

Instructor Introduces:

Goals

Objectives

Activities

Products

Computational Thinking and Intuition Development

Background

Students read and discuss in groups of 2-3.
Stimulate discussion about their understanding of
computer errors.

Types of Computer Errors (six types)

Each student reads about one type and
describes to the rest of the group.

Error Accumulation in Series Summation

Short lecture by the instructor

Exercise 1: Error Accumulation in Series Summation

Exercise 2: Error Accumulation in Series Summation

Computer Numbers and their Precision II Errors and Uncertainties in Calculations

Exercise: Round Off Error

Go to your calculator or computer and calculate $2 \times \frac{1}{3} - \frac{2}{3}$. Explain why the answer is not zero.

Exercise Error Accumulation in Sine Series

In the listing below we give the Python code Sine.py that computes a power series to evaluate $\sin(x)$. You can modify it to work this exercise. Note that rather than compute a factorial for each term in the series in Equation (2) or (7), we instead use the simple relation between successive terms in the series to use previous term in the series to compute the next one.

1. Write a program or use Excel or Vensim that calculates the series in Equation (2).
2. Evaluate the series for the maximum number of terms $N = 5, 10, 12, 15, 17, 20$.
3. For each value of N , evaluate the series for $x = \frac{\pi}{2}, \pi, \frac{5\pi}{2}$.
4. In each calculation, compare your computed value with the exact value (the one built into the program) and compute the relative error:

$$\frac{|\text{series} - \sin(x)|}{|\sin(x)|}$$

5. For each value of x , make a plot of the relative error versus the number of terms N . You should obtain a plot like Figure 1.

```
# Sine.py      power series for sin(x)
from numpy import *

x = math.pi/2.          # initialization
N = 10
term = x
sum = 0.0
for i in range(2, (N + 1)/2):
    sum = sum + term
    term = -term*x*x/(2*i-1.)/(2*i-2.)
print('N,sum = ', N,sum)
print("Enter and return a character to finish")
s = raw_input()
```