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Math 313

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September 19, 2016

## MATLAB Tutorial 2

Exercise 2.1:

(a)  $2x_1 + x_2 + 5x_3 = -1$

$x_1 + 6x_3 = 2$

$-6x_1 + 2x_2 + 4x_3 = 3$

$$\begin{bmatrix} 2 & 1 & 5 & -1 \\ 1 & 0 & 6 & 2 \\ -6 & 2 & 4 & 3 \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 6 & 2 \\ 2 & 1 & 5 & -1 \\ -6 & 2 & 4 & 3 \end{bmatrix}$$

$$\sim \begin{bmatrix} 1 & 0 & 6 & -2 \\ 0 & 1 & -7 & -5 \\ 0 & 2 & 40 & 15 \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 6 & 2 \\ 0 & 1 & -7 & -5 \\ 0 & 0 & 54 & 25 \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 6 & 2 \\ 0 & 1 & -7 & -5 \\ 0 & 0 & 1 & 25/54 \end{bmatrix}$$

$$\sim \begin{bmatrix} 1 & 0 & 0 & 2 - \frac{6 \cdot 25}{54} \\ 0 & 1 & 0 & -5 + \frac{7 \cdot 25}{54} \\ 0 & 0 & 1 & 25/54 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & -0.7778 \\ 0 & 1 & 0 & -1.7592 \\ 0 & 0 & 1 & 0.4629 \end{bmatrix}$$

(b) `>> C = [2 1 5; 1 0 6; -6 2 4]`

C =

2 1 5

1 0 6

-6 2 4

`>> d = [-1; 2; 3]`

d =

-1

2

3

`>> x = C\d`

x =

-0.7778

-1.7593

0.4630

```
(c) >> C*x-d
```

```
ans =
```

```
1.0e-15 *
```

```
-0.4441
```

```
0
```

```
0
```

### Exercise 2.2

```
>> C = [-10 4; 15 -6]
```

```
C =
```

```
-10 4
```

```
15 -6
```

```
>> d = [0;0]
```

```
d =
```

```
0
```

```
0
```

```
>> x = C\d
```

Warning: Matrix is singular to working precision.

```
x =
```

```
NaN
```

```
NaN
```

Solve by hand:

$$-10x_1 + 4x_2 = 0$$

$$15x_1 - 6x_2 = 0$$

$$\rightarrow \begin{bmatrix} -10 & 4 & 0 \\ 15 & -6 & 0 \end{bmatrix} \sim \begin{bmatrix} 1 & -2/5 & 0 \\ 5 & -2 & 0 \end{bmatrix}$$

$$\sim \begin{bmatrix} 1 & -2/5 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\rightarrow x_1 = 2/5 x_2$$

1 free variable.

It didn't like the free variable?

## Exercise 2.3

```
(a) >> C = [1 -3 2; -2 6 -4; 4 -12 8]
```

```
C =
```

```
1 -3 2
```

```
-2 6 -4
```

```
4 -12 8
```

```
>> d = [0;0;0]
```

```
d =
```

```
0
```

```
0
```

```
0
```

```
>> rref([C d])
```

```
ans =
```

```
1 -3 2 0
```

```
0 0 0 0
```

```
0 0 0 0
```

Thus  $x_1 = 3x_2 + 2x_3$ . There are two free variables.

## Exercise 2.7

```
(a) L = [0 1/2 1/4 1 1/3; 1/3 0 1/4 0 0; 1/3 1/2 0 0 1/3; 1/3 0 1/4 0 1/3; 0 0 1/4 0 0]
```

```
L =
```

```
0 0.5000 0.2500 1.0000 0.3333
```

```
0.3333 0 0.2500 0 0
```

```
0.3333 0.5000 0 0 0.3333
```

```
0.3333 0 0.2500 0 0.3333
```

```
0 0 0.2500 0 0
```

```
(b) >> I = [1 0 0 0; 0 1 0 0; 0 0 1 0; 0 0 0 1; 0 0 0 0 1]
```

```
I =
```

```
1 0 0 0 0
0 1 0 0 0
0 0 1 0 0
0 0 0 1 0
0 0 0 0 1
```

```
>> d = [0;0;0;0;0]
```

```
d =
```

```
0
0
0
0
0
```

```
>> rref([L-I;d])
```

```
ans =
```

```
1.0000    0    0    0 -6.3333    0
0 1.0000    0    0 -3.1111    0
0    0 1.0000    0 -4.0000    0
0    0    0 1.0000 -3.4444    0
0    0    0    0    0    0
```

This tells us that  $x_5$  is our free variable and  $x_1 = 6\frac{1}{3}x_5$ ,  $x_2 = 3\frac{1}{9}x_5$ ,  $x_3 = 4x_5$ ,  $x_4 = 3\frac{4}{9}x_5$ .

(c) Website A has the highest PageRank. In order of decreasing PageRank, the others are C, D, B, E.