MATLAB commands in Numeric Python

The idea of this document (and the corresponding XML instance) is to provide a quick reference[1] for switching from MATLAB to an open-source environment, such as Python, Scilab, Octave and Gnuplot, or R for numeric processing and data visualisation.

Where Octave and Scilab commands are omitted, expect Matlab compatibility, and similarly where non given use the generic command.

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1 Help

Desc.	MATLAB/Octave	Python IPython	R
Browse help interactively	`doc` Octave: `help -i % browse with Info`	`help()`	`help.start()`
Help on using help	`help help` or `doc doc`	`help`	`help()`
Help for a function	`help plot`	`help(plot)` or `?plot`	`help(plot)` or `?plot`
Help for a toolbox/library package	`help splines` or `doc splines`	`help(pylab)`	`help(package='splines')`
Demonstration examples	`demo`		`demo()`
Example using a function			`example(plot)`

1.1 Searching available documentation

Desc.	MATLAB/Octave	Python	R
Search help files	`lookfor plot`		`help.search('plot')`
Find objects by partial name			`apropos('plot')`
List available packages	`help`	`help(); modules [Numeric]`	`library()`
Locate functions	`which plot`		`find(plot)`
List available methods for a function			`methods(plot)`

1.2 Using interactively

Desc.	MATLAB/Octave	Python IPython	R
Start session	Octave: `octave -q`	`ipython -pylab`	`Rgui`
Auto completion	Octave: `TAB` or `M-?`	`TAB`	
Run code from file	`foo(.m)`	`execfile('foo.py')` or `run foo.py`	`source('foo.R')`
Command history	Octave: `history`	`hist -n`	`history()`
Save command history	`diary on [..] diary off`		`savehistory(file=".Rhistory")`

End session	`exit` or `quit`	`CTRL-D`
		`CTRL-Z # windows`
		`sys.exit()`
			`q(save='no')`

[1] References: Hankin, Robin. *R for Octave users* (2001), available from http://cran.r-project.org/doc/contrib/R-and-octave-2.txt (accessed 2005.07.24); Martelli, Alex. *Python in a Nutshell* (O'Reilly, 2003); Langtangen, Hans Petter. *Python Scripting for Computational Science* (Springer, 2004); Ascher et al.: *Numeric Python manual* (2001), available from http://numeric.scipy.org/numpy.pdf (accessed 2005.06.25); Hunter, John. *The Matplotlib User's Guide* (2005), available from http://matplotlib.sf.net/ (accessed 2005.07.31); Moler, Cleve. *Numerical Computing with MATLAB* (MathWorks, 2004), available from http://www.mathworks.com/moler/ (accessed 2005.03.10); Eaton, John W. *Octave Quick Reference* (1996); Merrit, Ethan. *Demo scripts for gnuplot version 4.0* (2004), available from http://gnuplot.sourceforge.net/demo/ (accessed 2005.07.24); Woo, Alex. *Gnuplot Quick Reference* (2004), available from http://www.gnuplot.info/docs/gpcard.pdf (accessed 2005.07.14); Venables & Smith: *An Introduction to R* (2005), available from http://cran.r-project.org/doc/manuals/R-intro.pdf (accessed 2005.07.25); Short, Tom. *R reference card* (2005), available from http://www.rpad.org/Rpad/R-refcard.pdf (accessed 2005.07.24).

2 Operators

Help on operator syntax	`help -`		`help(Syntax)`

2.1 Arithmetic operators

Desc.	MATLAB/Octave	Python	R
Defining a number	`a=1; b=2;`	`a=1; b=1`	`a<-1; b<-2`
Addition	`a + b`	`a + b` or `add(a,b)`	`a + b`
Subtraction	`a - b`	`a - b` or `subtract(a,b)`	`a - b`
Multiplication	`a * b`	`a * b` or `multiply(a,b)`	`a * b`
Division	`a / b`	`a / b` or `divide(a,b)`	`a / b`

Power, a^b	`a ^ b`	`a ** b`
		`pow(a,b)`
		`power(a,b)`
			`a ^ b`

Remainder	`rem(a,b)`	`a % b`
		`fmod(a,b)`
		`remainder(a,b)`
			`a %% b`

Integer division			`a %/% b`
In place operation to save array creation overhead	Octave: `a+=1`	`a+=b` or `add(a,b,a)`	
Factorial, $n!$	`factorial(a)`		`factorial(a)`

2.2 Relational operators

Desc.	MATLAB/Octave	Python	R
Equal	`a == b`	`a == b` or `equal(a,b)`	`a == b`
Less than	`a < b`	`a < b` or `less(a,b)`	`a < b`
Greater than	`a > b`	`a > b` or `greater(a,b)`	`a > b`
Less than or equal	`a <= b`	`a <= b` or `less_equal(a,b)`	`a <= b`
Greater than or equal	`a >= b`	`a >= b` or `greater_equal(a,b)`	`a >= b`
Not Equal	`a ~= b`	`a != b` or `not_equal(a,b)`	`a != b`

2.3 Logical operators

Desc.	MATLAB/Octave	Python	R
Short-circuit logical AND	`a && b`		`a && b`
Short-circuit logical OR	`a || b`		`a || b`
Element-wise logical AND	`a & b` or `and(a,b)`	`logical_and(a,b)` or `a and b`	`a & b`
Element-wise logical OR	`a | b` or `or(a,b)`	`logical_or(a,b)` or `a or b`	`a | b`
Logical NOT	`~a` or `not(a)` Octave: `~a` or `!a`	`logical_not(a)` or `not a`	`!a`
Logical EXCLUSIVE OR	`xor(a, b)`	`logical_xor(a,b)`	`xor(a, b)`
True if any element is nonzero	`any(a)`		
True if all elements are nonzero	`all(a)`		

2.4 root and logarithm

Desc.	MATLAB/Octave	Python math	R	
Square root	`sqrt(a)`	`math.sqrt(a)`	`sqrt(a)`	$\sqrt{a}$
Logarithm, base e (natural)	`log(a)`	`math.log(a)`	`log(a)`	$\ln a = \log_e a$
Logarithm, base 10	`log10(a)`	`math.log10(a)`	`log10(a)`	$\log_{10} a$

Logarithm, base 2 (binary)	`log2(a)`	`math.log(a, 2)`	`log2(a)`	$\log_2 a$
Exponential function	`exp(a)`	`math.exp(a)`	`exp(a)`	e^a

2.5 Round off

Desc.	MATLAB/Octave	Python math	R
Round	`round(a)`	`math.round(a)`	`round(a)`
Round up	`ceil(a)`	`math.ceil(a)`	`ceil(a)`
Round down	`floor(a)`	`math.floor(a)`	`floor(a)`
Round towards zero	`fix(a)`		

2.6 Mathematical constants

Desc.	MATLAB/Octave	Python math	R
$\pi = 3.141592$	`pi`	`math.pi`	`pi`
$e = 2.718281$	`exp(1)`	`math.e` or `math.exp(1)`	`exp(1)`
Missing numbers (Not-a-Number)	`NaN`		
Infinity, $+\infty$	`Inf`		

2.7 Complex numbers

Desc.	MATLAB/Octave	Python cmath	R	
Imaginary unit	`i`	`z = 1j`	`1i`	$i = \sqrt{-1}$
A complex number, $3 + 4i$	`z = 3+4i`	`z = 3+4j` or `z = complex(3,4)`	`z <- 3+4i`	
Absolute value (modulus)	`abs(z)`	`abs(3+4j)`	`abs(3+4i)` or `Mod(3+4i)`	
Real part	`real(z)`	`z.real`	`Re(3+4i)`	
Imaginary part	`imag(z)`	`z.imag`	`Im(3+4i)`	
Argument	`arg(z)`		`Arg(3+4i)`	
Complex conjugate	`conj(z)`	`z.conjugate()`	`Conj(3+4i)`	

2.8 Trigonometry

Desc.	MATLAB/Octave	Python	R	
Arctangent, $\arctan(b/a)$	`atan(a,b)`	`atan2(b,a)`	`atan2(b,a)`	
Hypotenus; euclidean distance		`hypot(x,y)`		$\sqrt{x^2 + y^2}$

2.9 Generate random numbers

Desc.	MATLAB/Octave	Python Numeric.RandomArray	R
Uniform distribution	`rand(1,10)`	`random((10,))` `uniform(0,1,(10,))`	`runif(10)`
Uniform: Numbers between 2 and 7	`2+5*rand(1,10)`	`uniform(2,7,(10,))`	`runif(10, min=2, max=7)`
Uniform: 6,6 array	`rand(6)`	`uniform(0,1,(6,6))`	`matrix(runif(36),6)`
Normal distribution	`randn(1,10)`	`standard_normal((10,))`	`rnorm(10)`

3 Vectors

Desc.	MATLAB/Octave	Python Numeric,numarray	R

Row vector, $1 \times n$-matrix	`a=[2 3 4 5];`	`a=array([2,3,4,5])`	`a <- c(2,3,4,5)`
Column vector, $m \times 1$-matrix	`adash=[2 3 4 5]';`	`transpose(array([2,3,4,5]))`	`adash <- t(c(2,3,4,5))`

3.1 Sequences

Desc.	MATLAB/Octave	Python Numeric	R
1,2,3, ... ,10	`1:10`	`range(1,11)` `arange(1,11, typecode=Float)`	`seq(10)` or `1:10`
0.0,1.0,2.0, ... ,9.0	`0:9`	`arange(10.)`	`seq(0,length=10)`
1,4,7,10	`1:3:10`	`arange(1,11,3)`	`seq(1,10,by=3)`
10,9,8, ... ,1	`10:-1:1`	`arange(10,0,-1)`	`seq(10,1)` or `10:1`
10,7,4,1	`10:-3:1`	`arange(10,0,-3)`	`seq(from=10,to=1,by=-3)`
Linearly spaced vector of n=7 points	`linspace(1,10,7)`	`linspace(1,10,7)`	`seq(1,10,length=7)`
Reverse	`reverse(a)`	`a[::-1]` or `a.reverse()`	`rev(a)`

3.2 Concatenation

Desc.	MATLAB/Octave	Python Numeric	R
Concatenate two vectors	`[a a]`	`concatenate((a,a), axis=1)`	`c(a,a)`
Concatenate two vectors	`[a a*3]`	`concatenate((a,a*3), axis=1)`	`c(a,a*3)`
	`[1:4 a]`	`concatenate((range(1,5),a), axis=1)`	`c(1:4,a)`
a^3	`a.^3`	`a**3`	`a^3`

3.3 Repeating

Desc.	MATLAB/Octave	Python Numeric	R
1 2 3, 1 2 3	`[a a]`	`concatenate((a,a),axis=1)`	`rep(a,times=2)`
1 1 1, 2 2 2, 3 3 3		`repeat(a,ones(a.shape)*3)`	`rep(a,each=3)`
1, 2 2, 3 3 3		`repeat(a,a)`	`rep(a,a)`

3.4 Miss those elements out

Desc.	MATLAB/Octave	Python	R
miss the first element	`a(2:end)`	`a[1:]`	`a[-1]`
miss the tenth element	`a([1:9])`		`a[-10]`
miss 1,4,7, ...			`a[-seq(1,50,3)]`
last element	`a(end)`	`a[-1]`	

3.5 Max and min

Desc.	MATLAB/Octave	Python	R
pairwise max	`max(a,b)`		`pmax(a,b)`
pairwise max (by rows)	`max([a' b'])`		`cbind(max(a),max(b))`
	`max([a b])`		`max(a,b)`
	`[m i] = max(a)`		`m <- max(a) ; i <- which.max(a)`

3.6 Vector multiplication

Desc.	MATLAB/Octave	Python Numeric	R

Multiply two vectors	`a.*a`	`a*a`	`a*a`
Vector dot product, $u \cdot v$	`dot(u,v)`	`dot(u,v)`	

4 Matrices

Define a matrix	`a = [2 3;4 5]`	`a = array([[2,3],[4,5]])`	`rbind(c(2,3),c(4,5))` `array(c(2,3,4,5), dim=c(2,2))`	$\begin{bmatrix} 2 & 3 \\ 4 & 5 \end{bmatrix}$

4.1 Concatenation; rbind and cbind

Desc.	MATLAB/Octave	Python	R
Horizontal concatenation	`[1:4 , 1:4]`		
Vertical concatenation (bind rows)	`[1:4 ; 1:4]`		`rbind(1:4,1:4)`
bind columns	`[1:4 ; 1:4]'`		`cbind(1:4,1:4)` `t(rbind(1:4,1:4))`

4.2 Array creation

Desc.	MATLAB/Octave	Python Numeric	R	
0 filled array	`zeros(3,5)`	`zeros((3,5),Float)`	`matrix(0,3,5)` or `array(0,c(3,5))`	$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$
0 filled array of integers		`zeros((3,5))`		
1 filled array	`ones(3,5)`	`ones((3,5),Float)`	`matrix(1,3,5)` or `array(1,c(3,5))`	$\begin{bmatrix} 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \end{bmatrix}$
Any number filed array	`ones(3,5)*9`	`ones((3,5))*9`	`matrix(9,3,5)` or `array(9,c(3,5))`	$\begin{bmatrix} 9 & 9 & 9 & 9 & 9 \\ 9 & 9 & 9 & 9 & 9 \\ 9 & 9 & 9 & 9 & 9 \end{bmatrix}$
Identity matrix	`eye(3)`	`identity(3)`	`diag(1,3)`	$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$
Diagonal	`diag([4 5 6])`	`diag((4,5,6))`	`diag(c(4,5,6))`	$\begin{bmatrix} 4 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & 6 \end{bmatrix}$
Magic squares; *Lo Shu*	`magic(3)`			$\begin{bmatrix} 8 & 1 & 6 \\ 3 & 5 & 7 \\ 4 & 9 & 2 \end{bmatrix}$

4.3 Reshape and flatten matrices

Desc.	MATLAB/Octave	Python Numeric,numarray	R	
Reshaping	`reshape(1:6,2,3);`		`matrix(1:6,nrow=2)` `array(1:6,c(2,3))`	$\begin{bmatrix} 1 & 3 & 5 \\ 2 & 4 & 6 \end{bmatrix}$

Reshaping (by cols)	`reshape(1:6,3,2)';`	`reshape(arrayrange(1,7),(2,-1))`
		`a.shape = (2,3)`
		`a.setshape(2,3)`
			`matrix(1:6,nrow=3,byrow=T)`	$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$

Flatten to vector	`a(:)`	`ravel(transpose(a))`	`as.vector(a)`	
Flatten to vector (by rows)	`a'(:)`	`ravel(a)` or `a.shape = (size(a),)`	`a[row(a) <= col(a)]`	

4.4 Shared data (slicing)

Copy of a	b = a	b = a.copy()	b = a

4.5 Indexing and accessing elements (Python: slicing)

Desc.	MATLAB/Octave	Python	R

Input is a 3,4 array	`a = [ 11 12 13 14 ...`
	`21 22 23 24 ...`
	`31 32 33 34 ]`
		`a = array([[ 11, 12, 13, 14 ],`
		`[ 21, 22, 23, 24 ],`
		`[ 31, 32, 33, 34 ]])`
			`a <- rbind(c(11, 12, 13, 14),`
			`c(21, 22, 23, 24),`
			`c(31, 32, 33, 34))`

Element 2,3 (row,col)	a(2,3)	a[1,2]	a[2,3]
First row	a(1,:)	a[0,]	a[1,]
First column	a(:,1)	a[:,0]	a[,1]
All, except first row	a(2:end,:)	a[1:,]	a[-1,]
All, except row,column (2,3)	a([1 3],[1 2 4]);	take(take(a,[0,2]),[0,1,3],axis=1)	a[-2,-3]
Remove one column	a(:,[1 3 4])	take(a,[0,2,3],axis=1)	a[,-2]
Strides: Every second row		a[::2,1::2]	

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \end{bmatrix}$$

a_{23}

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \end{bmatrix}$$

$$\begin{bmatrix} a_{11} \\ a_{21} \\ a_{31} \end{bmatrix}$$

$$\begin{bmatrix} a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \end{bmatrix}$$

$$\begin{bmatrix} a_{11} & a_{13} & a_{14} \\ a_{31} & a_{33} & a_{34} \end{bmatrix}$$

$$\begin{bmatrix} a_{11} & a_{13} & a_{14} \\ a_{21} & a_{23} & a_{24} \\ a_{31} & a_{33} & a_{34} \end{bmatrix}$$

$$\begin{bmatrix} a_{12} & a_{14} \\ a_{32} & a_{34} \end{bmatrix}$$

4.6 Assignment

Desc.	MATLAB/Octave	Python	R
	a(:,1) = 99 a(:,1) = [99 98 97]'	a[:,0] = 99	a[,1] <- 99 a[,1] <- c(99,98,97)
Clipping: Replace all elements over 90	a(a>90) = 90;	choose(a>90, (a,90))	a[a>90] <- 90

4.7 Transpose and inverse

Desc.	MATLAB/Octave	Python Numeric	R
Transpose	a'	transpose(a)	t(a)
Non-conjugate transpose	a.' or transpose(a)		
Determinant	det(a)	determinant(a)	det(a)
Inverse	inv(a)	inverse(a)	solve(a)
Norms	norm(a)	norm(a)	
Eigenvalues	eig(a)	eigenvalues(a)	eigen(a)$values
Singular values	svd(a)	singular_value_decomposition(a)	svd(a)$d
Eigenvectors	[v,l] = eig(a)	eigenvectors(a)	eigen(a)$vectors
Rank	rank(a)	rank(a)	

4.8 Sum

Desc.	MATLAB/Octave	Python	R
Sum of each column	sum(a)	add.reduce(a [,axis=0])	apply(a,2,sum)
Sum of each row	sum(a')	add.reduce(a, axis=1)	apply(a,1,sum)

Sum of all elements	`sum(sum(a))`	`sum(a.flat)`	`sum(a)`
Cumulative sum (columns)	`cumsum(a)`	`add.accumulate(a, axis=0)`	`apply(a,2,cumsum)`

4.9 Sorting

Desc.	MATLAB/Octave	Python Numeric	R
Flat and sorted	`sort(a(:))`	`sort(a.flat)`	`sort(a)`
Sort columns	`sort(a)`	`argsort(a)` or `msort(a)`	`apply(a,2,sort)`
Sort rows	`sort(a')`	`argsort(a, axis=0)`	`apply(a,1,sort)`
Sort, return indices			`rank(a)` `order(a)`

4.10 Max and min

Desc.	MATLAB/Octave	Python	R
max in each column	`max(a)`	`argmax(a [,axis=0])` `amax(a [,axis=0])`	`apply(a,2,max)`
return indices, i	`[v i] = max(a)`		`i <- apply(a,1,which.max)`
max in each row	`max(a')`	`argmax(a, axis=1)` `amax(a, axis=1)`	`apply(a,1,max)`

max in array	`max(max(a))`
	`max(b,c)`
	`cummax(a)`
		`max(a.flat)`	`max(a)`
			`pmax(b,c)`
			`apply(a,2,cummax)`

4.11 Matrix manipulation

Desc.	MATLAB/Octave	Python MLab,matplotlib.pylab	R
Flip left-right	`fliplr(a)`	`fliplr(a)`	`a[,4:1]`
Flip up-down	`flipud(a)`	`a[::-1]` or `flipud(a)`	`a[3:1,]`
Rotate 90 degrees	`rot90(a)`	`rot90(a)`	
Repeat matrix: [a a a ; a a a]	`repmat(a,2,3)` Octave: `kron(ones(2,3),a)`		`kronecker(matrix(1,2,3),a)`
Triangular, lower	`tril(a)`	`tril(a)`	`a[lower.tri(a)] <- 0`
Triangular, upper	`triu(a)`	`triu(a)`	`a[upper.tri(a)] <- 0`

4.12 Equivalents to "size"

Desc.	MATLAB/Octave	Python	R
Matrix dimensions	`size(a)`	`a.shape()` or `a.getshape()`	`dim(a)`
Number of columns	`size(a,2)` or `length(a)`	`size(a, axis=1)` or `a.shape[1]`	`ncol(a)`
Number of elements	`length(a(:))`	`size(a)`	`prod(dim(a))`

4.13 Matrix- and elementwise- multiplication

Desc.	MATLAB/Octave	Python Numeric	R
Elementwise operations	`a .* b`	`multiply(a,b)`	`a * b`
Matrix product	`a * b`	`matrixmultiply(a,b)`	`a %*% b`

$$\begin{bmatrix} 1 & 5 \\ 9 & 16 \end{bmatrix}$$

$$\begin{bmatrix} 7 & 10 \\ 15 & 22 \end{bmatrix}$$

Inner matrix vector multiplication $a \cdot b'$		`innerproduct(a,b)`		$\begin{bmatrix} 5 & 11 \\ 11 & 25 \end{bmatrix}$
Outer product		`outerproduct(a,b)`	`outer(a,b)` or `a %o% b`	$\begin{bmatrix} 1 & 2 & 3 & 4 \\ 2 & 4 & 6 & 8 \\ 3 & 6 & 9 & 12 \\ 4 & 8 & 12 & 16 \end{bmatrix}$
Cross product			`crossprod(a,b)` or `t(a) %*% b`	$\begin{bmatrix} 10 & 14 \\ 14 & 20 \end{bmatrix}$
Kronecker product	`kron(a,b)`		`kronecker(a,b)`	$\begin{bmatrix} 1 & 2 & 2 & 4 \\ 3 & 4 & 6 & 8 \\ 3 & 6 & 4 & 8 \\ 9 & 12 & 12 & 16 \end{bmatrix}$
Matrix division, $b \cdot a^{-1}$	`a / b`			
Left matrix division, $b^{-1} \cdot a$ (solve linear equations)	`a \ b`	`solve_linear_equations(a,b)`	`solve(a,b)`	$Ax = b$

4.14 Find

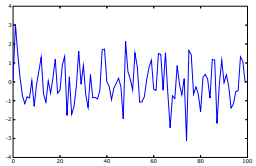
Desc.	MATLAB/Octave	Python Numeric,numarray	R
Non-zero elements, indices	`find(a)`	`nonzero(a.flat)`	`which(a != 0)`
Non-zero elements, array indices	`[i j] = find(a)`	`(i,j)=nonzero(a)`	`which(a != 0, arr.ind=T)`
Vector of non-zero values	`[i j v] = find(a)`	`v = compress(a.flat!=0, a.flat)`	`ij <- which(a != 0, arr.ind=T); v <- a[ij]`
Find, indices	`find(a>5.5)`	`nonzero(a.flat>5.5)`	`which(a>5.5)`
Return values		`compress(a.flat>5.5, a.flat)`	`ij <- which(a>5.5, arr.ind=T); v <- a[ij]`

5 File input and output

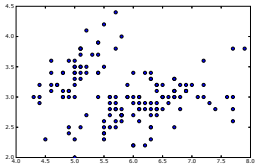
Desc.	MATLAB/Octave	Python matplotlib.pylab	R
Reading from a file	`f = load('data.txt')`	`f = load("data.txt")`	`f <- read.table("data.txt")`
Reading a CSV file	`x = dlmread('data.csv', ';')`	`f = load('data.csv', delimiter=';')`	`f <- read.table(file="data.csv", sep=";")`
Writing to a file	`save -ascii bar.txt f`	`save("bar.csv", f, fmt='%.6f')`	`write(f,file="bar.txt")`

6 Plotting

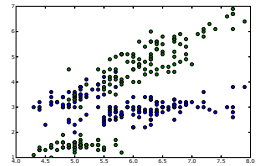
6.1 Basic x-y plots

Desc.	MATLAB/Octave	Python matplotlib.pylab	R	
1d line plot	`plot(a)`	`plot(a)`	`plot(a, type="l")`	

2d scatter plot	`plot(x(:,1),x(:,2),'o')`	`plot(x[:,0],x[:,1],'o')`	`plot(x[,1],x[,2])`



Two graphs in one plot	`plot(x1,y1, x2,y2)`	`plot(x1,y1,'bo', x2,y2,'go')`	



Overplotting: Add new plots to current	`plot(x1,y1)`
	`hold on`
	`plot(x2,y2)`
		`plot(x1,y1,'o')`
		`plot(x2,y2,'o')`
		`show() # as normal`
			`plot(x1,y1)`
			`matplot(x2,y2,add=T)`

subplots	`subplot(211)`	`subplot(211)`	
Plotting symbols and color	`plot(x,y,'ro-')`	`plot(x,y,'ro-')`	`plot(x,y,type="b",col="red")`

6.1.1 Axes and titles

Desc.	MATLAB/Octave	Python matplotlib.pylab	R
Turn on grid lines	`grid on`	`grid()`	`grid()`

1:1 aspect ratio	`axis equal`
	Octave:
	`axis('equal')`
	`replot`
		`figure(figsize=(6,6))`	`plot(c(1:10,10:1), asp=1)`

Set axes manually	`axis([ 0 10 0 5 ])`	`axis([ 0, 10, 0, 5 ])`	`plot(x,y, xlim=c(0,10), ylim=c(0,5))`

Axis labels and titles	`title('title')`
	`xlabel('x-axis')`
	`ylabel('y-axis')`
			`plot(1:10, main="title",`
			`xlab="x-axis", ylab="y-axis")`

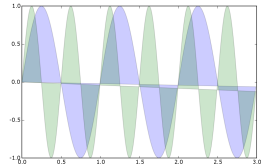
Insert text		`text(2,25,'hello')`	

6.1.2 Log plots

Desc.	MATLAB/Octave	Python matplotlib.pylab	R
logarithmic y-axis	`semilogy(a)`	`semilogy(a)`	`plot(x,y, log="y")`
logarithmic x-axis	`semilogx(a)`	`semilogx(a)`	`plot(x,y, log="x")`
logarithmic x and y axes	`loglog(a)`	`loglog(a)`	`plot(x,y, log="xy")`

6.1.3 Filled plots and bar plots

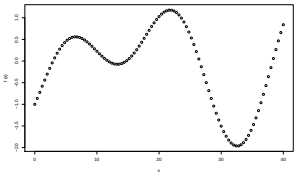
Desc.	MATLAB/Octave	Python matplotlib.pylab	R

Filled plot	`fill(t,s,'b', t,c,'g')`
	Octave: `% fill has a bug?`
		`fill(t,s,'b', t,c,'g', alpha=0.2)`	`plot(t,s, type="n", xlab="", ylab="")`
			`polygon(t,s, col="lightblue")`
			`polygon(t,c, col="lightgreen")` 

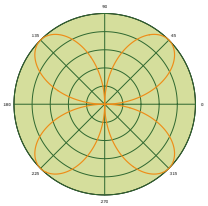
Stem-and-Leaf plot			`stem(x[,3])` 5 5 6 71 7 033 8 00113345567889 9 0133566677788 10 32674

6.1.4 Functions

Desc.	MATLAB/Octave	Python	R
Defining functions	`f = inline('sin(x/3) - cos(x/5)')`		`f <- function(x) sin(x/3) - cos(x/5)` $f(x) = \sin\left(\frac{x}{3}\right) - \cos\left(\frac{x}{5}\right)$

Plot a function for given range	`ezplot(f,[0,40])`
	`fplot('sin(x/3) - cos(x/5)',[0,40])`
	Octave: `% no ezplot`
		`x = arrayrange(0,40,.5)`
		`y = sin(x/3) - cos(x/5)`
		`plot(x,y, 'o')`
			`plot(f, xlim=c(0,40), type='p')` 

6.2 Polar plots

Desc.	MATLAB/Octave	Python	R
	`theta = 0:.001:2*pi;` `r = sin(2*theta);`	`theta = arange(0,2*pi,0.001)` `r = sin(2*theta)`	$\rho(\theta) = \sin(2\theta)$ 
	`polar(theta, rho)`	`polar(theta, rho)`	

6.3 Histogram plots

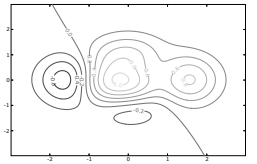
Desc.	MATLAB/Octave	Python	R

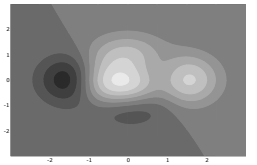
	`hist(randn(1000,1))`
	`hist(randn(1000,1), -4:4)`
	
	`plot(sort(a))`
			`hist(rnorm(1000))`
			`hist(rnorm(1000), breaks= -4:4)`
			`hist(rnorm(1000), breaks=c(seq(-5,0,0.25), seq(0.5,5,0.5)), freq=F)`
			`plot(apply(a,1,sort),type="l")`

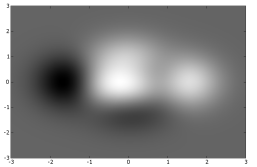
6.4 3d data

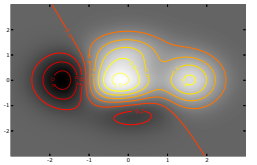
6.4.1 Contour and image plots

Desc.	MATLAB/Octave	Python matplotlib.pylab	R
Contour plot	`contour(z)`	`levels, colls = contour(Z, V, origin='lower', extent=(-3,3,-3,3))` `clabel(colls, levels, inline=1, fmt='%1.1f', fontsize=10)`	`contour(z)`
Filled contour plot	`contourf(z); colormap(gray)`	`contourf(Z, V, cmap=cm.gray, origin='lower', extent=(-3,3,-3,3))`	`filled.contour(x,y,z, nlevels=7, color=gray.colors)`
Plot image data	`image(z)` `colormap(gray)`	`im = imshow(Z, interpolation='bilinear', origin='lower', extent=(-3,3,-3,3))`	`image(z, col=gray.colors(256))`
Image with contours		`# imshow() and contour() as above`	
Direction field vectors	`quiver()`	`quiver()`	





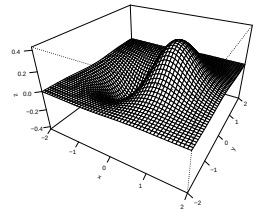


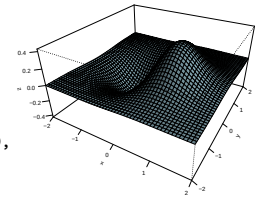


6.4.2 Perspective plots of surfaces over the x-y plane

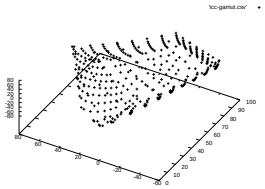
Desc.	MATLAB/Octave	Python Gnuplot.py,DISLIN,pylab	R	

	`n=-2:.1:2;`
	`[x,y] = meshgrid(n,n);`
	`z=x.*exp(-x.^2-y.^2);`
		`n=arrayrange(-2,2,.1)`
		`[x,y] = meshgrid(n,n)`
		`z = x*power(math.e,-x**2-y**2)`
			`f <- function(x,y) x*exp(-x^2-y^2)`
			`n <- seq(-2,2, length=40)`
			`z <- outer(n,n,f)`
				$f(x,y) = xe^{-x^2-y^2}$

Mesh plot	`mesh(z)`	`persp(x,y,z,`
		`  theta=30, phi=30, expand=0.6,`
		`  ticktype='detailed')`
			

Surface plot	`surf(x,y,z)` or `surfl(x,y,z)`
	Octave: `% no surfl()`
		`persp(x,y,z,`
		`  theta=30, phi=30, expand=0.6,`
		`  col='lightblue', shade=0.75, ltheta=120,`
		`  ticktype='detailed')`
			

6.4.3 Scatter (cloud) plots

3d scatter plot	`plot3(x,y,z,'k+')`	`cloud(z~x*y)`	

6.5 Save plot to a graphics file

Desc.	MATLAB/Octave	Python matplotlib.pylab	R

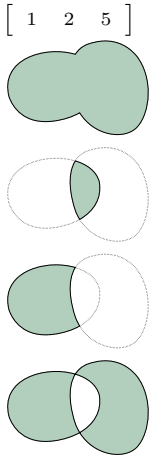
PostScript	`plot(1:10)`
	`print -depsc2 foo.eps`
	Octave:
	`gset output "foo.eps"`
	`gset terminal postscript eps`
	`plot(1:10)`
		`savefig('foo.eps')`	`postscript(file="foo.eps")`
			`plot(1:10)`
			`dev.off()`

PDF		`savefig('foo.pdf')`	`pdf(file='foo.pdf')`
SVG (vector graphics for www)		`savefig('foo.svg')`	`devSVG(file='foo.svg')`
PNG (raster graphics)	`print -dpng foo.png`	`savefig('foo.png')`	`png(filename = "Rplot%03d.png"`

7 Data analysis

7.1 Set membership operators

Desc.	MATLAB/Octave	Python	R
Create sets	`a = [ 1 2 2 5 2 ];` `b = [ 2 3 4 ];`	`a = set([1,2,2,5,2])` `b = set([2,3,4])`	`a <- c(1,2,2,5,2)` `b <- c(2,3,4)`
Set unique	`unique(a)`	`set(a)`	`unique(a)`
Set union	`union(a,b)`	`a.union(b)`	`union(a,b)`
Set intersection	`intersect(a,b)`	`a.intersection(b)`	`intersect(a,b)`
Set difference	`setdiff(a,b)`	`a.difference(b)`	`setdiff(a,b)`
Set exclusion	`setxor(a,b)`	`a.symmetric_difference(b)`	`setdiff(union(a,b),intersect(a,b))`
True for set member	`ismember(2,a)`	`2 in a` or `contains(a,2)`	`is.element(2,a)` or `2 %in% a`



7.2 Statistics

Desc.	MATLAB/Octave	Python	R
Average	`mean(a)`	`average(a [,axis=0])` `mean(a [,axis=0])`	`apply(a,2,mean)`
Median	`median(a)`	`median(a [,axis=0])`	`apply(a,2,median)`
Standard deviation	`std(a)`	`std(a [,axis=0])`	`apply(a,2,sd)`
Variance	`var(a)`	`var(a)`	`apply(a,2,var)`
Correlation coefficient	`corr(x,y)`	`corrcoef(x,y)`	`cor(x,y)`
Covariance	`cov(x,y)`	`cov(x,y)`	`cov(x,y)`

7.3 Interpolation and regression

Desc.	MATLAB/Octave	Python matplotlib.pylab	R

Straight line fit	`z = polyval(polyfit(x,y,1),x)`
	`plot(x,y,'o', x,z ,'-')`
		`(a,b) = polyfit(x,y,1)`
		`plot(x,y,'o', x,a*x+b,'-')`
			`z <- lm(y~x)`
			`plot(x,y)`
			`abline(z)`

Linear least squares $y = ax + b$	`a = x\y`	`(a,b) = linear_least_squares(x,y)[0]`	`solve(a,b)`
Polynomial fit	`polyfit(x,y,3)`	`polyfit(x,y,3)`	

7.4 Non-linear methods

7.4.1 Polynomials, root finding

Desc.	MATLAB/Octave	Python	R	
Find zeros of polynomial	`roots([1 -1 -1])`		`polyroot(c(1,-1,-1))`	$x^2 - x - 1 = 0$
Find a zero near $x = 1$	`f = inline('1/x - (x-1)')` `fzero(f,1)`			$f(x) = \frac{1}{x} - (x - 1)$
Solve symbolic equations	`solve('1/x = x-1')`			$\frac{1}{x} = x - 1$
Evaluate polynomial	`polyval([1 2 1 2],1:10)`	`polyval(array([1,2,1,2]),arange(1,11))`		

7.4.2 Differential equations

Desc.	MATLAB/Octave	Python scipy	R
Difference function and approximate derivative	`diff(a)`	`diff(x,axis=0)`	
Solve differential equations			

7.5 Fourier analysis

Desc.	MATLAB/Octave	Python Numeric.FFT	R
Fast fourier transform	`fft(a)`	`fft(a)`	`fft(a)`
Inverse fourier transform	`ifft(a)`	`inverse_fft(a)`	`fft(a, inverse=TRUE)`

8 Symbolic algebra/Calculus

Desc.	MATLAB/Octave	Python	R

9 Programming

Desc.	MATLAB/Octave	Python	R
Script file extension	`.m`	`.py`	`.R`
Comment symbol (rest of line)	`%` Octave: `%` or `#`	`#`	`#`
Import library functions	`% must be in MATLABPATH` Octave: `% must be in LOADPATH`	`from pylab import *`	`library(RSvgDevice)`
Eval	`string='a=234';` `eval(string)`	`string="a=234"` `eval(string)`	`string <- "a <- 234"` `eval(parse(text=string))`

9.1 Loops

Desc.	MATLAB/Octave	Python	R
for-statement	`for i=1:5; disp(i); end`	`for i in range(1,6): print(i)`	`for(i in 1:5) print(i)`

Multiline for statements	`for i=1:5`
	`  disp(i)`
	`  disp(i*2)`
	`end`
		`for i in range(1,6):`
		`  print(i)`
		`  print(i*2)`
			`for(i in 1:5) {`
			`  print(i)`
			`  print(i*2)`
			`}`

9.2 Conditionals

Desc.	MATLAB/Octave	Python	R	
if-statement	`if 1>0 a=100; end`	`if 1>0: a=100`	`if (1>0) a <- 100`	
if-else-statement	`if 1>0 a=100; else a=0; end`			
Ternary operator (if?true:false)			`ifelse(a>0,a,0)`	$a > 0?a : 0$

9.3 Debugging

Desc.	MATLAB/Octave	Python	R
Most recent evaluated expression	`ans`		`.Last.value`
List variables loaded into memory	`whos` or `who`		`objects()`
Clear variable x from memory	`clear x` or `clear [all]`		`rm(x)`
Print	`disp(a)`	`print a`	`print(a)`

9.4 Working directory and OS

Desc.	MATLAB/Octave	Python os	R
List files in directory	`dir` or `ls`	`os.listdir(".")`	`list.files()` or `dir()`
List script files in directory	`what`	`grep.grep("*.py")`	`list.files(pattern="\.r$")`
Displays the current working directory	`pwd`	`os.getwd()`	`getwd()`
Change working directory	`cd foo`	`os.chdir('foo')`	`setwd('foo')`
Invoke a System Command	`!notepad`	`os.system('notepad')`	`system("notepad")`
	Octave: `system("notepad")`	`os.popen('notepad')`	

[2] This document is still draft quality. Most shown 2d plots are made using Matplotlib, and 3d plots using R and Gnuplot, provided as examples only.

[3] Version numbers and download URL for software used: Python 2.4.1, http://www.python.org/; Numeric 24.0b2, http://numeric.scipy.org/; Matplotlib 0.83.2, http://matplotlib.sf.net/; IPython 0.6.15, http://ipython.scipy.org/; R 2.1.1, http://www.r-project.org/; Octave 2.1.50, http://www.octave.org/; Scilab 3.1.1, http://www.scilab.org/; Gnuplot 4.0, http://www.gnuplot.info/.

[4] For referencing: Gundersen, Vidar Bronken. *MATLAB commands in Numeric Python* (Oslo/Norway, 2005), available from: http://www.37mm.no/matlab-python-xref.html

[5] Contributions are appreciated: The best way to do this is to edit the XML and send patches to vbg+mpy @ 37mm.no