CS368 MATLAB Programming

Lecture 8

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Based on lecture slides by Michael O’Neill and Beck Hasti

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Loops are used when the same task is repeated for a large number of times.

If these tasks can be done simultaneously in parallel, vectorization is preferred in MATLAB: define the repeating task as a function, and apply the function to a vector or matrix.

If these tasks must be done sequentially, then a for loop could be used.

If these tasks are done for an unknown number of times until some condition is met, then a while loop could be used. More details in the next lecture.
For Loop over Indices

Code

- \textit{for } t = 1:n \ldots f(t) \ldots \textit{end} repeats the function \( f \) for \( n \) times.
- \( t \) is the counter or index variable.
- In MATLAB, since \( i \) is the complex number \( \sqrt{-1} \), using \( i \) as the index variable is not recommended.
- In MATLAB, for loop is count controlled, meaning changing the counter variable inside the loop has no impact on the number of times the loop is repeated.
For Loop over Values

Code

- `for t = v ... f(t) ... end` repeats the function `s` for `length(v)` times, one for each value in `v`.
- `v = 1:n` is the special case in which the set is the index set.
For Loop Example, Factorial

Code

- To compute the factorial of \( n \geq 0 \):
  
  1. \( f = 1; \) % defines the variable to store the product.
  2. \( \text{for } t = 1:n \) % starts the for loop for \( n \) times.
  3. \( f = f \times t; \) % multiplies the current value to the product.
  4. \( \text{end} \) % ends the for loop.
To compute the sum of the values in a vector $v$:

1. $s = 0$; % defines the variable to store the sum.
2. $for \ t = v$ % starts the for loop over the vector.
3. $s = s + t$; % adds the current value to the sum.
4. $end$ % ends the for loop.
Continue and Break
Code

- It is possible to stop a for loop without finishing all iterations.
- `continue` skips the remaining code of the current iteration.
- `break` skips the remaining code of the current iteration and all remaining iterations.
- Avoid using `continue` and `break` and use `if` and `while` instead. More details next lecture.
For Loop Quiz Questions

Quiz
**Contraction Mapping**

**Math**

- A function $f$ is a contraction map if $|f(x) - f(y)| < k|x - y|$ for some $k \in [0, 1)$, and for all $x$ and $y$.

- Every contraction mapping has a unique fixed point $x^*$ such that $f(x^*) = x^*$. 
Fixed Point Iterations
Math

- The fixed point $x^*$ could be found by fixed point iterations.

1. Start with any $x_0$.
2. Compute $x_{n+1} = f(x_n)$, for $n = 0, 1, 2, ...$
3. The sequence $x_0, x_1, x_2, ...$ converges to $x^*$.

- Newton’s method to solve non-linear system of equations is an example of a fixed point algorithm. More details in a later lecture.
A vector can be constructed using a for loop.

1. \( v = \text{zeros}(n) \) \% initializes an empty vector.
2. \textit{for} \( t = 1:n \) \% starts the loop.
3. \( v(t) = \ldots \) \% fills in the vector.
4. \textit{end} \% ends the loop.
Loop over a Matrix

Code

- A matrix can be constructed using a nested for loop.

1. \( w = \text{zeros}(n, m) \) \% initializes an empty matrix.
2. \texttt{for } s = 1:n \% starts the outer loop.
3. \texttt{for } t = 1:m \% starts the inner loop.
4. \( w(s, t) = \ldots \) \% fills in the matrix.
5. \texttt{end} \% ends the inner loop.
6. \texttt{end} \% ends the outer loop.
Nested Loop Quiz Questions

Quiz
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