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MATLAB

Array creation

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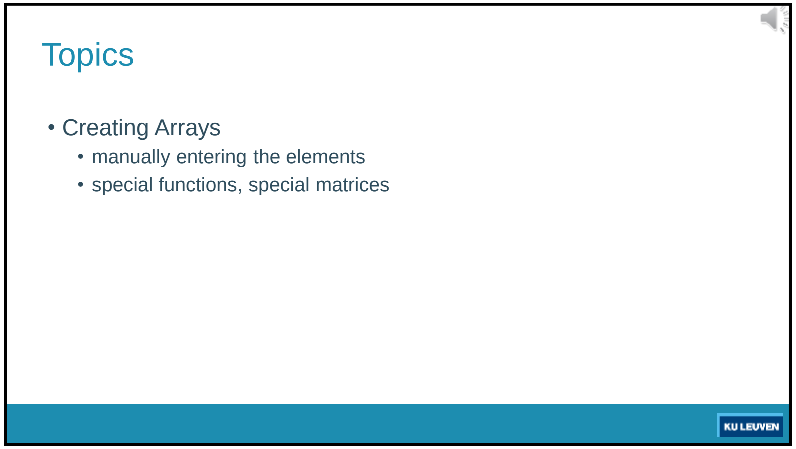

Topics

- Creating Arrays
  - manually entering the elements
  - special functions, special matrices

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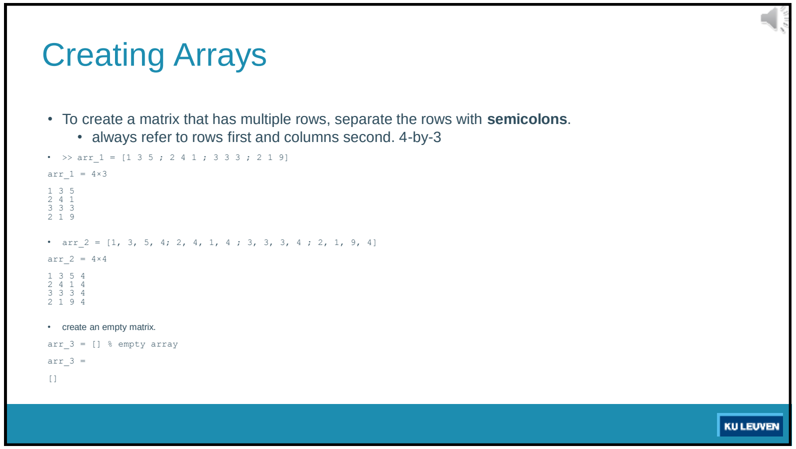

Creating Arrays

- To create a matrix that has multiple rows, separate the rows with **semicolons**.
  - always refer to rows first and columns second. 4-by-3

```
•  >> arr_1 = [1 3 5 ; 2 4 1 ; 3 3 3 ; 2 1 9]

arr_1 = 4×3

1 3 5
2 4 1
3 3 3
2 1 9

•  arr_2 = [1, 3, 5, 4; 2, 4, 1, 4 ; 3, 3, 3, 4 ; 2, 1, 9, 4]

arr_2 = 4×4

1 3 5 4
2 4 1 4
3 3 3 4
2 1 9 4
```

- create an empty matrix.

```
arr_3 = [] % empty array

arr_3 =

[]
```

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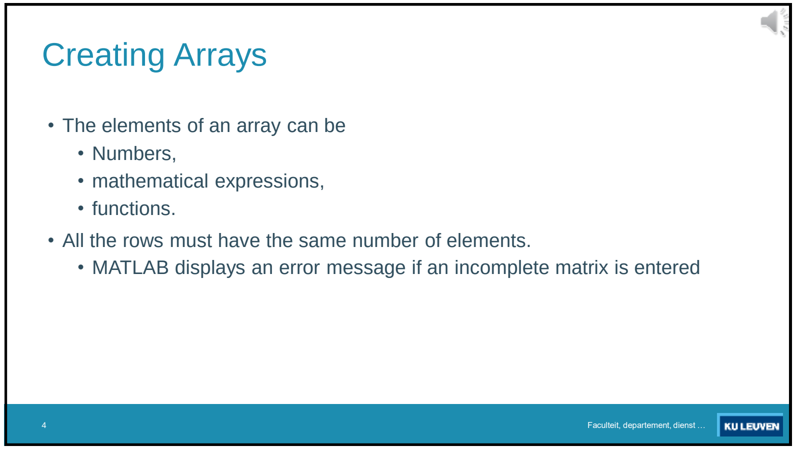

Creating Arrays

- The elements of an array can be
  - Numbers,
  - mathematical expressions,
  - functions.
- All the rows must have the same number of elements.
  - MATLAB displays an error message if an incomplete matrix is entered

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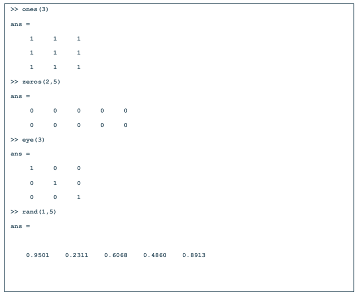
Creating Arrays

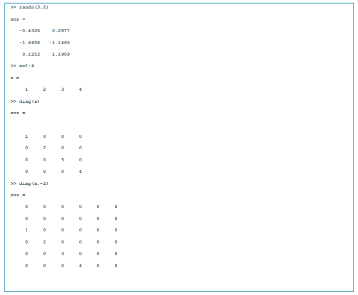
MATLAB provides functions for creating standard arrays.

```
>> help elmat
  Elementary matrices and matrix manipulation.

  Elementary matrices.
    zeros       - Zeros array.
    ones        - Ones array.
    eye         - Identity matrix.
    repmat      - Replicate and tile array.
    rand        - Uniformly distributed random numbers.
    randn       - Normally distributed random numbers.
    linspace    - Linearly spaced vector.
    logspace    - Logarithmically spaced vector.
    freqspace   - Frequency spacing for frequency response.
    meshgrid    - X and Y arrays for 3-D plots.
    accumarray  - Construct an array with accumulation.
    :           - Regularly spaced vector and index into matrix.
```

Examples



```
>> ones(3)

ans =

     1     1     1

     1     1     1

     1     1     1

>> zeros(2,5)

ans =

     0     0     0     0     0

     0     0     0     0     0

>> eye(3)

ans =

     1     0     0

     0     1     0

     0     0     1

>> rand(1,5)

ans =


    0.9501    0.2311    0.6068    0.4860    0.8913
```



```
>> randn(3,2)

ans =

   -0.4326    0.2877

   -1.6656   -1.1465

    0.1253    1.1909

>> a=1:4

a =

     1     2     3     4

>> diag(a)

ans =


     1     0     0     0

     0     2     0     0

     0     0     3     0

     0     0     0     4

>> diag(a,-2)

ans =

     0     0     0     0     0     0

     0     0     0     0     0     0

     1     0     0     0     0     0

     0     2     0     0     0     0

     0     0     3     0     0     0

     0     0     0     4     0     0
```

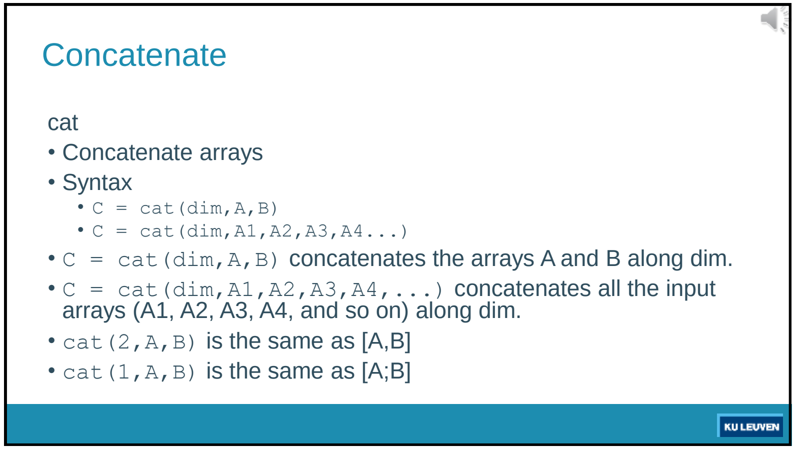
Test matrices

- Use the `gallery` function to create test matrices
- `doc gallery`

Concatenating Arrays

- Arrays can be concatenated by enclosing them inside of square brackets [ ]
  - Use **space or comma** to glue horizontally
  - Use **semicolon** to specify to glue vertically
  - Dimensions must fit!

```
>> A = [[1 2 3],rand(1,3)]
A =
    1.0000    2.0000    3.0000    0.9649    0.1576    0.9706
>> B = [A;A]
B =
    1.0000    2.0000    3.0000    0.9649    0.1576    0.9706
    1.0000    2.0000    3.0000    0.9649    0.1576    0.9706
```



Concatenate

cat

- Concatenate arrays
- Syntax
  - `C = cat(dim,A,B)`
  - `C = cat(dim,A1,A2,A3,A4...)`
- `C = cat(dim,A,B)` concatenates the arrays A and B along dim.
- `C = cat(dim,A1,A2,A3,A4,...)` concatenates all the input arrays (A1, A2, A3, A4, and so on) along dim.
- `cat(2,A,B)` is the same as [A,B]
- `cat(1,A,B)` is the same as [A;B]

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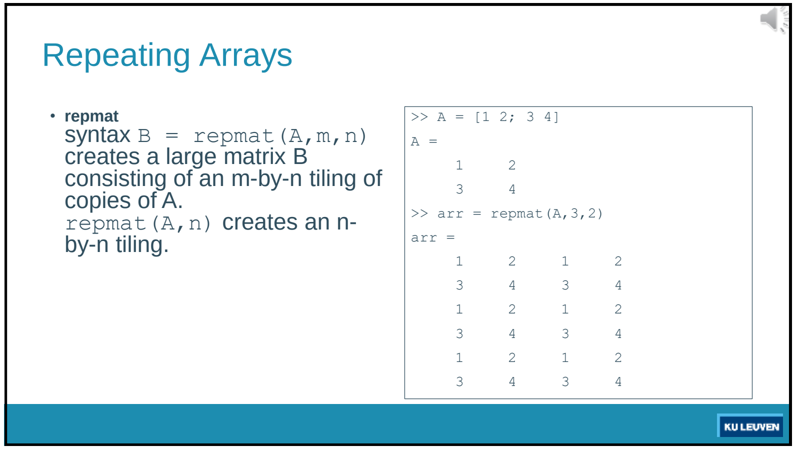

Repeating Arrays

- **repmat**
  syntax `B = repmat(A,m,n)` creates a large matrix B consisting of an m-by-n tiling of copies of A.
  `repmat(A,n)` creates an n-by-n tiling.

```
>> A = [1 2; 3 4]
A =
      1     2
      3     4
>> arr = repmat(A,3,2)
arr =
      1     2     1     2
      3     4     3     4
      1     2     1     2
      3     4     3     4
      1     2     1     2
      3     4     3     4
```

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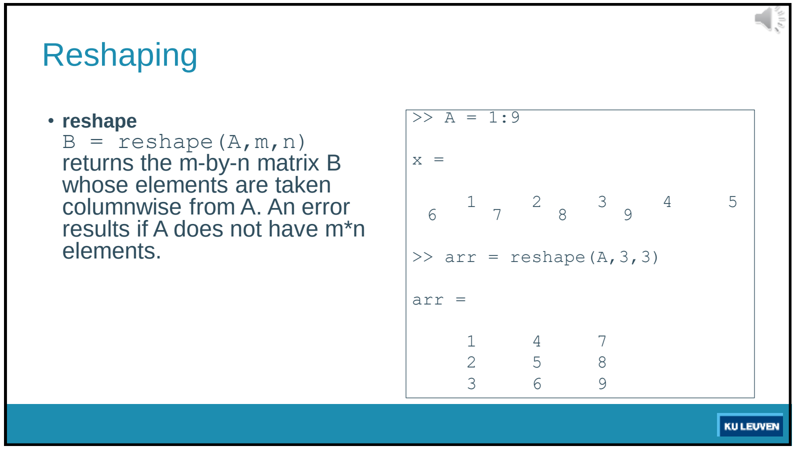

Reshaping

- **reshape**
  `B = reshape(A,m,n)`
  returns the m-by-n matrix B whose elements are taken columnwise from A. An error results if A does not have m*n elements.

```
>> A = 1:9

x =

       1       2       3       4       5
  6       7       8       9

>> arr = reshape(A,3,3)

arr =

       1     4     7
       2     5     8
       3     6     9
```

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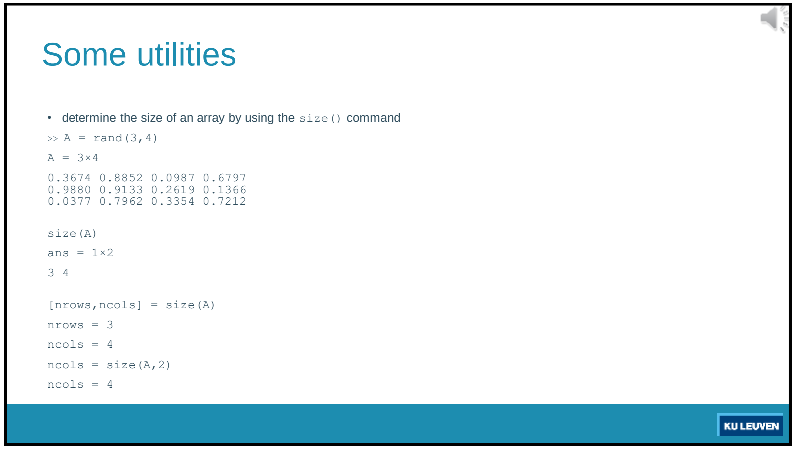

Some utilities

- determine the size of an array by using the `size()` command

```
>> A = rand(3,4)
A = 3×4
0.3674 0.8852 0.0987 0.6797
0.9880 0.9133 0.2619 0.1366
0.0377 0.7962 0.3354 0.7212

size(A)
ans = 1×2
3 4

[nrows,ncols] = size(A)
nrows = 3
ncols = 4
ncols = size(A,2)
ncols = 4
```

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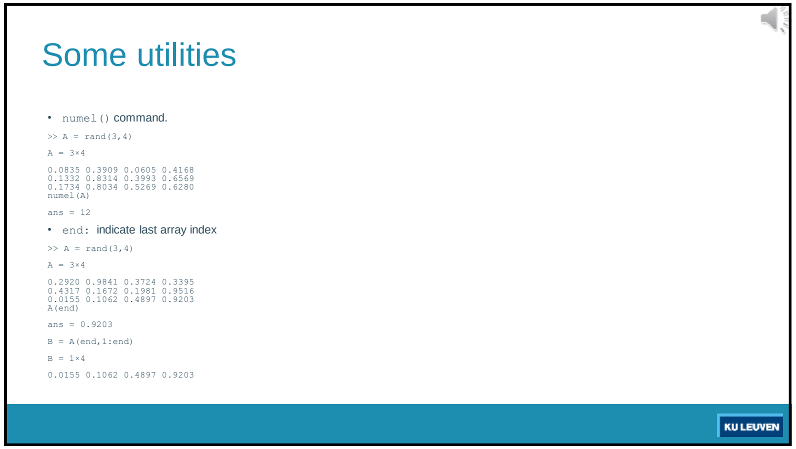

Some utilities

- `numel()` command.

```
>> A = rand(3,4)

A = 3×4

0.0835 0.3909 0.0605 0.4168
0.1332 0.8314 0.3993 0.6569
0.1734 0.8034 0.5269 0.6280
numel(A)

ans = 12
```

- `end:` indicate last array index

```
>> A = rand(3,4)

A = 3×4

0.2920 0.9841 0.3724 0.3395
0.4317 0.1672 0.1981 0.9516
0.0155 0.1062 0.4897 0.9203
A(end)

ans = 0.9203

B = A(end,1:end)

B = 1×4

0.0155 0.1062 0.4897 0.9203
```

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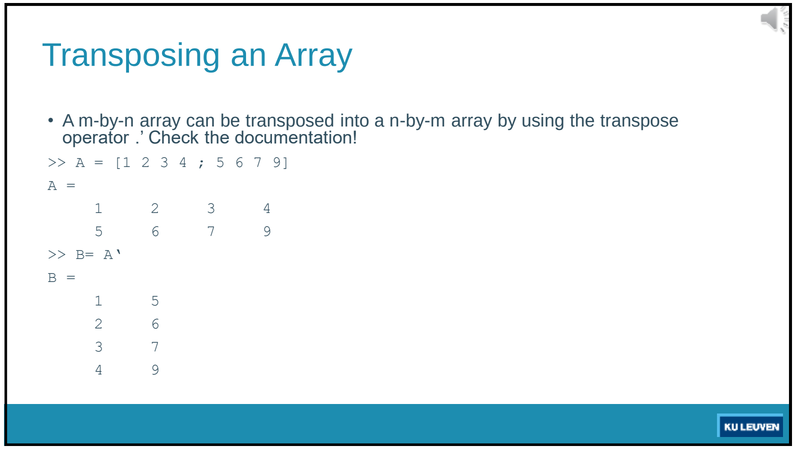

Transposing an Array

- A m-by-n array can be transposed into a n-by-m array by using the transpose operator .' Check the documentation!

```
>> A = [1 2 3 4 ; 5 6 7 9]
A =
        1       2       3       4
        5       6       7       9
>> B= A'
B =
        1       5
        2       6
        3       7
        4       9
```

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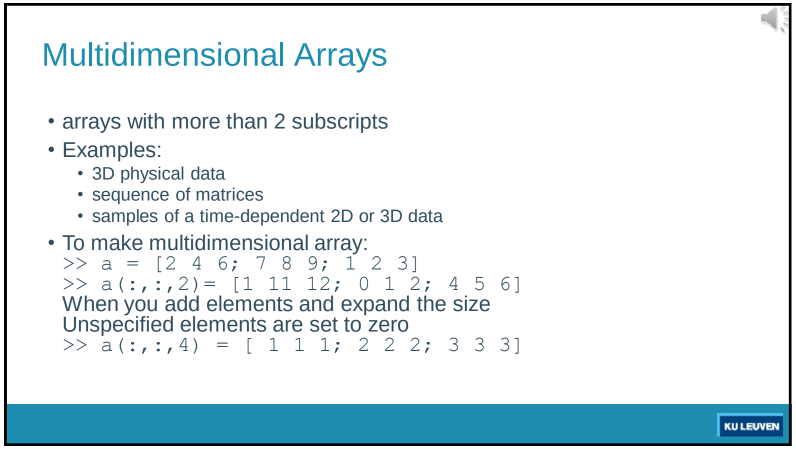

Multidimensional Arrays

- arrays with more than 2 subscripts
- Examples:
  - 3D physical data
  - sequence of matrices
  - samples of a time-dependent 2D or 3D data
- To make multidimensional array:

```
>> a = [2 4 6; 7 8 9; 1 2 3]
>> a(:,:,2)= [1 11 12; 0 1 2; 4 5 6]
```

When you add elements and expand the size
Unspecified elements are set to zero

```
>> a(:,:,4) = [ 1 1 1; 2 2 2; 3 3 3]
```

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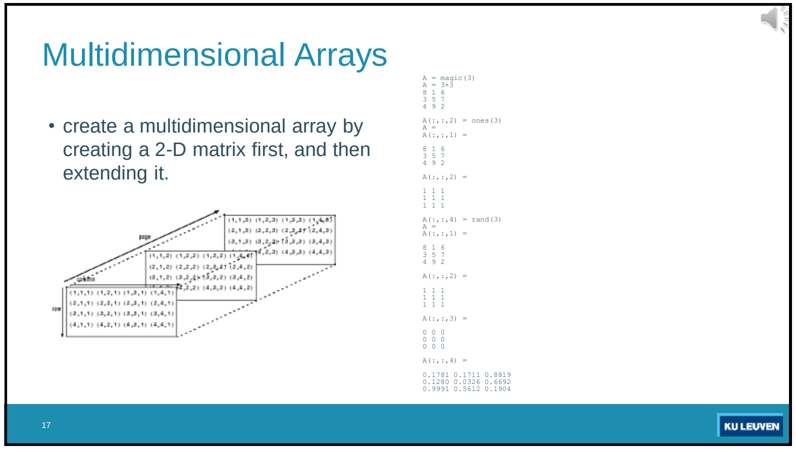

Multidimensional Arrays

- create a multidimensional array by creating a 2-D matrix first, and then extending it.

page
column
row
(1,1,3) (1,2,3) (1,3,3) (1,4,3)
(2,1,3) (2,2,3) (2,3,3) (2,4,3)
(3,1,3) (3,2,3) (3,3,3) (3,4,3)
(4,2,3) (4,3,3) (4,4,3)
(1,1,2) (1,2,2) (1,3,2) (1,4,2)
(2,1,2) (2,2,2) (2,3,2) (2,4,2)
(3,1,2) (3,2,2) (3,3,2) (3,4,2)
(4,2,2) (4,3,2) (4,4,2)
(1,1,1) (1,2,1) (1,3,1) (1,4,1)
(2,1,1) (2,2,1) (2,3,1) (2,4,1)
(3,1,1) (3,2,1) (3,3,1) (3,4,1)
(4,1,1) (4,2,1) (4,3,1) (4,4,1)

```
A = magic(3)
A = 3×3
8 1 6
3 5 7
4 9 2

A(:,:,2) = ones(3)
A =
A(:,:,1) =

8 1 6
3 5 7
4 9 2

A(:,:,2) =

1 1 1
1 1 1
1 1 1

A(:,:,4) = rand(3)
A =
A(:,:,1) =

8 1 6
3 5 7
4 9 2

A(:,:,2) =

1 1 1
1 1 1
1 1 1

A(:,:,3) =

0 0 0
0 0 0
0 0 0

A(:,:,4) =

0.1781 0.1711 0.8819
0.1280 0.0326 0.6692
0.9991 0.5612 0.1904
```

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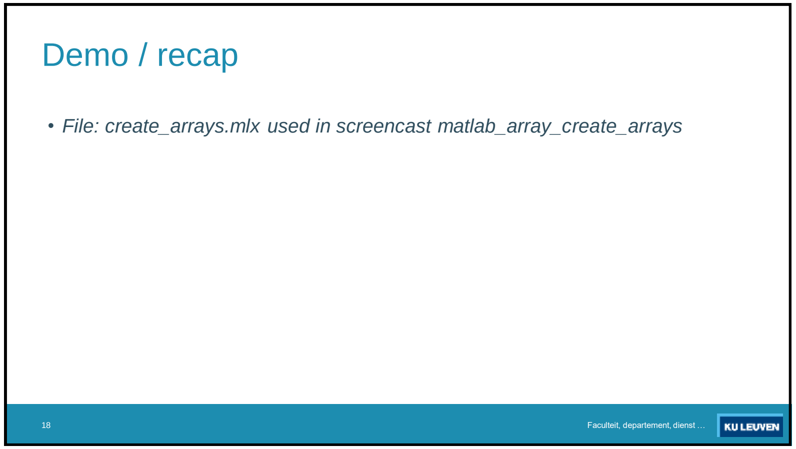

Demo / recap

- *File: create_arrays.mlx used in screencast matlab_array_create_arrays*