MATLAB

Applications: Statistics

CS101 Lecture #24

2017-01-04

Administrivia

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- Homework #12 is due Friday, Jan. 13.
- No lab *next* week.
- Final examination will be held Jan. 20, Friday 8am-11am in A-0414.

Statistics

Random numbers

- MATLAB supports many varieties of RNG:
  - `rand`, uniform distribution $[0, 1)$
  - `randn`, normal distribution
  - `randi`, random integers $[0, n)$

rand

```
rand(5);        % generate 5x5 matrix
rand(5,1);      % generate 5x1 row vector
10 * rand(3); % 3x3 matrix from [0,10)
```

randi

```
randi(5);        % generate number from [0,5]
randi(5,2);      % generate 2x2 matrix
randi([-5,5],10,1); % from [-5,5] in 10x1
```

randn

```
randn();        % single normal number
randn(5);       % generate 5x5 matrix
randn(5,2);     % generate 5x2 matrix
```

Example: Seed

```
randn( 'seed',1 );
x = linspace( 0,2*pi,101 )';
y = sin( x/50 ) ./ x + .002 * randn( 101,1 );
% Right-array division (./)
clf  %Clear current figure window
plot( x,y,'.' );
```

Statistical quantities

- Many operations are available:
  - `mean` (average), `median`, `std`
  - `max`, `min`, `range`
  - `iqr` (interquartile range), `corrcoef` (the correlation coefficient of two random variables is a measure of their linear dependence) (not yet supported in Octave)
  - `sort`
  - `boxplot`, `hist`

Statistical quantities

- Many operations are available:
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  - `boxplot`, `hist`

```
x = randn( 6,1 );
y = randn( 6,1 );
A = [x y 2*y+3 ];
R = iqr ( A )
```

Equation solving

Systems of equations

- A classical linear algebra problem:

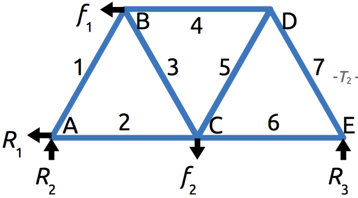
$$\underline{\underline{A}}\underline{x} = \underline{b}$$

$$\begin{pmatrix} 2 & 3 \\ 3 & 2 \end{pmatrix} \underline{x} = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$$

```
A = [ 2 3 ; 3 2 ]
b = [ 1 0 ]';
x = A \ b;  % easy solution!
```

- This is called 'left division'.

- Consider a truss problem solved by the method of joints.



$$0.5\ T_1 + T_2 = R_1 = f_1$$
$$0.866\ T_1 = -R_2 = -0.433\ f_1 - 0.5\ f_1$$
$$-0.5\ T_1 + 0.5\ T_3 + T_4 = -f_1$$
$$0.866\ T_1 + 0.866\ T_3 = 0$$
$$-T_2 - 0.5\ T_3 + 0.5\ T_5 + T_6 = 0$$
$$0.866\ T_3 + 0.866\ T_5 = f_2$$
$$-T_4 - 0.5\ T_5 + 0.5\ T_7 = 0$$

Systems of equations

$$\begin{pmatrix} 0.5 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0.866 & 0 & 0 & 0 & 0 & 0 & 0 \\ -0.5 & 0 & 0.5 & 0 & 0 & 0 & 0 \\ 0.866 & 0 & 0.866 & 0 & 0 & 0 & 0 \\ 0 & -1 & -0.5 & 0 & 0.5 & 1 & 0 \\ 0 & 0 & 0.866 & 0 & 0.866 & 0 & 0 \\ 0 & 0 & 0 & -1 & -0.5 & 0 & 0.5 \end{pmatrix} \underline{x} = \begin{pmatrix} 1000 \\ -1433 \\ -1000 \\ 0 \\ 0 \\ 2000 \\ 0 \end{pmatrix}$$

$$\underline{\underline{T}}\underline{x} = \underline{f}$$

Solution finding

- An effective way to solve equations is to set the left- and right-hand sides to equal each other.

$$\exp\left(-\sin^2 bx\right) = 2 - x^2$$

- OR, subtract so they go to zero:

$$\exp\left(-\sin^2 bx\right) - 2 + x^2 = 0$$

```
function [ rhs ] = lhs( x )
    b = 1.0;
    rhs = exp(-sin(b.*x).^2) - 2 + x.^2;
end
fplot( @lhs,[ -10 10 ] );
fzero( @lhs,0 );
```

Solution finding

- Polynomial `roots` are also easy to find:

$$2x^3 + 3x^2 - 4x - 5 = 0$$

```
roots( [ 2 3 -4 -5 ] )
```

Question

```
A = [ 5 4 1- 2 2 ];
B = [ 5 4 1 -2 2 ];
```

Are `A` and `B` equal in value?

A Yes
B No

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B No ⋆