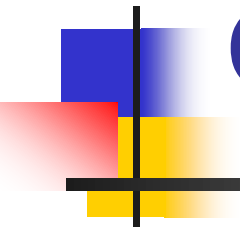

Chapter 4: Loops (Cont.)

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Logical Arrays and Vectorization

- Relational Operators

```
>>a=[1 0
       -2 1 ];
>> b=0;
>>d=(a>b)
    d=[1 0;
         0  1]
>>e=(a>=-3)
    e= [1 0;
         1  1]
```

created by relational and logic operators

named: **Logical array**
type: **logical**

How many bytes are necessary to store d or e?

Which one is right?

>>whos

Name	Size	Bytes	Class
a	2x2	32	double array
d	2x2	4	logical array

Grand total is 8 elements using 36 bytes

Command Window

```
>> a=[1  0
        -2  1 ];
    b=0;
    d=(a>b)

d =

     1     0
     0     1

>> whos
  Name        Size                Bytes  Class

  a           2x2                    32  double array
  b           1x1                     8  double array
  d           2x2                    32  double array (logical)

Grand total is 9 elements using 72 bytes

>>
```

Additional Inspiration

《三字经●弟子规》之第四篇《信》第二段

见未真，勿轻言；

知未的，勿轻传；

事非宜，勿轻诺，

苟轻诺，进退错。

Logical Arrays and Vectorization (Cont.)

- logical function

  非0即有归为1

  Values other than 0 or 1 converted to logical 1

>>c=logical(a)

```
c =

     1     0
     1     1
```

```
>> logical(a)

ans =

     1     0
    -2     1

>> help logical
```

Which one is right?

Logical Arrays and Vectorization (Cont.)

Which version?

>> help logical

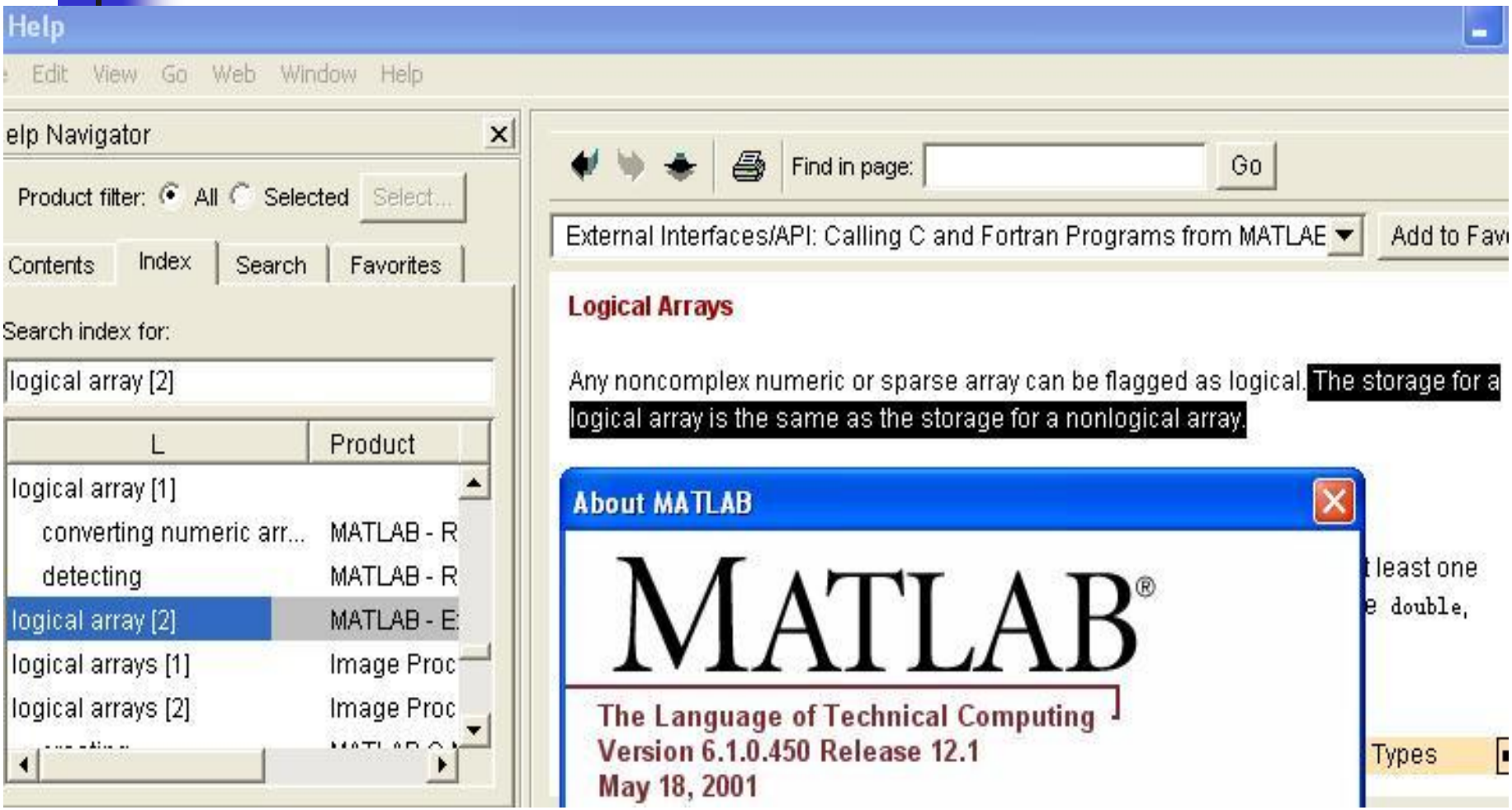
LOGICAL Convert numeric values to logical.

LOGICAL(X) returns an array that can be used for logical indexing or logical tests. Logical arrays are also created by the relational operators (==,<,>,~, etc.) and functions like ANY, ALL, ISNAN, ISINF, and ISFINITE.

A(B), where B is a logical array, returns the values of A at the indices where the real part of B is nonzero (B must be the same size as A). A(B) is the same as A(FIND(B)).

Most arithmetic operations remove the logicalness from an array. For example, adding zero to a logical array removes its logical characteristic. A = +A is the easiest way to convert a logical double array, A, to a strictly numeric double array.

Logical Arrays and Vectorization (Cont.)



Logical Arrays and Vectorization (Cont.)

```
>> whos
```

Name	Size	Bytes	Class
a	2x2	32	double array
b	2x2	4	logical array
c	2x2	4	logical array

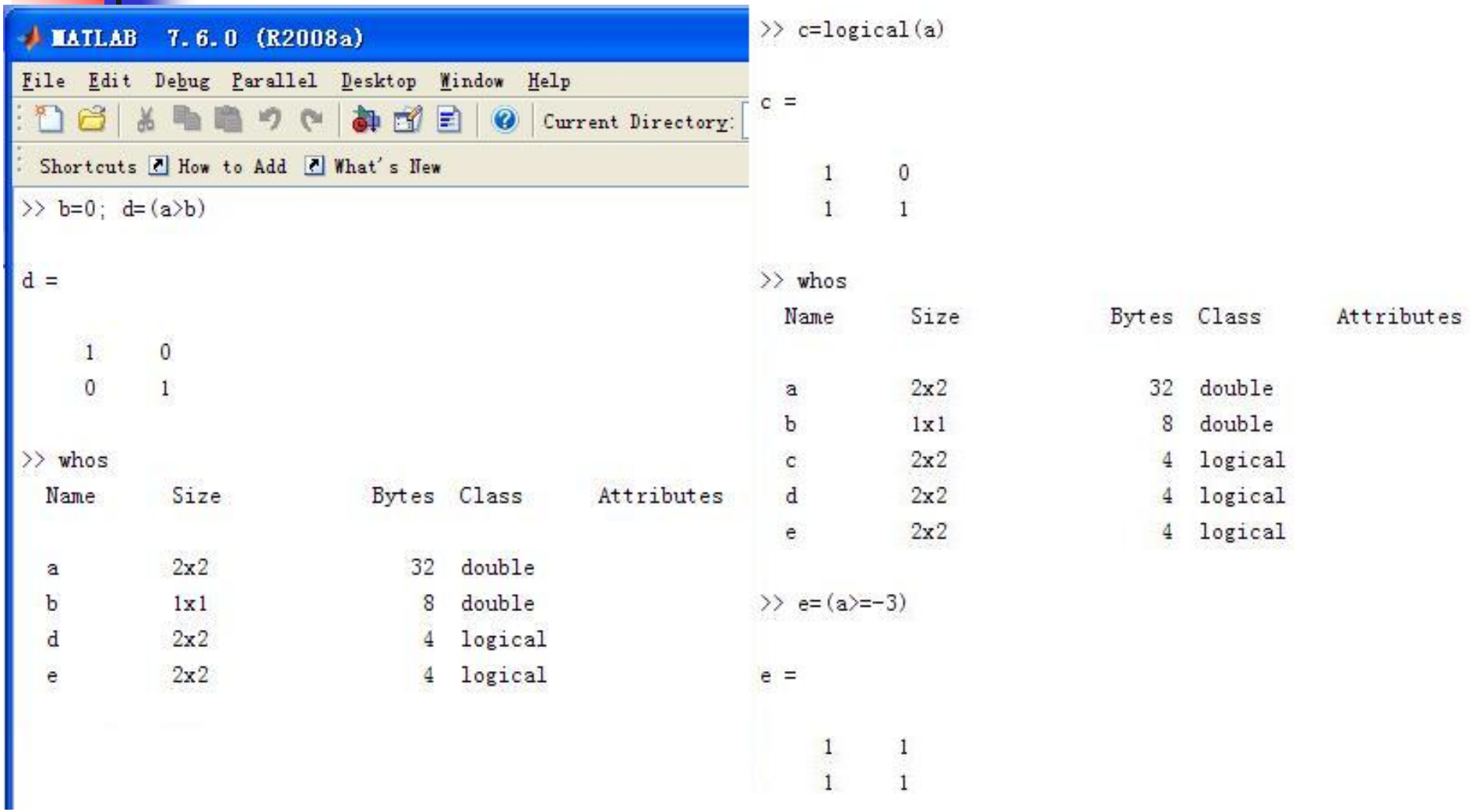
Grand total is 12 elements using 40 bytes

```
>> c=logical(a)
c =
     1     0
    -2     1
>> whos
  Name        Size                Bytes  Class
  a           2x2                    32  double array
  ans         2x2                    32  double array (logical)
  b           1x1                     8  double array
  c           2x2                    32  double array (logical)
  d           2x2                    32  double array (logical)
Grand total is 17 elements using 136 bytes
>> ver
-------------------------------------------------------
MATLAB Version 6.1.0.450 (R12.1) on PCWIN
```

Which one is right?

Which is earlier?

MATLAB 7.6 version：



Significance of Logical Arrays

- Select a portion of a matrix

Array =

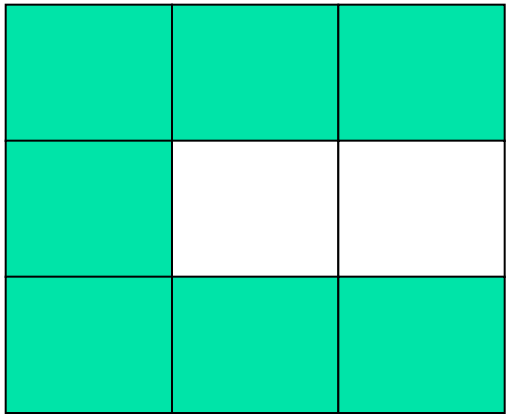
1 2 3
4 5 6

Array(:,1)

Array =

1 2 3
4 5 6

Array(1,:)



- How to select elements whose values are >=a0?

Significance of Logical Arrays (Cont.)

Example (i): Assume that *a* is an m*n matrix.

```
a0=4;
for i=1:m
   for j=1:n
       if (a(i,j)>=a0)
          a(i,j)=a(i,j)^2;
       end
    end
end
```

Significance of Logical Arrays (Cont.)

```
b=(a>=a0);
a(b) = a(b).^2;
```

Function: Select all elements for which the logical array *b* is nonzero and leave all the other elements in the array unchanged.

Significance of Logical Arrays (Cont.)

- Example (ii)

```
a=[1 2 3;4 5 6;7 8 10];
for i=1:size(a,1)
    for j=1:size(a,2)
        if a(i,j)>5
            a(i,j)=sqrt(a(i,j));
        else
            a(i,j)=a(i,j)^2;
        end
    end
end
```

>> help size

SIZE Size of matrix.

D = SIZE(X), for M-by-N matrix X, returns the two-element row vector D = [M, N] containing the numbers of rows and columns in the matrix. For N-D arrays, SIZE(X) returns a 1-by-N vector of dimension lengths.

[M,N] = SIZE(X) returns the numbers of rows and columns in separate output variables. [M1,M2,M3,...,MN] = SIZE(X) returns the lengths of the first N dimensions of X.

M = SIZE(X,DIM) returns the length of the dimension specified by the scalar DIM. For example, SIZE(X,1) returns the number of rows.

Significance of Logical Arrays (Cont.)

```
a =

    1.0000    4.0000    9.0000
   16.0000   25.0000    2.4495
    2.6458    2.8284    3.1623
```

Significance of Logical Arrays (Cont.)

```
b=(a>5)
a(b)=sqrt(a(b));
a(~b)=a(~b).^2;
```

Wonderful! Brilliant! Marvelous! Ingenious!

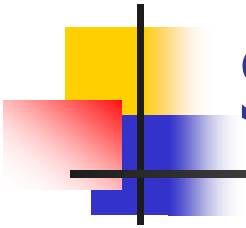
```
b =

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

```
a =

    1.0000    4.0000    9.0000
   16.0000   25.0000    2.4495
    2.6458    2.8284    3.1623
```

It is much **faster** than the way of using for-loop-branch.



Sincere Thanks!

- Using this group of PPTs, please read

- [1] Yunong Zhang, Weimu Ma, Xiao-Dong Li, Hong-Zhou Tan, Ke Chen, MATLAB Simulink modeling and simulation of LVI-based primal-dual neural network for solving linear and quadratic programs, Neurocomputing 72 (2009) 1679-1687

- [2] Yunong Zhang, Chenfu Yi, Weimu Ma, Simulation and verification of Zhang neural network for online time-varying matrix inversion, Simulation Modelling Practice and Theory 17 (2009) 1603-1617