# Worksheet #1 (2017/09/11)

Name: ID:

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- We plan to cover Sec. 1.1.1 to 1.2.4 (inclusive) today.
- We will use Chapter 01 slides 1–12.
- This is corresponding to the textbook pages 1–10.

1) Scientific computing is often related to simulating nature phenomenons. The overall problem solving process can be divided into five different steps. What exactly do these five steps perform? Please elaborate.
   a) Model:
   b) Algorithm:
   c) Implementation:
   d) Execution:
   e) Presentation:

2) The surface area of the Earth can be approximated by the formula $A = 4\pi r^2$, where $r$ is the radius of a sphere. There are at least four sources of inaccuracy of the resulting Earth surface area, or say approximations. List and describe these sources.

3) What id the difference between precision and accuracy. Give examples for illustrations.

4) What is the difference between truncation errors and rounding errors? Please identify the major causes of them.

5) Demo: Rounding Error vs. Truncation Error

   This demo demonstrates the tradeoff between rounding error and truncation error when using finite-precision, floating-point arithmetic. The specific problem is computing the change in the surface area $A$ of the Earth if its radius $r = 6371$ km changes by a given amount $\Delta r$. Two different formulas are used, one from geometry, $\Delta A = 4\pi(r + \Delta r)^2 - 4\pi^2$, that is theoretically exact (assuming perfect real arithmetic), and the other a simple approximation derived from calculus, $\Delta A \approx 8\pi r \Delta r$, whose accuracy depends on the amount by which the radius changes. For a relatively small change, the exact formula suffers substantial rounding error, whereas the approximate formula is very accurate. For a relatively large change, on the other hand, the exact formula does not suffer significant rounding error, whereas the approximate formula becomes very inaccurate.

   The user first selects the precision to be used in the calculation, from one to sixteen decimal digits, and then selects an amount by which the Earth's radius is changed by dragging or clicking on the vertical scale. The number of correct digits in the results produced by the two formulas is indicated by the red (exact) and blue (approximate) bars.