

R Environment

<code>Ctrl + L (Windows)</code>	Clear command window
<code>ls()</code>	List objects in environment
<code>rm(obj)</code>	Remove object
<code>print('text')</code> <code>print(obj)</code>	Displays text or object

Operations and Special Characters

<code>+, -, *, /, ^</code>	Arithmetic operations
<code>%*%</code>	Matrix multiplication
<code>'</code>	Transpose
<code>==, !=, <, >, <=, >=</code>	Relational operators
<code>#</code>	Comment
<code><-</code> or <code>=</code>	Assignment

Elementary Math Functions

<code>sqrt(x)</code>	Square root
<code>exp(x=3)</code>	Exponential of x
<code>abs(x=-1)</code>	Absolute value of x
<code>log(x= exp(1), b=exp(1))</code>	Logarithm with base b. If b is not specified, e is assumed by default

Vectors, Matrices, Arrays, Lists, Data Frames

<code>c(1,2,3)</code>	Combine values into vector
<code>m:n</code>	Sequence from m to n (can't do spacing)
<code>seq(fr om= 1,t o=1 0,by=2)</code>	Sequence with step. For decreasing step, by must be -ve
<code>seq(fr om= 3,t o=2 7,l eng th.o ut=40)</code>	Sequence with as many numbers specified
<code>rep(x= c(3 ,62 ,8.3), tim es= 3,e ach=2)</code>	Repeat values. The value for times provides the number of times to repeat x, and each provides the number of times to repeat each element of x.
<code>sort(x =c(2.5 ,-1 ,-1 0,3.44),d ecr eas i ng =FALSE)</code>	Sort a vector in increasing or decreasing order
<code>length (x= c(3 ,2, 8,1))</code>	Determines how many entries exist in a vector given as the argument x
<code>myvec[1]</code> <code>myvec[c(1,3,5)]</code>	Retrieve specific elements from a vector
<code>myvec[-1]</code> <code>myvec[-c(1,3,5)]</code>	Delete elements by using negative versions of the indexes
<code>myvec[m:n]</code>	Retrieve elements from a vector with a sequence of indices from m to n
<code>prod(m yvec)</code>	Multiply all elements in a vector



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Vectors, Matrices, Arrays, Lists, Data Frames (cont)

`matrix (data = c(-3,2,89,3,0.17), nrow = 2, ncol = 2, byrow = FALSE)` Create a matrix filled in a column-by-column fashion

`rbind(1:3, 4:6)` Bind together vectors as rows of a matrix

`cbind(c(1,4), c(2,5), c(3,6))` Bind together vectors as columns of a matrix

`dim(mymat)` Provides the dimensions of a matrix

`nrow(mymat)`

`ncol(mymat)`

`A[,n]` Refers to the elements in all the rows of column n of the matrix A

`A[n,]` Refers to the elements in all the columns of row n of the matrix A

`A[,m:n]` Refers to the elements in all the rows between columns m and n of the matrix A

`A[m:n,]` Refers to the elements in all the columns between rows m and n of the matrix A

`A[m:n,p:q]` Refers to the elements in rows m through n and columns p through q of the matrix A.

Indexing can be done using individual indices in vectors.

To delete or omit elements from a matrix, use negative indexes.

`diag(x=3)` Create an identity matrix of size 3 x 3

`diag(x=A)` Identify the values along the diagonal of a square matrix

`t(A)` Find the transpose of a matrix

`solve(A)` Find the inverse of a matrix

`list(matrix(1:4, nrow=2, ncol=2), c(T,F), T,T), "hello")` Create a list containing mixed object types. To name the components of a list as it's being created, assign a label to each component in the list command

`lst[[i]]` Access the ith element of a list

`lst[1:2]` Returns a sublist of selected elements

`names(lst)` Name list components to make the elements more recognizable and easier to work with

`lst$name` Access element by name (or create new column)

`x[['name']]`

`x$nested <- list(a=1:3)` Add a nested list to an existing list



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Vectors, Matrices, Arrays, Lists, Data Frames (cont)

```
data.frame(person=c("Peter", "Lois", "Meg", "Chris", "Stewie"),
age=c(42, 40, 17, 14, 1),
gender=factor(c("M", "F", "F", "M", "M")),
stringsAsFactors=TRUE)
```

Create a data frame. stringsAsFactors is used to control automatic conversion of character strings to factors

```
df[df$ gender == 'M', ]
```

Logical Subset

Subset rows where gender is M

Data frames are treated like matrices,
so you can also use functions like nrow(df).

Non-numeric Values

TRUE (or T)

Logical values

FALSE (or F)

any(mat)

Returns TRUE if any of the logicals in the vector are TRUE and returns FALSE otherwise

all(mat)

Returns a TRUE only if all of the logicals are TRUE, and returns FALSE otherwise

"This is a character string -
"

Character strings

nchar(x=str)

Returns the number of characters in a string.

length(x=str) != nchar(x=str)

```
cat("Hello",
"world\n",
".\n",
sep=" ")
```

Sends output directly to the console screen and doesn't formally return anything

```
paste("Hello",
"world",
".",
sep=" ")
```

Concatenates and then returns the final character string as a usable R object

```
substr(x=str,
start=21,
stop=27)
```

Extracts a substring from x, starting at start and ending at stop

```
sub(pattern="chuck",
replacement="hurl",
x=str)
```

Replaces the first match of pattern in x with replacement

```
gsub(pattern="chuck",
replacement="hurl",
x=bar)
```

Replaces all matches of pattern in x with replacement

```
factor(x=c("low",
"medium",
"high",
"medium"))
```

Converts a vector x into a categorical variable with labeled levels (similar to enums from other languages)



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Non-numeric Values (cont)

`levels (x= myvec)` Lists the categories (levels) in the factor x

Multidimensional Arrays

`array(dat a=1:24, dim=c(3, 4, 2))` Creates a 3D array with 3 rows, 4 columns, and 2 layers

`array(dat a=r ep(1:2 4,t ime s=3),d im= c(3 ,4, - 2,3))` Creates a 4D array with dimensions 3×4×2×3

`A[, , n]` All rows and columns in the n-th matrix (3rd dim) of A

`A[, m, n]` All rows in column m of the n-th matrix

`A[i, ,]` All columns and layers of row i

`A[, , , p]` All rows, columns, and matrices in the p-th 4th dimension slice

`A[m:n, , ,]` All columns and dimensions for rows m through n

`A[, , m:n]` All rows and columns for matrices m through n

`A[1:2, 2:3, 1, 1]` A specific 2×2 submatrix from layer 1, 4th-dim slice 1

Statistics

`sum(xdata)` Sum all elements in a vector

`mean(x data, na.rm= FALSE)` Calculates the arithmetic mean

`median (xdata)` Finds the median of a data

`table(xdata)` Returns the frequencies

`xtab[x tab ==m ax(xtab)]` Returns the mode, where xtab is a table of xdata

`min(xdata)` Returns the smallest value

`max(xdata)` Returns the largest value

`range(xdata)` Returns the smallest and largest values

`round(x, n)` Round to the specified number of decimal places (n)

`tapply(chickwts$weight, INDEX=chickwts$feed, FUN=mean)` Applies mean to the numerical data for each grouping variable

`quanti le(x=x data, prob=0.8)` Returns the quantile(s) of interest

`quanti le(x=x data, prob=c (0.2 5, 0.5 ,0.75))`

`summar y(x data)` Provides statistics automatically

`var(xdata)` Direct R commands for computing measures of spread (variance, standard deviation, interquartile range)

`sd(xdata)`

`IQR(xdata)`



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Statistics (cont)

<code>cov(xd ata ,ydata)</code>	Computes the covariance between two numeric vectors
<code>cor(xd ata ,ydata)</code>	Computes the correlation coefficient between two numeric vectors
<code>plot(x, y, line="l ", xlab="x -ax is", ylab="y -ax - is")</code>	Creates a scatter plot of y versus x

Probability

Basic Probability Formulas

$\Pr(A \cup B) = \Pr(A) + \Pr(B) - \Pr(A \cap B)$	
$\Pr(A \cap B) = 0$	If A and B are disjoint/mutually exclusive (cannot happen at the same time)
$\Pr(A \cap B) = \Pr(A) \times \Pr(B)$	If A and B are independent (not related)
$\Pr(A^C) = 1 - \Pr(A)$	
$\Pr(A B) = \Pr(A \cap B) / \Pr(B)$	
$P(X > x) = 1 - P(X \leq x)$	
<code>cumsum(X.prob)</code>	Calculates CDF of discrete RV
<code>sum(X.prob*X.outcomes)</code>	Calculates $E[X]$ (X is discrete RV)
<code>sum((X.outcomes-X.mean)^2 X.prob)</code>	Calculates $\text{Var}(X)$ (X is discrete RV) Alternative: $E[X^2] - (E[X])^2$
$F(x) = \int^x f(u) du$	CDF (continuous)

Plot Probabilities vs. Realizations

<code>barplot(height=X.prob, ylim=c(0,0.5), names.arg=X.outcomes, space=0, xlab="x", ylab="Pr(X = x)")</code>	PMF
<code>barplot(X.cumul, names.arg=X.outcomes, space=0, xlab="x", ylab="Pr(X <= x)")</code>	CDF (discrete)

Common Probability Distributions

<i>X ~ Binomial(size, prob)</i> (X is discrete RV)	
<code>dbinom(x=5,size=8,prob=1/6)</code>	Calculates $P(X = x)$ where x is no. of trials
<code>sum(dbinom(x=0:5,size=8,prob=1/6))</code>	Calculates $P(X \leq q)$ where x is no. of trials
<code>pbinom(q=5,size=8,prob=1/6)</code>	
<code>qbinom(p=0.95,size=8,prob=1/6)</code>	Finds smallest x given $P(X \leq x) = p$ (inverse of CDF)
<i>X ~ Pois(λ)</i> (X is discrete RV)	



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Probability (cont)

<code>dpois(x=3,lambda=3.22)</code>	Calculates $P(X = x)$ where x is no. of events observed
<i>Tip:</i> $P(X = 5)$ is meaningless so $P(X < 5) = P(X \leq 5)$	
<code>ppois(q=3,lambda=3.22)</code>	Calculates $P(X \leq q)$ where q is no. of events
<code>qpois(p=0.95,lambda=3.22)</code>	Finds smallest x given $P(X \leq x) = p$ (inverse of CDF)
<code>rpois(n=15,lambda=3.22)</code>	Generates n random numbers from a Poisson distribution given λ
$X \sim \text{Normal}(\mu, \sigma)$ (X is continuous RV)	
<code>dnorm(x, mean, sd)</code>	Returns the height of the normal distribution curve at x
<code>pnorm(q, mean, sd)</code> Default: $\mu = 0, \sigma = 1$	Calculates $P(X \leq q)$ given μ and σ or $P(Z \leq z)$ if defaults are used
<code>qnorm(p, mean, sd)</code>	Finds smallest x given $P(X \leq x) = p$ (inverse of CDF)
<code>qnorm(p, lower.tail=FALSE)</code>	Finds smallest z given $P(Z > z) = p$ Equal to $P(Z \leq z) = 1 - p$
<code>rnorm(n, mean, sd)</code>	Generates n random numbers from a Normal distribution given μ and σ

QQ Plots and Histograms

<code>hist(chickwts\$weight, main="", xlab="weight", xlim=c(xi,xf))</code>	Draws a histogram of the given data
<code>qqnorm(chickwts\$weight, main="Normal QQ plot of weights")</code>	Creates a QQ plot
<code>qqline(chickwts\$weight, col="gray")</code>	Adds a reference line to the QQ plot



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