Basic Mathematical Operations on Arrays

A picture as an matrix

1458-by-2084

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A color picture is made up of RGB matrices

\[ M(i,j) = 0.3R(i,j) + 0.59G(i,j) + 0.11B(i,j) \]

For each row index \( i \)
For each column index \( j \)

Scalar operation

Vectorized Operation
(no loop required!)

<table>
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<tr>
<th>3R + 0.59G + 0.11B</th>
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\[ M = 0.3R + 0.59G + 0.11B \]

Vectorized addition

\[
\begin{align*}
x & = \begin{bmatrix} 2 & 1 & 0.5 & 8 \end{bmatrix} \\
y & = \begin{bmatrix} 1 & 2 & 0 & 1 \end{bmatrix} \\
\end{align*}
\]

\[
\begin{align*}
z & = x + y \\
& = \begin{bmatrix} 3 & 3 & 0.5 & 9 \end{bmatrix}
\end{align*}
\]

Matlab code:
\[ z = x + y \]

means \( z(k) = x(k) + y(k) \) for all \( k \)
Vectorized element-by-element arithmetic operations on arrays

\[
\begin{array}{ccc}
\text{Vectorize +} & \rightarrow & \text{Vectorize +} \\
\text{Vectorize -} & \rightarrow & \text{Vectorize -} \\
\text{Vectorize *} & \rightarrow & \text{Vectorize *} \\
\text{Vectorize /} & \rightarrow & \text{Vectorize /} \\
\text{Vectorize ^} & \rightarrow & \text{Vectorize ^} \\
\end{array}
\]

A dot (.) is necessary in front of these math operators.

Vectorized code— a Matlab-specific feature

- Code that perform element-by-element arithmetic/relational/logical operations on vector (or array) operands in one step
  
  - Scalar operation: \( x + y \)  
  where \( x, y \) are scalar variables
  
  - Vectorized code: \( x + y \)  
  where \( x, y \) are vectors of same shape and length

Vectorized element-by-element arithmetic operations between an array and a scalar

\[
\begin{array}{ccc}
\text{Vectorize +} & \rightarrow & \text{Vectorize +} \\
\text{Vectorize -} & \rightarrow & \text{Vectorize -} \\
\text{Vectorize *} & \rightarrow & \text{Vectorize *} \\
\text{Vectorize /} & \rightarrow & \text{Vectorize /} \\
\text{Vectorize ^} & \rightarrow & \text{Vectorize ^} \\
\end{array}
\]

A dot (.) is necessary in front of these math operators.

The dot in \( +, -, * \) not necessary but OK.