

Computing for Math and Stats

Lecture 11.

Computing with Loops

- Loops are used to do repetitive things
- Some of them involve doing the same thing on many different elements of an array
 - Often these can be done with Matlab's array operations, but sometimes we have to do them the hard way with loops.
- Some problems involve repetitive computations
 - Sums of sequences (series)
 - Successive approximations
 - Operations where we compute the element of an array using the result of the computation of the previous element

Series

- One of the most common is Taylor Series
- Used to compute functions like exponential, sine, cosine, etc
 - Taylor series is the starting point. Many numerical optimizations are applied and the end result does not resemble Taylor series.
- It is one of the most useful examples for programming courses.

Exponential

$$e^x = \sum_{i=0}^N \frac{x^i}{i!} = \sum_{i=0}^N S_i$$

$$S_i = \frac{x^i}{i!} = \frac{x^{i-1} x}{i(i-1)!} = S_{i-1} \frac{x}{i}$$

See myexp.m

Exponential

- Easy to write the program
- Could be made more efficient
 - Especially if written in a compiled language
- We can improve it since
 - There is no need to compute factorial at every step
 - There is no need to raise x to the i -th power in every step
- See `myexp1.m`

Exponential

- Then there is the issue of convergence
- We do not examine here the theoretical aspects of convergence
- In theory we should have infinite summation
 - In practice we cannot
- There is no point adding more terms when the addition is lost in the round-off error
- After that we stop.
- See myexp2.m

The break command

- This command gets us out of a loop (the innermost)
- Normally executed within an if statement
- Can be used to get us out of a script or function file as well.
- Has to be used with care
- There is also the “continue” command that takes us to the next iteration directly.
- See myexp2.m

The while loop

- A more flexible form of the for loop is the while loop.
- Checks if a condition is true and as long as it is, it keeps going
- No need to have a loop variable (but we usually have)
- Can iterate as many times as needed.
 - This opens the possibility of infinite loops
- See myexp3.m