

# *Analysis of bivariate binomial data: Twin analysis*

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March 23, 2017

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### *Simple data manipulation for data-frames*

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Here are some key data-manipulation moves on a data-frame which is how we typically organize our data in R. After having read the data into R it will typically be a data-frame, if not we can force it to be a data-frame. The basic idea of the utility functions is to get a simple and easy to type way of making simple data-manipulation on a data-frame much like what is possible in SAS or STATA.

The functions, say, `dcut`, `dfactor` and so on are all functions that basically does what the base R `cut`, `factor` do, but are easier to use in the context of data-frames and have additional functionality.

---

```
1 library(mets)
2 data(melanoma)
```

---

```
1 is.data.frame(melanoma)
2 melanoma=as.data.frame(melanoma)
```

---

```
[1] TRUE
```

Here we work on the melanoma data that is already read into R and is a data-frame.

### *dUtility functions*

The structure for all functions is

- `dfunction(dataframe,y~x|ifcond,...)`

to use the function on `y` in a dataframe grouped by `x` if condition `ifcond` is valid. The basic functions are

...

A generic function `daggregate`, `daggr`, can be called with a function as the argument

- `daggregate(dataframe, y~x | ifcond, fun=function, ...)`

without the grouping variable (x)

- `daggregate(dataframe, ~y | ifcond, fun=function, ...)`

A useful feature is that y and x as well as the subset condition can be specified using regular-expressions or by wildcards (default). Here to illustrate this, we compute the means of certain variables.

---

```
1 dmean(melanoma, thick+I(log(thick))-sex | I(days>500))
2 dmean(melanoma, ~thick+I(log(thick)) | I(days>500))
3 dmean(melanoma, ~thick+I(log(thick)))
```

---

```
      sex    thick I(log(thick))
1  0 242.9580    5.060086
2  1 320.2429    5.353321
      thick I(log(thick))
271.582011    5.168691
      thick I(log(thick))
291.985366    5.223341
```

or summary of all variables starting with "s" and that contains "a"

---

```
1 dmean(melanoma, "s*"+"*a*"~sex | I(days>500))
```

---

```
      sex    status    days
1  0 1.831933 2399.143
2  1 1.714286 2169.800
```

### *Renaming, deleting, keeping, dropping variables*

---

```
1 melanoma=drename(melanoma, tykkelse~thick)
2 names(melanoma)
```

---

```
[1] "no"      "status"  "days"   "ulc"     "tykkelse" "sex"
```

#### Deleting variables

---

```
1 data(melanoma)
2 melanoma=drm(melanoma, ~thick+sex)
3 names(melanoma)
```

---

```
[1] "no"      "status"  "days"   "ulc"
```

#### or sas style

---

```
1 data(melanoma)
2 melanoma=ddrop(melanoma, ~thick+sex)
3 names(melanoma)
```

---

```
[1] "no"      "status"  "days"   "ulc"
```

alternatively we can also keep certain variables

---

```
1 data(melanoma)
2 melanoma=dkeep(melanoma, ~thick+sex+status+days)
3 names(melanoma)
```

---

```
[1] "thick"  "sex"    "status"  "days"
```

*Looking at the data*


---

```

1 data(melanoma)
2 dstr(melanoma)

```

---

```

'data.frame':      205 obs. of  6 variables:
 $ no      : int  789 13 97 16 21 469 685 7 932 944 ...
 $ status: int   3 3 2 3 1 1 1 1 3 1 ...
 $ days   : int  10 30 35 99 185 204 210 232 232 279 ...
 $ ulc    : int   1 0 0 0 1 1 1 1 1 1 ...
 $ thick  : int  676 65 134 290 1208 484 516 1288 322 741 ...
 $ sex    : int   1 1 1 0 1 1 1 1 0 0 ...

```

The data can in Rstudio be seen as a data-table but to list certain parts of the data in output window

---

```

1 dlist(melanoma)

```

---

```

      no  status days ulc  thick sex
1   789  3      10  1    676  1
2    13  3      30  0     65  1
3    97  2      35  0    134  1
4    16  3      99  0    290  0
5    21  1     185  1   1208  1
---
201 317  2     4492  1    706  1
202 798  2     4668  0    612  0
203 806  2     4688  0     48  0
204 606  2     4926  0    226  0
205 328  2     5565  0    290  0

```

---

```

1 dlist(melanoma, ~.|sex==1)

```

---

```

      no  status days ulc  thick
1   789  3      10  1    676
2    13  3      30  0     65
3    97  2      35  0    134
5    21  1     185  1   1208
6   469  1     204  1    484
---
191 445  2     3909  1    806
195 415  2     4119  0     65
197 175  2     4207  0     65
198 493  2     4310  0    210
201 317  2     4492  1    706

```

---

```

1 dlist(melanoma, ~ulc+days+thick+sex|sex==1)

```

---

```

      ulc days thick sex
1     1   10   676  1
2     0   30    65  1
3     0   35   134  1
5     1  185  1208  1
6     1  204   484  1
---
191 1   3909  806  1
195 0   4119   65  1
197 0   4207   65  1
198 0   4310  210  1
201 1   4492  706  1

```

## Getting summaries

```
1 dsummary(melanoma)
```

---

no	status	days	ulc	thick
Min. : 2.0	Min. :1.00	Min. : 10	Min. :0.000	Min. : 10
1st Qu.:222.0	1st Qu.:1.00	1st Qu.:1525	1st Qu.:0.000	1st Qu.: 97
Median :469.0	Median :2.00	Median :2005	Median :0.000	Median : 194
Mean :463.9	Mean :1.79	Mean :2153	Mean :0.439	Mean : 292
3rd Qu.:731.0	3rd Qu.:2.00	3rd Qu.:3042	3rd Qu.:1.000	3rd Qu.: 356
Max. :992.0	Max. :3.00	Max. :5565	Max. :1.000	Max. :1742

  

sex
Min. :0.0000
1st Qu.:0.0000
Median :0.0000
Mean :0.3854
3rd Qu.:1.0000
Max. :1.0000

or for specific variables

```
1 dsummary(melanoma,~thick+status+sex)
```

---

thick	status	sex
Min. : 10	Min. :1.00	Min. :0.0000
1st Qu.: 97	1st Qu.:1.00	1st Qu.:0.0000
Median : 194	Median :2.00	Median :0.0000
Mean : 292	Mean :1.79	Mean :0.3854
3rd Qu.: 356	3rd Qu.:2.00	3rd Qu.:1.0000
Max. :1742	Max. :3.00	Max. :1.0000

Summaries in different groups (sex)

```
1 dsummary(melanoma,thick+days+status~sex)
```

---

```
sex: 0
```

thick	days	status
Min. : 10.0	Min. : 99	Min. :1.000
1st Qu.: 97.0	1st Qu.:1636	1st Qu.:2.000
Median : 162.0	Median :2059	Median :2.000
Mean : 248.6	Mean :2283	Mean :1.833
3rd Qu.: 306.0	3rd Qu.:3131	3rd Qu.:2.000
Max. :1742.0	Max. :5565	Max. :3.000

---

```
sex: 1
```

thick	days	status
Min. : 16.0	Min. : 10	Min. :1.000
1st Qu.: 105.0	1st Qu.:1052	1st Qu.:1.000
Median : 258.0	Median :1860	Median :2.000
Mean : 361.1	Mean :1946	Mean :1.722
3rd Qu.: 484.0	3rd Qu.:2784	3rd Qu.:2.000
Max. :1466.0	Max. :4492	Max. :3.000

and only among those with thin-tumours or only females (sex==1)

```
1 dsummary(melanoma,thick+days+status~sex|thick<97)
```

---

```
sex: 0
```

thick	days	status
Min. :10.00	Min. : 355	Min. :1.000
1st Qu.:32.00	1st Qu.:1762	1st Qu.:2.000
Median :64.00	Median :2227	Median :2.000

```

Mean      :51.48   Mean      :2425   Mean      :2.034
3rd Qu.   :65.00   3rd Qu.   :3185   3rd Qu.   :2.000
Max.      :81.00   Max.      :4688   Max.      :3.000

```

```

-----
sex: 1
      thick      days      status
Min.   :16.00   Min.    : 30   Min.    :1.000
1st Qu.:30.00   1st Qu.:1820  1st Qu.:2.000
Median :65.00   Median :2886   Median :2.000
Mean   :55.75   Mean    :2632   Mean    :1.875
3rd Qu.:81.00   3rd Qu.:3328   3rd Qu.:2.000
Max.   :81.00   Max.    :4207   Max.    :3.000

```

```

1 dsummary(melanoma,thick+status~+1|sex==1)

```

```

      thick      status
Min.   : 16.0   Min.    :1.000
1st Qu.:105.0   1st Qu.:1.000
Median :258.0   Median :2.000
Mean   :361.1   Mean    :1.722
3rd Qu.:484.0   3rd Qu.:2.000
Max.   :1466.0   Max.    :3.000

```

### Tables between variables

```

1 dtable(melanoma,~status+sex)

```

```

      sex  0  1
status
1         28 29
2         91 43
3          7  7

```

### All bivariate tables

```

1 dtable(melanoma,~status+sex+ulc,level=2)

```

```

      status
sex  1  2  3
0    28 91  7
1    29 43  7

```

```

      status
ulc   1  2  3
0     16 92  7
1     41 42  7

```

```

      sex
ulc   0  1
0     79 36
1     47 43

```

### All univariate tables

```

1 dtable(melanoma,~status+sex+ulc,level=1)

```

```

status
1  2  3
57 134 14

```

```
sex
  0  1
126 79

ulc
  0  1
115 90
```

### *Making new variables for the analysis*

To define a bunch of new covariates within a data-frame

---

```
1 melanoma= transform(melanoma,
2     thick2=thick^2,
3     lthick=log(thick) )
4 dhead(melanoma)
```

---

```
      no status days ulc thick sex  thick2  lthick
1 789      3   10   1   676   1  456976  6.516193
2  13      3   30   0    65   1   4225  4.174387
3  97      2   35   0   134   1  17956  4.897840
4  16      3   99   0   290   0  84100  5.669881
5  21      1  185   1  1208   1 1459264  7.096721
6 469      1  204   1   484   1  234256  6.182085
```

When the above definitions are done using a condition this can be achieved using the `dtransform` function that extends `transform` with a possible condition

---

```
1 melanoma=dtransform(melanoma,ll=thick*1.05^ulc,sex==1)
2 melanoma=dtransform(melanoma,ll=thick,sex!=1)
3 dmean(melanoma,ll~sex+ulc)
```

---

```
      sex ulc      ll
1    0   0 173.7342
2    1   0 197.3611
3    0   1 374.5532
4    1   1 523.1198
```

### *Making factors (groupings)*

On the melanoma data the variable `thick` gives the thickness of the melanom tumour. For some analyses we would like to make a factor depending on the thickness. This can be done in several different ways

---

```
1 melanoma=dcut(melanoma,~thick,breaks=c(0,200,500,800,2000))
```

---

New variable is named `thickcat.o` by default.

To see levels of factors in data-frame

---

```
1 dlevels(melanoma)
```

---

```
thickcat.o #levels=:4
[1] "[0,200]" "(200,500]" "(500,800]" "(800,2e+03]"
-----
```

## Checking group sizes

---

```
1 dtable(melanoma,~thickcat.0)
```

---

```
thickcat.0
      [0,200]   (200,500]   (500,800] (800,2e+03]
           109           64           20           12
```

## With adding to the data-frame directly

---

```
1 dcut(melanoma,breaks=c(0,200,500,800,2000)) <- gr.thick1-thick
2 dlevels(melanoma)
```

---

```
thickcat.0 #levels=:4
[1] "[0,200]"      "(200,500]"      "(500,800]"      "(800,2e+03]"
-----
gr.thick1 #levels=:4
[1] "[0,200]"      "(200,500]"      "(500,800]"      "(800,2e+03]"
-----
```

new variable is named thickcat.o (after first cut-point), or to get quartiles with default names thick.cat.4

---

```
1 dcut(melanoma) <- ~ thick ### new variable is thickcat.4
2 dlevels(melanoma)
```

---

```
thickcat.0 #levels=:4
[1] "[0,200]"      "(200,500]"      "(500,800]"      "(800,2e+03]"
-----
gr.thick1 #levels=:4
[1] "[0,200]"      "(200,500]"      "(500,800]"      "(800,2e+03]"
-----
thickcat.4 #levels=:4
[1] "[10,97]"      "(97,194]"      "(194,356]"      "(356,1.74e+03]"
-----
```

or median groups, here starting again with the original data,

---

```
1 data(melanoma)
2 dcut(melanoma,breaks=2) <- ~ thick ### new variable is thick.2
3 dlevels(melanoma)
```

---

```
thickcat.2 #levels=:2
[1] "[10,194]"      "(194,1.74e+03]"
-----
```

to control new names

---

```
1 data(melanoma)
2 mela= dcut(melanoma,thickcat4+dayscat4~thick+days,breaks=4)
3 dlevels(mela)
```

---

```
thickcat4 #levels=:4
[1] "[10,97]"      "(97,194]"      "(194,356]"      "(356,1.74e+03]"
-----
dayscat4 #levels=:4
[1] "[10,1.52e+03]"      "(1.52e+03,2e+03]"      "(2e+03,3.04e+03]"
[4] "(3.04e+03,5.56e+03]"
-----
```

or

---

```

1 data(melanoma)
2 dcut(melanoma,breaks=4) <- thickcat4~dayscat4~thick~days
3 dlevels(melanoma)

```

---

```

thickcat4 #levels=:4
[1] "[10,97]"      "(97,194]"      "(194,356]"      "(356,1.74e+03]"
-----
dayscat4 #levels=:4
[1] "[10,1.52e+03]" "(1.52e+03,2e+03]" "(2e+03,3.04e+03]"
[4] "(3.04e+03,5.56e+03]"
-----

```

This can also be typed out more specifically

---

```

1 melanoma$gthick = cut(melanoma$thick,breaks=c(0,200,500,800,2000))
2 melanoma$gthick =
  ↪ cut(melanoma$thick,breaks=quantile(melanoma$thick),include.lowest=TRUE)

```

---

## Working with factors

To see levels of covariates in data-frame

---

```

1 data(melanoma)
2 dcut(melanoma,breaks=4) <- thickcat4~thick
3 dlevels(melanoma)

```

---

```

thickcat4 #levels=:4
[1] "[10,97]"      "(97,194]"      "(194,356]"      "(356,1.74e+03]"
-----

```

To relevel the factor

---

```

1 dtable(melanoma,~thickcat4)
2 melanoma = drelevel(melanoma,~thickcat4,ref="(194,356]")
3 dlevels(melanoma)

```

---

```

thickcat4
      [10,97]      (97,194]      (194,356] (356,1.74e+03]
           56           53           45           51
thickcat4 #levels=:4
[1] "[10,97]"      "(97,194]"      "(194,356]"      "(356,1.74e+03]"
-----
thickcat4.(194,356] #levels=:4
[1] "(194,356]"      "[10,97]"      "(97,194]"      "(356,1.74e+03]"
-----

```

or to take the third level in the list of levels, same as above,

---

```

1 melanoma = drelevel(melanoma,~thickcat4,ref=2)
2 dlevels(melanoma)

```

---

```

thickcat4 #levels=:4
[1] "[10,97]"      "(97,194]"      "(194,356]"      "(356,1.74e+03]"
-----
thickcat4.(194,356] #levels=:4
[1] "(194,356]"      "[10,97]"      "(97,194]"      "(356,1.74e+03]"
-----
thickcat4.2 #levels=:4
[1] "(97,194]"      "[10,97]"      "(194,356]"      "(356,1.74e+03]"
-----

```



To combine levels of a factor (first combining first 3 groups into one)

```

1 melanoma = drelevel(melanoma,~thickcat4,newlevels=1:3)
2 dlevels(melanoma)

thickcat4 #levels=:4
[1] "[10,97]" "(97,194]" "(194,356]" "(356,1.74e+03]"
-----
thickcat4.(194,356] #levels=:4
[1] "(194,356]" "[10,97]" "(97,194]" "(356,1.74e+03]"
-----
thickcat4.2 #levels=:4
[1] "(97,194]" "[10,97]" "(194,356]" "(356,1.74e+03]"
-----
thickcat4.1:3 #levels=:2
[1] "[10,97]-(194,356]" "(356,1.74e+03]"
-----

```

or to combine groups 1 and 2 into one group and 3 and 4 into another

```

1 dkeep(melanoma) <- ~thick+thickcat4
2 melanoma = drelevel(melanoma,gthick2~thickcat4,newlevels=list(1:2,3:4))
3 dlevels(melanoma)

thickcat4 #levels=:4
[1] "[10,97]" "(97,194]" "(194,356]" "(356,1.74e+03]"
-----
gthick2 #levels=:2
[1] "[10,97]-(97,194]" "(194,356]-(356,1.74e+03]"
-----

```

### Changing order of factor levels

```

1 dfactor(melanoma,levels=c(3,1,2,4)) <- thickcat4.2~thickcat4
2 dlevel(melanoma,~ "thickcat4*")
3 dtable(melanoma,~thickcat4+thickcat4.2)

thickcat4 #levels=:4
[1] "[10,97]" "(97,194]" "(194,356]" "(356,1.74e+03]"
-----
thickcat4.2 #levels=:4
[1] "(194,356]" "[10,97]" "(97,194]" "(356,1.74e+03]"
-----

thickcat4.2 (194,356] [10,97] (97,194] (356,1.74e+03]
thickcat4
[10,97] 0 56 0 0
(97,194] 0 0 53 0
(194,356] 45 0 0 0
(356,1.74e+03] 0 0 0 51

```

### Combine levels but now control factor-level names

```

1 melanoma=drelevel(melanoma,gthick3~thickcat4,newlevels=list(group1.2=1:2,group3.4=3:4))
2 dlevels(melanoma)

thickcat4 #levels=:4
[1] "[10,97]" "(97,194]" "(194,356]" "(356,1.74e+03]"
-----
gthick2 #levels=:2

```

```

[1] "[10,97]-(97,194]" "(194,356]-(356,1.74e+03]"
-----
thickcat4.2 #levels=:4
[1] "(194,356]" "[10,97]" "(97,194]" "(356,1.74e+03]"
-----
gthick3 #levels=:2
[1] "group1.2" "group3.4"
-----

```

### *Making a factor from existing numeric variable and vice versa*

A numeric variable "status" with values 1,2,3 into a factor by

---

```

1 data(melanoma)
2 melanoma = dfactor(melanoma,~status,
  ↪ labels=c("malignant-melanoma","censoring","dead-other"))
3 melanoma = dfactor(melanoma,sex1~sex,labels=c("females","males"))
4 dtable(melanoma,~sex1+status.f)

```

---

	status.f	malignant-melanoma	censoring	dead-other
sex1				
females		28	91	7
males		29	43	7

A gender factor with values "M", "F" can be converted into numerics by

---

```

1 melanoma = dnumeric(melanoma,~sex1)
2 dstr(melanoma,"sex*")
3 dtable(melanoma,~'sex*',level=2)

```

---

```

'data.frame':      205 obs. of  3 variables:
 $ sex   : int  1 1 1 0 1 1 1 1 0 0 ...
 $ sex1  : Factor w/ 2 levels "females","males": 2 2 2 1 2 2 2 2 1 1 ...
 $ sex1.n: num  2 2 2 1 2 2 2 2 1 1 ...

      sex
sex1    0  1
females 126  0
males    0  79

      sex
sex1.n  0  1
1 126  0
2  0  79

      sex1
sex1.n females males
1      126    0
2       0    79

```