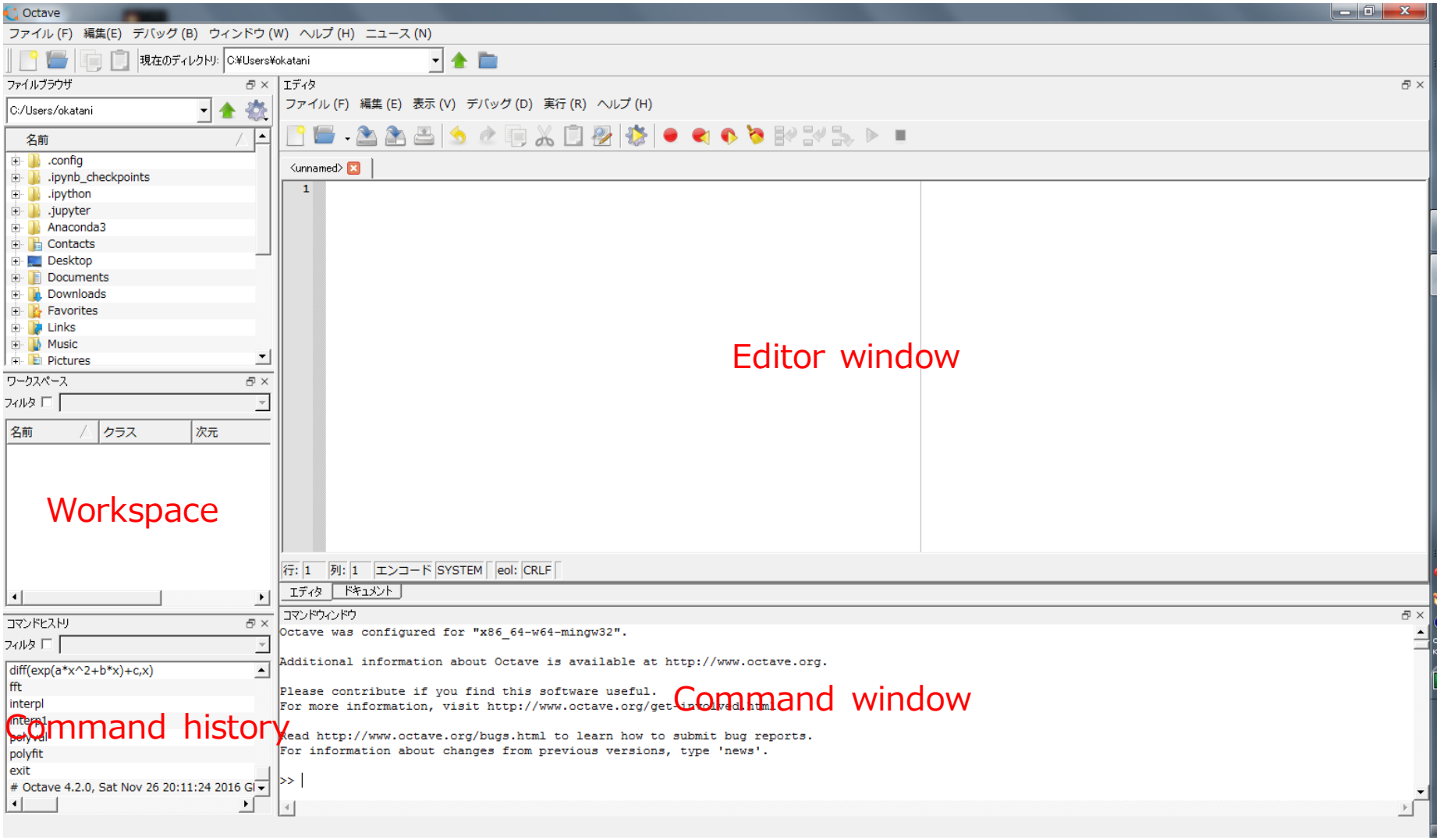
2. Fundamentals of Octave (&MATLAB)

- Octave GUI(Graphical User Interface)
- Command Window
- Scripts
- Variables
- Matrices
- Arithmetic operations & special values
- Mathematical functions
- Input/output with files
- Loops
- Conditional branch & flow control
- Plotting grpahs

Octave GUI


Octave
ファイル (F) 編集(E) デバッグ (B) ウィンドウ (W) ヘルプ (H) ニュース (N)
現在のディレクトリ: C:¥Users¥okatani
ファイルブラウザ
C:/Users/okatani
名前
.config
.ipynb_checkpoints
.ipython
.jupyter
Anaconda3
Contacts
Desktop
Documents
Downloads
Favorites
Links
Music
Pictures
ワークスペース
フィルタ
名前
クラス
次元
Workspace
コマンドヒストリ
フィルタ
diff(exp(a*x^2+b*x)+c,x)
fft
interpl
polyval
polyfit
exit
Octave 4.2.0, Sat Nov 26 20:11:24 2016 GI
Command history
エディタ
ファイル (F) 編集 (E) 表示 (V) デバッグ (D) 実行 (R) ヘルプ (H)
<unnamed>
1
Editor window
行: 1 列: 1 エンコード SYSTEM eol: CRLF
エディタ ドキュメント
コマンドウィンドウ
Octave was configured for "x86_64-w64-mingw32".
Additional information about Octave is available at http://www.octave.org.
Please contribute if you find this software useful.
For more information, visit http://www.octave.org/get-involved.html
Read http://www.octave.org/bugs.html to learn how to submit bug reports.
For information about changes from previous versions, type 'news'.
>>
Command window

Using Command Window

- Example: Type “1+2” and press the Enter key after the prompt “>>”

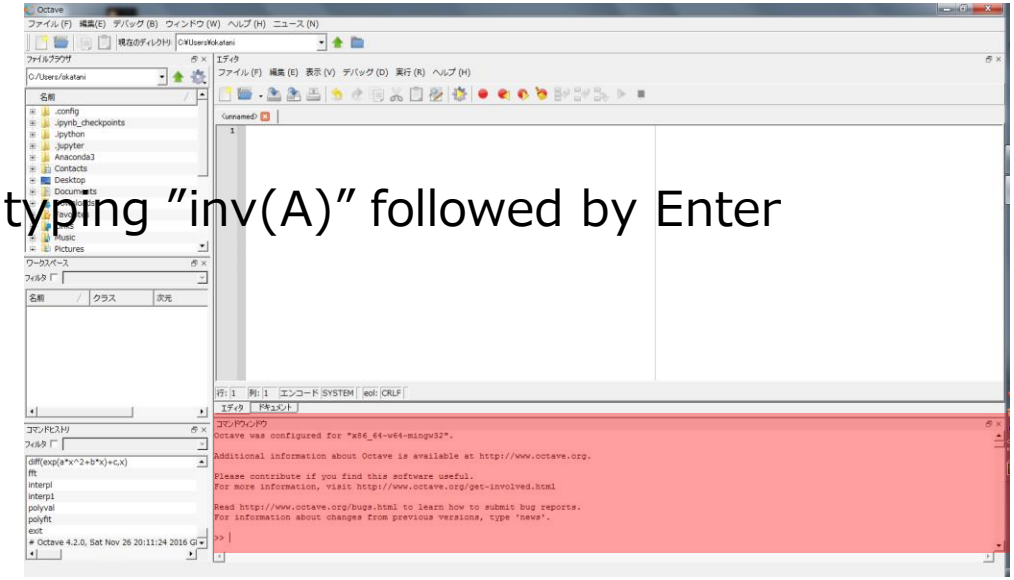
```
>> 1+2
ans =  3
>>
```

- You can create a 2x2 matrix A by typing as follows:

```
>> A=[1,2;3,4]
A =
   1   2
   3   4
```

- You can calculates its inverse by typing ”inv(A)” followed by Enter

```
>> inv(A)
ans =
  -2.00000   1.00000
   1.50000  -0.50000
```

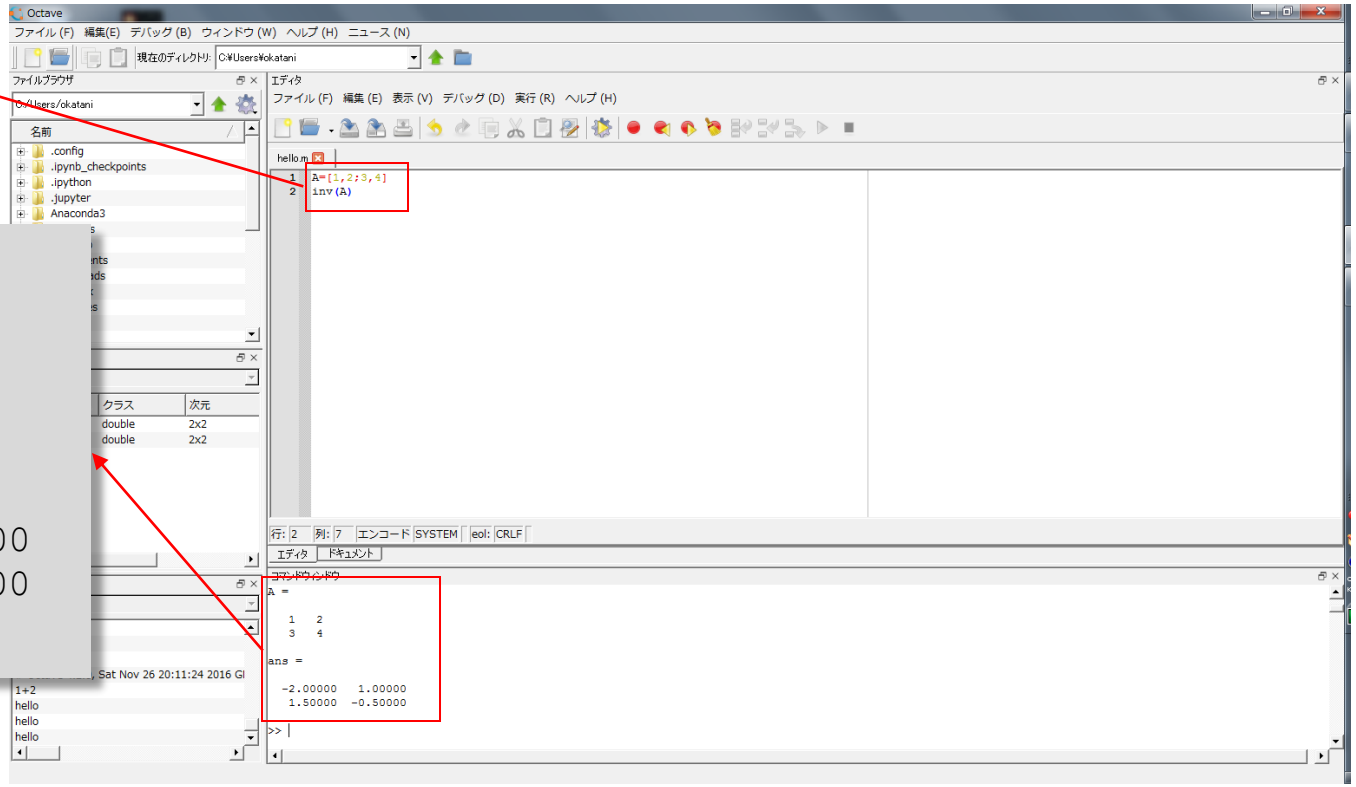


Writing a script file

- Type as follows in the Editor window, select “Save File”-“File” in the Editor window menu, type “hello”, and click “Save”
  - The script should be saved as “hello.m”
- Type “hello” followed by Enter to run the contents
  - Same as choosing “Save File and Run”-”Run” in the menu

```
A=[1,2;3,4]
inv(A)
```

```
>> A=[1,2;3,4]
A =
   1   2
   3   4
>> inv(A)
ans =
  -2.00000   1.00000
   1.50000  -0.50000
```



Using variables

- You can create and use a variable like `A` in the earlier example
  - The name of a variable should be different from existing files and variables
  - There is no limitation in the length of variable names; it must be less than 19 characters in MATLAB, though

```
>> the_1st_variable=[1;2];
>> the_1st_variable
the_1st_variable =

   1
   2
```

- Numeric characters and '_' (underscore) can be used for variable names
- Result won't be displayed by typing ';'(semicolon) at the end

- All the variables you created so far will be displayed in Workspace
- You can remove a variable with the data by typing clear

```
>> clear A
```

Using matrices

- The most fundamental data representation in Octave/Matlab
- A matrix of any size can be created by using ‘,’ to separate elements and ‘;’ to separates rows;

2x3 matrix

```
>> A=[1,2,3;2,3,4]
A =
   1   2   3
   2   3   4
```

3x2 matrix

```
>> B=[1,2;2,3;3,4]
B =
   1   2
   2   3
   3   4
```

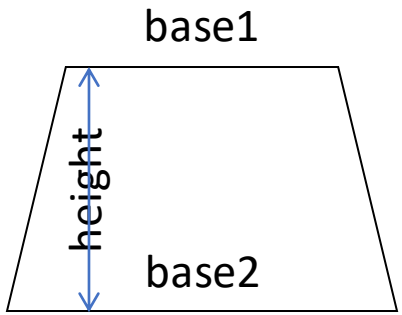
- You can get the size of a matrix using a built-in function `size`

```
>> size(A)
ans =
   2   3
>> size(B)
ans =
   3   2
```

Arithmetic operation and special values

- Basic operators : `+, -, *, /`

```
>> base1=3.0;base2=5.0;height=3.0;
>> area=(base1+base2)*height/2
area =  12
```



- Exponentiation : ^

```
>> 2^40
ans =    1.0995e+12
```

- π

```
>> pi
ans =  3.1416
```

- Imaginary unit : `i` or `j`

```
>> i
ans =  0 + 1i
>> j
ans =  0 + 1i
>> exp(-pi*i)
ans = -1.0000e+00 - 1.2246e-16i
```

$$e^{i\pi} = -1$$

(Euler's formula)

Mathematical functions

- Trigonometric functions
  - sin, sinh, asin, cos, cosh, acos, tan, tanh, atan, atan2
- Exponential, log functions, etc.
  - exp, log, log10, sqrt
- Various operations on matrix elements
  - sum, max, min, sort, mod
- Absolute value and complex numbers
  - abs, conj, imag, real

```
>> sin(pi/2)
ans =  1
>> sin(pi)
ans =    1.2246e-16
>> log(e)
ans =  1
```

```
>> A
A =
   1   2   3
   2   3   4
>> sum(A)
ans =
   3   5   7
>> sum(sum(A))
ans =  15
```

```
>> a=2.0-3.0j
a =  2 - 3i
>> imag(a)
ans = -3
>> real(a)
ans =  2
>> abs(-a)
ans =  3.6056
>> conj(a)
ans =  2 + 3i
```

Input and output with files

- You can write the value of a variable into a specified file:

```
>> save('A.txt', 'A')
```

- Then read the written value from the file:

```
>> load('A.txt')
>> A
A =
   1   2   3
   2   3   4
```

```
>> B=load('A.txt')
>> B.A
ans =
   1   2   3
   2   3   4
```

- You can also save/load the whole contents of Workspace into/from a specified file

```
>> save('workspace1')
```

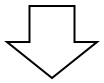
```
>> load('workspace1')
```

Loops

- Repeat a series of commands with `for index=start:step:end … end`

Script

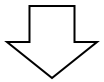
```
# loop1.m
for i=1:10
  x = 2^i;
  printf('%d: %f¥n', i, x)
endfor
```



Result

```
>> loop1
1: 2.000000
2: 4.000000
3: 8.000000
4: 16.000000
5: 32.000000
6: 64.000000
7: 128.000000
8: 256.000000
9: 512.000000
10: 1024.000000
```

```
# loop2.m
# calculate position of a vehicle
# with a constant acceleration
a = 1.0; # acceleration
for t=0.0:0.5:3 # time
  y=.5*a*t^2; # position
  printf('%f: %f¥n', t, y)
endfor
```



```
>> loop2
0.000000: 0.000000
0.500000: 0.125000
1.000000: 0.500000
1.500000: 1.125000
2.000000: 2.000000
2.500000: 3.125000
3.000000: 4.500000
```

Conditional branch & flow control

- if-elseif-else-end structure

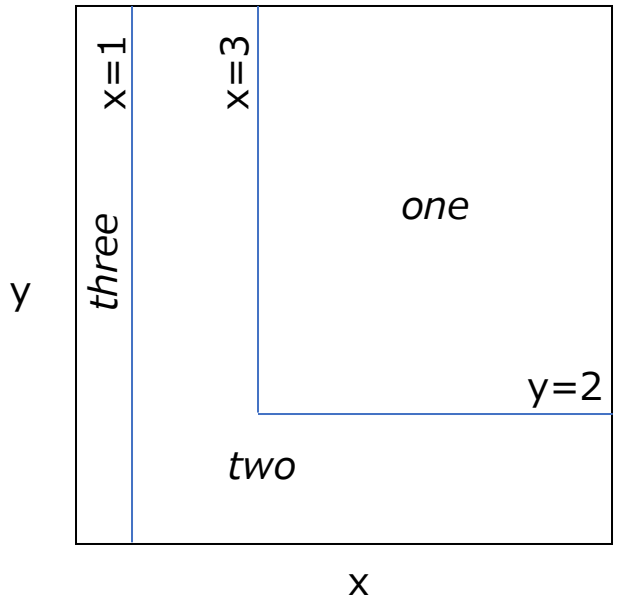
Script

```
#ifelse1.m
if x > 3.0 && y > 2.0
  disp('one')
elseif x > 1.0
  disp('two')
else
  disp('three')
endif
```

Logical AND
(if both are true)

```
#ifelse2.m
if x < 3.0 || y < 2.0
  if x < 1.0
    disp('three')
  else
    disp('two')
  end
else
  disp('one')
endif
```

Logical OR
(if either is true)



Results

```
>> x=4;y=5;
>> ifelse1
one
>> x=2;y=5;
>> ifelse2
two
>> x=y=0;
>> ifelse1
three
```

Comparison Operators

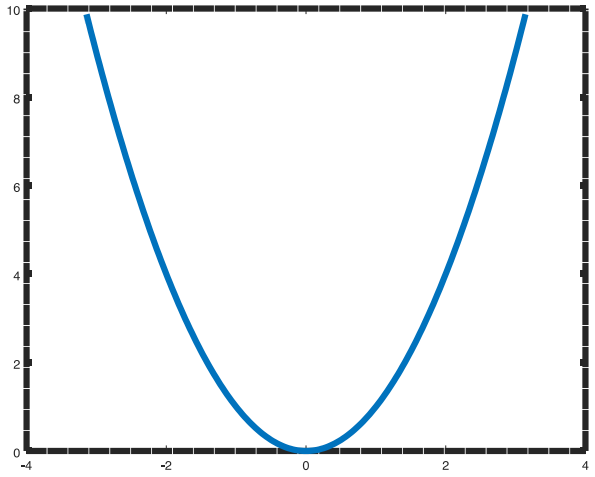
```
x <= y   less
than

or equal
x == y   equal
x >= y
greater than

or equal
x != y    not
equal
```

Plotting a graph

- `plot(x,y)`, where `x` is a vector of length m storing x coordinates and `y` is a vector of the same length storing y coordinates

```
>> x=-pi:pi/100:pi;
>> y=x.^2;
>> plot(x,y)
```

'.^' expresses squaring each element

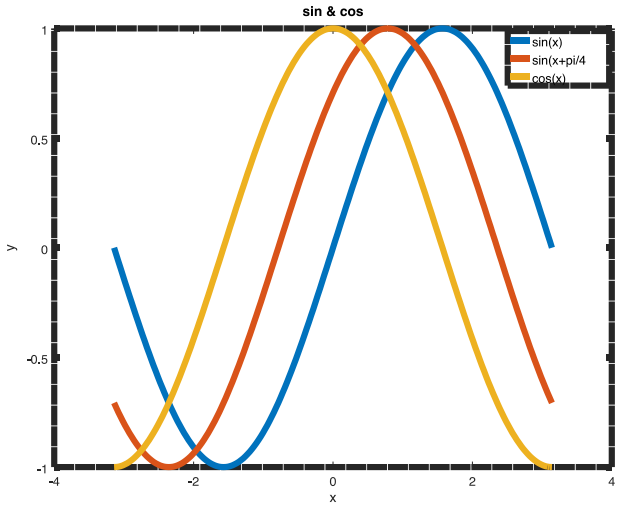


- To plot different curves in a single graph

```
>> plot(x,sin(x),x,sin(x+.25*pi),x,cos(x))
```

- To set axis labels, titles, and legends

```
>> xlabel('x'), ylabel('y'), title('sin & cos')
>> legend('sin(x)','sin(x+pi/4)','cos(x)')
```



- To change font sizes (before calling `plot`)

```
>> set(0,"defaultaxesfontsize",20)
>> set(0,"defaulttextfontsize",20)
```

Exercises 2.1 (assignments)

- Find all numbers of 3 digits such that the sum of the cubes of its digits equals the number itself; an example is 153, because $1^3+5^3+3^3 = 153$
- Revise the script below to find these numbers

```
for i = 100:999
  i1 = mod(i, 10);
  i2 = mod(floor(i/10), 10);
  i3 = floor(i/100);
  disp([i3 i2 i1])
endfor
```

Hint: This script scans every three-digit number and gets its three digits

- Write a script that finds the same numbers in a different way by filling in the blanks below:

```
for i3 = 1:9
  for i2 = 0:9
    for i1 = 0:9
      [          ]
    endfor
  endfor
endfor
```