

PBI

# HOW TO WORK WITH PISA IN R

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*First printing, August 2013*

# Contents

*Introduction to PISA*      5

*Get your data*      7

*R packages with PISA data*      7

*Selecting a subset of countries*      9

*Differences between PISA datasets*      9

*R packages with supplementary functions*      9

*Additional datasets*      10

*dataset: countryOntology*      10

*Data manipulation*      13

*Statistical procedures*      15

*Rankings*      15

*Data Visualisation*      19

*Introduction to R*      21

*Bibliography*      23



# *Introduction to PISA*

Here there should be an introduction to the PISA data. Who is doing this study and why.

Few words about data structure and availability <sup>1</sup> <sup>2</sup>.

<sup>1</sup> The programme for international student assessment (pisa). <http://www.oecd.org/pisa/>

<sup>2</sup> The organisation for economic co-operation and development (oecd). <http://www.oecd.org/>



## Get your data

In order to work with PISA data in R you need to load the data first. There are at least two ways how to do this.

You can download raw data from PISA website <sup>3</sup>. The raw data is available as compressed text files and you can read these files with the `read.fwf()` function. <sup>4</sup>

The second, much easier, approach is to install R package that already consists required data. There are two sets of packages that you may be interested in. Packages with PISA data and packages with supplementary functions that makes it easier to analyse this data set.

<sup>3</sup> The programme for international student assessment (pisa). <http://www.oecd.org/pisa/>

<sup>4</sup> The `read.fwf()` function is a standard way to read text files in the fixed width format.

### *R packages with PISA data*

Right now there are There are five packages with PISA data. Each package contains data from single PISA study. These packages have following names: `PISA2000lite`, `PISA2003lite`, `PISA2006lite`, `PISA2009lite`, `PISA2012lite`.

Installation of R package requires the download first. Since the datasets are large be prepared to download about 200MB from Internet. But you need to do this only once, per dataset.

In order to install any of these data packages you will need the `devtools` package. In the chapter you will find more details how to install that one.

Suppose that you have the `devtools` package. Than to get data from study PISA 2009 you need to run following commands.

```
library(devtools)
install_github("PISA2009lite", "pbiecek")
```

As a result you shall see an output like that: Depending on your Internet bandwidth it may take a while.

```

Installing github repo(s) PISA2009lite/master from pbiecek
Downloading PISA2009lite.zip from https://github.com/pbiecek/PISA2009lite/archive/master.zip
Installing package from /var/folders/g3/j8pnss9j3130g4nhj31wxm0000103/T/RtmptdZ54R/PISA2009lite.zip
Installing PISA2009lite
'/Library/Frameworks/R.framework/Resources/bin/R' --vanilla CMD INSTALL \
  '/private/var/folders/g3/j8pnss9j3130g4nhj31wxm0000103/T/RtmptdZ54R/PISA2009lite-master' \
  --library='/Library/Frameworks/R.framework/Versions/3.0/Resources/library' \
  --with-keep.source --install-tests

* installing *source* package 'PISA2009lite' ...
** data
*** moving datasets to lazyload DB
** demo
** help
*** installing help indices
** building package indices
** testing if installed package can be loaded
* DONE (PISA2009lite)

```

If there is not ERROR in your output it looks like everything went smoothly. The package is installed. In order to work with it you need to load it. Use the `library()` function for that.

```
library(PISA2009lite)
```

You will find five data sets in this package [actually ten, I will explain this later]. These are: data from student questionnaire, school questionnaire, parent questionnaire, cognitive items and scored cognitive items.

```

dim(student2009)
## [1] 515958    437
dim(parent2009)
## [1] 106287     90
dim(school2009)
## [1] 18641     247
dim(item2009)
## [1] 515958    273

```



```
dim(scoredItem2009)
## [1] 515958    227
```

For most of variables in each data set there is a dictionary which decode answers for particular question. Dictionaries for all questions for a given data set are stored as a list of named vectors, these lists are named after corresponding data sets [just add suffix 'dict'].

For example fist six entries in a dictionary for variable CNT in the data set student2009.

```
head(student2009dict\CNT)
##           ALB           ARG           AUS           AUT           AZE
##  "Albania"  "Argentina"  "Australia"  "Austria" "Azerbaijan"
##           BEL
##  "Belgium"
```

### *Selecting a subset of countries*

In some cases you would not work on whole datasets, but only on some subset of countries. You can do this by subsetting the dataset. For example, let's take only three countries out of the dataset

```
student2009selected <- subset(student2009, CNT %in% c("ITA", "FRA", "POL"))
dim(student2009selected)
## [1] 40120    437
```

### *Differences between PISA datasets*

There are some differences between different PISA releases.

In PISA 2000 there are three datasets `math2000`, `read2000`, `scie2000` with data from articular area. Different students take different tests, thus these datasets vary in number of rows. All of them contains answers from students questionnaire. In following PISA studies there is a single `student20xx` dataset with outcomes from all areas.

### *R packages with supplementary functions*

To make it easier to work with PISA data you may use the package `PISAtools`. The installation is similar to the installation of dataset.

```
library(devtools)
install_github("PISAtools", "pbiecek")
library(PISAtools)
```

And the package is ready to use. In next chapters we will show some useful functions that are available there.

### *Additional datasets*

In the PISAtools package you will find some additional dataset that might be helpful when working with PISA data. Let's introduce them one by one.

#### *dataset: countryOntology*

This ontology was derived from FAO website <sup>5</sup>. It contains information about 211 countries. It may be useful to verify to which group a given country belongs. Let's see columns in this dataset.

<sup>5</sup> Food and agriculture organization of the united nations (fao). <http://www.fao.org/home/en/>

```
head(countryOntology, 2)
```

Last column IS\_IN\_GROUP describes to which groups given country belongs. Other columns are just different classifications of particular country.

	IS03	IS02	UN_CODE	UNDP_CODE	FA0STAT_CODE	GAUL_CODE	FA0TERM_CODE	AGROVOC_CODE	NAME_EN
1	GRD	GD	308	GRN	86	99	15417	3384	Grenada
2	LBY	LY	434	LIB	124	145	15442	4312	Libya
	LISTNAME_EN								
1	Grenada								
2	Libya								
	IS_IN_GROUP								
1	"FAO_2006, CARICOM_1985, World, CARICOM, CARIFORUM, NFIDC, Americas, Caribbean, FAO, SIDS"								
2	"CEN_SAD, CAEU, World, AMU, northern_Africa, Africa, FAO, COMESA"								

You can access the information easily with the function `getCountryIdsFromRegion()`. Then you can specify from which region/group of countries you would like to get data. As a result you will get a set of country IDs.

For example, which countries are classified as countries from Western Europe?<sup>6</sup>.

<sup>6</sup> These names are case insensitive

```
getCountryIdsFromRegion(region="western_Europe")  
## [1] "LUX" "CHE" "DEU" "NLD" "FRA" "MCO" "LIE" "AUT" "BEL"
```



## *Data manipulation*

Here there should be an information how to reshape data.

Subselect variables, combine student and school datasets and similar things.



## Statistical procedures

### Rankings

First we will see how to create ranking for countries. It's easy to do this for all countries, but since there is a lot of them in order to save space we will do this for european countries only.

So first, let's subselect only european countries. The dataset PISAeurope will have the same variables like student2009 but only rows for students from Europe. <sup>7</sup>

<sup>7</sup> In remaining examples you can replace PISAeurope by student2009 and then you will get ranking for all countries.

```
europe <- getCountryIdsFromRegion(region="Europe")
PISAeurope <- student2009[student2009$CNT %in% europe, ]
```

First let's calculate weighted average performance for all these countries. You can do this with the function `getWeightedAverages()`. You need to specify three arguments. Variables with performance (here Plausible values from Math, Reading and Science), grouping variable (here country) and weights.

As a result you will get data.frame with weighted averages.

```
getWeightedAverages(PISAeurope[,c("PV1MATH", "PV1READ", "PV1SCIE")],
  factor(PISAeurope$CNT), PISAeurope$W_FSTUWT)
```

	PV1MATH	PV1READ	PV1SCIE
ALB	376.8412	384.8553	390.0552
AUT	495.3798	470.0181	494.3429
BEL	515.6946	506.0709	506.9133
BGR	427.8899	428.7424	439.2365
CHE	535.0264	500.1675	517.0095
CZE	492.5683	478.3270	500.8206
DEU	512.0990	497.2816	520.2056
DNK	503.2260	495.2494	498.9904

```

ESP 483.7105 480.9529 488.4244
EST 512.0336 500.3432 527.5742
FIN 540.4180 535.5694 553.6443
FRA 496.7549 495.3661 497.8581
GBR 492.5210 493.9524 513.6889
GRC 465.4492 481.8291 469.3762
HRV 460.6449 475.8268 486.8437
HUN 489.9584 494.2865 502.2476
IRL 487.3271 495.9401 508.2677
ISL 507.3673 500.5733 495.6023
ITA 483.2503 486.3324 489.2809
LIE 533.6883 498.4257 518.5018
LTU 476.4921 467.9608 490.9942
LUX 488.1766 471.1547 483.1795
LVA 481.4847 483.5472 492.8094
MDA 397.3944 388.2060 413.1806
MLT 462.5997 442.1508 461.3761
MNE 402.7139 407.0327 401.5027
NLD 525.8939 508.1992 522.6339
NOR 497.5454 503.0985 499.1366
POL 494.2307 500.1981 507.4326
PRT 487.2701 489.1076 492.8555
ROU 426.4127 424.4139 428.0784
RUS 467.9225 459.4349 478.5926
SRB 442.6190 442.3280 442.8573
SVK 496.7076 477.4750 490.9146
SVN 501.0395 482.7662 511.2549
SWE 493.8699 497.7079 494.8899

```

But initially we were going to derive rankings. It's straight forward. Just use `getRanking()` with same options like for `getWeightedAverages()`.

```

getRanking(PISAeurope[,c("PV1MATH", "PV1READ", "PV1SCIE")],
           factor(PISAeurope$CNT), PISAeurope$W_FSTUWT)

```

	PV1MATH	PV1READ	PV1SCIE
ALB	36	36	36
AUT	14	27	19
BEL	5	3	11
BGR	32	32	32
CHE	2	8	6



CZE	17	23	13
DEU	6	11	4
DNK	9	14	15
ESP	23	22	25
EST	7	6	2
FIN	1	1	1
FRA	12	13	16
GBR	18	16	7
GRC	28	21	29
HRV	30	25	26
HUN	19	15	12
IRL	21	12	9
ISL	8	5	17
ITA	24	18	24
LIE	3	9	5
LTU	26	28	22
LUX	20	26	27
LVA	25	19	21
MDA	35	35	34
MLT	29	31	30
MNE	34	34	35
NLD	4	2	3
NOR	11	4	14
POL	15	7	10
PRT	22	17	20
ROU	33	33	33
RUS	27	29	28
SRB	31	30	31
SVK	13	24	23
SVN	10	20	8
SWE	16	10	18

Note that there is an optional argument `sort`. You can select the column according to which rows should be sorted (by default they are sorted alphabetically).

```
getRanking(PISAeurope[,c("PV1MATH", "PV1READ", "PV1SCIE")],
           factor(PISAeurope$CNT), PISAeurope$W_FSTUWT, sort=1)
```

	PV1MATH	PV1READ	PV1SCIE
FIN	1	1	1

CHE	2	8	6
LIE	3	9	5
NLD	4	2	3
BEL	5	3	11
DEU	6	11	4
EST	7	6	2
ISL	8	5	17
DNK	9	14	15
SVN	10	20	8
NOR	11	4	14
FRA	12	13	16
SVK	13	24	23
AUT	14	27	19
POL	15	7	10
SWE	16	10	18
CZE	17	23	13
GBR	18	16	7
HUN	19	15	12
LUX	20	26	27
IRL	21	12	9
PRT	22	17	20
ESP	23	22	25
ITA	24	18	24
LVA	25	19	21
LTU	26	28	22
RUS	27	29	28
GRC	28	21	29
MLT	29	31	30
HRV	30	25	26
SRB	31	30	31
BGR	32	32	32
ROU	33	33	33
MNE	34	34	35
MDA	35	35	34
ALB	36	36	36

### *Use case - gender differences*

Here the distribution of performance between countries and genders can be presented

*Different approaches to ranking calculation*

- Standard PISA approach via PV
- Percentage of correct answers
- Percentage of correct answers after removing k outliers in items
- Top 90% percentile of the distribution
- Absolute dominance defined as one country over performs other only it also over perform on more than 50% of items

Here there should be an information how to do some simple statistics with the data.

Like weighted regression.

Maybe mixed effect model or generalized mixed effect model.



## *Data Visualisation*

Some examples how to create charts with the use of this data.



# *Introduction to R*

Very short introduction to R. With references to other materials.





## *Bibliography*

Food and agriculture organization of the united nations (fao). <http://www.fao.org/home/en/>.

The organisation for economic co-operation and development (oecd). <http://www.oecd.org/>.

The programme for international student assessment (pisa). <http://www.oecd.org/pisa/>.