

Session 3: Basics of R

math operations; using variables

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RAF Sessions on R and RStudio

Calculator-like operations

- Standard interactive R
- RStudio console provides some conveniences
- Can do some simple programming interactively

Example: Roll angle for a 4-min turn

$$\frac{v^2}{r} = g \tan \phi$$

$$2\pi r = vT$$

$$\phi = \arctan \left(\frac{2\pi v}{gT} \right)$$

The Equation:

$$\phi = \arctan\left(\frac{2\pi v}{gT}\right)$$

```
TAS <- 200
gravity <- 9.8
T <- 60 * 4 # time in seconds
atan (2 * pi * TAS / (gravity * T)) * 180 / pi
## [1] 28.1149
## gives required roll angle in degrees
```

See the Calculator under Tools

Math Conventions

focus on what might seem different

Operator precedence:

- :: \$ [] PEU: %x% (MD)(AS)
and L-to-R associativity
"1:5 * 2" : has precedence

1:5 * 2 # 1:10 or 2,4,6...?

[1] 2 4 6 8 10

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T | F & F # & has priority

[1] TRUE

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- `! (& &&) (| ||)` xor
- `&` vectorized;
`&&` single-valued, efficient

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`## [1] TRUE`

`27 %% 6`

`## [1] 3`

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modulus: `%%` (mention `%x%`)

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Operators to note:

exponentiation: `^` (accepts `**`)

modulus: `%%` (mention `%x%`)

integer division: `/%/%`

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1:5 * 2 # 1:10 or 2,4,6...?  
## [1] 2 4 6 8 10
```

```
T | F & F # & has priority  
## [1] TRUE
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27 %% 6  
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```
b <- 5.3 %/% 2.6; b  
## [1] 2  
is.integer(b); as.integer(b)  
## [1] FALSE  
## [1] 2
```

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exponentiation: `^` (accepts `**`)

modulus: `%%` (mention `%x%`)

integer division: `%/%`

define vector: `c(...)`

test if element present: `%in%`

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1:5 * 2 # 1:10 or 2,4,6...?  
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b <- 5.3 %/% 2.6; b  
## [1] 2  
is.integer(b); as.integer(b)  
## [1] FALSE  
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```

```
a <- c("alpha", "beta", "gamma")  
c("gamma", "eta") %in% a  
## [1] TRUE FALSE
```

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exponentiation: `^` (accepts `**`)
modulus: `%%` (mention `%x%`)
integer division: `%/%`
define vector: `c(...)`
test if element present: `%in%`
equality test: `'=='`, not `'='`

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1:5 * 2 # 1:10 or 2,4,6...?  
## [1] 2 4 6 8 10
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```
T | F & F # & has priority  
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b <- 5.3 %/% 2.6; b  
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a <- c("alpha", "beta", "gamma")  
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integer division: `/%/`

define vector: `c(...)`

test if element present: `%in%`

equality test: `'=='`, not `'='`

missing: `'+='`, `'++'`, etc.

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1:5 * 2 # 1:10 or 2,4,6...?  
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```

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27 %% 6  
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is.integer(b); as.integer(b)  
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a <- c("alpha", "beta", "gamma")  
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VECTOR OPERATIONS

Vector Arithmetic:

- Loops seldom needed:
Most functions work
vectorized. Very useful; cf.
Ranadu/R/AirTemperature.R

R input and response:

```
a <- 1:10; a[1:5] <- a[6:10]; a
## [1] 6 7 8 9 10 6 7 8 9 10
```

VECTOR OPERATIONS

Vector Arithmetic:

- Loops seldom needed: Most functions work vectorized. Very useful; cf. Ranadu/R/AirTemperature.R
- If vector operations use different-length vectors, the shorter one will be recycled.

R input and response:

```
a <- 1:10; a[1:5] <- a[6:10]; a
## [1] 6 7 8 9 10 6 7 8 9 10

2*a; a <- a + 1:2; print (a)
## [1] 12 14 16 18 20 12 14 16 18 20
## [1] 7 9 9 11 11 8 8 10 10 12
```

VECTOR OPERATIONS

Vector Arithmetic:

- Loops seldom needed: Most functions work vectorized. Very useful; cf. Ranadu/R/AirTemperature.R
- If vector operations use different-length vectors, the shorter one will be recycled.
- Logical tests are very useful:
As indices
(vectors, data.frames)
To replace select values:

```
Data[Data$TASX < 130, ] <- NA
```


E.g, print each 10 s in sequence:

```
a[a %% 10 == 0]
```

R input and response:

```
a <- 1:10; a[1:5] <- a[6:10]; a
## [1] 6 7 8 9 10 6 7 8 9 10
```

```
2*a; a <- a + 1:2; print(a)
## [1] 12 14 16 18 20 12 14 16 18 20
## [1] 7 9 9 11 11 8 8 10 10 12
```

```
Data <- data.frame("Time"=1:4)
Data["ATX"]=c(10.3, 10.6, 10.9, 11.2)
Data["TASX"] <- c(131.3, 129.8, 132.9, 135.6)
Valid <- (Data$TASX > 130.); Valid
## [1] TRUE FALSE TRUE TRUE
DataValid <- Data[Valid, ]; DataValid
##   Time ATX TASX
## 1    1 10.3 131.3
## 3    3 10.9 132.9
## 4    4 11.2 135.6
```

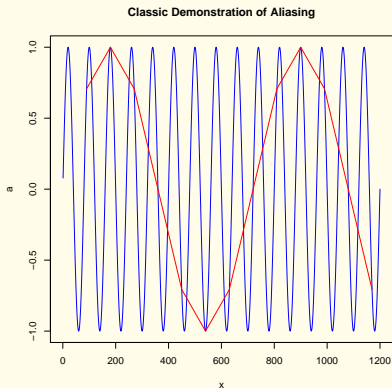
VECTOR OPERATIONS

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- Logical tests are very useful:
As indices
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To replace select values:
`Data[Data$TASX < 130,] <- NA`
E.g., print each 10 s in sequence:
`a[a %% 10 == 0]`

R input and response:

```
a <- sin((x <- 1:1200) * pi/40) # period is 80 s
r <- 1:1200 %% 90 == 0        # sample at 90 s
plot(x,a,type='l', col='blue')
lines(x[r],a[r], col='red')
title("Classic Demonstration of Aliasing")
```



USING VARIABLES

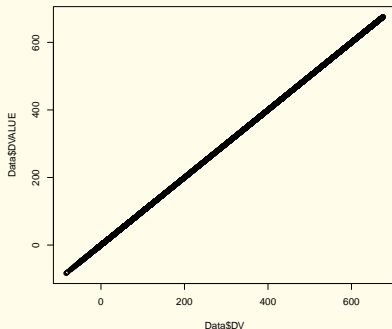
- Variables can hold many things, allowing you to organize your work:
 - ▶ text, vectors, data-frames, arrays, matrices, lists, ...
 - ▶ fit results
 - ▶ plot characteristics
- Suggestion: Make use of this wherever possible
 - ▶ Create data-frames to hold data for plots.
 - ▶ Include new variables in the relevant data-frames.
 - ▶ When fitting, save the results in unique variables.

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R input and response:

```
## [1] "/Data/CONTRAST/CONTRASTrf17.nc"  
Data <- getNetCDF(fname, varNames)  
Data["DV"] <- Data$GGALTB - Data$PALT  
names(Data)[2:6]  
## [1] "GGALTB" "GGALT" "PALT" "DVALUE" "DV"  
mean(Data$GGALTB - Data$GGALT, na.rm = TRUE)  
## [1] -6.891452e-05  
sd(Data$GGALTB - Data$GGALT, na.rm = TRUE)  
## [1] 0.01321829  
plot(Data$DV, Data$DVALUE)
```



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Exercise: Partition the data by GGQUAL

This will show that the standard deviation for GGQUAL == 5 (highest quality) is much smaller.

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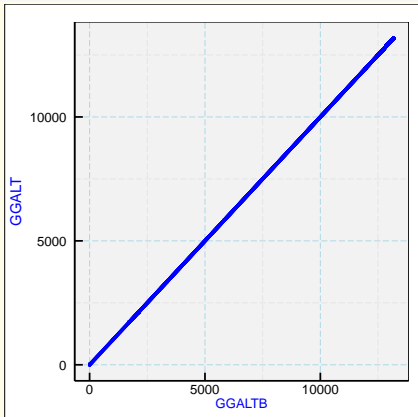
R input and response:

```
fit1 <- lm (GGALTB ~ GGALT, data=Data)
names(fit1)
## [1] "coefficients" "residuals"      "effects"
## [5] "fitted.values" "assign"          "qr"
## [9] "xlevels"       "call"           "terms"
summary(fit1)
##
## Call:
## lm(formula = GGALTB ~ GGALT, data = Data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.77737 -0.00101 -0.00004  0.00094  0.37749
##
## Coefficients:
##              Estimate Std. Error  t value Pr(>|t|)
## (Intercept) -1.936e-03  4.312e-04 -4.491e+00 7.14e-0
## GGALT        1.000e+00  3.539e-08  2.826e+07 < 2e-1
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.'
##
## Residual standard error: 0.01321 on 21359 degrees of freedom
## Multiple R-squared:  1, Adjusted R-squared:
## F-statistic: 7.986e+14 on 1 and 21359 DF, p-value:
coefficients(fit1) #or summary(fit1)$coefficients
## (Intercept)          GGALT
## -0.00193629  1.00000016
```

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R input and response:

```
# nicer plot, using 'grammar of graphics'  
# 'g' will be container for plot characteristics  
require(ggplot2)  
g <- ggplot(data=Data, aes(x=GGALTB, y=GGALT))  
g <- g + geom_point(size=2, color='blue', shape=20)  
g <- g + theme_WAC()  
print(g)
```



NEXT TIME: Guide to 'Ranadu'

Also:

- Review and catch-up
- Suggestions re 'style' and 'traps'