# Enough R for Intro to Statistical Modeling



A couple dozen functions suffice to carry out your work in Introduction to Statistical Modeling. This sheet provides the names of functions, a review of formula syntax, and some examples of use.

## Help

```
help()
apropos()
?
??
example()
```

## Arithmetic

Basic arithmetic is very similar to a calculator.

```
# basic ops: + - * / ^ ( )
log()
exp()
sqrt()
log10()
abs()
```

## Randomization/Iteration

```
do()          # mosaic
sample()      # mosaic augmented
resample()    # with replacement
shuffle()     # mosaic
```

## Graphics

```
bwplot()
xyplot()
densityplot()
histogram()
plotFun() # mosaic
```

## Numerical Summaries

These functions have a formula interface to match plotting.

```
mean()   # mosaic augmented
median() # mosaic augmented
sd()     # mosaic augmented
var()    # mosaic augmented
tally()  # mosaic
qdata()  # mosaic
pdata()  # mosaic
IQR()
```

## Model Building and Inference

```
mm()       # mosaic
lm()       # linear models
glm()      # for logistic models
resid()
fitted()
confint()
anova()
summary()
makeFun() # mosaic
listFun() # devel
```

## Interactive

Only for classroom use.

```
mLM()  mLineFit()  mLinAlgebra()
mCI()  mHypTest() mPower()
```

## Formulas for Models

```
response ~ a+b # main effects
response ~ a*b # interaction, too
```

Do not use | or `groups=`.

## Formulas for Graphs and Numerics

Plotting (e.g. `xyplot`, `densityplot`, `bwplot`) and simple numerics (e.g. `tally`, `mm`) use formulas in the following ways:

```
fname( y ~ x | z, data=...,
                  groups=... )
```

`y`: is y-axis variable. Leave blank for densityplots
`x`: is x-axis variable
`z`: conditioning variable (separate panes in graphs)
`groups`: conditioning variable (overlaid in graphs)
For other things y   x — z can usually be read y or depends on x separately for each z .

## Data and Variables

```
fetchData()   # mosaic
names()
head()
levels()
subset()
with()
transform()
as.factor()
merge()
rank()
```

## Model Terms

```
# All cases the same:
response ~ 1
# Main effects & intercept
response ~ X + Y
# Exclude intercept
# (Rarely used.  Be careful!)
response ~ X + Y - 1
# Main effects and interaction:
response ~ X * Y
# Pure interaction (Rarely used.)
response ~ X:Y
#Polynomial terms:
response ~ poly(X,2)
# Random model vectors (pedagogical)
response ~ rand(2) # mosaic
```

## Common Example Datasets

Can be used directly with `data=`:

```
Galton # heights
CPS85 # wages
KidsFeet
Marriage
SAT
```

Read in with `fetchData()`:

```
utils = fetchData("utilities.csv")
alder = fetchData("alder.csv")
grades = fetchData("grades.csv")
courses = fetchData("courses.csv")
# Load software in development:
fetchData("m155development.R")
```

## Quick Look at a Data Frame

```
cps = fetchData("CPS85")
names(cps)    nrow(cps)     summary(cps)
head(cps)     sample(cps,size=5)
```

## Tallying

A simple count of the number in each level

```
tally(~sex, data = CPS85)
```

A two-way table of counts

```
tally(~sex + married, data = CPS85)
```

Conditional proportions: A | B means "A conditioned on B".

```
tally(~sex | married, data = CPS85)
```

Different from `~married|sex`.

## New Dataframe Variable

```
g = fetchData("Galton")
```

Add a variable named `mid`

```
g = transform(g,
     mid=(father+1.08*mother)/2)
names(g)  #confirm that it's there

[1] "family" "father" "mother" "sex"
[5] "height" "nkids"  "mid"
```

## Subsets

Sometimes you want only part of a data set.

```
boys = subset(KidsFeet, sex=="B")
elig = subset(CPS85,
        wage>10 & married=="Single")
pros = subset(CPS85,
   sector %in% c("prof","manag"))
```

**... Random subset**

```
subset(CPS85, size = 4)
```

## Data from Google Spreadsheets

In Google, choose FILE/PUBLISH TO THE WEB. Get link to the published data as CSV, sheet 1. Copy the link

```
mydat=fetchGoogle("https://docs.google...")
```

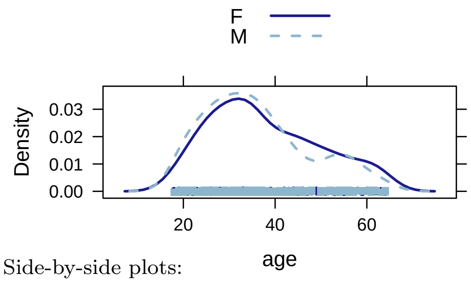
## Distributions

Simple distribution

```
densityplot(~age, data = CPS85)
```

Overlaying two (or more) groups

```
densityplot( ~ age, groups=sex,
             data=CPS85,
             auto.key=TRUE)
```




Side-by-side plots:

```
densityplot(~age | sex, data = CPS85)
```

```
bwplot(age ~ sector, data = CPS85)
```

## Scatter Plots

```
xyplot(wage ~ age, data = CPS85)
```

`groups=` and `|` work as with `densityplot()`.

## Plotting Model Values

```
mod = lm(wage ~ educ+sex,data=CPS85 )
xyplot(fitted(mod) ~ educ,data=CPS85 )
xyplot(wage+fitted(mod) ~ educ,data=CPS85)
```

## Extract Model Information

```
mod = lm(wage ~ educ + sex, data = CPS85)
coef(mod)
fitted(mod)
resid(mod)
f = makeFun(mod)  # model function
```

## P's and Q's

Want to find the value that separates the lower 30% from the higher 70%:

```
qdata(0.3, wage, data = CPS85)
```

Have a value and want to find what fraction of the cases are at or below the value:

```
pdata(10, wage, data = CPS85)
```

## Randomization

Sample

```
mysamp = sample(CPS85, size = 100)
```

Resample:

```
lm(wage~educ,data=resample(CPS85))
```

Shuffle (for hypothesis testing)

```
lm(wage~shuffle(educ),data=CPS85)
```

Probability distributions:

```
rnorm(10,mean=25,sd=2)
rbinom(10,prob=.5,size=40)
rpois(10,lambda=50) # events per period
rexp(10,rate=0.01) # 1/average time btwn events
```

## Confidence Intervals

**... via "normal theory"**

```
mod = lm( wage ~ educ, data=CPS85 )
confint(mod)

                2.5 % 97.5 %
(Intercept) -2.7997 1.3077
educ         0.5958 0.9051
```

See also `summary(mod)`.

**... via bootstrapping**

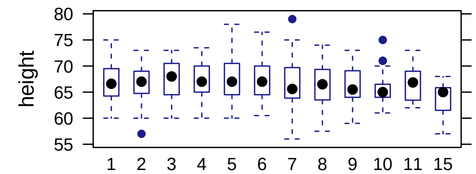
```
s = do(500)*
  lm(wage~educ, data=resample(CPS85))
sd(s) # standard error

Intercept      educ      sigma r.squared
  1.05120   0.08648    0.28221   0.02799
```

See also `confint(s)`

## Quantitative → Categorical

```
bwplot( height ~ as.factor(nkids),
        data=Galton )
```




## Sums of Squares, Dot Products

```
sum( fitted(mod)^2 )
sum( resid(mod)^2 )
with( data=CPS85, sum(wage^2))
sum(fitted(mod)*resid(mod)) # dot prod
```

## Something is Wrong

```
run = fetchData("repeat-runners.csv")
mean(net, data = run)

[1] NA
```

Some of the data was missing, thus the NA. **The FIX**:

```
options(na.rm = TRUE)
mean(net, data = run)

[1] 88.27
```

## Can't Find Something Here?

Send a note to `kaplan@macalester.edu`