Scalars & Arrays & Outputs

Expected Skills.
Students can...

- *explain the difference between scalars and arrays of numbers in MatLab.*

- *perform operations with scalars and arrays in MatLab.*

- *generate effective MatLab plots and format outputs.*

Discussion Questions

(a) What is the difference between a scalar and an array?

(b) How does addition/subtraction/multiplication/division work for scalars and arrays?

(c) How can we use arrays in MatLab?

(d) What are some best practices to format your outputs and style your plots in MatLab?

Scalar & Array Operations

MATLAB stands for matrix laboratory. It's very useful to know how to manipulate matrices in MATLAB. Create four random matrices A, B, C, and D, such that A is 2-by-3, B is 3-by-3, C is 3-by-2, and D is 3-by-3. (Random matrices of size m-by-n can be created in MATLAB with rand(m,n).) Perform the following operations on these matrices using MATLAB. If the operation cannot be done, explain (mathematically) why not.

(a) $2A + C^\intercal$

(b) $C - 3B$

(c) $3B - 2D$

(d) AD

(e) CA

(f) AC

(g) BD

(h) DB

(i) BC

(j) CB

(k) AB

(l) $2D^\intercal + B$

(m) $\det(D)$

(n) $\det(A)$

(o) $C^\intercal D$

(p) $BA^\intercal$

(q) $-2A^\intercal + 5C$

(r) $B^\intercal + D$

(s) $\frac{1}{2}(B + B^\intercal)$

(t) $\frac{1}{2}(B - B^\intercal)$

(u) $AA^\intercal$

(v) $A^\intercal A$

(w) $\det(AA^\intercal)$

(x) $\det(A^\intercal A)$

(y) $B(AD)^\intercal$

(z) $ADB^\intercal$

Approximating π

Discovered by Madhava of Sangamagrama in the 14th century and again in 1668 by James Gregory, the series expansion

$$\arctan(x) = \sum_{j=0}^{\infty} \frac{(-1)^j x^{2j+1}}{2j+1},$$

proved to be a large breakthrough in computing π.

(a) Obtain a series expansion for π with $x = 1$.

(b) Write a MATLAB program to approximate π using your previous series expansion.

    (i) Compute the approximation using $N = 11, 101, 1001, 10001, 100001$ terms and report your results.

    (ii) Compute the error in the approximation using the built-in constant for π.

    (iii) Plot the absolute error as a function of N. Consider using a long scale on both the x and y-axis of your plot.

It may be helpful to use these MatLab commands:

`pi, for, while, sum, loglog, format`

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