L4. Iteration with for-loops

The idea of Repetition
The for-loop construct

Motivating Problem:
Computing Square Roots

Given a positive number $A$, find its square root.

A Geometric Restatement

Given a positive number $A$, find a square whose area is $A$.

An Initial Guess

$W = 1$

$L = A$

How can we make this rectangle "more square"?

Observation

The answer is in between $L$ and $W$: $W < s < L$

Idea:

$L1 = (L+W)/2$

$W1 = A/L1$

$L1$

$W1$
Repeat:

\[ L_1 = (L_0 + W_0)/2 \quad W_2 = A/L_2 \]

A Script

\[
\begin{align*}
A &= \text{input}('A:\'); \\
L_0 &= A; \quad W_0 = A/L_0; \\
L_1 &= (L_0 + W_0)/2; \quad W_1 = A/L_1; \\
L_2 &= (L_1 + W_1)/2; \quad W_2 = A/L_2; \\
L_3 &= (L_2 + W_2)/2; \quad W_3 = A/L_3; \\
L_4 &= (L_3 + W_3)/2; \quad W_4 = A/L_4;
\end{align*}
\]

A Modified Script

\[
\begin{align*}
A &= \text{input}('A:\'); \\
L &= A; \quad W = A/L; \\
L &= (L + W)/2; \quad W = A/L; \\
L &= (L + W)/2; \quad W = A/L; \\
L &= (L + W)/2; \quad W = A/L; \\
L &= (L + W)/2; \quad W = A/L;
\end{align*}
\]

Handling the Repetition

\[
\begin{align*}
A &= \text{input}('A:\'); \\
L &= A; \quad W = A/L; \\
\text{for } k=1:4 \\
&\quad L = (L + W)/2; \quad W = A/L; \\
\text{end}
\end{align*}
\]

More General

\[
\begin{align*}
A &= \text{input}('A:\'); \\
nSteps &= \text{input}('nSteps:\'); \\
L &= A; \quad W = A/L; \\
\text{for } k=1:nSteps \\
&\quad L = (L + W)/2; \quad W = A/L; \\
\text{end}
\end{align*}
\]

To repeat something N times:

\[
\begin{align*}
N &= _____ \\
\text{for } i = 1:N \\
&\quad \text{Put the something here} \\
\text{end}
\end{align*}
\]
To repeat something $N$ times:

\[ N = \underline{\hspace{2cm}} \]

\[ \text{for } i = 1:N \]

\[ \underline{\text{Put the something here}} \]

\[ \text{end} \]

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**Another Example**

\[ \text{for } k = 1:10 \]

\[ x = \underline{\text{rand}}; \]

\[ \text{fprintf(‘%10.6f\n’,x)} \]

\[ \text{end} \]

Displays 10 random numbers.

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**Built-In Function rand**

The statement

\[ x = \text{rand} \]

assigns a "random" number between 0 and 1 to the variable $x$.

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**Another Example**

\[ \text{for } k = 1:10 \]

\[ x = \underline{\text{rand}}; \]

\[ \text{fprintf(‘%10.6f\n’,x)} \]

\[ \text{end} \]

Displays 10 random numbers.

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**E.g.,**

0.579736
0.609194
0.256451
0.246079
0.149936
0.564178
0.027311
0.790830
0.437630
0.997130
Simulation Using `rand`

Question:

A stick with unit length is split into two parts.

The breakpoint is randomly selected.

On average, how long is the shorter piece?

```matlab
s = 0;
for k=1:1000
    % Break the k-th stick
    x = rand;
    if x<=.5
        % Shorter part has length x
        s = s+x;
    else
        % Shorter part has length 1-x
        s = s+(1-x);
    end
end
ave = s/1000
```