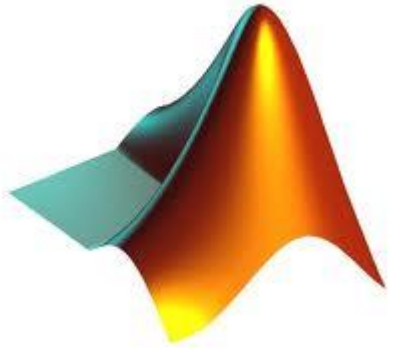
Úvod do MATLAB-u

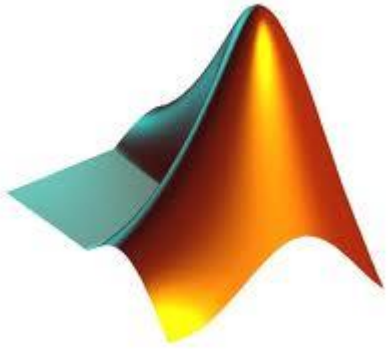
MATLAB

- **Pôvodne:** Interaktívny program na operácie s maticami
- **Teraz:** Vysoko úrovňový jazyk na technické výpočty a interaktívne prostredie na:
  - tvorbu algoritmov, vizualizáciu a analýzu dát a numerické výpočty



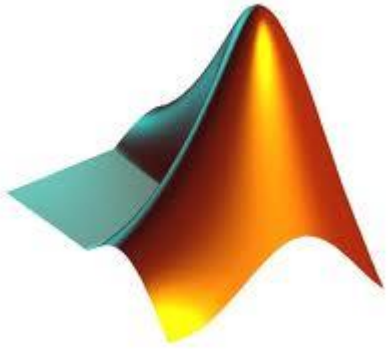
MATLAB

- Interaktívny nástroj na analýzu, návrh a riešenie problémov
- Matematické funkcie pre lineárnu algebru, štatistiku, Fourierovu analýzu, filtrovanie...
- Funkcie na vizualizáciu 2D a 3D dát
- Nástroje na vytvorenie GUI



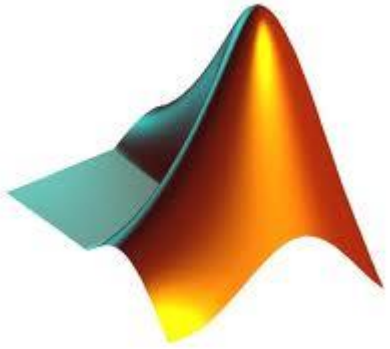
MATLAB

- **Využitie:** spracovanie signálu, spracovanie obrazu, testovanie a meranie, finančné modelovanie a analýza, výpočtová biológia...
- Toolboxy rozširujú prostredie MATLAB na riešenie tried problémov z konkrétnych oblastí



MATLAB - functions

- Function list
  - http://www.mathworks.com/help/matlab/functionlist.html
- Tutorial:
  - http://www.mathworks.com/help/pdf_doc/matlab/getstart.pdf



Toolbox

- Image Processing Toolbox
- Image Acquisition Toolbox
- Video and Image Processing Blockset
- Iné Toolboxy
  - Statistics, Bioinformatics, Wavelet, Fuzzy Logic, Econometrics

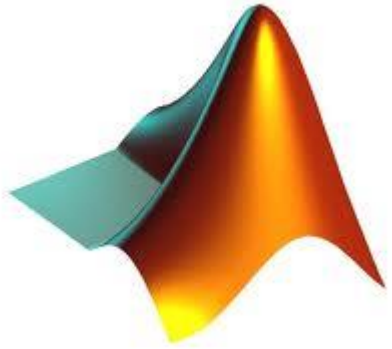
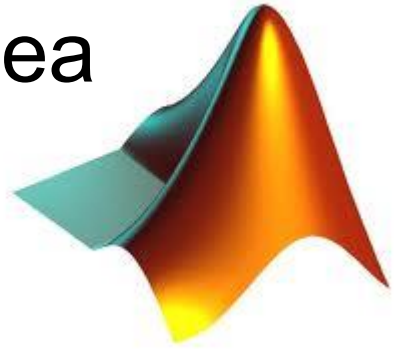
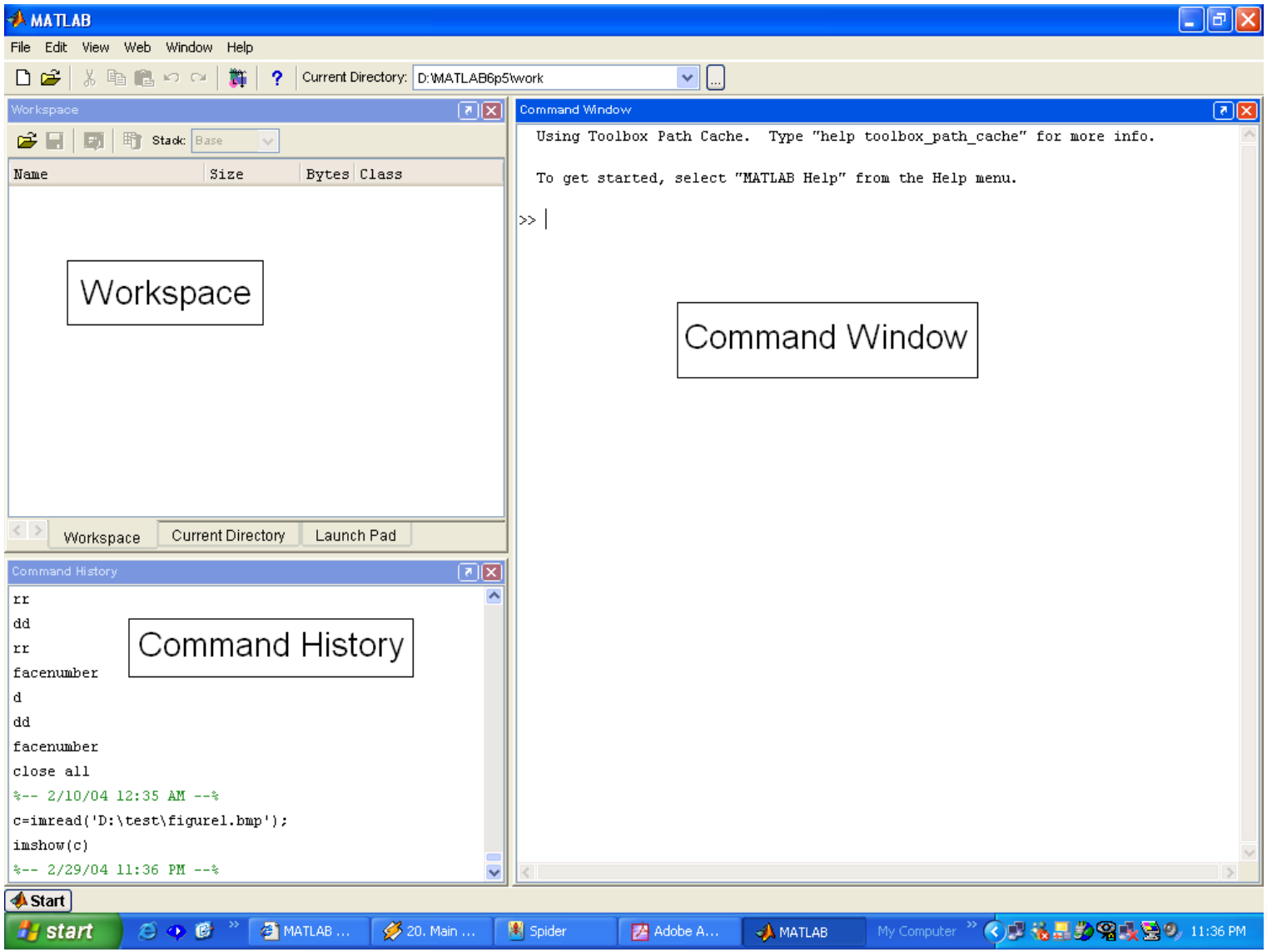


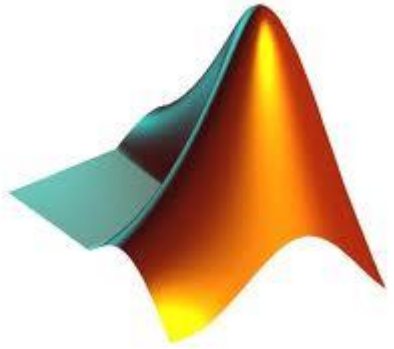
Image Processing Toolbox

- **Image Analysis**
  - segmentácia, matematická morfológia, extrakcia príznakov, detekcia hrán
- **Spracovanie obrazu**
  - zvýšenie kontrastu, prevod medzi farebnými modelmi
- FFT, DCT
- Zobrazovanie sekvencií obrázkov a videa



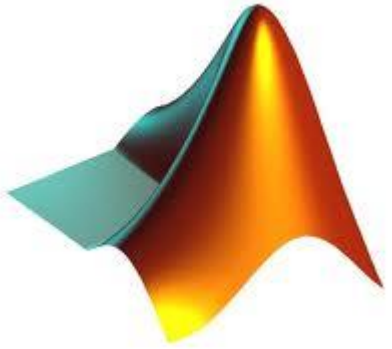
MATLAB prostredie





MATLAB prostredie

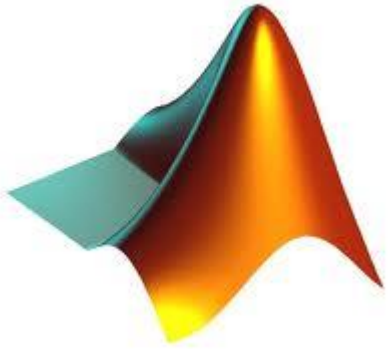
- Command window
  - písanie príkazov, výstupy, chyby
- Workspace
  - premenné, ich hodnoty a typy
- Command History
  - použité príkazy sa dajú „drag and drop“ do command window



Demá

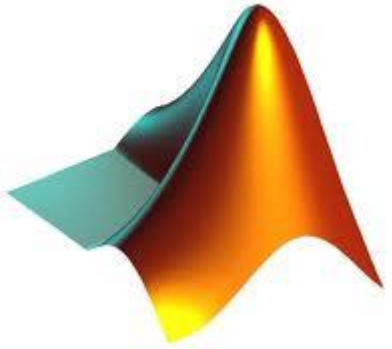
- >> demo
  - Záložka Demos
  - 3D Visualisation
  - Teapot, Images and Colormaps

- >> help commandname
- >> lookfor keyword



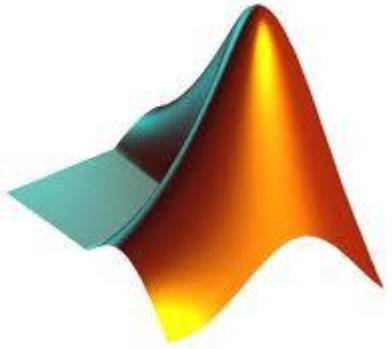
Command window

- 3 + 4 - 7
- t = 3 + 4 – 7
- k = 3 + 4 - 7;
- k
- k;
- 3^2*4
- 2+2 / 1+1



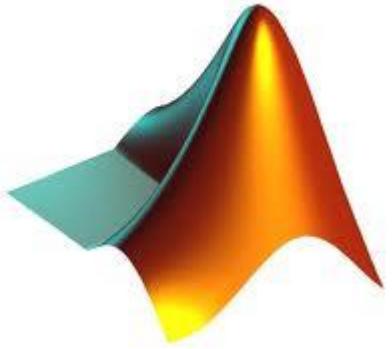
Command window

- 1/0 (Inf)
- 0/0 (NaN)
- MATLAB je Case Sensitive!
- K a k sú rôzne premenné
- 15 miest, ale ukazuje len 5
- format long / format short



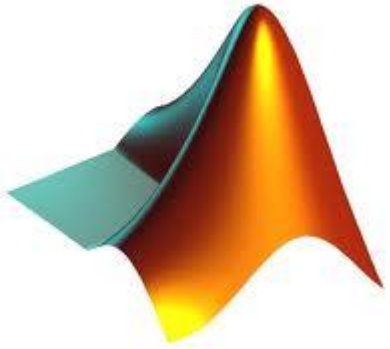
Command window

- MATLAB má množstvo vstavaných funkcií
- sin, cos, tan, asin, acos
- sin(pi/2)
- log, log10, log2
- log10(100)



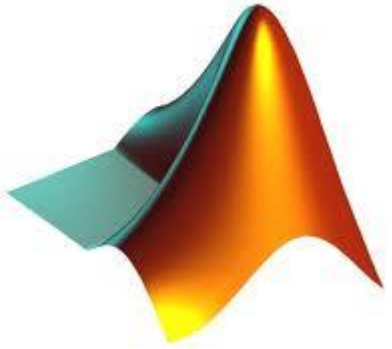
Vektory v MATLAB-e

- v = [1, 2, 3, 4]
- v = [1 2 3 4]
- v = [1; 2; 3; 4]
- Workspace: tabuľka, graf
- v = start: step: end
- v = 2:2:9
  - v = [2, 4, 6, 8]
- v = 2:5
  - v = [2, 3, 4, 5]



Vektory v MATLAB-e

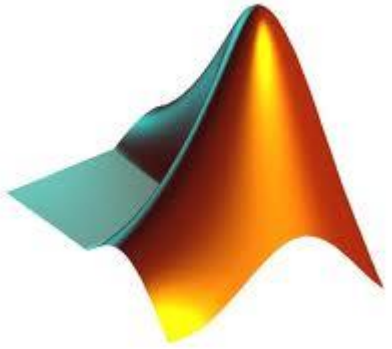
- v = linspace(1, 5, 10)
- v (4) = 0
- v (5:7) = 0
- v (1: 2: 7) = 0



Matice v MATLAB-e

- vytvorenie
  - A=[1 2 3; 4 5 6; 7 8 9];
  - 3 x 3
- špeciálne:
  - zeros(), ones(), eye(), rand(), randn(), magic()

```
p = zeros(3, 3) == zeros(3);
o = ones(3, 3) == ones(3);
r = rand(3, 3) == rand(3);
r1 = randn(1,10);
k = magic(3);
```



Matice v MATLAB-e

- Prístup (riadok, stĺpec)

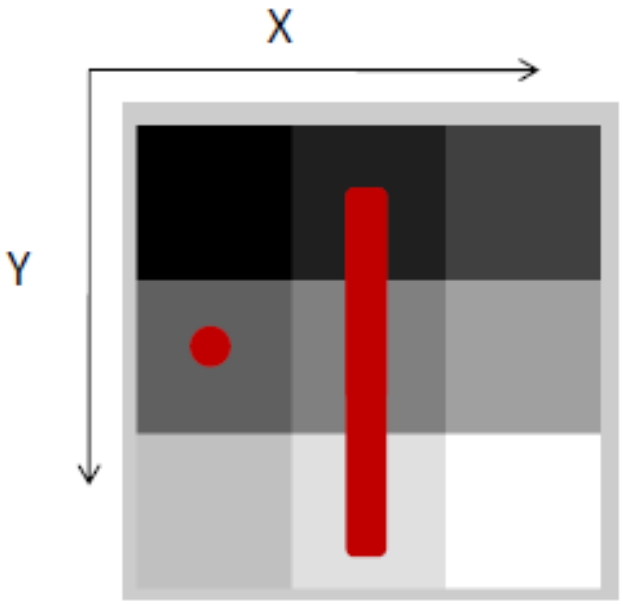
```
>> A(2,1)
ans = 4
```

- : celý riadok alebo stĺpec

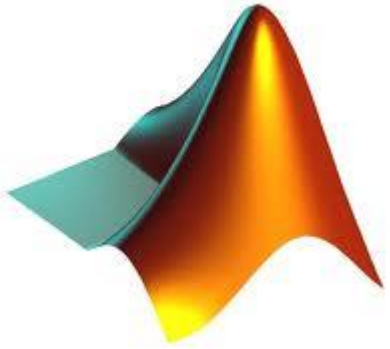
```
>> A(:,2)
ans =
     2
     5
     8
```

- Interval

```
>> A(1:2,2)
ans =
     2
     5
```




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



Operácie

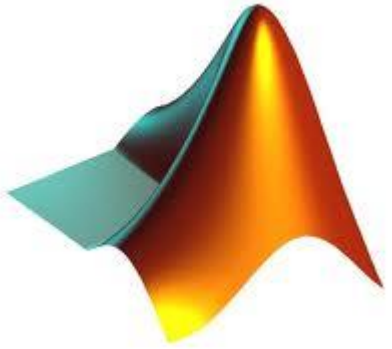
- maticové:

  +, -, *, /, ^

- Medzi prvkami:

  .*, ./, .^, sqrt(), sin(), cos(), ...

- size(A) – rozmery
- sum(A) – suma po stĺpcoch
- sum(sum(A)) – suma všetkých prvkov
- sum(A(:))



Operácie

- >> A+A

  ans = 2 4 6

  8 10 12

  14 16 18

- >> A*A

  ans = 30 36 42

  66 81 96

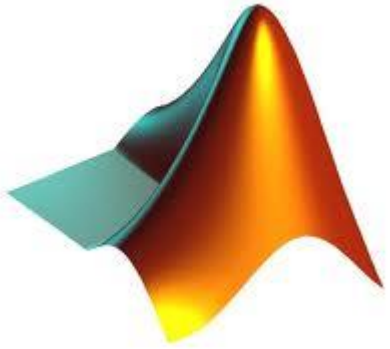
  102 126 150

- >> A.*A

  ans = 1 4 9

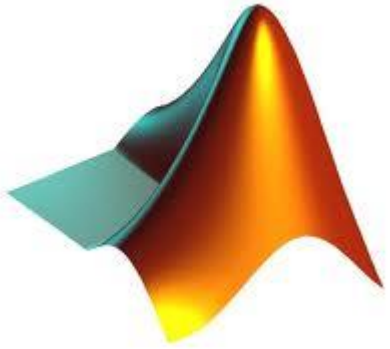
  16 25 36

  49 64 81



Názvy premenných

- Názvy premenných
- 63 signifikantnych znakov
- Začína písmenom
- Bez diakritiky a medzier
- Rozlišuje veľkosť písmen
- Odlišné od názvov príkazov a preddefinovaných premenných (pi, i, j, eps, ...)
- exist meno



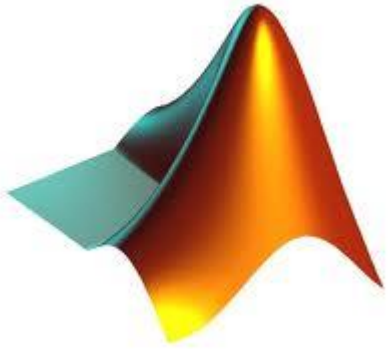
Logické operátory

- Logické operátory

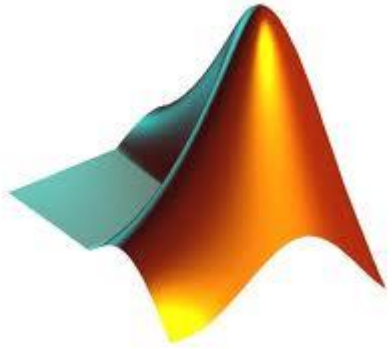
  `==, <, >, ~=, ~, …`

- `find('podmienka')`
  - vráti indexy vyhovujúcich prvkov

Symbol	Represents	Symbol	Represents
>	Greater than	>=	Greater or equal to
<	Less than	<=	Less or equal to
~=	Not equal to	= =	Equal to
Not	~	And	&
Or	| (single vertical line)		

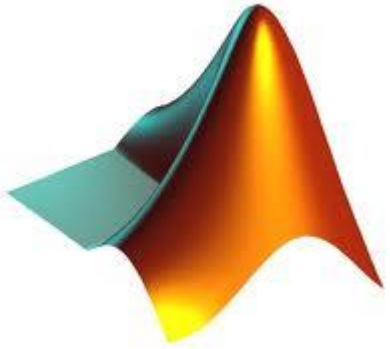


```
>>A=[7 3 5; 6 2 1]
>>Idx=find(A<4)
     A=
        7 3 5
        6 2 1
     Idx=
        3
        4
        6
```



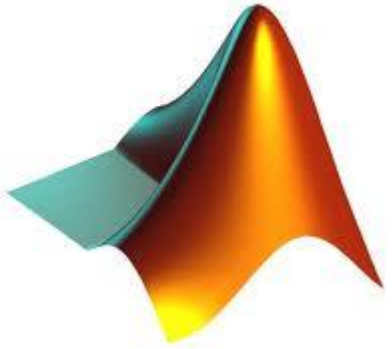
```
>> [row col]=find(A==7)

   row =  3

   col =  1

>> [row col]=find(A>7)

   row =  3

          3

   col =  2

          3

>> Indx=find(A<5)

  Indx =  1

          2

          4

          7
```

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



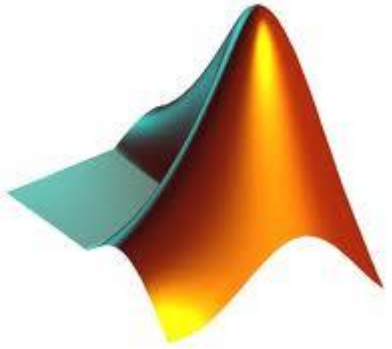
Graf $y=x^2$

- `x = linspace(0, 5, 100);`
- `y1 =x;`
- `plot(x,y1); grid;`
- `y2 = x.^2;`
- `y3 = x.^3;`
- `plot(x,y1, x,y2, x,y3); grid;`



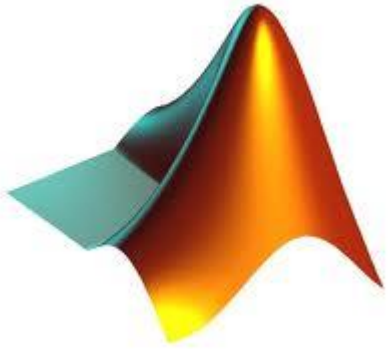
Polia

- `v = zeros (1,100);`
- Funkcie pre 1D polia:
  - sum, max, min, sort, mean
  - s = sum(v);

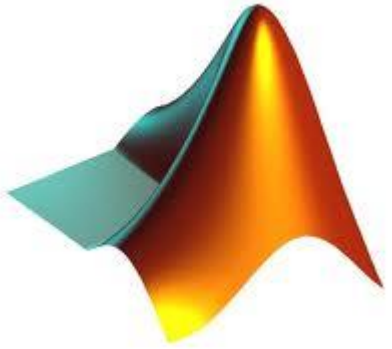


Ret'azce

- `s = 'string'`
- `l =length(s);`
- `s(3)`
- `strcmp, findstr`

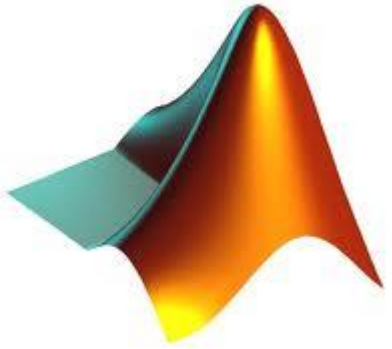


- flow control:
  - `if`
  - `switch`
  - `for`
  - `while`
  - `break`



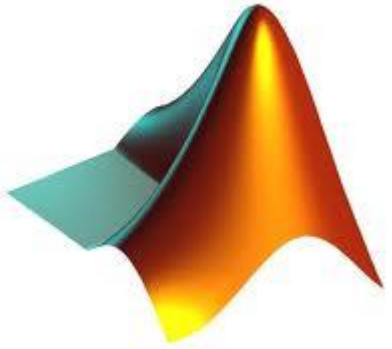
What if...

```
IF expression
  statements
ELSEIF expression
  statements
ELSE
  statements
END
```



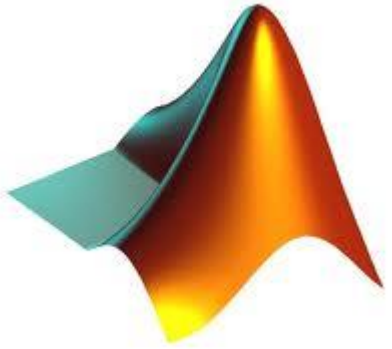
for

```
FOR variable=expr
  statements
END
```



Výpis textu

- `fprintf ('Hello World!');`
- `fprintf ('Hodnota x je %g', x);`
- Nie je vhodné pre vektory
  - \n nový riadok
  - %g kompaktný zápis
  - %c jeden znak
  - %e exponenciálny zápis
  - %s string



Timing

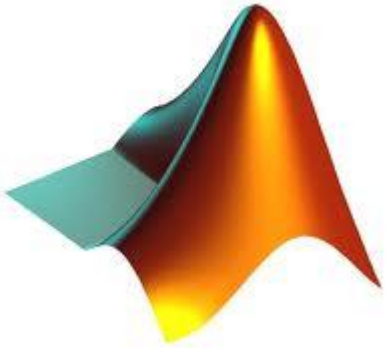
- tic; prikazy; toc;
- V sekundách
- V m-file

  t0 = cputime

  ....príkazy, výpočty

  t1 = cputime

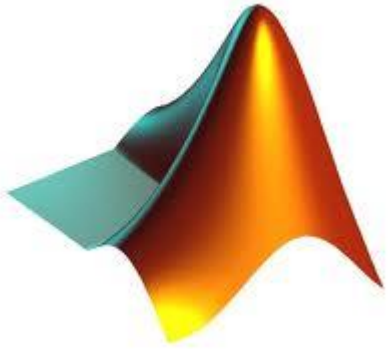
  fprintf('vypočet trval %g', t1- t0)



Alokácia premenných

```
tic
x = 0;
for k = 2:100000
  x(k) = x(k-1) + 5;
end
toc
```

```
tic
x = zeros(1, 100000);
for k = 2:100000
  x(k) = x(k-1) + 5;
end
toc
```



MATLAB špecialitka

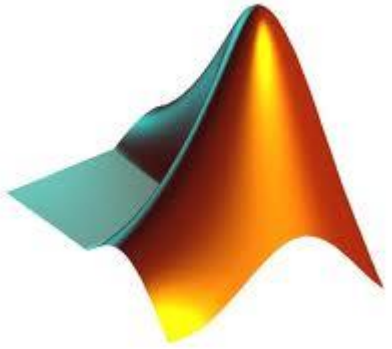
- Chceme vytvoriť pole kde $v(p) = \frac{p}{\sin(p)+2}$
- 1: `for p = 1:1000`

  `v(p) = (p/sin(p)+2); end`
- 2: `v = zeros (1, 1000);`

  `for p = 1:1000`

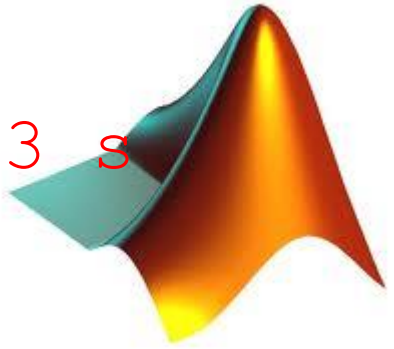
  `v(p) = (p/sin(p)+2); end`
- 3: `p = 1:1000`

  `v = (p./sin(p)+2)`



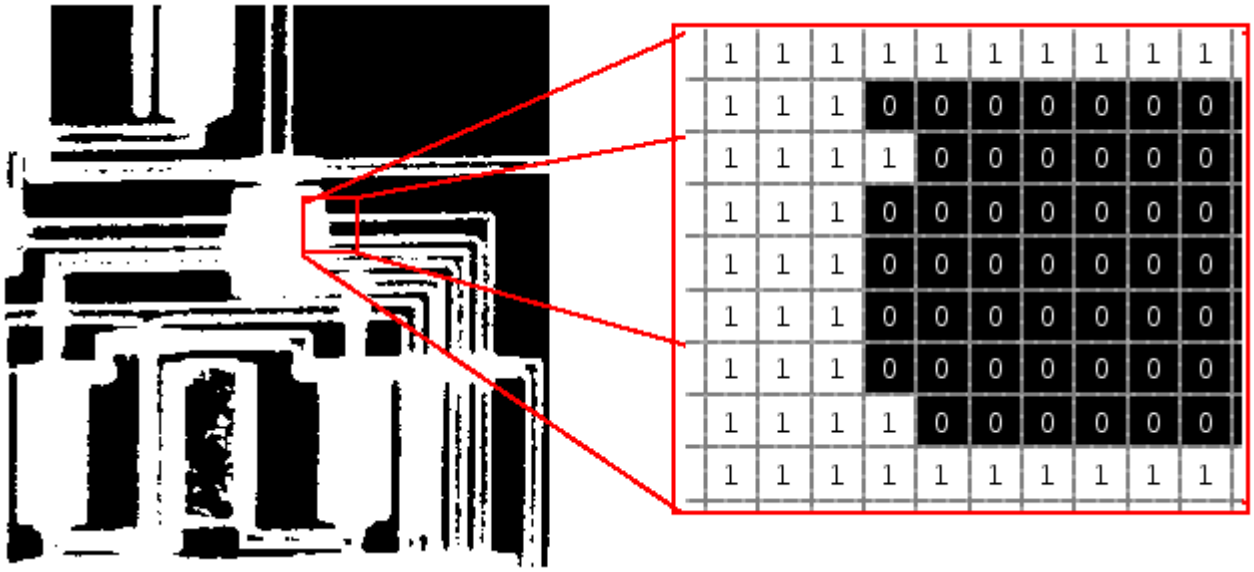
MATLAB špecialitka

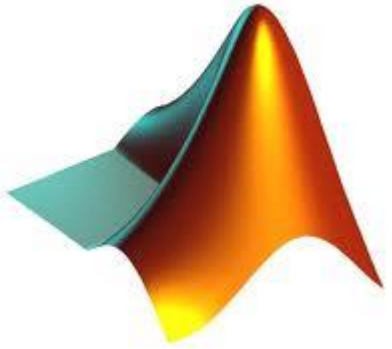
- Chceme vytvoriť pole kde $v(p) = \frac{p}{\sin(p)+2}$
- 1:
```
for p = 1:1000
v(p) = (p/sin(p)+2); end
```
1.82 s
- 2:
```
v = zeros (1, 1000);
for p = 1:1000
v(p) = (p/sin(p)+2); end
```
0.16 s
- 3:
```
p = 1:1000
v = (p./sin(p)+2)
```
0.0083 s



Obrázky

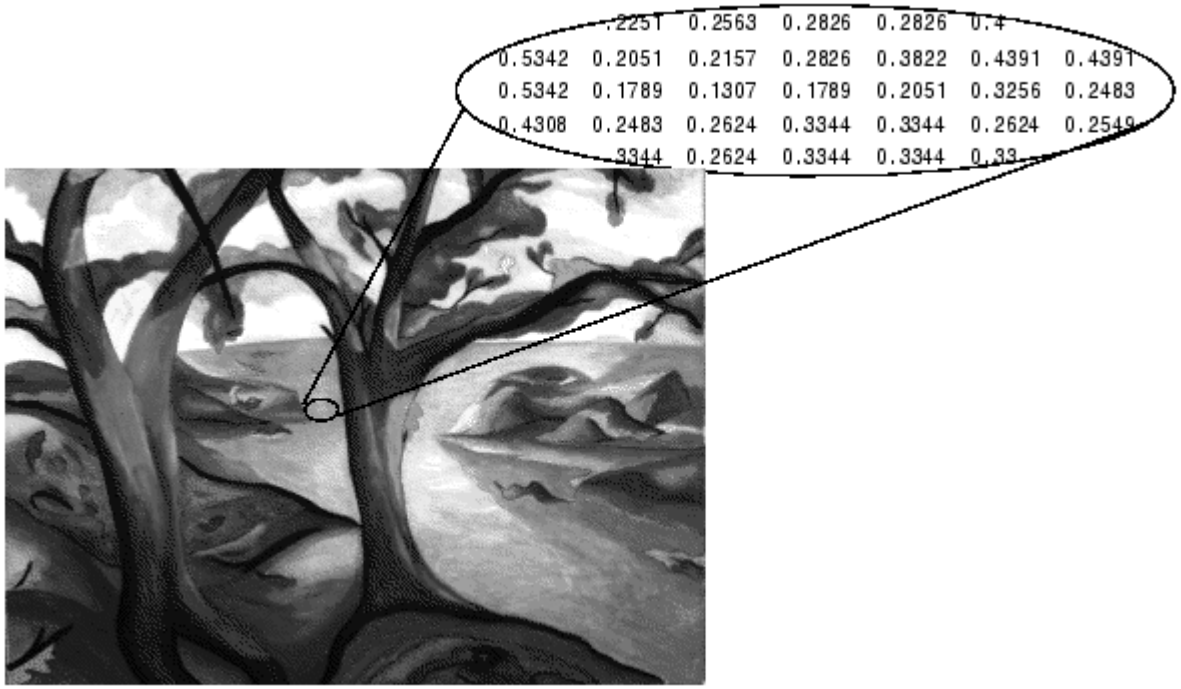
- **binárne: {0,1}**
- šedotónové: uint8, double ...
- RGB: $m \times n \times 3$

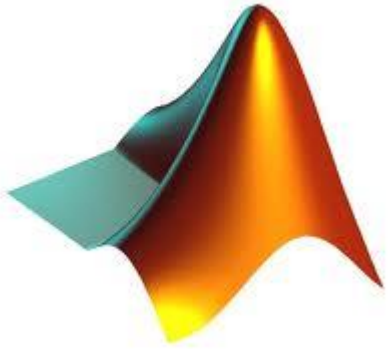




Obrázky

- binárne: {0,1}
- **šedotónové: uint8, double ...**
- RGB: m × n × 3



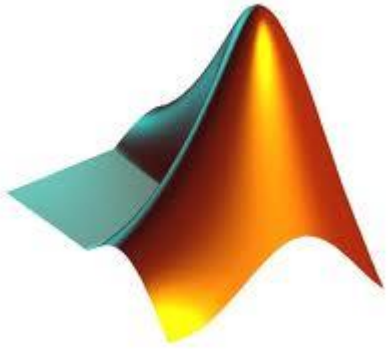


Obrázky

- binárne: {0,1}
- šedotónové: uint8, doul
- **RGB: m × n × 3**

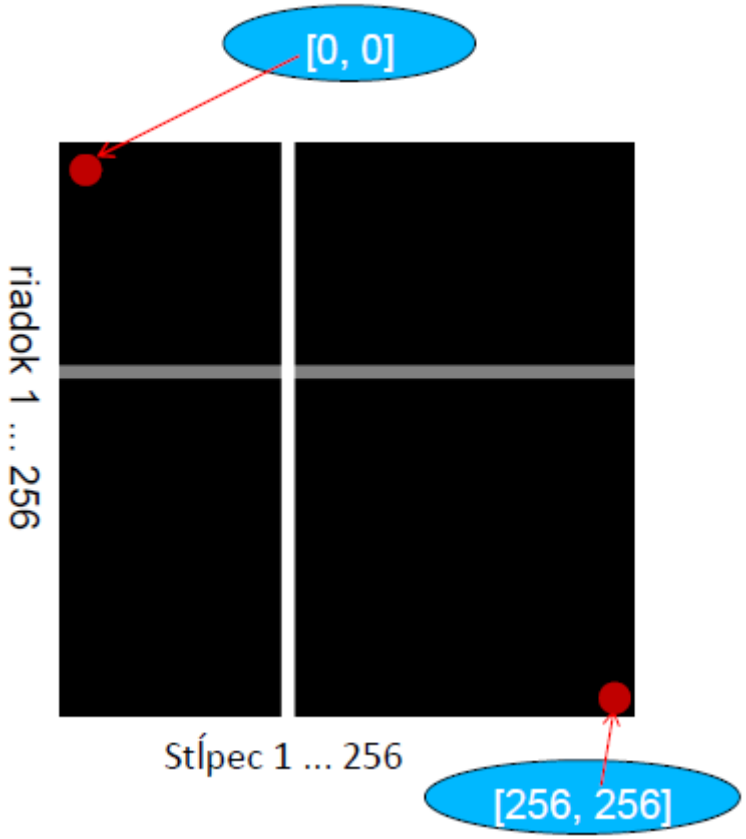
Import a Export

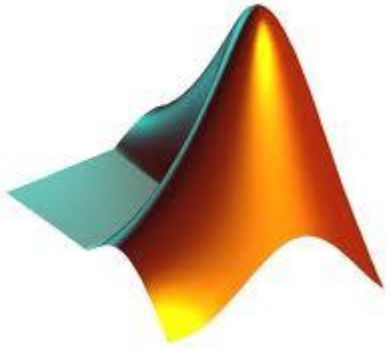
```
img = imread('apple.jpg');
dim = size(img);
figure;
imshow(img);
imwrite(img, 'output.bmp', 'bmp');
```

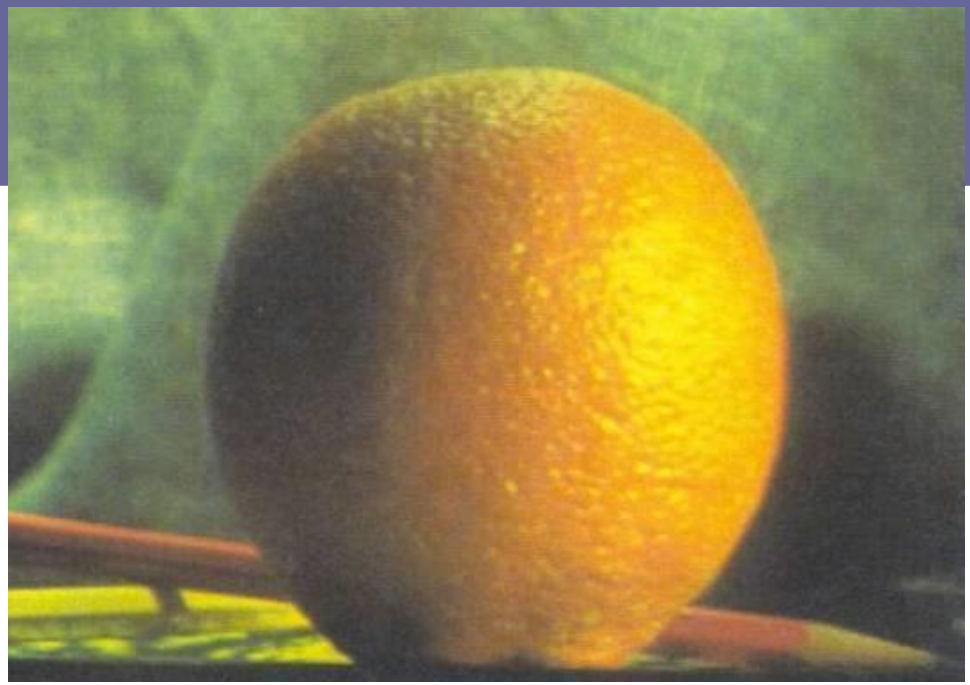


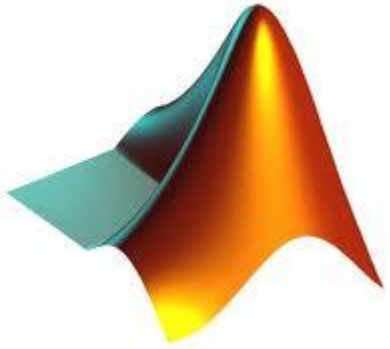
Šedotónový obraz

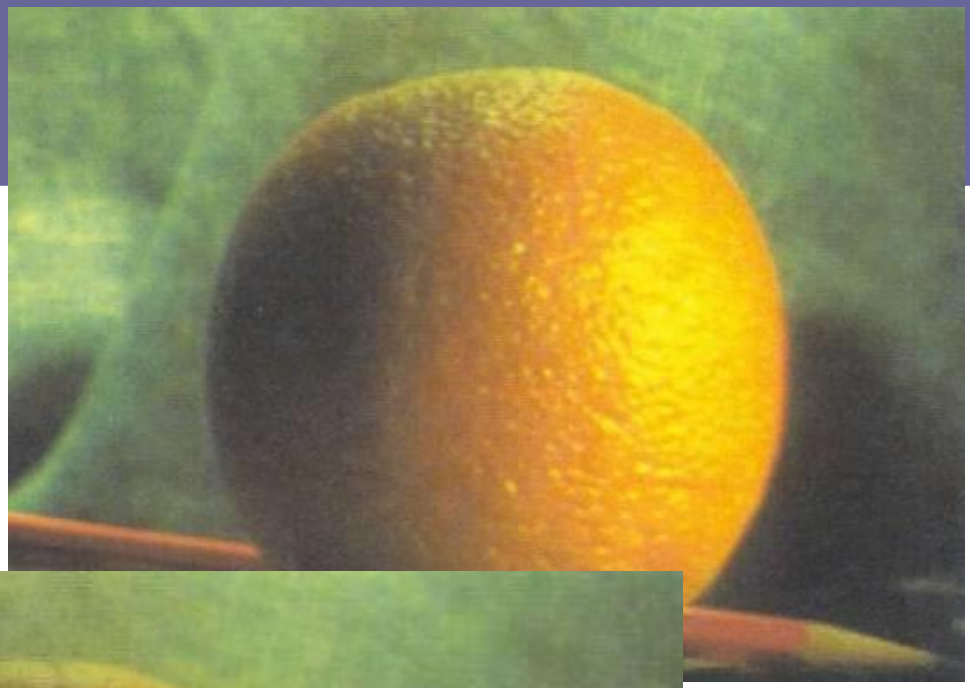
```
row = 256;
col = 256;
img = zeros(row, col);
img(100:105, :) = 0.5;
img(:, 100:105) = 1;
figure;
imshow(img);
```

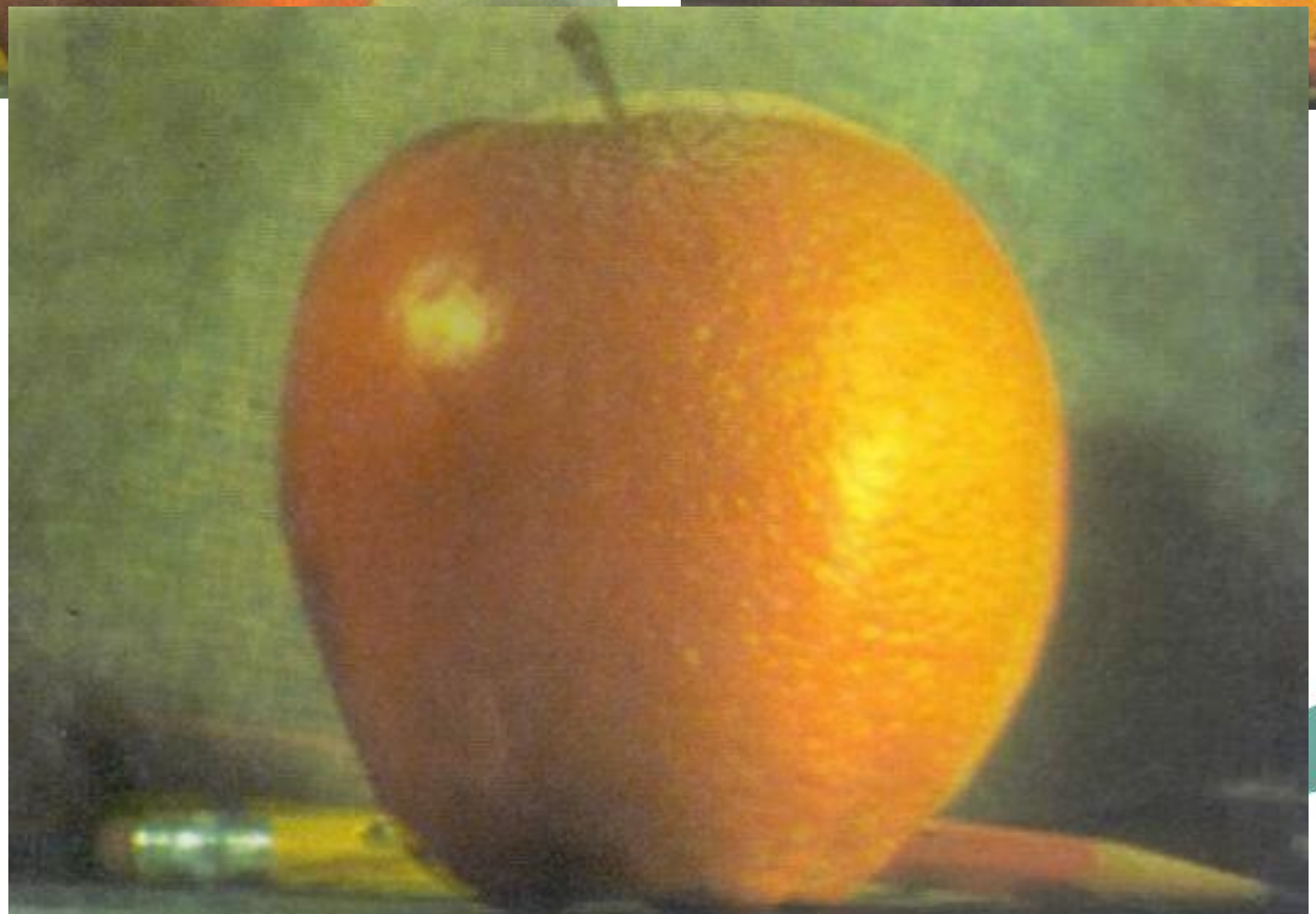


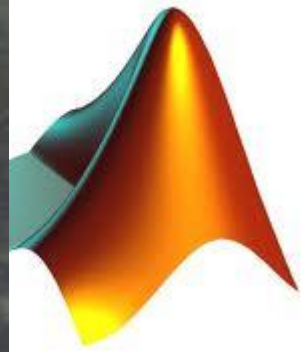












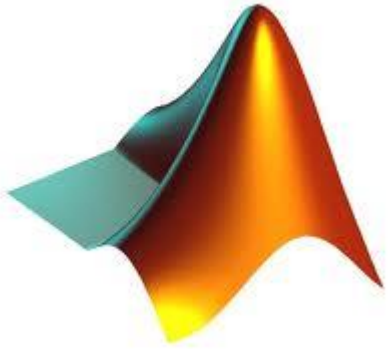
A a B veľkosti (540*380), zmiešanie

```
apple = imread('apple.jpg');
orange = imread('orange.jpg');
```

Hrubá sila

```
% measure performance using stopwatch timer
tic
for i = 1 : size(apple, 1)
   for j = 1 : size(apple, 2)
       for k = 1 : size(apple, 3)
           output(i, j, k) = (apple(i, j, k) + orange(i, j, k))/2;
       end
   end
end
toc
```

? sekúnd



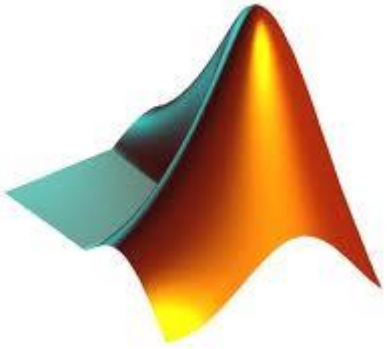
A a B veľkosti (540*380), zmiešanie

```
apple = imread('apple.jpg');
orange = imread('orange.jpg');
```

Maticový prístup

```
tic
  Output = (apple + orange)/2;
toc
```

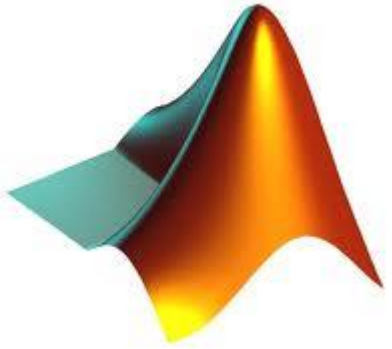
? sekúnd



Optimalizácia výkonu

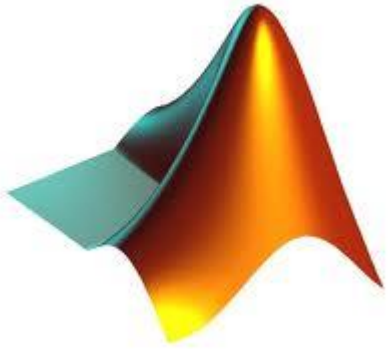
- Rýchle vektorové a maticové operácie
- Pomalé cykly

- Ako vektorizovať kód
  - http://www.mathworks.com/support/tech-notes/1100/1109.html



Užitočné skratky

- Ctrl r
  - zakomentovať vyznačené
- Ctrl t
  - odkomentovať vyznačené
- Ctrl c
  - prerušiť bežiaci program/príkaz
- why, spy



Úloha

- **Rozdiel medzi obrázkami**
  - Načítať do matice A a B
  - Zmeniť na double // A=double(A);
  - Odčítať
  - Zobraziť absolútnu hodnotu rozdielového obrázku
    // abs(C)