Random Numbers

rand([M, N, P], 'datatype'); % uniformly distributed random numbers between 0 & 1

randn([M, N, P], 'datatype'); % normally distributed random numbers

(b - a) \* rand + a; % random number between a & b (can use with either of the two functions shown above)

randi([a, b], [M, N, P]); % uniformly distributed random integers between a & b

Data Types

**Name | Description | Range | Fractions?**

logical | representing false and true | 0 & 1 | no

uint8 | unsigned 8-bit integers | 0 ... 2^8 | no

int8 | signed 8-bit integers | -2^8 ... 2^8 | no

single | single precision "real" numbers | -realmax ... realmax | yes

double | double precision "real" numbers | -realmax ... realmax | yes

% 16, 32, 64-bit also available for unsigned/signed int.

Operators and Special Characters

Arithmetic Operators

MATLAB uses standard mathematical symbols: +, -, \*, /, ^

For element-wise operations, use '.' before the mathematical operator

Relational Operators

**Symbol | Role**

== | Equal to

~= | Not equal to

> | Greater than

>= | Greater than or equal to

< | Less than

<= | Less than or equal to

Logical Operators

**Symbol | Role**

& | logical AND

| | logical OR

~ | logical NOT

Special Characters

**Symbol | Role**

, | Separator for row elements

: | Indexing all elements in list, also used for vector creation

; | Separator for column elements

( ) | Operator Precedence

[ ] | Array creation, multiple output argument assignment

% | Comment

"" | String constructor

~ | Argument placeholder (suppress specific output)

= | Assignment

Special Arrays

zeros(M, N); % 0 array

false(M, N); % logical false array

Array Comparisons

A = rand(M, N); % random array

mask = A > 0.5; % logical array where TRUE if >0.5 and FALSE if <=0.5

Other Functions

who -file <filename>; % List variables in .mat file

pause(1); % Pause script for 1 second

Image Processing

Finding Area

f = figure;

imshow('file.png');

p = drawpolygon(f.Children); % trace polygon

coords = p.Position;

x\_coords = coords(:, 1); % x-coordinates of points

y\_coords = coords(:, 2); % y-coordinates of points

area\_px\_2 = polyarea(x\_coords, y\_coords); % area of desired object [px^2]

l = drawline(f.Children); % trace scaler bar

length\_px = sqrt((l.Position(2,1)-l.Position(1,1))^2+(l.Position(2,2)-l.Position(1,2))^2); % length of scale bar in [px]

m\_per\_px = actual\_scale\_length / length\_px; % [m] per [px]

m\_per\_px\_2 = (meters\_per\_pixel^2) \* area\_px\_2; % area of desired object [m^2]

Geolocation

longitudes = [153.02];

latitudes = [-27.46];

origin = [mean(longitudes), mean(latitudes)]; % arbitrary origin

radius = 6373.6; % radius of Earth

circumference = 2 \* pi \* radius;

km\_per\_degree\_latitude = circumference / 360;

km\_per\_degree\_longitude = km\_per\_degree\_latitude \* cos(deg2rad(-27.5)); % near Brisbane

% coordinates to plot

x = (longitudes - origin(1)) \* km\_per\_degree\_longitude;

y = (latitudes - origin(2)) \* km\_per\_degree\_latitude;

Images from Array

Random Greyscale Image

A = randi([0, 255], M, N, 'uint8');

Random Colour Image

A = randi([0 255], M, N, 3, 'uint8');

Create Colour Image using Array Indexing

A = 255 \* ones(M, N, 3, 'uint8'); % white image

A(:, :, 1) = r;

A(:, :, 2) = g;

A(:, :, 3) = b;

% change specific regions using array indexing

A(a:b, c:d, 1) = r;

A(a:b, c:d, 2) = g;

A(a:b, c:d, 3) = b;

Editing an Image

image = imread('image.png');

% mask certain colour range which can be modified

mask = image(:, :, 1) > r & image(:, :, 2) > g & image(:, :, 3) > b;

% channels 1 2 3 are Red/Green/Blue or Colour/Saturation/Value respectively

imshow(A); % Display Image

image(A); % Similar functionality, useful when used in combination with other plots

Save an Animation

f = figure;

set(f, 'Visible', 'on')

video = VideoWriter('file\_name.avi');

x = []; % x-values

y = []; % y-values

plot1 = plot(x(1), y(1)); % Create plot object

for i = 1:length(t)

% Update plot object data

plot1.XData = x(i);

plot1.YData = y(i);

drawnow

frame = getframe;

writeVideo(video, frame);

end

close(video); % Close video object

Sound Processing

f = 523.251; % frequency of note

Fs = 8192; % sampling rate

t = 0:1 / Fs:1; % length of sound

y = sin(2 \* pi \* f \* t); % sine wave of sound

Y = [sound1a + sound1b]; % play sounds simultaneously, (must be same dimension)

Y = [sound1; sound2]; % append sounds

soundsc(y, Fs) % play sound (‘sc’ scales between -1 & 1)

resample(y, Fs, Q); % resample audio at Fs/Q sample rate

Fs / 2; % half speed

Fs \* 2; % double speed

% useful formulas/conversions

duration = length(y) / Fs;

t = linspace(0, duration, length(y)+1);

plot(t, y, '.-'); ylim([-1, 1]);

audiowrite('music.wav', y, Fs) % write sound to audio file

Random walks

Initialisation

M = 10000; % number of particles

N = 200; % number of steps

Delta = 1; % size of the steps

p = 0.5; % probability of jumping left

x = zeros(N+1, M); % initialise particles at 0

Computation

for i = 1:N

r = rand(1, M); % random number for each particle

left\_mask = r < p; % mask left-moving particles

x(i + 1, left\_mask) = x(i, left\_mask) - Delta; % move them left

right\_mask = ~left\_mask; % mask right-moving particles

x(i + 1, right\_mask) = x(i, right\_mask) + Delta; % move them right

end

Step number vs position graph

f = figure;

plot(x, '.-');

xlabel('Step number n');

ylabel('Position x\_n');

Animate positions

f = figure;

set(f, 'Visible', 'on');

plot1 = plot(x(1, :), zeros(1, M), '.', 'MarkerSize', 20)

L = max(abs(x(:)));

xlim([-L, L]);

for i = 1:N

plot1.XData = x(i, :);

end

Cellular automata

Initialisation

N = 50; % number of steps

C = 100; % number of cells

A = false(N + 1, C); % Empty logical array that will contain each iteration

A = rand(1, C) > 0.5; % use random initial state

% manually set initial state (same length as C)

% A(1, :) = [0 1 0 1 1 1 0 0 1];

Computation

for i = 1:N

% Arrays of centre, left and right neighbours for the current iteration

P = A(i, :);

% Wrap-around boundary cell as ghost cell

L = [P(C), P(1:C - 1)];

R = [P(2:C), P(1)];

% Dead ghost cell

L = [0, P(1:C - 1)];

R = [P(2:C), 0];

% Logical arrays of all possible configurations

C000 = (L == 0 & P == 0 & R == 0);

C001 = (L == 0 & P == 0 & R == 1);

C010 = (L == 0 & P == 1 & R == 0);

C011 = (L == 0 & P == 1 & R == 1);

C100 = (L == 1 & P == 0 & R == 0);

C101 = (L == 1 & P == 0 & R == 1);

C110 = (L == 1 & P == 1 & R == 0);

C111 = (L == 1 & P == 1 & R == 1);

% Determine the logical mask for our simulation

live\_mask = C001 | C011 | C010 | C100; % Rule for cellular automation

% Set live cells for next iteration

A(i + 1, live\_mask) = 1;

end

imshow(~A, 'InitialMagnification', 'Fit') % Using NOT as live cells are black