CS368 MATLAB Programming

Lecture 8

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

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Coordination Game

Quiz
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

- \textit{for} \ t = v \ \textit{...f}(t)\ \textit{... end} repeats the function \textit{s} for \textit{length}(v) times, one for each value in \textit{v}.
- \textit{v} = \textit{1:n} is the special case in which the set is the index set.
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

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, Sum of Series

Quiz
For Loop, Continued Fraction Quiz
For Loop, Pie
Quiz
For Loop, Fixed Point 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 $f(x^*) = x^*$. 
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.
Loop over a Vector

Code

- A vector can be constructed using a for loop.

1. \( v = \text{zeros}(n) \) \% initializes an empty vector.
2. \( \text{for } t = 1:n \) \% starts the loop.
3. \( v(t) = \ldots \) \% fills in the vector.
4. \( \text{end} \) \% ends the loop.
A matrix can be constructed using a nested for loop.

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

Quiz
Nested Loop, Path Count

Quiz
Nested Loop, Integral Image
Quiz