations, ignoring the first 5 iterations, for Columns B through F. Then in Row 24 perform the same relative ratio computation as you did in row 21. Do you see a similar stabilization? What does this mean?

Using the information that you have computed; can you estimate how long it would take to compute the square root of 2 to 1,024,000 significant digits? Explain your answer.

Save a copy of the console output and the Excel spreadsheet to your ENB as evidence of the work you have done.

Deliverable

Each individual is expected to provide evidence of these experiments in their ENB. If we do not see notes that make it clear that you did the work, we can only assume that you just copied the results from someone else.

Submission

Students are expected to **complete** this part of their ENB prior to midnight.