CS368 MATLAB Programming

Lecture 2

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Game

Admin

Scalar Operations, Binary

Code

- $x + y$ is $x + y$.
- $x - y$ is $x - y$.
- $x * y$ is xy.
- x / y and $y \setminus x$ are $\frac{x}{y}$.
- $x \hat{} y$ is x^y.

Scalar Operations, Unary

Code

- *sqrt(x)* is $\sqrt{x}$.
- *exp(x)* is e^x .
- *log(x)* is natural log or $\ln(x)$, *log10(x)* is $\log_{10}(x)$.
- *sin(x)* with x in radians, *sind(x)* with x in degrees, *asin(y)* is $\arcsin(y)$ in radians, *asind(x)* is $\arcsin(y)$ in degrees.
- *cos(x)*, *cosd(x)*, *acos(y)*, *acosd(y)*.
- *tan(x)*, *tand(x)*, *atan(y)*, *atand(y)*.

Scalar Operations, Unary Integer

Code

- *round(x)* is rounding x to nearest integer.
- *floor (x)* is $\lfloor x \rfloor$, largest integer $\leqslant x$.
- *ceil (x)* is $\lceil x \rceil$, smallest integer $\geqslant x$.
- *mod(x, y)* is $x \,(\mod y)$, the remainder when x is divided by y, integer division.

Scalar Operations, Rounding

Quiz

Scalar Math Operations, Infinity

Quiz

Scalar Operations, Precision

Quiz

Scalar Operations, Numerical Instability

Quiz

Scalar Math Operations, Numerical Instability Again

Quiz

Numerical Instability

Code

- The number of decimal places that is displayed can be changed.
- The number of decimal places that can be stored is fixed.

1. $\pi, e, \sqrt{2}$ etc are approximate values (accurate up to 16 decimal places).
2. Underflow may occur: numbers that are too close to 0 are stored as **0** .
3. Overflow may occur: numbers that are too large are stored as **Inf** .

Vector Multiplication

Math

- $\begin{bmatrix} a \\ b \end{bmatrix} \odot \begin{bmatrix} c \\ d \end{bmatrix} = \begin{bmatrix} ac \\ bd \end{bmatrix}$ is the element-wise product.
- $\begin{bmatrix} a \\ b \end{bmatrix} \cdot \begin{bmatrix} c \\ d \end{bmatrix} = \begin{bmatrix} a & b \end{bmatrix} \begin{bmatrix} c \\ d \end{bmatrix} = ac + bd$ is the inner product, also called the dot product for matrices.
- $\begin{bmatrix} a \\ b \end{bmatrix} \otimes \begin{bmatrix} c \\ d \end{bmatrix} = \begin{bmatrix} a \\ b \end{bmatrix} \begin{bmatrix} c & d \end{bmatrix} = \begin{bmatrix} ac & ad \\ bc & bd \end{bmatrix}$ is the outer product.

Vector Multiplication

Code

- Suppose M and W are two row vectors having the same size.
- *M .∗ W* is the element-wise product $M \odot W$.
- *M ∗ W'* and *dot(M, W)* are the inner product $M \cdot W = MW^T$.
- *M' ∗ W* is the outer product $M \otimes W = M^T W$.

General Vector Operations

Code

- Suppose M and W are two row vectors having the same size, and c is a scalar.
- $M + W$ and $M - W$ are element-wise and also vector addition and subtraction.
- $M .\hat{} W$ and $M .\hat{} c$ are element-wise exponentiation.

General Vector Operations, Unary

Code

- Most of the built-in unary operations are element-wise when applied to vectors.
- For example, the square root function can be applied element-wise to vectors directly.

1. *sqrt ([a b c])* is $\begin{bmatrix}\sqrt{a} & \sqrt{b} & \sqrt{c}\end{bmatrix}$.
2. *[a b c] .^ 0.5* is also $\begin{bmatrix}\sqrt{a} & \sqrt{b} & \sqrt{c}\end{bmatrix}$.
3. *[a b c] ^ 0.5* results in an error.

Vector Operations, Multiplication

Quiz

Vector Operations, Exponentiation

Quiz

Vector Operations, Trig Operations

Quiz

Matrix Multiplication

Math

- $\begin{bmatrix} a & b \\ c & d \end{bmatrix} \odot \begin{bmatrix} e & f \\ g & h \end{bmatrix} = \begin{bmatrix} ae & bf \\ cg & dh \end{bmatrix}$ is the element-wise product.
- $\begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} e \\ f \end{bmatrix} = \begin{bmatrix} ae + bf \\ ce + df \end{bmatrix}$ and
  $\begin{bmatrix} e & f \end{bmatrix} \begin{bmatrix} a & b \\ c & d \end{bmatrix} = \begin{bmatrix} ea + fc & eb + fd \end{bmatrix}$ are matrix products.
- $\begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} e & f \\ g & h \end{bmatrix} = \begin{bmatrix} ae + bg & af + bh \\ ce + dg & cf + dh \end{bmatrix}$ is also the matrix product.

Matrix Multiplication

Code

- Suppose M and W are two matrices.
- M .* W, when M and W have the same size, is the element-wise product $M \odot W$.
- $M * W$, when number of columns of M is the same as the number of rows of W, is the matrix product MW.

General Matrix Operations, Binary

Code

- Suppose M and W are two matrices, and c is a scalar.
- $M + W$ and $M - W$ are element-wise and also matrix addition and subtraction.
- $M .* W$ is element-wise, and $M * W$ is matrix multiplication.
- $M ./ W$ and $W .\backslash M$ are element-wise, and M / W and $W \backslash M$ find the matrix X such that $MX = W$, the solution of systems of linear equations. More details in a later lecture.
- $M .\hat{} W$ and $M .\hat{} c$ are element-wise, and $M \hat{} c$ is matrix exponentiation.

General Matrix Operations, Unary

Code

- Most of the built-in unary operations are element-wise when applied to matrices.
- For example, the square root function can be applied element-wise to matrices directly.

1. *sqrt ([a b; c d])* is $\begin{bmatrix} \sqrt{a} & \sqrt{b} \\ \sqrt{c} & \sqrt{d} \end{bmatrix}$.
2. *[a b; c d] .^ 0.5* is also $\begin{bmatrix} \sqrt{a} & \sqrt{b} \\ \sqrt{c} & \sqrt{d} \end{bmatrix}$.
3. *[a b; c d] ^ 0.5* is the actual square root of the matrix, it finds a matrix $\begin{bmatrix} e & f \\ g & h \end{bmatrix}$ such that $\begin{bmatrix} e & f \\ g & h \end{bmatrix} \begin{bmatrix} e & f \\ g & h \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$.

Matrix Operations, Multiplication

Quiz

Matrix Operations, Multiplication Again

Quiz

Matrix Operations, Division

Quiz

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