VG101: Introduction to Computer and Programming

Week5 Checklist

Tips for HW/Lab

- Indent your code and name your variables properly! It can save you from shot by your future colleague.
- **Test your code!** Don't leave it there after finishing coding and hope it works.
- Do follow function prototype (just copy it from PDF)!
- When accessing elements in a matrix, make sure the index is valid.

```
b = [];
b(1:3) = [3,4,5]; % it actually works, but don't use it
```

What should I do when my code doesn't work?

- Pray. The God will help me to make it work.
- Stare at the code. It will fear me and fix itself.
- Send an email to TA saying that "Oh TA, my code doesn't work."
- Look through the code with naked eyes to find what is wrong.
- Rubber Duck Debugging.
- Use debugger (breakpoint).

Monte Carlo Method & Random Number

- Monte Carlo Method
- Random number (Pseudorandom)

```
rand('state',0); % set random seed
rand(3)
% Result:
%   [0.9501    0.4860    0.4565
%    0.2311    0.8913    0.0185
%    0.6068    0.7621    0.8214]
```

- Generate random number: `rand()`, `randn()`, `randi()`
- Set random state as current time: `rand('state', datenum(clock))`
- Scaling random number: how to use `rand()` to generate random integer?

```
% Generate random integer in [0, 100]
x = floor(rand() * 101) % why 101?
```

String

- string is a 1-D matrix of chars
- `strcmp(s1, s2)` : compare two strings
- `strncmp(s1, s2, n)` : compare first n characters
- `strcmpi, strncmpi` : compare ignoring case
- `isletter('A') == 1` : true for letters
- `isspace(' ') == 1` : true for space

```
isspace('  Find spa ces ')
% ans = [1 1 0 0 0 0 1 0 0 0 1 0 0 0 1]
```

- `strrep('This is a good example', 'good', 'great')`
- `strfind('This is a good example', 'good') == 11` : the starting indices of substring
- `num2str`, `str2num`, `str2double`

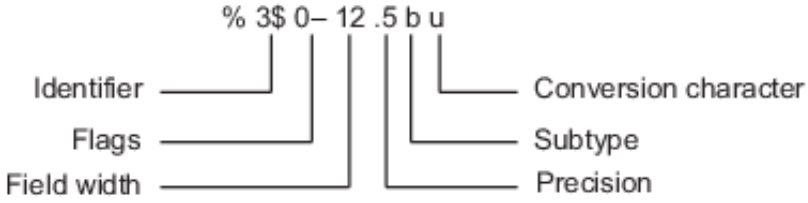
File I/O

- what is file?
- `fid` (file descriptor)
- `fid = fopen(filename, permission)`
  - where the file will be read/written
  - permission:

Permission	Explanation
'r'	Open file for reading.
'w'	Open or create new file for writing. Discard existing contents, if any.
'a'	Open or create new file for writing. Append data to the end of the file.
'r+'	Open file for reading and writing.
'w+'	Open or create new file for reading and writing. Discard existing contents, if any.
'a+'	Open or create new file for reading and writing. Append data to the end of the file.

- `fclose(fid)`
- `fprintf(fid, format, A, ...)`

- `stdout`, `stderr`
- `fprintf(1, 'hello\n')`
- `fprintf(2, 'hello\n')`
- Formatting Operator: A formatting operator starts with a percent sign, %, and ends with a conversion character. The conversion character is required. Optionally, you can specify identifier, flags, field width, precision, and subtype operators between % and the conversion character. (Spaces are invalid between operators and are shown here only for readability).



- Identifier, Flags, Subtype (skip)
- Field Width: Minimum number of characters to print. The field width operator can be a number, or an asterisk (*) to refer to an input argument.
- Precision:
  - For `%f`, `%e`, or `%E` : Number of digits to the right of the decimal point. Example: `'%.4f'` prints pi as `'3.1416'`
  - For `%g` or `%G` : Number of significant digits. Example: `'%.4g'` prints `pi` as `'3.142'`
- Conversion Character

Conversion	Details
%d or %i	Base 10
%u	Base 10
%o	Base 8 (octal)
%x	Base 16 (hexadecimal), lowercase letters a–f
%X	Same as %x, uppercase letters A–F
%f	Fixed-point notation (Use a precision operator to specify the number of digits after the decimal point.)
%e	Exponential notation, such as 3.141593e+00 (Use a precision operator to specify the number of digits after the decimal point.)
%E	Same as %e, but uppercase, such as 3.141593E+00 (Use a precision operator to specify the number of digits after the decimal point.)
%g	The more compact of %e or %f, with no trailing zeros (Use a precision operator to specify the number of significant digits.)
%G	The more compact of %E or %f, with no trailing zeros (Use a precision operator to specify the number of significant digits.)
%c	Single character
%s	Character vector or string array. The type of the output text is the same as the type of `format`.

Reference: https://www.mathworks.com/help/releases/R2018a/matlab/ref/fprintf.html

- `[A count] = fscanf(fid, format, sizeA)`
- `[A count] = fscanf(fid, format)`
    - Reads data from an open text file into *column vector* `A` (with dimensions `sizeA`) and interprets values in the file according to the format specified by `format`. The `fscanf` function reapplies the format throughout the entire file and positions the file pointer at the end-of-file marker (or `sizeA` is reached).
    - If `fscanf` cannot match `format` to the data, it reads only the portion that matches and stops processing.

Numeric Field：

Conversion Specifier	Details
%d	Base 10
%i	(Too complicated. Please refer to the document page)
%ld or %li	64-bit values, base 10, 8, or 16
%u	Base 10
%o	Base 8 (octal)
%x	Base 16 (hexadecimal)
%lu, %lo, %lx	64-bit values, base 10, 8, or 16
%f, %e, %g	Floating-point fields can contain any of the following (not case sensitive): Inf, -Inf, NaN, or -NaN.

Character Fields:

Conversion Specifier	Details
%s	Read all characters *excluding white spaces*.
%c	Read any single character, including white space. To read multiple characters at a time, specify field width.

Reference: https://www.mathworks.com/help/releases/R2018a/matlab/ref/fscanf.html

```
x = 1:1:5;
y = [x;rand(1,5)];
fileID = fopen('nums2.txt','w');
fprintf(fileID,'%d %4.4f\n',y);
fclose(fileID);
% 1 0.8147
% 2 0.9058
% 3 0.1270
% 4 0.9134
% 5 0.6324

fileID = fopen('nums2.txt','r');
formatSpec = '%d %f';
sizeA = [2 Inf];
A = fscanf(fileID,formatSpec,sizeA)
%A = 2×5
%
%    1.0000    2.0000    3.0000    4.0000    5.0000
```

```
%    0.8147    0.9058    0.1270    0.9134    0.6324
fclose(fileID);
```

- Difference between *Text File* and *Binary File*.
- `[count, errmsg] = fwrite(fid ,A, precision)`
- `A = fread(fid, count, precision)`
  - Notice that, these two are for binary file.
  - Read with the same format that you write
  - If another format wanted, read in the format as written and then do transfer

```
fid = fopen('alphabet.txt', 'r');
c = fread(fid, 5)
fclose(fid);
% c = [65; 66; 67; 68; 69]

fid = fopen('alphabet.txt', 'r');
d = fread(fid, 5, 'uint8=>char')'
fclose(fid);
% d = 'ABCDE'
```

- `status = fseek(fid,offset,origin)`
- `position = ftell(fid)`

```
A = 1:5;
fid = fopen('five.bin','w');
fwrite(fid, A,'short');
status = fclose(fid);

% Read the third number:
fid = fopen('five.bin','r');
fseek(fid, 4,'bof'); % why 4?
a = fread(fid,1,'short'); % a == 3
% Instead:
% fseek(fid, 3,'bof');
% a = fread(fid, 1,'short');
% a == 768. Why?

ftell(fid) % ans == 6

% read the second number
fseek(fid,-4,'cof'); % why -4?
a = fread(fid,1,'short');

fclose(fid);
```

- `fgetl(fid)`: read lines

- `feof(fid)` : true if reach end-of-file

```
% In fgetl_demo.m:
fid = fopen('fgetl_demo.m', 'r');
n = 0;
while feof(fid) == 0
    tline = fgetl(fid);
    n = n+1;
    disp(sprintf('%d:%s',n,tline));
end
fclose(fid);
% 1:clc
% 2:clear
% 3:fid = fopen('fgetl_demo.m', 'r');
% 4:n = 0;
% 5:while feof(fid) == 0
% 6:tline = fgetl(fid);
% 7:n = n+1;
% 8:fprintf('%d:%s\n',n,tline);
% 9:end
% 10:fclose(fid);
```

Newline

- Windows: `\r\n`
- Mac OS X, Linux: `\n`
- When in MATLAB, it will be decided by MATLAB setting, so `\n` should be fine

Use file I/O and string manipulation to extract information from a file

- If the format known, read as format
- If length known, use matrix manipulation to slice
- Use space to separate words
- Be careful with `\n` (stored or discarded by the reading function)
- Sometimes, read the content and manipute in a matrix can be easier than manipute in file

Plot Functions

- Special window: `figure`
- `plot()`

```
% Plot y = sin(x) function
x = 0: 0.01: 10;
y = sin(x);
plot(x, y, 'ro');
title('y=sin(x)');
xlabel('x');
ylabel('y');
```

- LineSpec (See lecture 6 pages 35)
- Multiple lines in one graph: `hold on`
- Plot multiple graphs: `subplot`
- 3D plot: `plot3`, `meshgrid`, `contour`, `mesh`, `surf`
- Almost all of these can be done by mouse

```
% 3D plot
[x,y]=meshgrid(-4:0.1:4);
z=(x.^2-y.^2).*exp(-(x.^2+y.^2));
contour(x,y,z);
mesh(x,y,z);
surf(x,y,z);
```

Images

- Read as array (**uint8**)
- RGB channels
- Load image: `img = imread(filename)`
- Show image: `imshow(C)`, `image(C)`
- Write to image file `imwrite(C, filename)`
- Colormap: used to color black-white images, used in plot

More on Matrix Manipulations

- `linspace`

```
linspace(0, 20, 6) % a list within [0 20], 6 elements in total
% C = [0 4 8 12 16 20]
```

- `length`, `size`
- `max`, `min`
- `sum`, `mean`, `std`, `var`
- `round`, `ceil`, `floor`, `fix`
- `find`

```
a = rand(1,5);
find(a == max(a));
```

Exercise (Prepare for Your Midterm Exam)

- Write a script finding all prime numbers below 1000.
- Given text file as below:

```
Date  Price
Oct19 21.5
Oct20 21.9
Oct21 23.5
Oct22 23.0
Oct23 24.4
Oct24 23.5
Oct25 23.3
Oct26 22.8
Oct27 23.3
Oct28 24.5
Oct29 23.4
```

Read the file above, and calculate mean, variance, highest price, lowest price and outputs to `Analysis.txt` as format:

```
The mean of prices is xxx.
The variance of prices is xxx.
xxx(Date) has highest price: xxx.
xxx(Date) has lowest price: xxx.
```

- A drunk person walks in a square. He starts at (0,0). Each second he randomly choose a direction and move forward one unit distance. Simulate his behavior in 100 seconds and use `plot` to show his trajectory.
- Another drunk person walks on a path (1D). He starts at x=0. Each second he randomly choose go positive direction or negative direction. Plot the probability distribution of his position after 100 seconds.
- Generate an 256*256 image as below