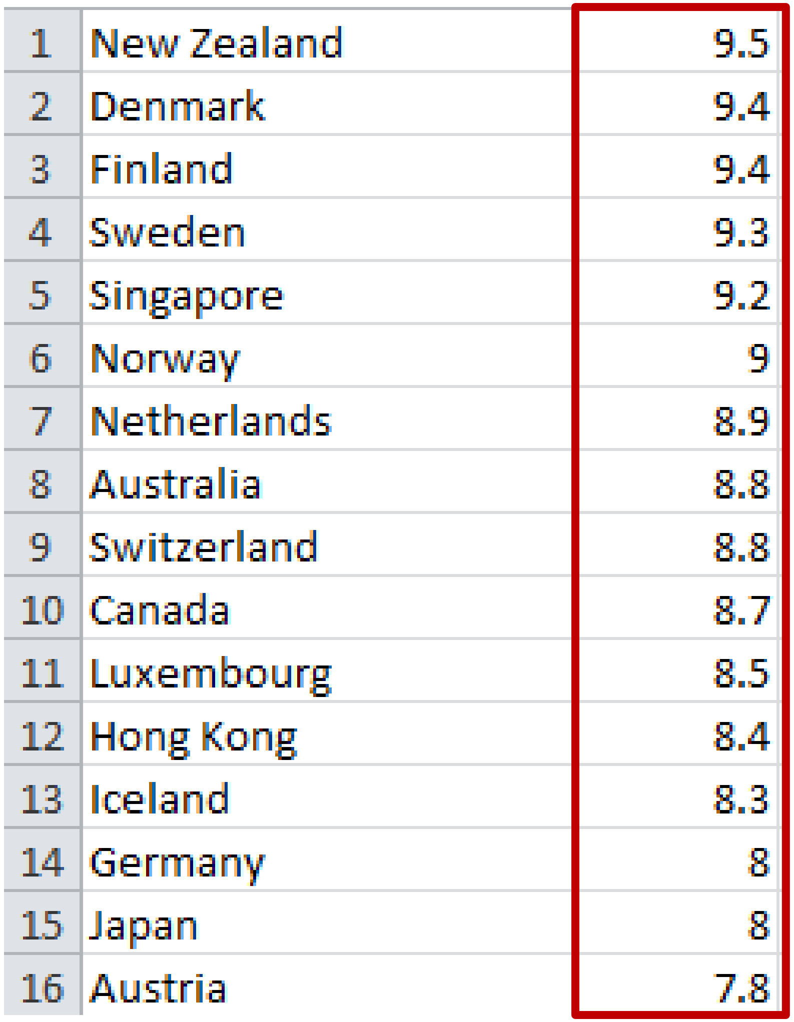
Working With Vectors



1	New Zealand	9.5
2	Denmark	9.4
3	Finland	9.4
4	Sweden	9.3
5	Singapore	9.2
6	Norway	9
7	Netherlands	8.9
8	Australia	8.8
9	Switzerland	8.8
10	Canada	8.7
11	Luxembourg	8.5
12	Hong Kong	8.4
13	Iceland	8.3
14	Germany	8
15	Japan	8
16	Austria	7.8

Methods to Combine Vectors

- cbind(*V1, V2*) – as columns
- rbind(*V1, V2*) – as rows
- data.frame(*V1, V2)* – into a data frame
- Recycling occurs when vectors of unequal length are combined

Combining Vectors into Tables

- Matrix
  - A vector of equal length vectors
  - All values must be of same type
- Data Frame
  - Matrix like structure
  - Ideal for mixed data types

Using the matrix Function

- Creates a matrix from a single vector
- General form

  matrix(*data*, *nrow*=n, *ncol*=n, *byrow*=FALSE)

  - *data:* a data vector to be converted
  - *nrow:* specify desired number of rows
  - *ncol:* specify desired number of columns
  - *byrow:* if FALSE matrix filled by columns, otherwise by rows

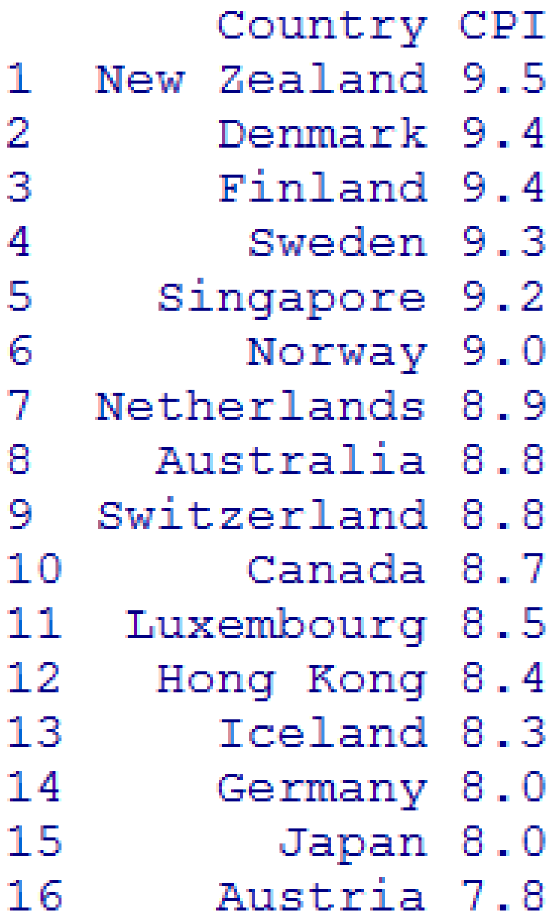
Using the matrix Function

- Example:

```
mat1 <- matrix(1:12, nrow=4, byrow=TRUE)
```

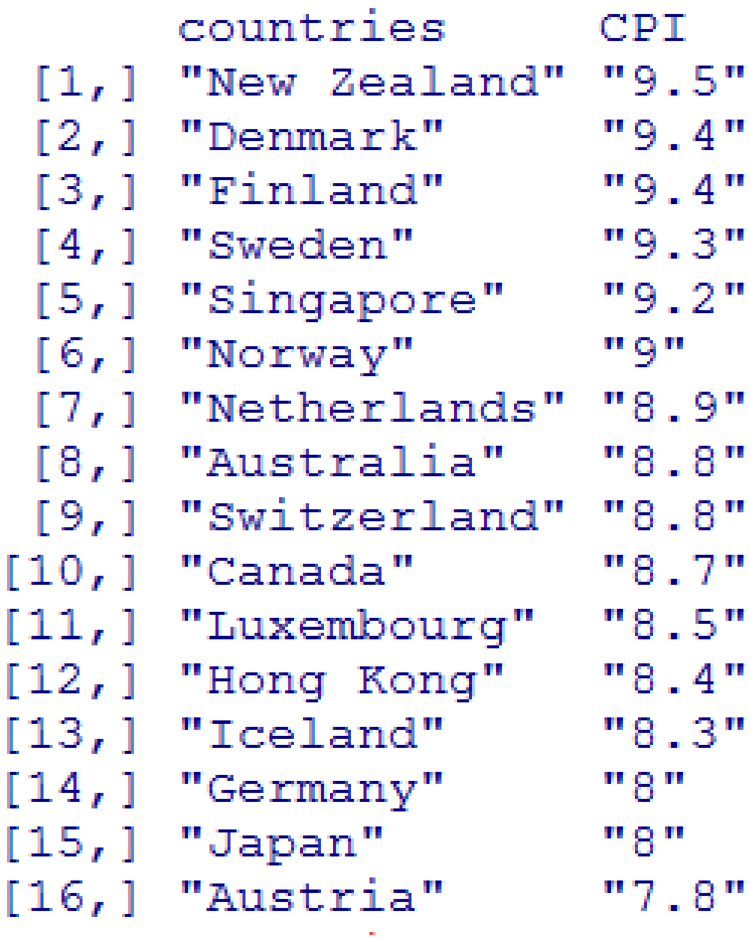
Accessing Multiple Dimensions

cpidf[??]



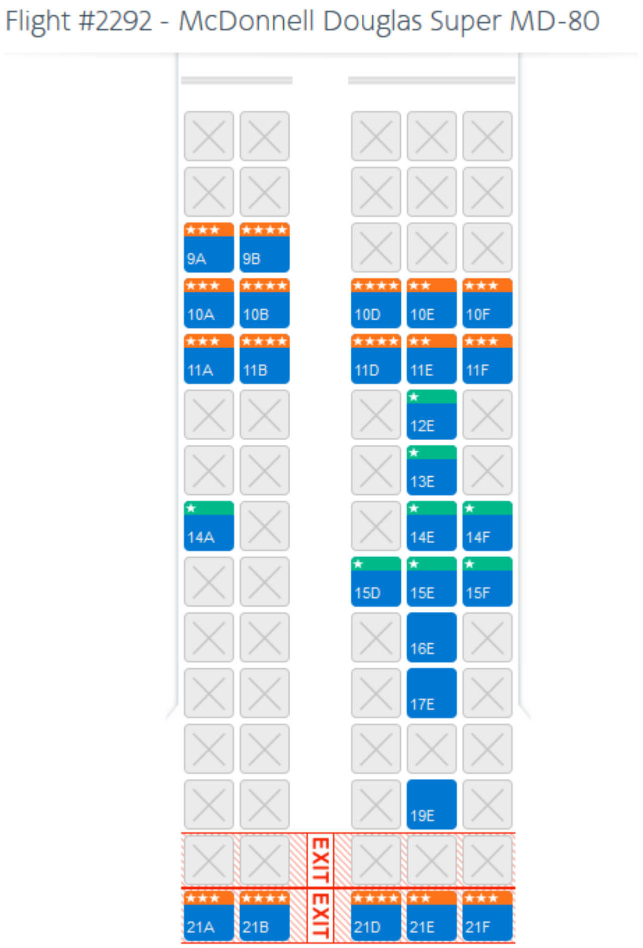
```
        Country CPI
1   New Zealand 9.5
2       Denmark 9.4
3       Finland 9.4
4        Sweden 9.3
5     Singapore 9.2
6        Norway 9.0
7   Netherlands 8.9
8     Australia 8.8
9   Switzerland 8.8
10       Canada 8.7
11   Luxembourg 8.5
12    Hong Kong 8.4
13      Iceland 8.3
14      Germany 8.0
15        Japan 8.0
16      Austria 7.8
```

cpicb[??]



```
      countries     CPI
 [1,] "New Zealand" "9.5"
 [2,] "Denmark"     "9.4"
 [3,] "Finland"     "9.4"
 [4,] "Sweden"      "9.3"
 [5,] "Singapore"   "9.2"
 [6,] "Norway"      "9"
 [7,] "Netherlands" "8.9"
 [8,] "Australia"   "8.8"
 [9,] "Switzerland" "8.8"
[10,] "Canada"      "8.7"
[11,] "Luxembourg"  "8.5"
[12,] "Hong Kong"   "8.4"
[13,] "Iceland"     "8.3"
[14,] "Germany"     "8"
[15,] "Japan"       "8"
[16,] "Austria"     "7.8"
```

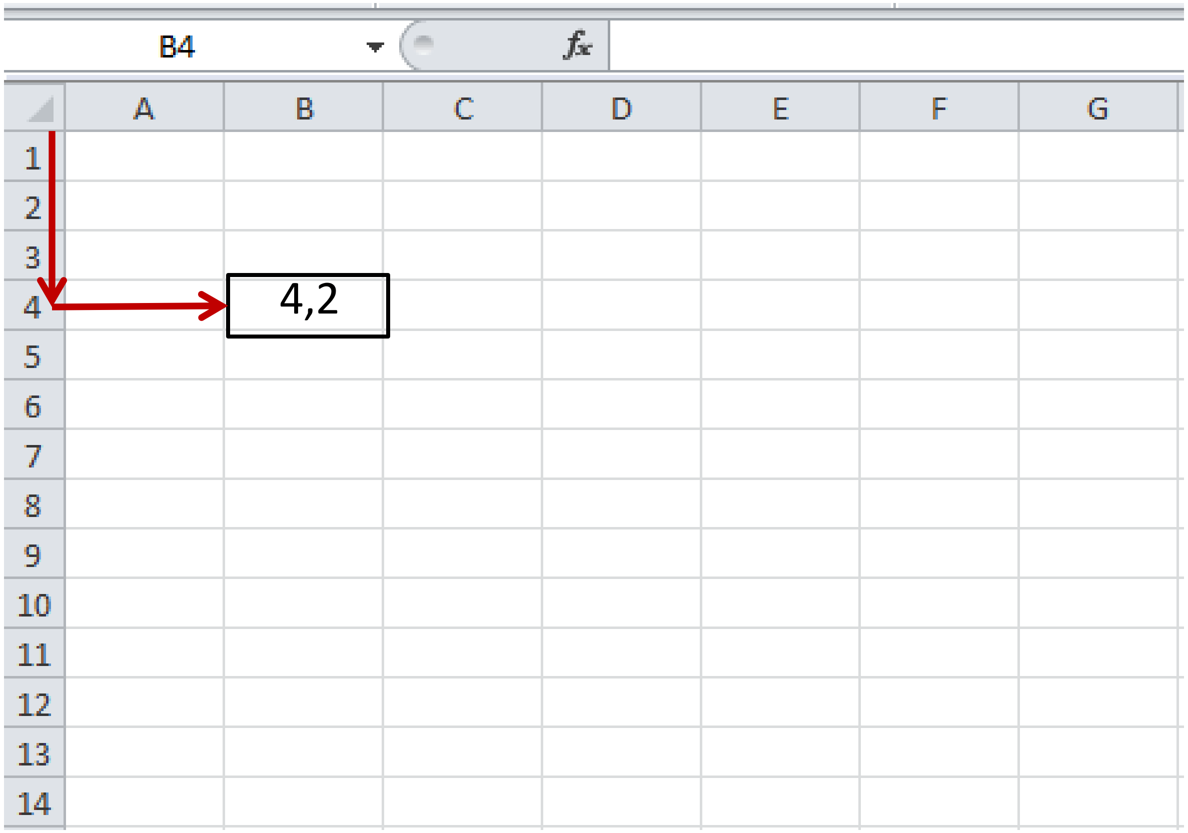
Accessing Multiple Dimensions



Flight #2292 - McDonnell Douglas Super MD-80

Accessing Multiple Dimensions

R is backwards compared to Excel



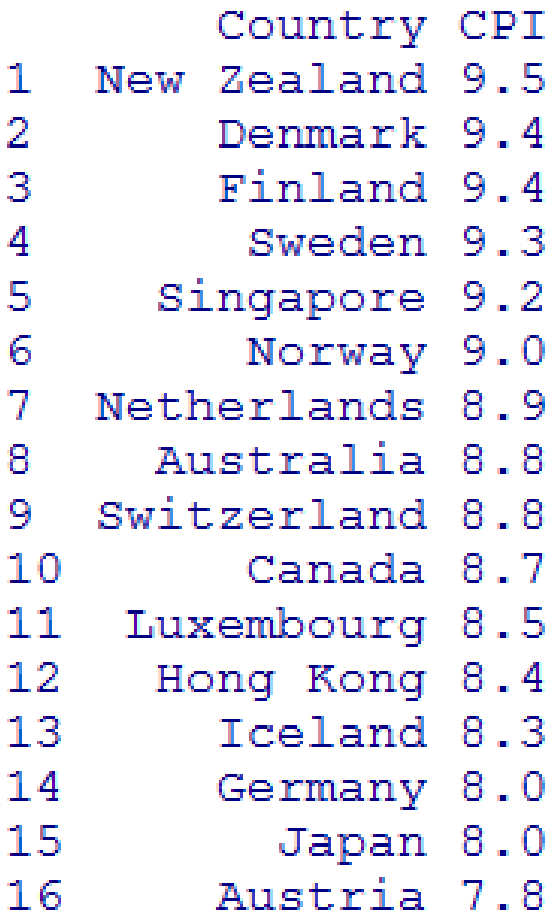
B4

4,2

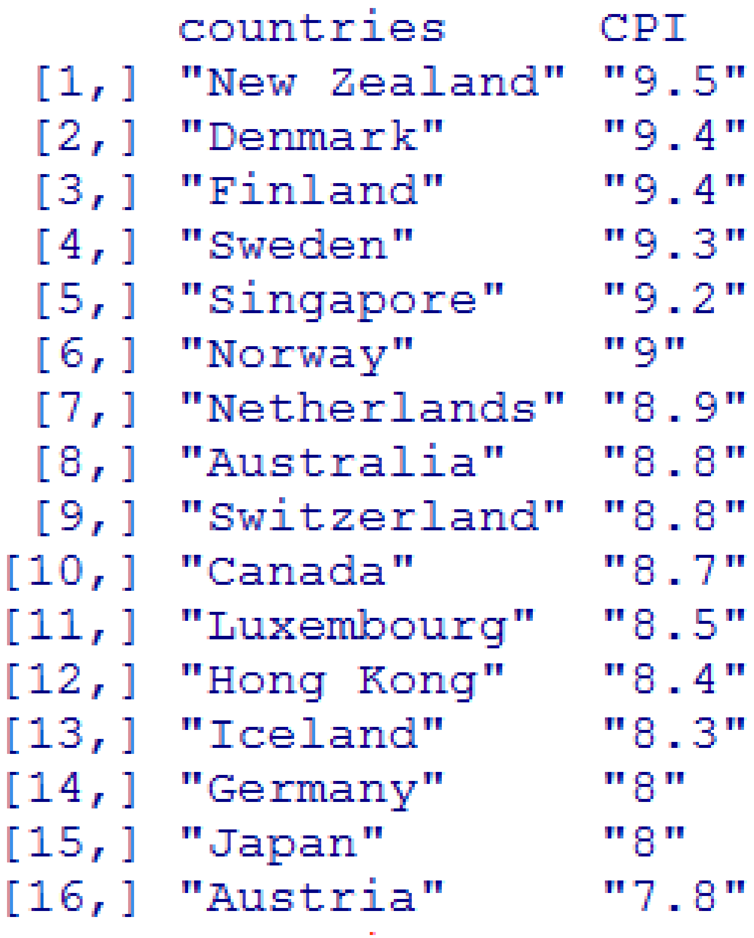
Accessing Multiple Dimensions

cpidf[row,col]

cpicb[row,col]



```
       Country CPI
1  New Zealand 9.5
2      Denmark 9.4
3      Finland 9.4
4       Sweden 9.3
5    Singapore 9.2
6       Norway 9.0
7  Netherlands 8.9
8    Australia 8.8
9  Switzerland 8.8
10      Canada 8.7
11  Luxembourg 8.5
12   Hong Kong 8.4
13     Iceland 8.3
14     Germany 8.0
15       Japan 8.0
16     Austria 7.8
```



```
      countries     CPI  
 [1,] "New Zealand" "9.5"
 [2,] "Denmark"     "9.4"
 [3,] "Finland"     "9.4"
 [4,] "Sweden"      "9.3"
 [5,] "Singapore"   "9.2"
 [6,] "Norway"      "9"  
 [7,] "Netherlands" "8.9"
 [8,] "Australia"   "8.8"
 [9,] "Switzerland" "8.8"
[10,] "Canada"      "8.7"
[11,] "Luxembourg"  "8.5"
[12,] "Hong Kong"   "8.4"
[13,] "Iceland"     "8.3"
[14,] "Germany"     "8"  
[15,] "Japan"       "8"  
[16,] "Austria"     "7.8"
```

Accessing Multiple Dimensions

- Accessing sub-elements (matrix or data frame):
  - mat1[2,3] *# element in the second row and third column*
  - mat1[1:2,2:3] *# sub-matrix of the first two rows and the second and third columns*
  - mat1[2,] *# the second row*
  - mat1[,2] *# the second column*
  - mat1[,-2] *# matrix with the second column removed*

Accessing Data Frames

- Treat a row as a vector: cpidf[row#,]
- Treat a column as a vector (all rows)
  1. FrameName[,col#]
  2. FrameName$ColName
  3. attach(FrameName)
  4. with(FrameName, ColName or function using Colname)
- Get all column names: names(FrameName)
- Get all row names: row.names(FrameName)

Additional Matrix Functions

- dim(mat1) – returns size of matrix
- rowSums(mat1)/colSums(mat1) - summarize
- rowMeans(mat1)/colMeans(mat1) - average
- apply(mat1,1,sum)
  - *not as fast as row…/col… but more robust in handling missing values*
  - *can perform other functions besides sum and means*
- NOTE: mat1 can also be indexes or expression

Applying Functions Across Data

- General form:
  apply(*array*, *rc*, *function*, …)
  - *array:* matrix or array to analyze (R coerces if needed)
    **Be sure to remove unwanted vectors
  - *rc:* specifies boundaries of application
    1=rows, 2=columns, c(1,2)=all cells
  - *function:* functions like mean, median, sqrt
  - *…:* additional arguments to the function
- sapply – apply for vectors
- lapply – apply for lists

Putting it all Together

- Indexing Vectors

```
myvector[membernumbers]
cpi$Country[ 1:5 ]
cpi$Country[ c(1,5 )]
```

- Indexing Table-like structures

```
mymatrix[rows, columns]
cpi[  ,  2:16  ]
```

Applying Functions Across Data

- apply(🟥 , 🟩 , 🟦 , 🟨)
  - 🟥 matrix or array (R tries to coerce)
  - 🟩 1=rows, 2=columns, c(1,2)=all cells
  - 🟦 functions like mean, median, sqrt
  - 🟨 additional arguments to the function
- apply(mymatrix , 1 , sum , na.rm=TRUE)
- cpi[, 2:11]

Substituting Expressions

- cpi[, 2:11]

Suppose we wanted to analyze only those years after 2005?

names(cpi)>'y2005'