CS368 MATLAB Programming

Lecture 8

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

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Vectorization

Math

- 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

- *for t = 1:n* ...$f(t)$... *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 $n \geqslant 0$:

1. *f = 1;* % defines the variable to store the product.
2. *for t = 1:n* % starts the for loop for n times.
3. *f = f * t;* % multiplies the current value to the product.
4. *end* % ends the for loop.

For Loop Example, Sum

Code

- 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 $x^\star$ such that $f(x^\star) = x^\star$.

Fixed Point Iterations

Math

- The fixed point $x^{\star}$ 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 $x^{\star}$.

- Newton's method to solve non-linear system of equations is an example of a fixed point algorithm. More details in a later lecture.

Loop over a Vector

Code

- A vector can be constructed using a for loop.

1. *v = zeros(n)* % initializes an empty vector.
2. *for t = 1:n* % starts the loop.
3. *v(t) = ...* % fills in the vector.
4. *end* % ends the loop.

Loop over a Matrix

Code

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

1. *w = zeros(n, m)* % initializes an empty matrix.
2. *for s = 1:n* % starts the outer loop.
3. *for t = 1:m* % starts the inner loop.
4. *w(s, t) = ...* % fills in the matrix.
5. *end* % ends the inner loop.
6. *end* % ends the outer loop.

Nested Loop Quiz Questions

Quiz

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