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Пакеты научных вычислений

Лекция 1. Среда функционирования MatLab. Базовые понятия

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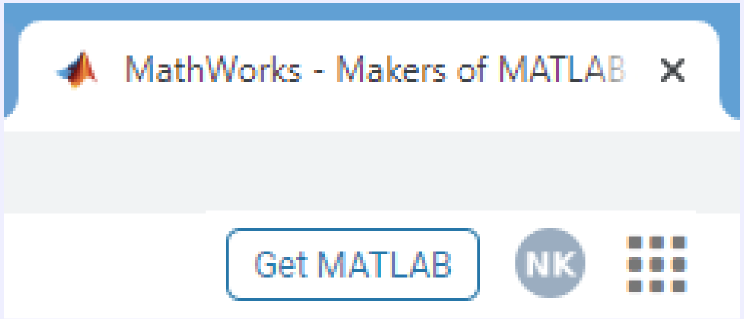
MatLab на mathworks.com

- Войти на сайт https://www.mathworks.com/
- Зарегистрироваться по своей почте *sfedu.ru
- Нажать кнопку GetMatLab
- Выбрать MatLab Online



Успехов!

Содержание:

- Источники для изучения (ресурсы)
- Многооконный интерфейс
- Гид по ресурсу ML **Home** и **Edit**
- Работа со справкой интерактивно
- Базовый функционал ML
- Создание script-файлов и функций

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Осваиваем MatLab

- https://samoychiteli.ru/document21400.html
- https://exponenta.ru/academy/study_material
- Help MatLab (»имяфункции+F1 или вся справка: » help)
- Examples MatLab:

(»help examples или »demos)

MatLab Home

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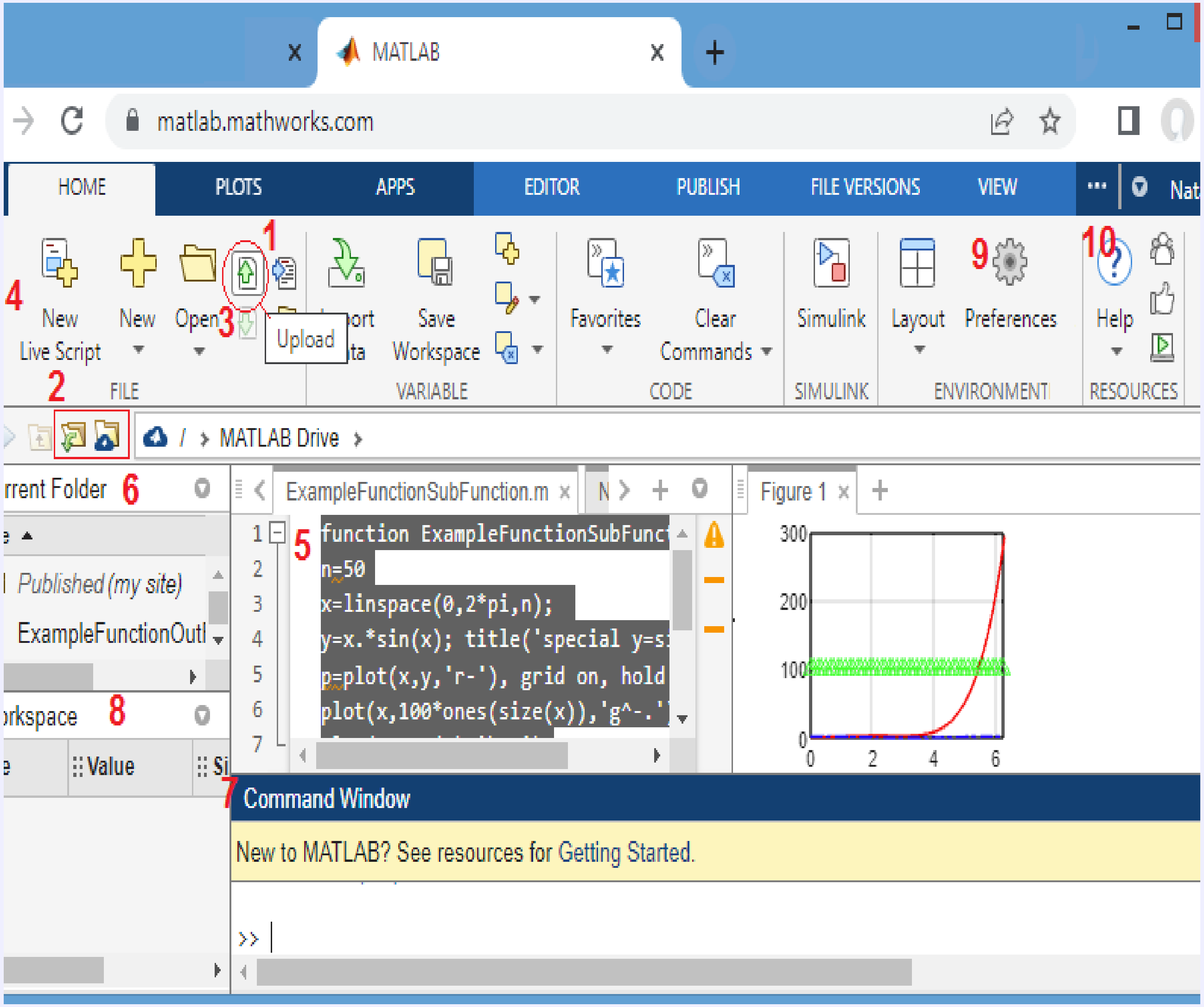
MatLab удаленно на https://www.mathworks.com/



```
function ExampleFunctionSubFunc
n=50
x=linspace(0,2*pi,n);
y=x.*sin(x); title('special y=s
p=plot(x,y,'r-'), grid on, hold
plot(x,100*ones(size(x)),'g^-.'
```

New to MATLAB? See resources for Getting Started.

```
>>
```

Home

1 - загрузить файл с комп.

2 - поместить в облако MLDrive

3 - (неактивная стрелка вниз) выгрузить файл на комп. после сохранения

4 - Создать пустой *mlx ; New – пустой script: *.m

5 - файловый редактор

6 - Current Folder

7 - Command Window , рабочее окно, среда в/вывода (интерактивный калькулятор)

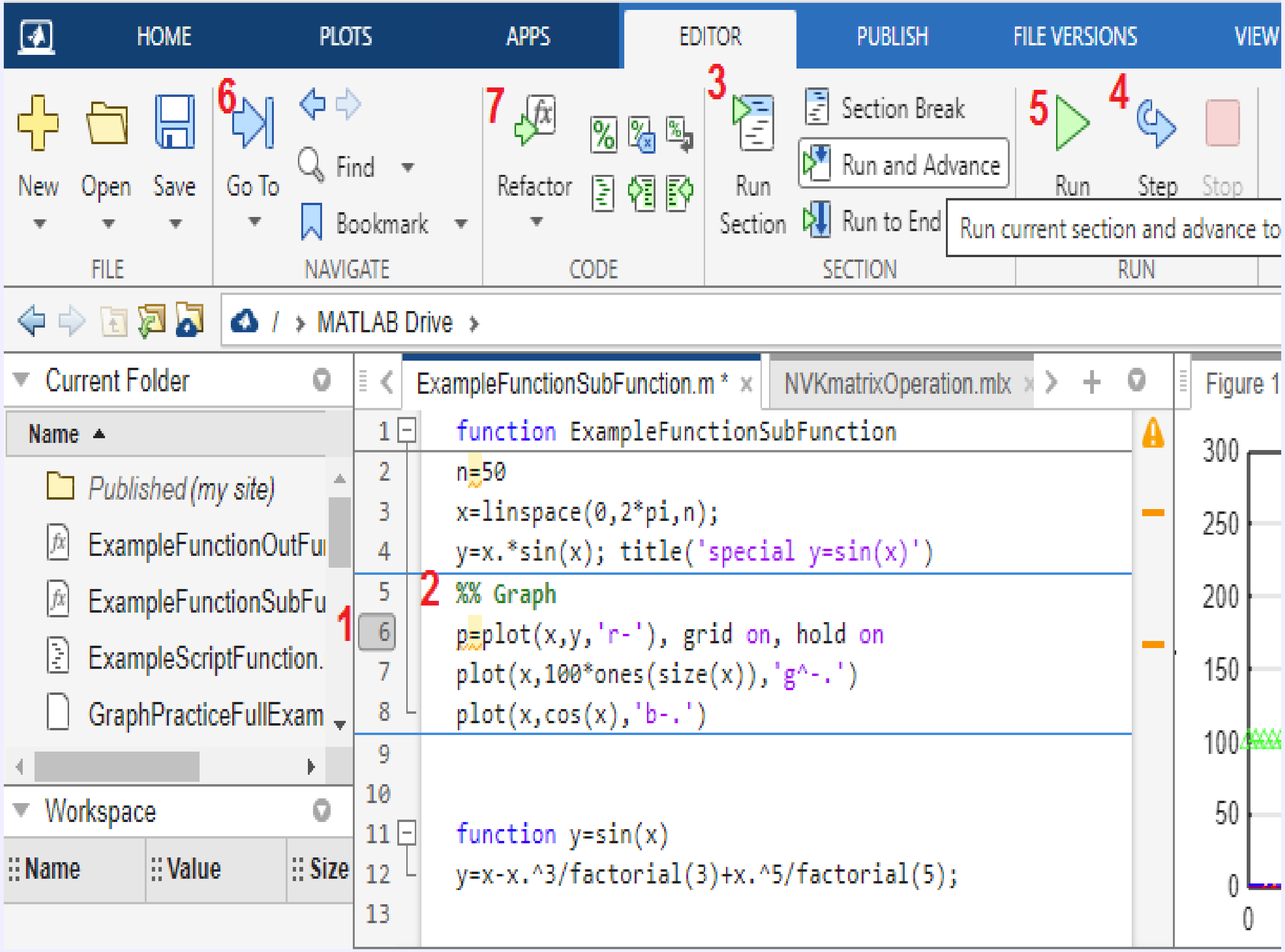
8 - Workspace - информация о переменных (глобальных)

9 - Preferences – персональные настройки

10 - Справка – Help или ?

MatLab Editor

Интерактивное освоение Editor



```
function ExampleFunctionSubFunction
n=50
x=linspace(0,2*pi,n);
y=x.*sin(x); title('special y=sin(x)')
%% Graph
p=plot(x,y,'r-'), grid on, hold on
plot(x,100*ones(size(x)),'g^-.')
plot(x,cos(x),'b-.')


function y=sin(x)
y=x-x.^3/factorial(3)+x.^5/factorial(5);
```

Editor

1 - л.к.м. щелкнуть на номере строки – точка прерывания

2 - %% - знак начала секции; % - знак комментария

3 - выполнить секцию

4 - выполнять построчно

5 Выполнить весь файл

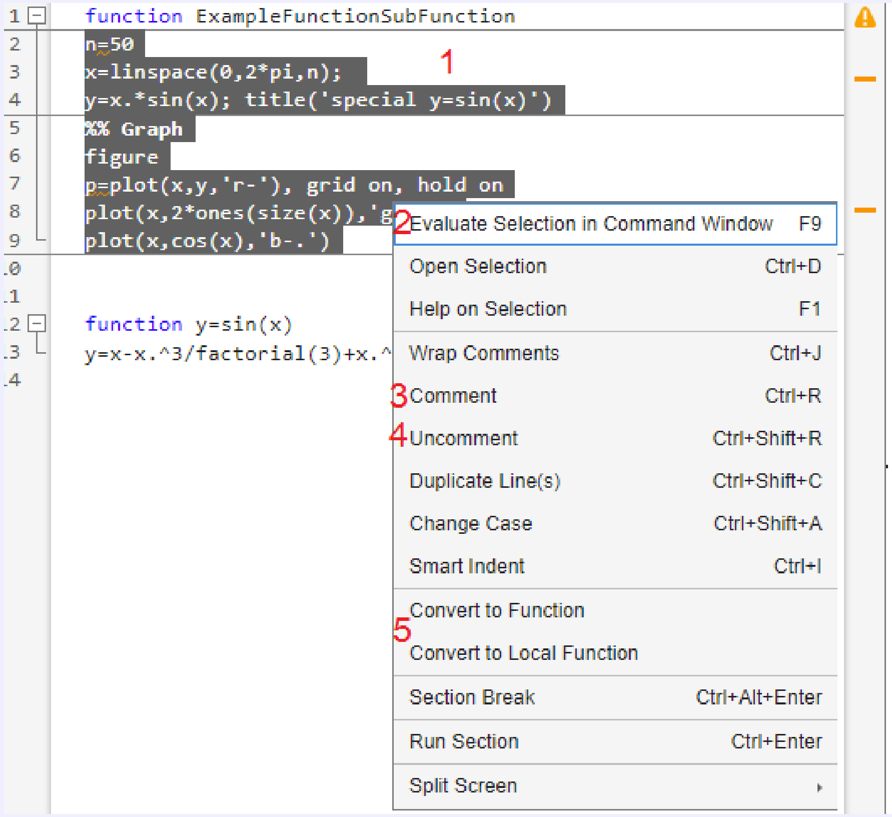
6 - выполнить всё до строки с курсором

7 - Выделенная часть кода преобразуется в локальную функцию (в том же теле скрипта),

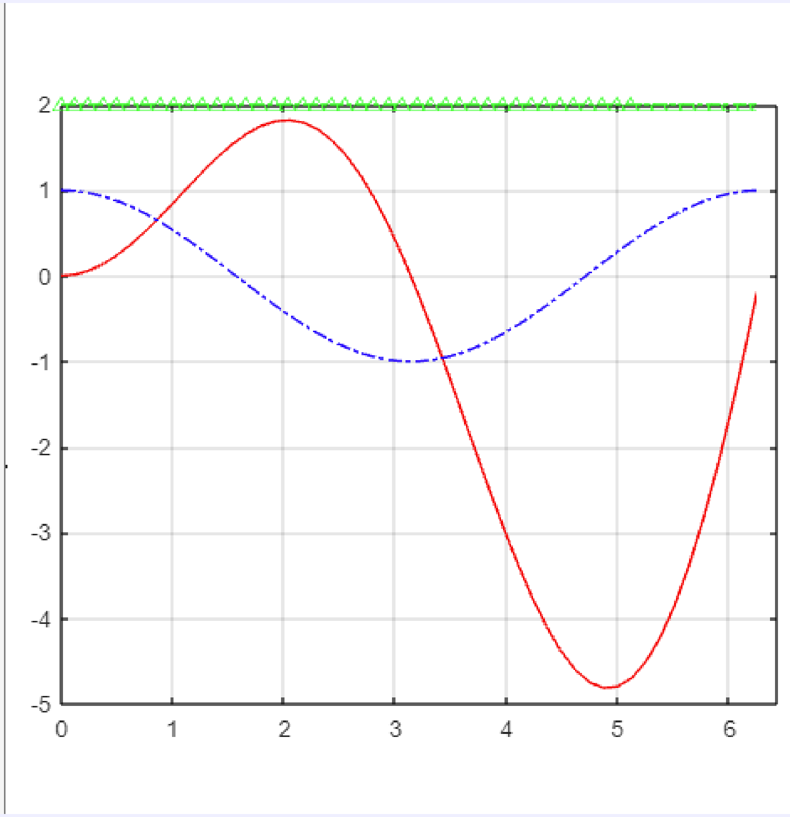
Stop - прерывает отладчик

Локальное меню

MatLab эффективен с Local Menu



```
function ExampleFunctionSubFunction
n=50
x=linspace(0,2*pi,n);
y=x.*sin(x); title('special y=sin(x)')
%% Graph
figure
p=plot(x,y,'r-'), grid on, hold on
plot(x,2*ones(size(x)),'g
plot(x,cos(x),'b-.')


function y=sin(x)
y=x-x.^3/factorial(3)+x.^
```



1 - выделить код, подлежащий воздействию, щелкнуть правой кнопкой мыши

2 - выполнить выделенное

3 - закомментировать выделенное

4 - раскомментировать выделенное

5 - конвертировать в локальную или внешнюю функцию

КОНСТРУКТОРЫ МАТРИЦ

ONES – из единиц

ZEROS – из нулей

EYE – единичных матриц

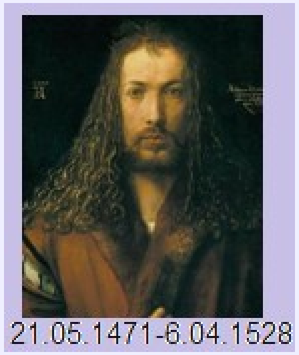
MAGIC – магический квадрат (идея Альбрехта Дюрера)

Случайных :

RAND – элементы равномерно распределены на отрезке [0,1]

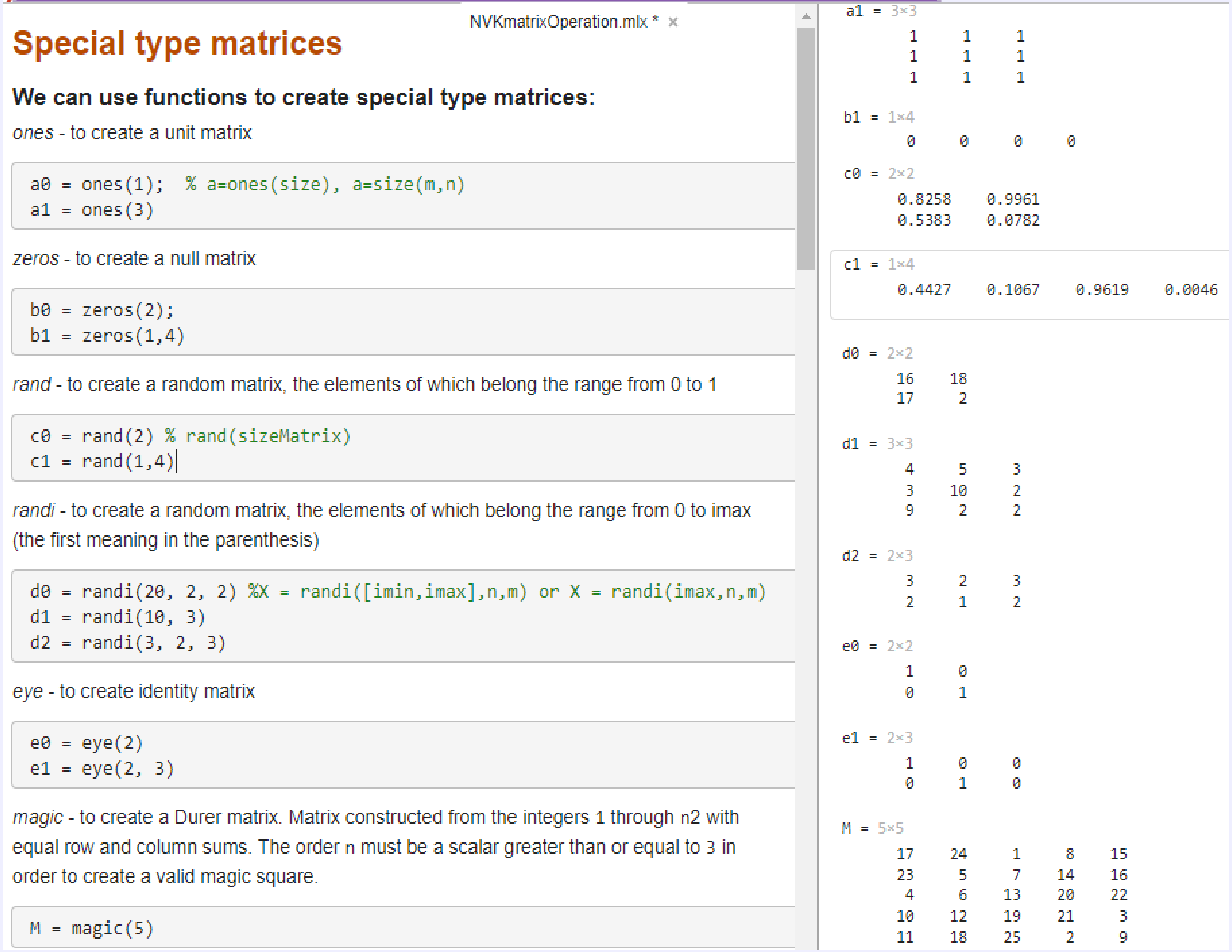
RANDN – элементы нормально распределены

RANDI – целочисленные на заданном отрезке или с ограничением сверху



21.05.1471-6.04.1528

Примеры создания матриц



Special type matrices

We can use functions to create special type matrices:

ones - to create a unit matrix

```
a0 = ones(1);  % a=ones(size), a=size(m,n)
a1 = ones(3)
```

zeros - to create a null matrix

```
b0 = zeros(2);
b1 = zeros(1,4)
```

rand - to create a random matrix, the elements of which belong the range from 0 to 1

```
c0 = rand(2) % rand(sizeMatrix)
c1 = rand(1,4)
```

randi - to create a random matrix, the elements of which belong the range from 0 to imax (the first meaning in the parenthesis)

```
d0 = randi(20, 2, 2) %X = randi([imin,imax],n,m) or X = randi(imax,n,m)
d1 = randi(10, 3)
d2 = randi(3, 2, 3)
```

eye - to create identity matrix

```
e0 = eye(2)
e1 = eye(2, 3)
```

magic - to create a Durer matrix. Matrix constructed from the integers 1 through n2 with equal row and column sums. The order n must be a scalar greater than or equal to 3 in order to create a valid magic square.

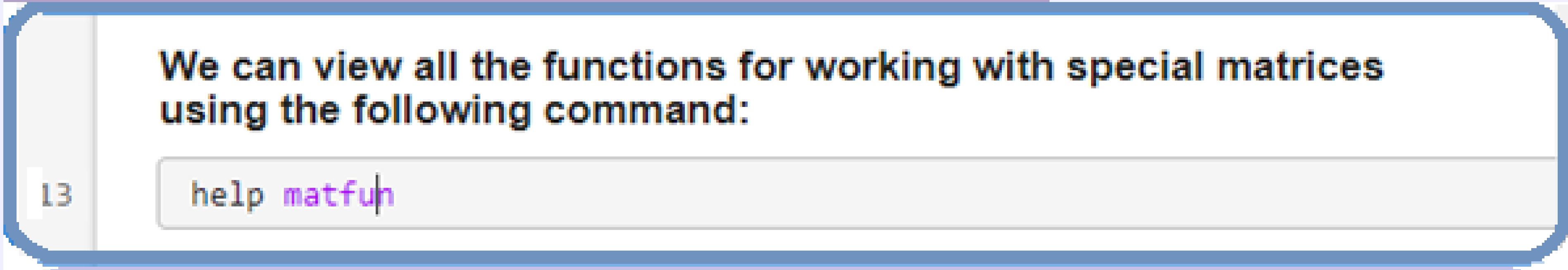
```
M = magic(5)
```

```
a1 = 3×3
         1     1     1
         1     1     1
         1     1     1

b1 = 1×4
         0     0     0     0

c0 = 2×2
      0.8258    0.9961
      0.5383    0.0782

c1 = 1×4
      0.4427    0.1067    0.9619    0.0046

d0 = 2×2
        16    18
        17     2

d1 = 3×3
         4     5     3
         3    10     2
         9     2     2

d2 = 2×3
         3     2     3
         2     1     2

e0 = 2×2
         1     0
         0     1

e1 = 2×3
         1     0     0
         0     1     0

M = 5×5
        17    24     1     8    15
        23     5     7    14    16
         4     6    13    20    22
        10    12    19    21     3
        11    18    25     2     9
```

MATFUN

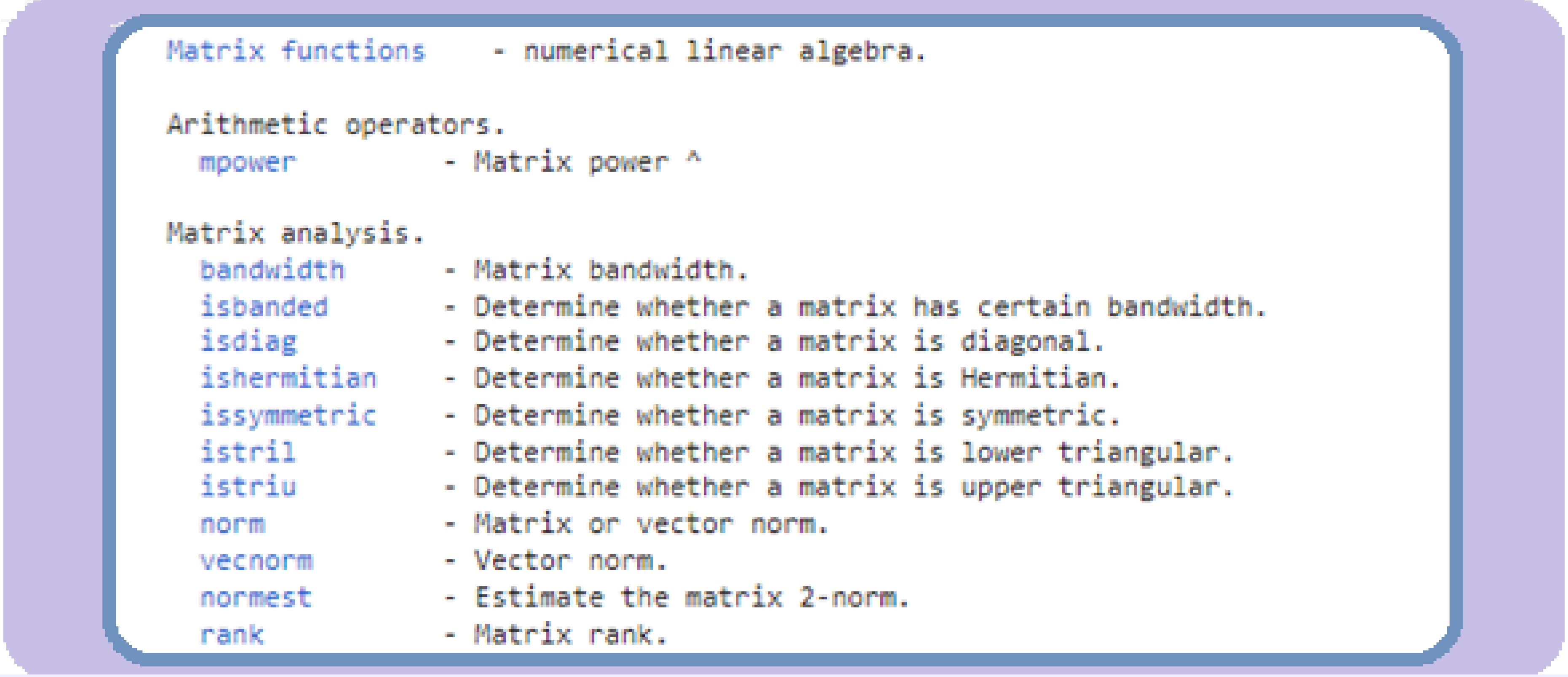
Библиотека матричных функций

Примеры матричных функций



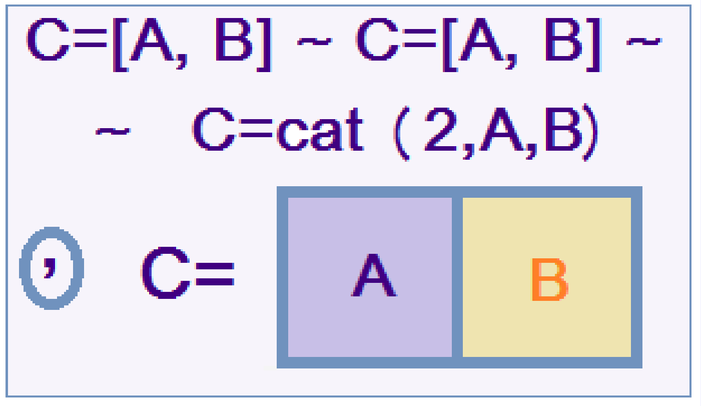
We can view all the functions for working with special matrices using the following command:

```
help matfun
```



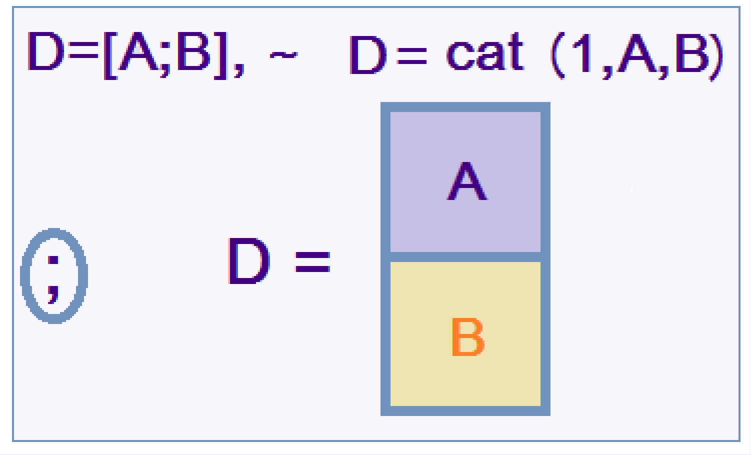
```
Matrix functions    - numerical linear algebra.

Arithmetic operators.
  mpower          - Matrix power ^

Matrix analysis.
  bandwidth       - Matrix bandwidth.
  isbanded        - Determine whether a matrix has certain bandwidth.
  isdiag          - Determine whether a matrix is diagonal.
  ishermitian     - Determine whether a matrix is Hermitian.
  issymmetric     - Determine whether a matrix is symmetric.
  istril          - Determine whether a matrix is lower triangular.
  istriu          - Determine whether a matrix is upper triangular.
  norm            - Matrix or vector norm.
  vecnorm         - Vector norm.
  normest         - Estimate the matrix 2-norm.
  rank            - Matrix rank.
```

Конкатенация



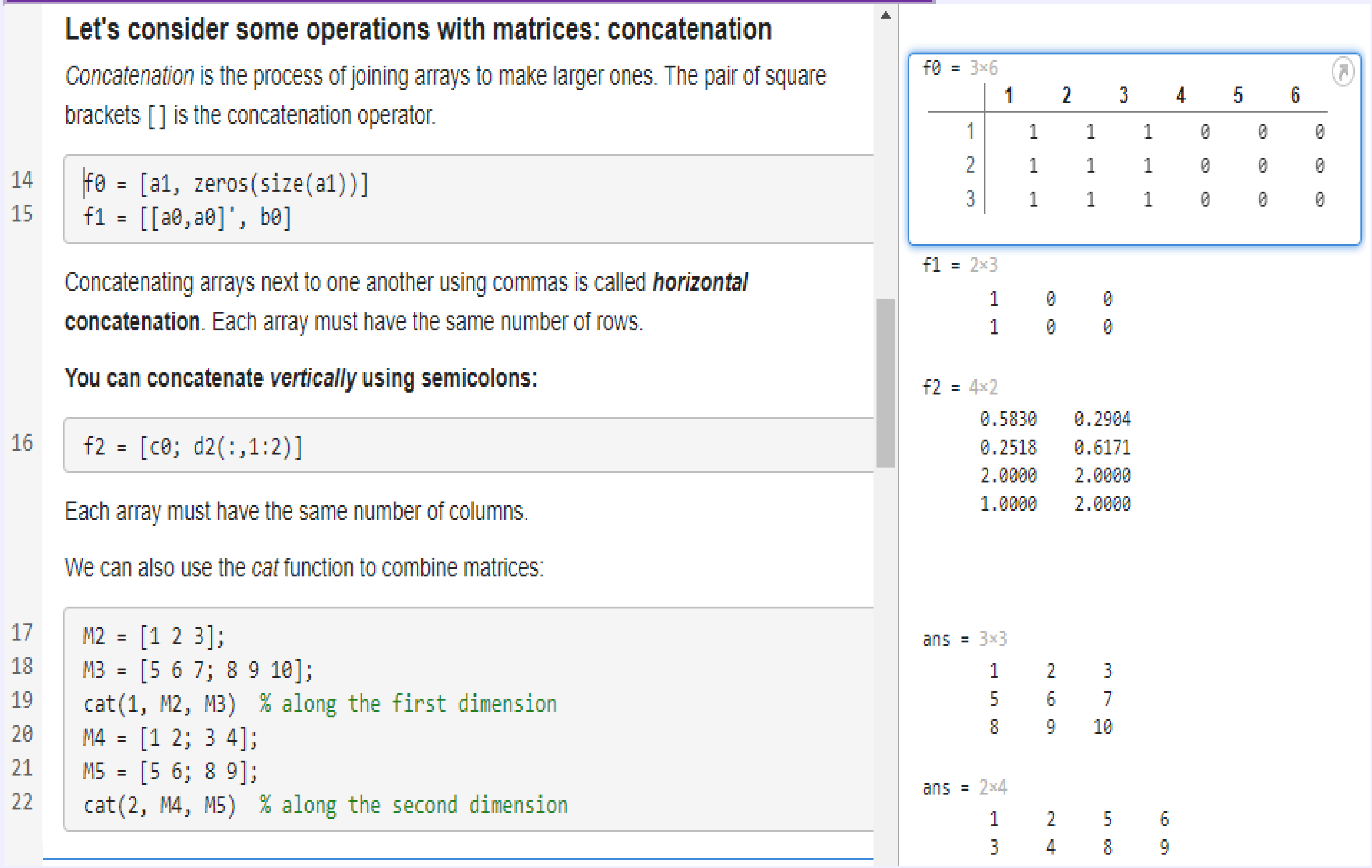
C=[A, B] ~ C=[A, B] ~

~ C=cat (2,A,B)



D=[A;B], ~ D= cat (1,A,B)

Примеры конкатенации



Let's consider some operations with matrices: concatenation

Concatenation is the process of joining arrays to make larger ones. The pair of square brackets [] is the concatenation operator.

```
f0 = [a1, zeros(size(a1))]
f1 = [[a0,a0]', b0]
```

Concatenating arrays next to one another using commas is called ***horizontal* concatenation**. Each array must have the same number of rows.

You can concatenate *vertically* using semicolons:

```
f2 = [c0; d2(:,1:2)]
```

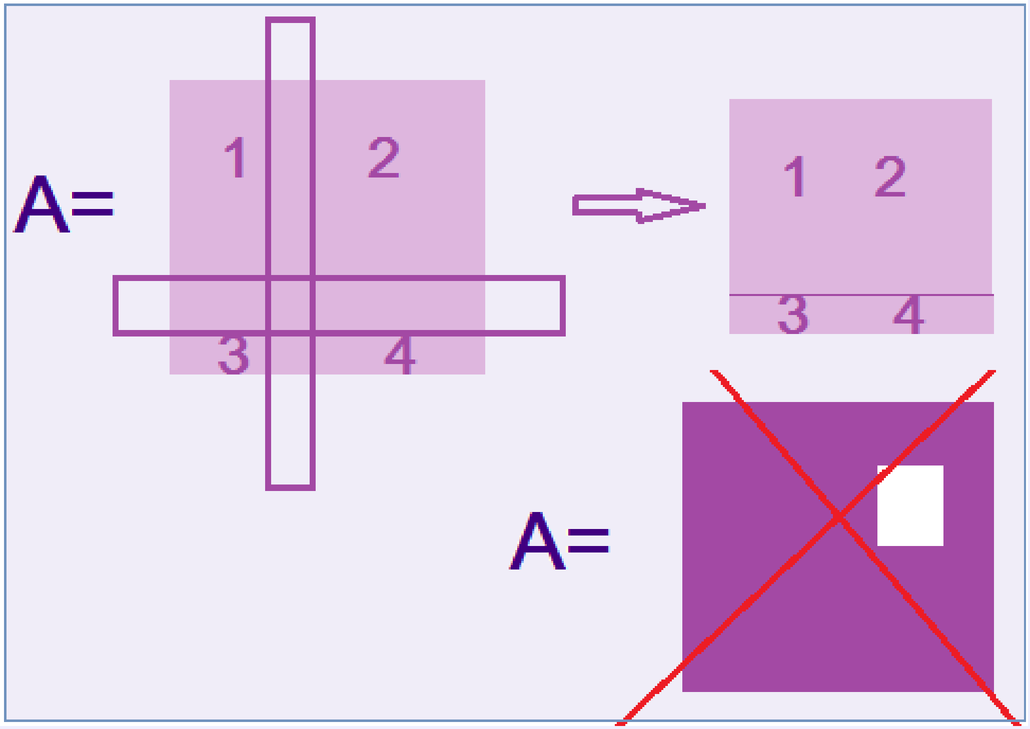
Each array must have the same number of columns.

We can also use the *cat* function to combine matrices:

```
M2 = [1 2 3];
M3 = [5 6 7; 8 9 10];
cat(1, M2, M3)  % along the first dimension
M4 = [1 2; 3 4];
M5 = [5 6; 8 9];
cat(2, M4, M5)  % along the second dimension
```

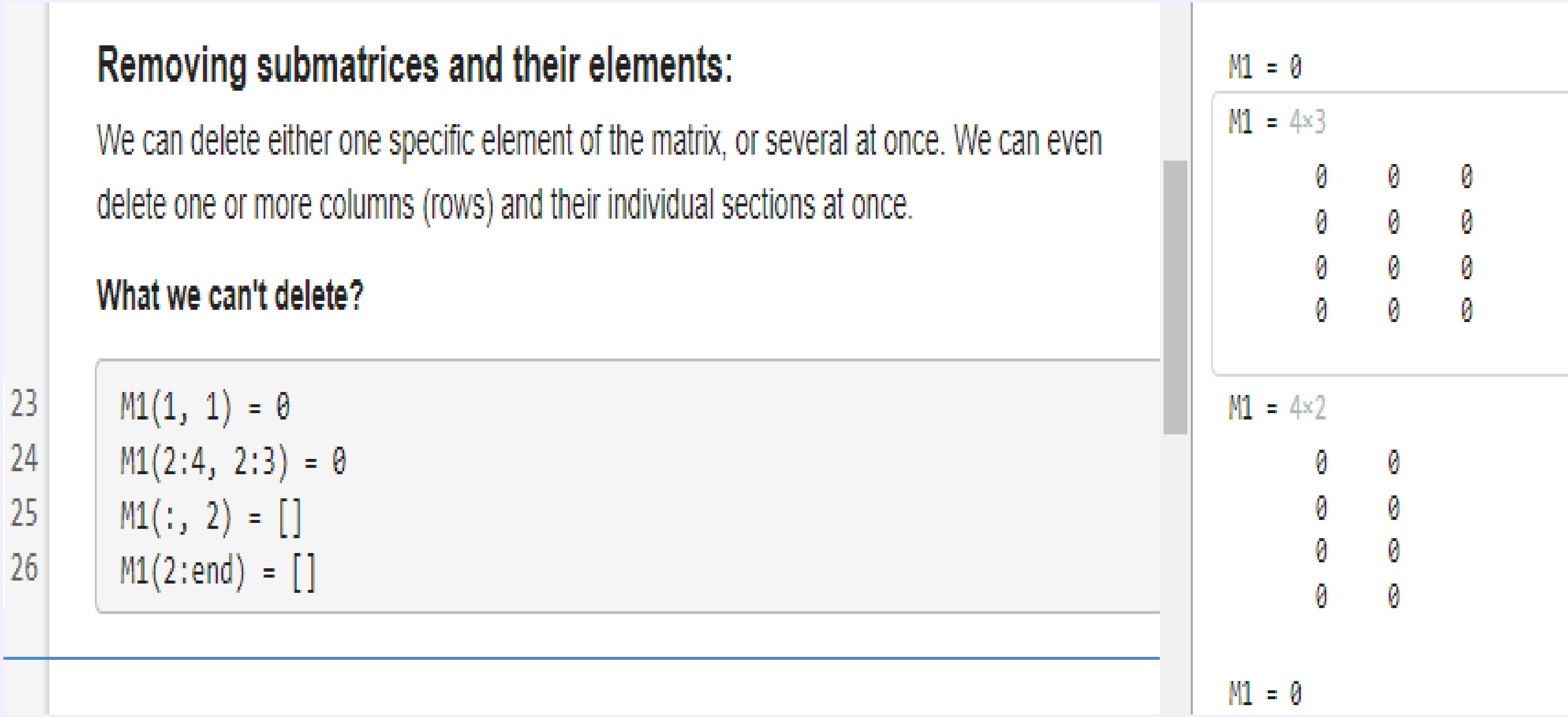
```
f0 = 3×6
          1     2     3     4     5     6
     1    1     1     1     0     0     0
     2    1     1     1     0     0     0
     3    1     1     1     0     0     0

f1 = 2×3
     1     0     0
     1     0     0

f2 = 4×2
    0.5830    0.2904
    0.2518    0.6171
    2.0000    2.0000
    1.0000    2.0000

ans = 3×3
     1     2     3
     5     6     7
     8     9    10

ans = 2×4
     1     2     5     6
     3     4     8     9
```

Удаление подматриц



Операции над матрицами

Примеры работы с подматрицами



Removing submatrices and their elements:

We can delete either one specific element of the matrix, or several at once. We can even delete one or more columns (rows) and their individual sections at once.

What we can't delete?

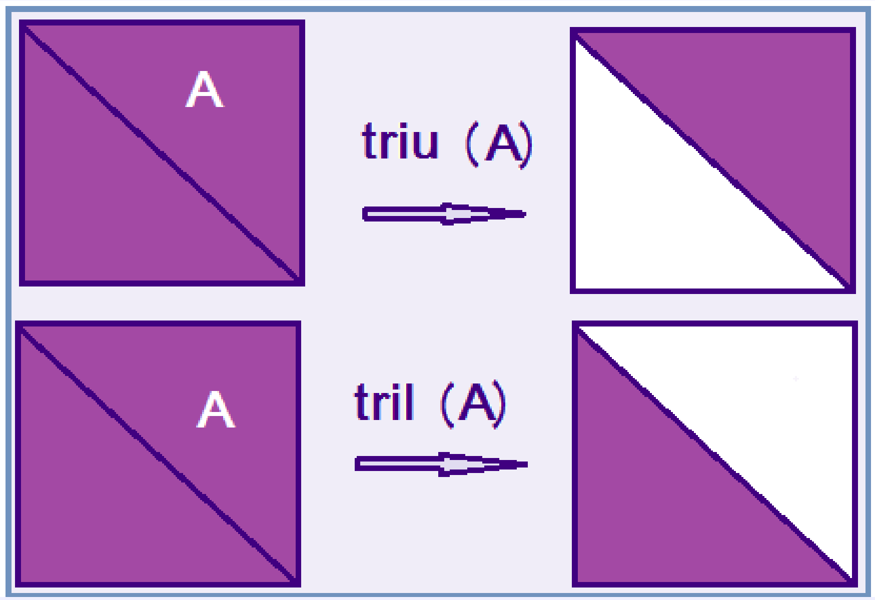
```
M1(1, 1) = 0
M1(2:4, 2:3) = 0
M1(:, 2) = []
M1(2:end) = []
```

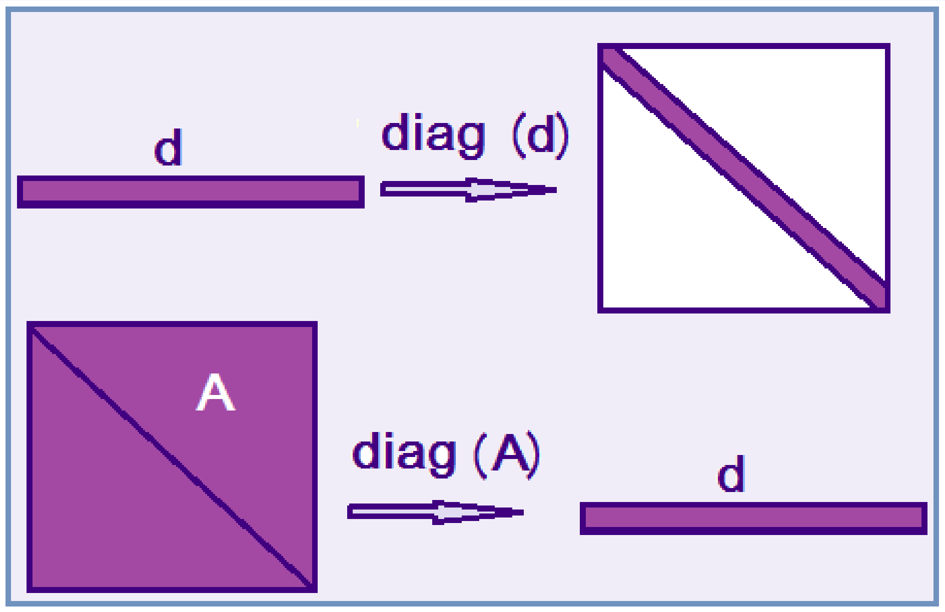
```
M1 = 0
M1 = 4×3
      0    0    0
      0    0    0
      0    0    0
      0    0    0

M1 = 4×2
      0    0
      0    0
      0    0
      0    0

M1 = 0
```

А так можно ? А (1:2:end) =[]

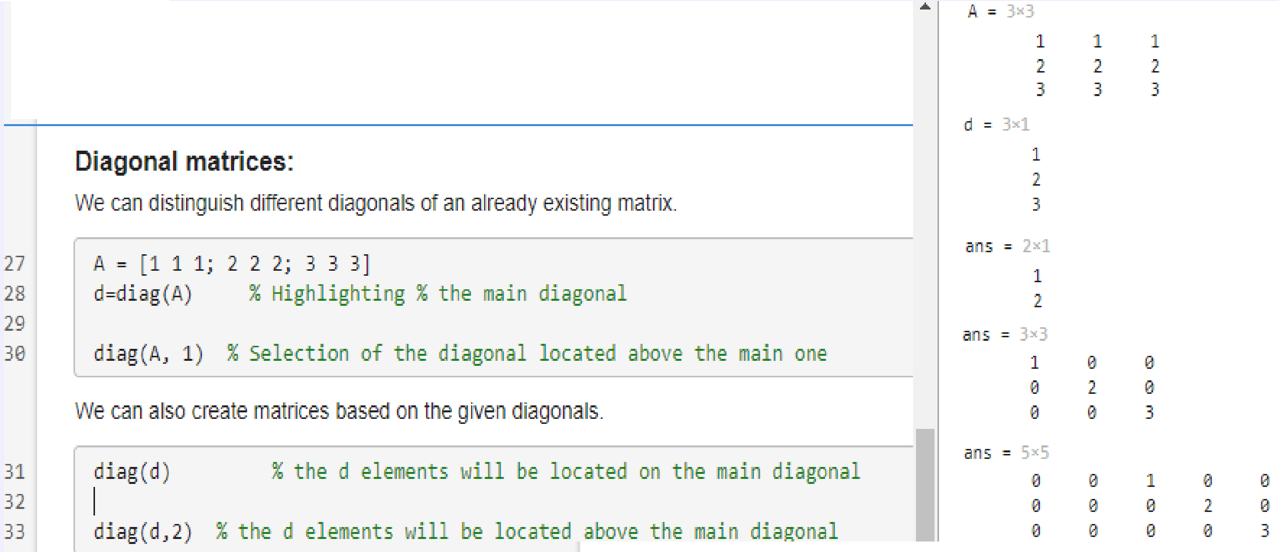
А так ? А (end:-2:1) =[]

Конструкторы диагональных и треугольных матриц





Специальные конструкторы матриц



Diagonal matrices:

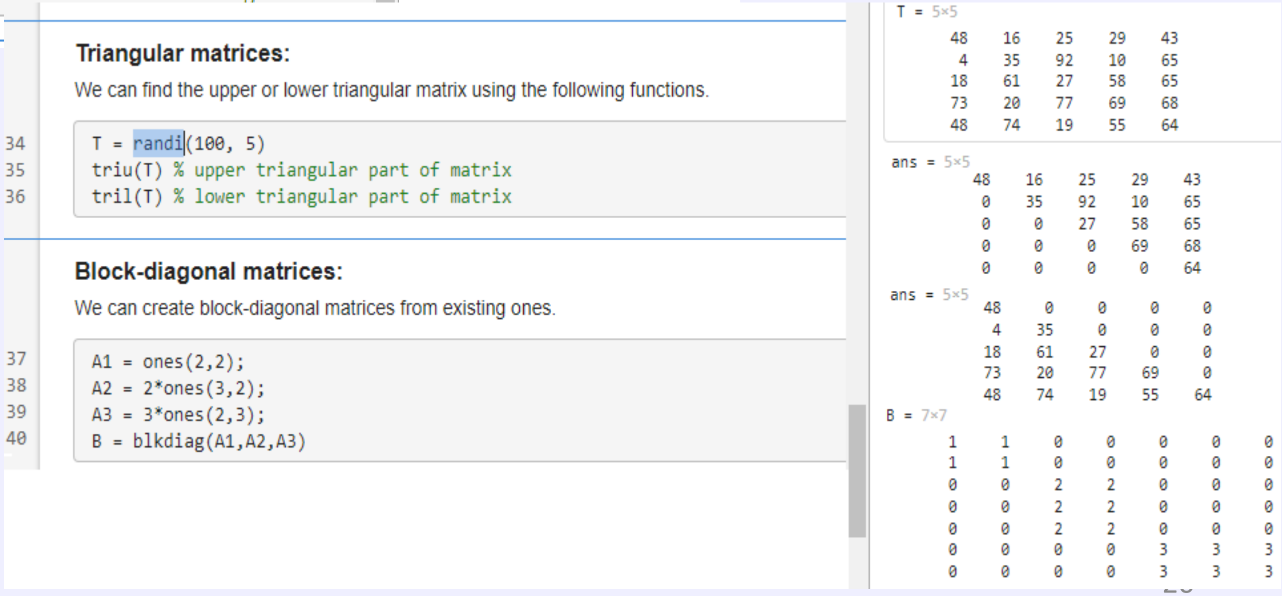
We can distinguish different diagonals of an already existing matrix.

```
A = [1 1 1; 2 2 2; 3 3 3]
d=diag(A)     % Highlighting % the main diagonal

diag(A, 1)  % Selection of the diagonal located above the main one
```

We can also create matrices based on the given diagonals.

```
diag(d)          % the d elements will be located on the main diagonal

diag(d,2)  % the d elements will be located above the main diagonal
```

```
A = 3×3
     1     1     1
     2     2     2
     3     3     3
d = 3×1
     1
     2
     3
ans = 2×1
     1
     2
ans = 3×3
     1     0     0
     0     2     0
     0     0     3
ans = 5×5
     0     0     1     0     0
     0     0     0     2     0
     0     0     0     0     3
```



Triangular matrices:

We can find the upper or lower triangular matrix using the following functions.

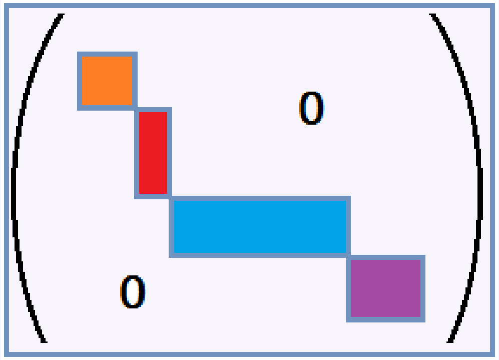
```
T = randi(100, 5)
triu(T) % upper triangular part of matrix
tril(T) % lower triangular part of matrix
```

Block-diagonal matrices:

We can create block-diagonal matrices from existing ones.

```
A1 = ones(2,2);
A2 = 2*ones(3,2);
A3 = 3*ones(2,3);
B = blkdiag(A1,A2,A3)
```

```
T = 5×5
    48    16    25    29    43
     4    35    92    10    65
    18    61    27    58    65
    73    20    77    69    68
    48    74    19    55    64
ans = 5×5
    48    16    25    29    43
     0    35    92    10    65
     0     0    27    58    65
     0     0     0    69    68
     0     0     0     0    64
ans = 5×5
    48     0     0     0     0
     4    35     0     0     0
    18    61    27     0     0
    73    20    77    69     0
    48    74    19    55    64
B = 7×7
     1     1     0     0     0     0     0
     1     1     0     0     0     0     0
     0     0     2     2     0     0     0
     0     0     2     2     0     0     0
     0     0     2     2     0     0     0
     0     0     0     0     3     3     3
     0     0     0     0     3     3     3
```



Блочно-диагональная матрица

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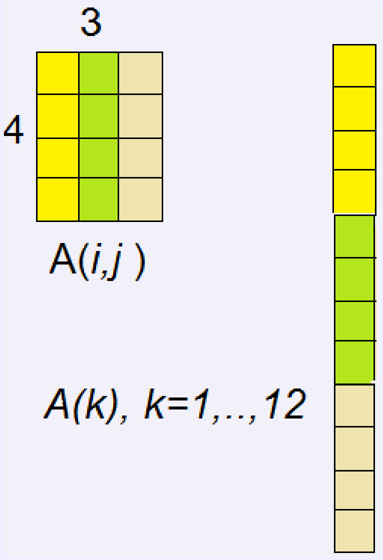
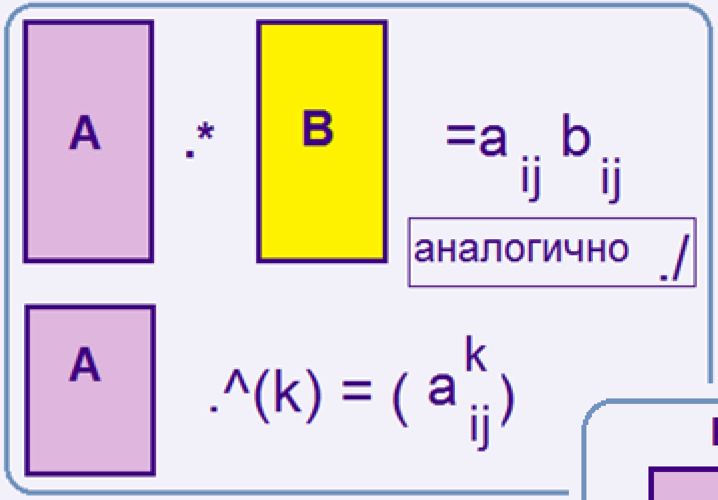
Редактирование содержания и формы матриц



Одинарная и двойная нумерация матриц



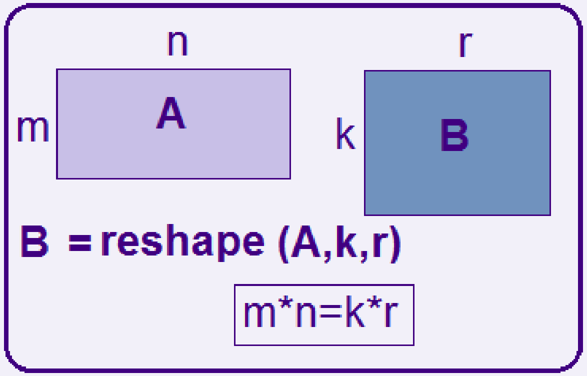
$A .* B = a_{ij} b_{ij}$

аналогично ./

$A .\hat{}(k) = (a_{ij}^{k})$

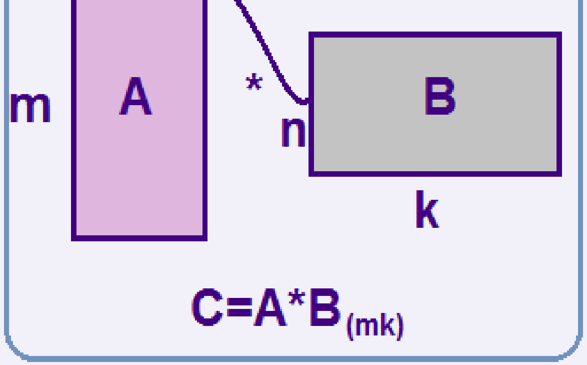
Векторные операции

Repmat – **самостоятельно!**



B = reshape (A,k,r)

m*n=k*r



$C=A*B_{(mk)}$

Правила матричной алгебры

Операции над матрицами

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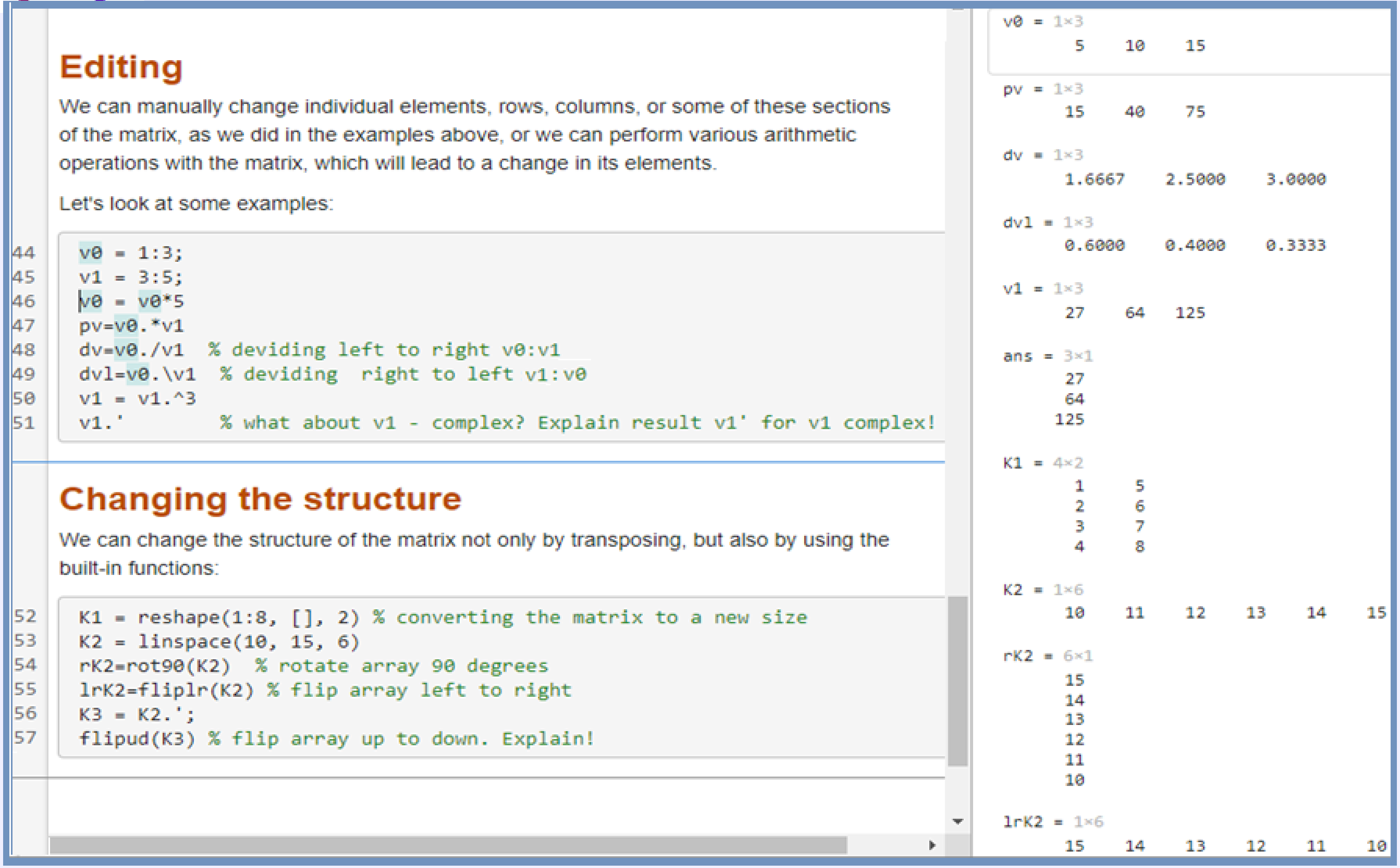
Примеры редактирования содержания и формы



Editing

We can manually change individual elements, rows, columns, or some of these sections of the matrix, as we did in the examples above, or we can perform various arithmetic operations with the matrix, which will lead to a change in its elements.

Let's look at some examples:

```
v0 = 1:3;
v1 = 3:5;
v0 = v0*5
pv=v0.*v1
dv=v0./v1  % deviding left to right v0:v1
dvl=v0.\v1  % deviding  right to left v1:v0
v1 = v1.^3
v1.'          % what about v1 - complex? Explain result v1' for v1 complex!
```

Changing the structure

We can change the structure of the matrix not only by transposing, but also by using the built-in functions:

```
K1 = reshape(1:8, [], 2) % converting the matrix to a new size
K2 = linspace(10, 15, 6)
rK2=rot90(K2)  % rotate array 90 degrees
lrK2=fliplr(K2) % flip array left to right
K3 = K2.';
flipud(K3) % flip array up to down. Explain!
```

```
v0 = 1×3
       5    10    15

pv = 1×3
      15    40    75

dv = 1×3
      1.6667    2.5000    3.0000

dvl = 1×3
      0.6000    0.4000    0.3333

v1 = 1×3
      27    64   125

ans = 3×1
      27
      64
     125

K1 = 4×2
       1     5
       2     6
       3     7
       4     8

K2 = 1×6
      10    11    12    13    14    15

rK2 = 6×1
      15
      14
      13
      12
      11
      10

lrK2 = 1×6
      15    14    13    12    11    10
```

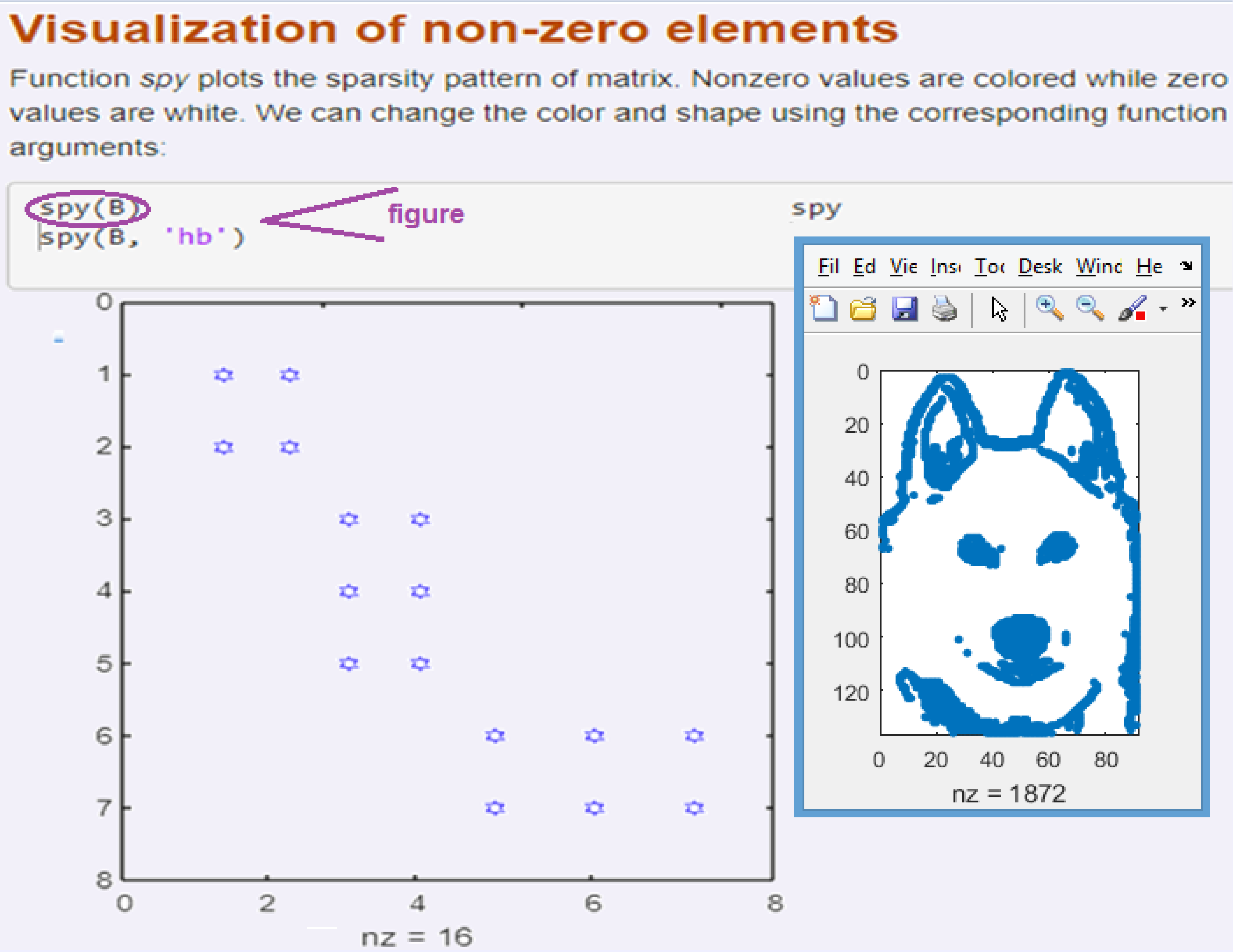
SPY

Визуализация структуры матрицы

(*ненулевых элементов*)

Визуализация структуры матрицы. Что не так?

spy(B) – **потерялся!**



Visualization of non-zero elements

Function *spy* plots the sparsity pattern of matrix. Nonzero values are colored while zero values are white. We can change the color and shape using the corresponding function arguments:

```
spy(B)
spy(B, 'hb')
```

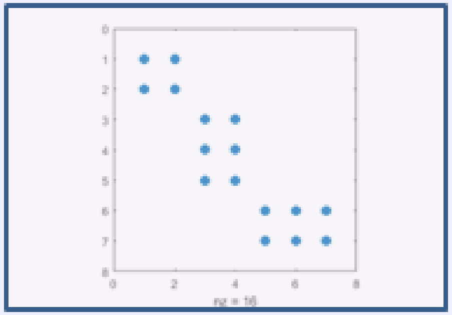
figure

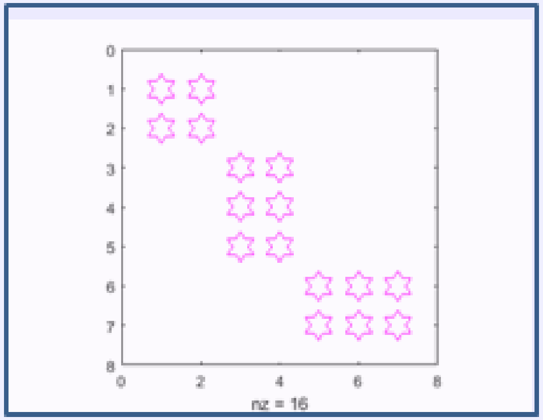
spy

SPY – в деталях

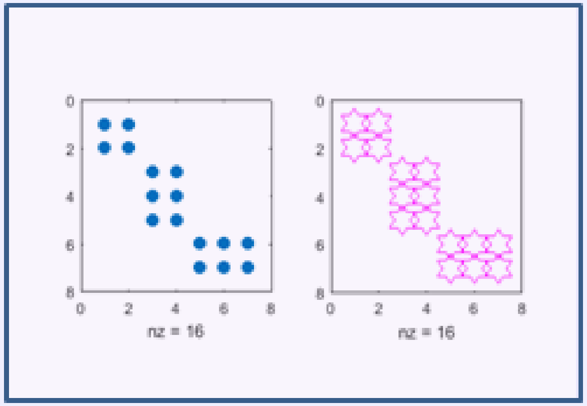
```
clear
% randi([vmin vmax],size)
B=blkdiag(rand(2), ones(3,2), ...
            randi([5,18],2,3)) % break line
nnz(B) % number of nonzero elements
spy(B,30)
spy(B,20,'hm')  % 20 - markersize,
```

```
clear
B=blkdiag(rand(2), ones(3,2), randi([5,18],2,3))
spy(B,30)
figure
spy(B,20)
```





```
clear
B=blkdiag(rand(2),...
    ones(3,2), randi([5,18],2,3))
nnz(B)
subplot(1,2,1),  spy(B,30)
subplot(1,2,2),   spy(B,20,'hm')
```



blkdiag – конструктор блочно-диагональной матрицы

subplot(n,m,nc) – конструктор матрицы из графических окон, n – число строк, m – ?, nc – номер окна (счет идёт последовательно по строкам)

Функции библиотеки **Elmat**

СИСТЕМНЫЕ ПЕРЕМЕННЫЕ И КОНСТАНТЫ MATLAB

clc	- очистить Command Window
clear	- удалить переменные Workspace
eps	- Floating point relative accuracy
realmax	- Largest positive floating point number
realmin	- Smallest positive floating point number
intmax	- Largest positive integer value
intmin	- Smallest integer value
flintmax	- Largest consecutive integer in floating point format 9.0072e+15
pi	- 3.1415926535897....
i , j	- Imaginary units
inf	- Infinity
nan	- Not-a-Number *(isnan(A));*
true	- True array
false	- False array
end	- Last index

ОПЕРАЦИИ MATLAB

»help ops

Arithmetic operators:

plus	- Plus	+
uplus	- Unary plus	+
minus	- Minus	-
uminus	- Unary minus	-
mtimes	- Matrix multiply	*
times	- Array multiply	.*
mpower	- Matrix power	^
power	- Array power	.^
mldivide	- Backslash or left matrix divide	\
mrdivide	- Slash or right matrix divide	/
ldivide	- Left array divide	.\
rdivide	- Right array divide	./
idivide	- Integer division with **rounding**option.	
kron	- Kronecker tensor product	

Relational operators:

eq (A,B)	- Equal	**A == B**
ne (A,B)	- Not equal	**A~=B**
lt (A,B)	- Less than	**A < B**
gt (A,B)	- Greater than	**A> B**
le (A,B)	- Less than or equal	**A <= B**
ge (A,B)	- Greater than or equal	**A >=B**

Logical operators:

and (relop - Short-circuit logical) **A && B**
B - is not calculated if A consists of logical 0;
result - scalar *true* or *false*
or relop - Short-circuit logical **A || B**
B - is not calculated if A consists of logical 1 ;
result - scalar true or false
and - Element-wise logical **&**
or - Element-wise logical **or** **|**
not - Logical NOT **~**
punct - Ignore function argument or output **~**
xor - Logical EXCLUSIVE OR
any - True if any element of vector is nonzero
all - True if all elements of vector are nonzero

СПЕЦИАЛЬНЫЕ СИМВОЛЫ

Special characters:

colon	- Colon	**:**
paren	- Parentheses and subscripting	**( )**
paren	- Brackets	**[ ]**
paren	- Braces and subscripting	**{ }**
punct	- Function handle creation	**@**
punct	- Decimal point	**.**
punct	- Structure field access	**.**
punct	- Parent directory	**..**
punct	- Continuation	**...**
punct	- Separator	**,**
punct	- Semicolon	**;**

Special characters:

punct	- Comment	**%**
punct	- Invoke operating system command	**!**
punct	- Assignment	**=**
punct	- Quote	**'**
transpose	- Transpose	**.'**
ctranspose	- **Complex conjugate transpose**	**'**
horzcat	- Horizontal concatenation	**[,]**
vertcat	- Vertical concatenation	**[;]**
subsasgn	- Subscripted assignment	**( ),{ },.**
subsref	- Subscripted reference	**( ),{ },.**

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Спасибо за внимание!
Увидимся!

Не стыдно не знать, досадно не хотеть узнать!