Debugging

Biostatistics 140.776

Something's Wrong!

Indications that something's not right

- `message`: A generic notification/diagnostic message produced by the `message` function; execution of the function continues
- `warning`: An indication that something is wrong but not necessarily fatal; execution of the function continues; generated by the `warning` function
- `error`: An indication that a fatal problem has occurred; execution stops; produced by the `stop` function
- `condition`: A generic concept for indicating that something unexpected can occur; programmers can create their own conditions

Something's Wrong!

Warning

```
> log(-1)
[1] NaN
Warning message:
In log(-1) : NaNs produced
```

Something's Wrong

```
printmessage <- function(x) {
        if(x > 0)
                print("x is greater than zero")
        else
                print("x is less than or equal to zero")
        invisible(x)
}
```

Something's Wrong

```
printmessage <- function(x) {
        if(x > 0)
                print("x is greater than zero")
        else
                print("x is less than or equal to zero")
        invisible(x)
}
> printmessage(1)
[1] "x is greater than zero"
> printmessage(NA)
Error in if (x > 0) { : missing value where TRUE/FALSE needed
```

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```
printmessage2 <- function(x) {
        if(is.na(x))
                print("x is a missing value!")
        else if(x > 0)
                print("x is greater than zero")
        else
                print("x is less than or equal to zero")
        invisible(x)
}
```

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```
printmessage2 <- function(x) {
        if(is.na(x))
                print("x is a missing value!")
        else if(x > 0)
                print("x is greater than zero")
        else
                print("x is less than or equal to zero")
        invisible(x)
}
> x <- log(-1)
Warning message:
In log(-1) : NaNs produced
> printmessage2(x)
[1] "x is a missing value!"
```

Something's Wrong!

How do you know that something is wrong with your function?

- What was your input? How did you call the function?
- What were you expecting? Output, messages, other results?
- What did you get?
- How does what you get differ from what you were expecting?
- Were your expectations correct in the first place?
- Can you reproduce the problem (exactly)?

Debugging Tools in R

The primary tools for debugging functions in R are

- `traceback`: prints out the function call stack after an error occurs; does nothing if there's no error
- `debug`: flags a function for "debug" mode which allows you to step through execution of a function one line at a time
- `browser`: suspends the execution of a function wherever it is called and puts the function in debug mode
- `trace`: allows you to insert debugging code into a function a specific places
- `recover`: allows you to modify the error behavior so that you can browse the function call stack

These are interactive tools specifically designed to allow you to pick through a function. There's also the more blunt technique of inserting `print`/`cat` statements in the function.

traceback

```
> mean(x)
Error in mean(x) : object 'x' not found
> traceback()
1: mean(x)
>
```

traceback

```
> lm(y ~ x)
Error in eval(expr, envir, enclos) : object 'y' not found
> traceback()
7: eval(expr, envir, enclos)
6: eval(predvars, data, env)
5: model.frame.default(formula = y ~ x, drop.unused.levels = TRUE)
4: model.frame(formula = y ~ x, drop.unused.levels = TRUE)
3: eval(expr, envir, enclos)
2: eval(mf, parent.frame())
1: lm(y ~ x)
```

debug

```
> debug(lm)
> lm(y ~ x)
debugging in: lm(y ~ x)
debug: {
    ret.x <- x
    ret.y <- y
    cl <- match.call()
    ...
    if (!qr)
        z$qr <- NULL
    z
}
Browse[2]>
```

debug

```
Browse[2]> n
debug: ret.x <- x
Browse[2]> n
debug: ret.y <- y
Browse[2]> n
debug: cl <- match.call()
Browse[2]> n
debug: mf <- match.call(expand.dots = FALSE)
Browse[2]> n
debug: m <- match(c("formula", "data", "subset", "weights", "na.action",
    "offset"), names(mf), 0L)
```

recover

```
> options(error = recover)
> read.csv("nosuchfile")
Error in file(file, "rt") : cannot open the connection
In addition: Warning message:
In file(file, "rt") :
  cannot open file 'nosuchfile': No such file or directory

Enter a frame number, or 0 to exit

1: read.csv("nosuchfile")
2: read.table(file = file, header = header, sep = sep, quote = quote, dec =
3: file(file, "rt")

Selection:
```

Summary

- There are three main indications of a problem/condition: message, warning, error; only an error is fatal
- When analyzing a function with a problem, make sure you can reproduce the problem, clearly state your expectations and how the output differs from your expectation
- Interactive debugging tools `traceback`, `debug`, `browser`, `trace`, and `recover` can be used to find problematic code in functions
- Debugging tools are not a substitute for thinking!