Intro stats with `mosaic`

ggformula version

Essential R syntax

Names in R are *case sensitive*

Function and arguments

```
rflip(10)
```

Optional arguments

```
rflip(10, prob = 0.8)
```

Assignment

```
x <- rflip(10, prob = 0.8)
```

Getting help on any function

```
help(mean)
```

Loading packages

```
library(mosaic)
```

Arithmetic operations

`+  -  *  /`	basic operations
`^`	exponentiation
`( )`	grouping
`sqrt(x)`	square root
`abs(x)`	absolute value
`log10(x)`	logarithm, base 10
`log(x)`	natural logarithm, base e
`exp(x)`	exponential function e^x
`factorial(k)`	$k! = k(k-1)\ \ldots 1$

Logical operators

`==`	is equal to (note double equal sign)
`!=`	is not equal to
`<`	is less than
`<=`	is less than or equal to
`>`	is greater than
`>=`	is greater than or equal to
`&`	`A & B` is `TRUE` if both `A` and `B` are `TRUE`
`|`	`A | B` is `TRUE` if one or both of `A` and `B` are `TRUE`
`%in%`	includes; for example `"C" %in% c("A", "B")` is `FALSE`

Formula interface

Use for graphics, statistics, inference, and modeling operations.

```
goal(y ~ x, data = mydata)
```

Read as "Calculate `goal` for `y` using `mydata` "broken down by" `x`, or "modeled by" `x`.

```
mean(age ~ sex, data = HELPrct)
```

For graphics:

```
goal(y ~ x | z, color = ~ w,
  data = mydata)
```

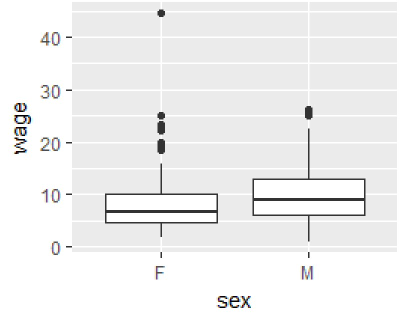
`y` : y-axis variable (*optional*)

`x` : x-axis variable (*required*)

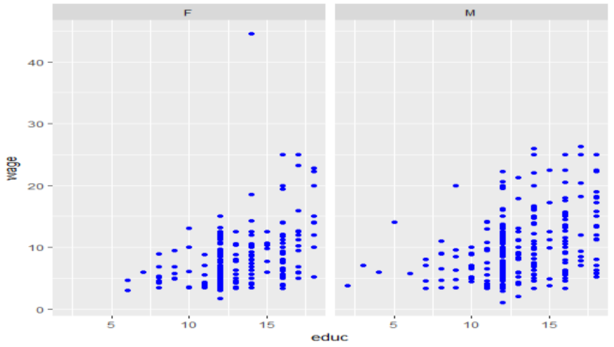
`z` : panel-by variable (*optional*)

`w` : color-by variable (*optional*)

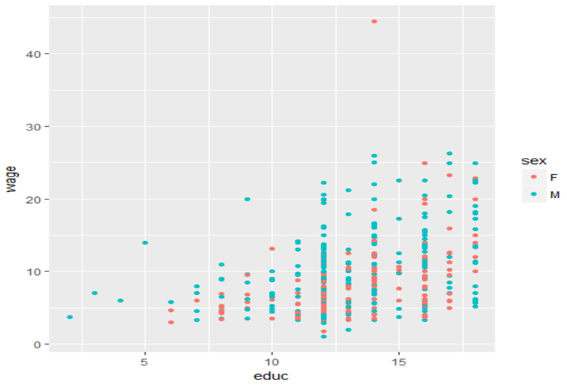
```
gf_boxplot(wage ~ sex,
   data = CPS85)
```



```
gf_point(wage ~ educ | sex,
  data = CPS85, color = "blue")
```



```
gf_point(wage ~ educ,
  color = ~ sex, data = CPS85)
```



Examining data

Print short summary of all variables

```
inspect(HELPrct)
```

Number of rows and columns

```
dim(HELPrct)
nrow(HELPrct)
ncol(HELPrct)
```

Print first rows or last rows

```
head(KidsFeet)
tail(KidsFeet, 10)
```

Names of variables

```
names(HELPrct)
```

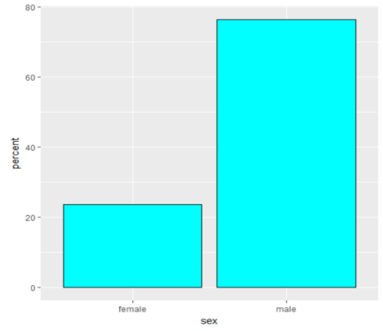
One categorical variable

Counts by category

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

Percentages by category

```
tally(~ sex, format =
  "percent",  data = HELPrct)
gf_percents(~ sex, data =
  HELPrct, fill = "cyan",
  color = "black")
`
```



Tests and confidence intervals

Exact test

```
result1 <-
  binom.test(~ (homeless ==
  "homeless"), data = HELPrct)
```

Approximate test (large samples)

```
result2 <-
  prop.test(~ (homeless ==
  "homeless"), data = HELPrct)
```

Extract confidence intervals and p-values

```
confint(result1)
pval(result2)
```

One quantitative variable

Make output more readable

```
options(digits = 3)
```

Compute summary statistics

```
mean(~ cesd, data = HELPrct)
```

Other summary statistics work similarly

```
median()  iqr() max()  min()
fivenum() sd()  var()  sum()
```

Table of summary statistics

```
favstats(~ cesd, data = HELPrct)
```

Summary statistics by group

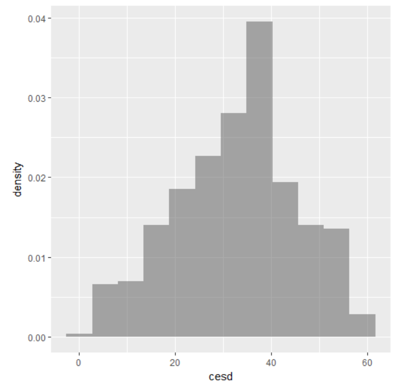
```
favstats(cesd ~ sex,
  data = HELPrct)
```

Quantiles

```
quantile(~ cesd, data = HELPrct,
  prob = c(0.25, 0.5, 0.8))
```

Histogram

```
gf_dhistogram(~ cesd, data =
  HELPrct, bins = 12)
```



Normal probability plot

```
gf_qq(~ cesd, data = HELPrct)
```

Density plot

```
gf_dens(~ cesd, data = HELPrct,
  color = "blue", size = 1.25)
```

One-sample t-test

```
result <- t.test(~ cesd,
  mu = 34, data = HELPrct)
```

Extract confidence intervals and p-values

```
confint(result)
pval(result)
```

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Two categorical variables

Contingency table with margins

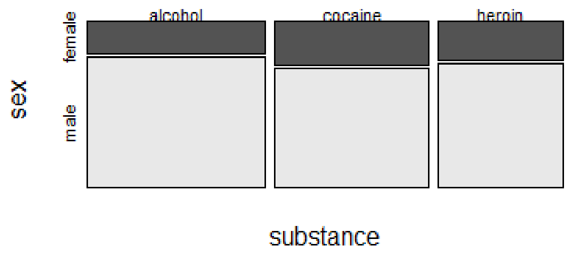
```
tally(~ substance + sex,
  margins = TRUE,
  data = HELPrct)
```

Percentages by column

```
tally(~ sex |substance,
  format = "percent",
  data = HELPrct)
```

Mosaic plot

```
mosaicplot(~ substance + sex,
  color = TRUE, data = HELPrct)
```



Chi-square test

```
xchisq.test(~ substance + sex,
  data = HELPrct,
  correct = FALSE)
```

Distributions

Normal distribution function

```
pnorm(13, mean = 10, sd = 2)
```

Normal distribution function with graph

```
xpnorm(1.645, mean = 0, sd = 1)
```

Normal distribution quantiles

```
qnorm(0.95) # mean = 0, sd = 1
```

Normal distribution quantiles with graph

```
xqnorm(0.85, mean = 10, sd = 2)
```

Binomial density function (“size” means *n*)

```
dbinom(5, size = 8, prob = 0.65)
```

Binomial distribution function

```
pbinom(5, size = 8, prob = 0.65)
```

Central portion of distribution

```
cdist("norm", 0.95)
cdist("t", c(0.90, 0.99), df = 5)
```

Plotting distributions

```
plotDist("binom", size = 8,
  prob = 0.65, xlim = c(-1, 9))
plotDist("norm", mean = 10,
  sd = 2)
```

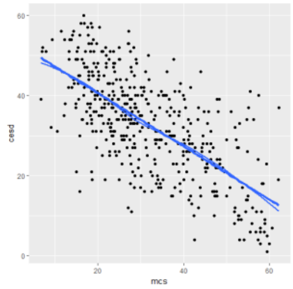
Two quantitative variables

Correlation coefficient

```
cor(cesd ~ mcs, data = HELPrct)
```

Scatterplot with regression line and smooth

```
gf_point(cesd ~ mcs,
         data = HELPrct) %>%
  gf_smooth(linetype = "dashed",
            color = "red") %>%
  gf_lm(size = 1.5)
```



Simple linear regression

```
cesdmodel <- lm(cesd ~ mcs,
  data = HELPrct)
msummary(cesdmodel)
```

Prediction

```
lm_fun <- makeFun(cesdmodel)
lm_fun(mcs = 35)
```

Extract useful quantities

```
anova(cesdmodel)
coef(cesdmodel)
confint(cesdmodel)
rsquared(cesdmodel)
```

Diagnostics; plot residuals

```
gf_dhistogram(~resid(cesdmodel)
gf_qq(~resid(cesdmodel))
```

Diagnostics; plot residuals vs. fitted

```
gf_point(resid(cesdmodel) ~
    fitted(cesdmodel)) %>%
  gf_lm(size = 2)
```

Categorical response, quantitative predictor

Logistic regression

```
logit_mod <-
  glm(homeless ~ age,
  family = binomial, data = HELPrct)
msummary(logit_mod)
```

Odds ratios and confidence intervals

```
exp(coef(logit_mod))
exp(confint(logit_mod))
```

Data manipulation

From `dplyr` package

For details, see **Tidyverse cheatsheet**

Drop, rename, or reorder variables

```
select()
```

Create new variables from existing ones

```
mutate()
```

Retain specific rows from data

```
filter()
```

Sort data rows

```
arrange()
```

Compute summary statistics by group

```
group_by()
summarize()
```

Importing data

Import data from file or URL

```
MustangPrice <-
  read.file("C:/MustangPrice.csv")
# NOTE: R uses forward slashes!
Dome <-
  read.file("http://www.mosaic-
  web.org/go/datasets/Dome.csv")
```

Randomization and simulation

Fix random number sequence

```
set.seed(42)
```

Toss coins

```
rflip(10) # default prob is 0.5
```

Do something repeatedly

```
do(5) * rflip(10, prob = 0.75)
```

Draw a simple random sample

```
sample(LETTERS, 10)
deal(Cards, 5) # poker hand
```

Resample with replacement

```
Small <- sample(KidsFeet, 10)
resample(Small)
```

Random permutation (shuffling)

```
shuffle(Cards)
```

Random values from distributions

```
rbinom(5, size = 10, prob = 0.7)
rnorm(5, mean = 10, sd = 2)
```

Quantitative response, categorical predictor

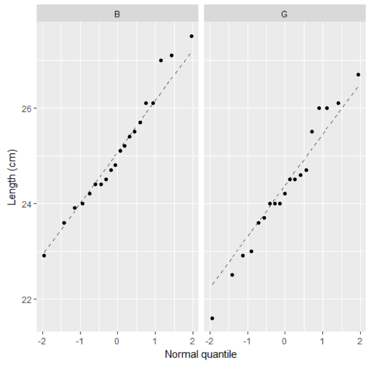
Two-level predictor: two-sample *t* test

Numeric summaries

```
favstats(~length | sex,
  data = KidsFeet)
```

Graphic summaries

```
gf_qq(~ length | sex,
      data =  KidsFeet) %>%
  gf_labs(x = "Normal quantile",
          y = "Length (cm)") %>%
  gf_qqline()
```



```
gf_boxplot(cesd ~ substance,
  data = HELPrct)
```

Two-sample *t*-test and confidence interval

```
result <- t_test(cesd ~ sex,
  data = HELPrct)
result # view results
confint(result)
```

More than two levels (Analysis of variance)

Numeric summaries

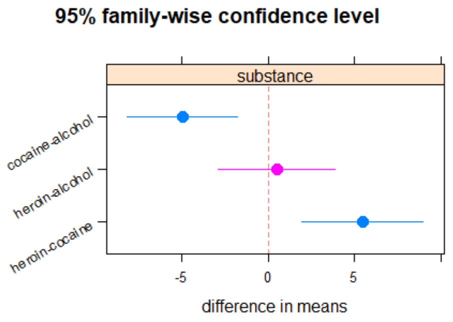
```
favstats(cesd ~ substance,
  data = HELPrct)
```

Fit and summarize model

```
modsubstance <- lm(cesd ~ substance,
  data = HELPrct)
anova(modsubstance)
```

Which differences are significant?

```
pairwise <- TukeyHSD(modsubstance)
mplot(pairwise)
```



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