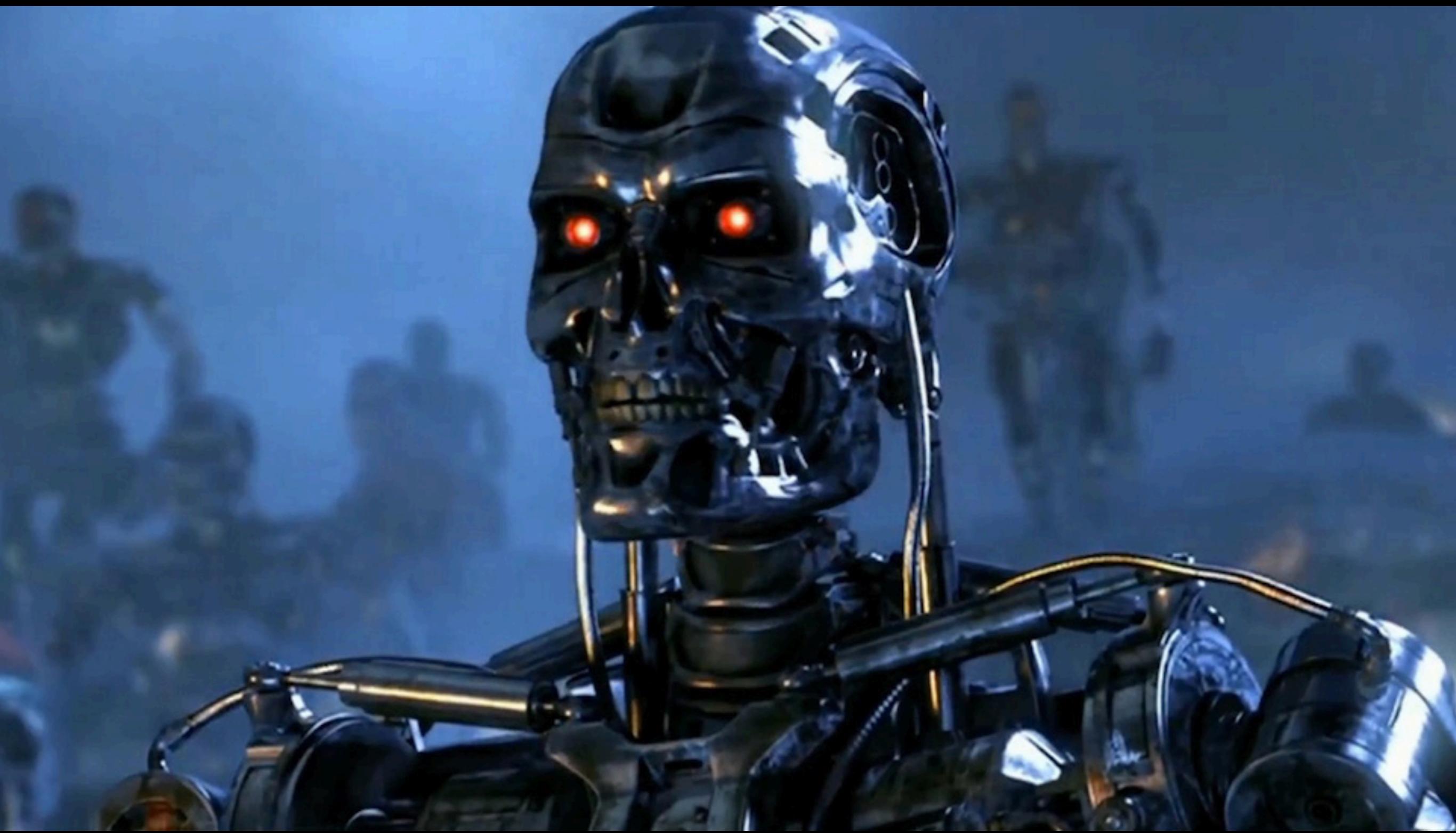


# Show me your model

Przemysław Biecek

MI<sup>2</sup>









**randomForestExplainer**

**archivist**

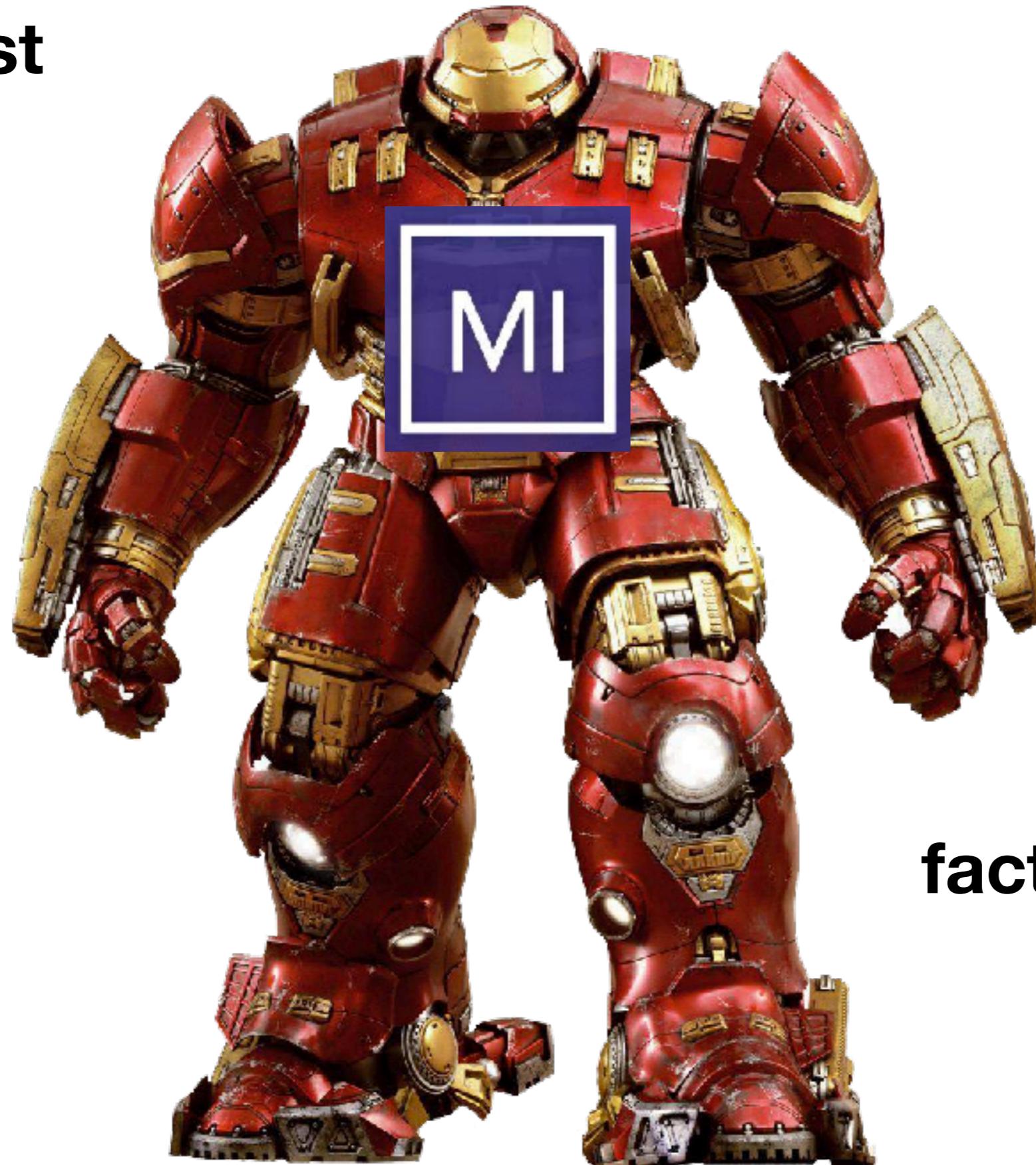
**ggfortify**

**pdp**



**live**

**factorMerger**



Czy potrzebujemy wizualizacji  
do zrozumienia modeli?

1) ...there is **a lot of opportunity to do visualization for machine learning**. Even many of the people working in the field don't have good intuitions for how their systems work, and they need tools to inspect what they're doing, debug, etc...

<https://eagereyes.org/blog/2017/eurovis-2017-conference-report-part-1>

EuroVis 2017 Conference

Robert Kosara

Senior Research Scientist at Tableau

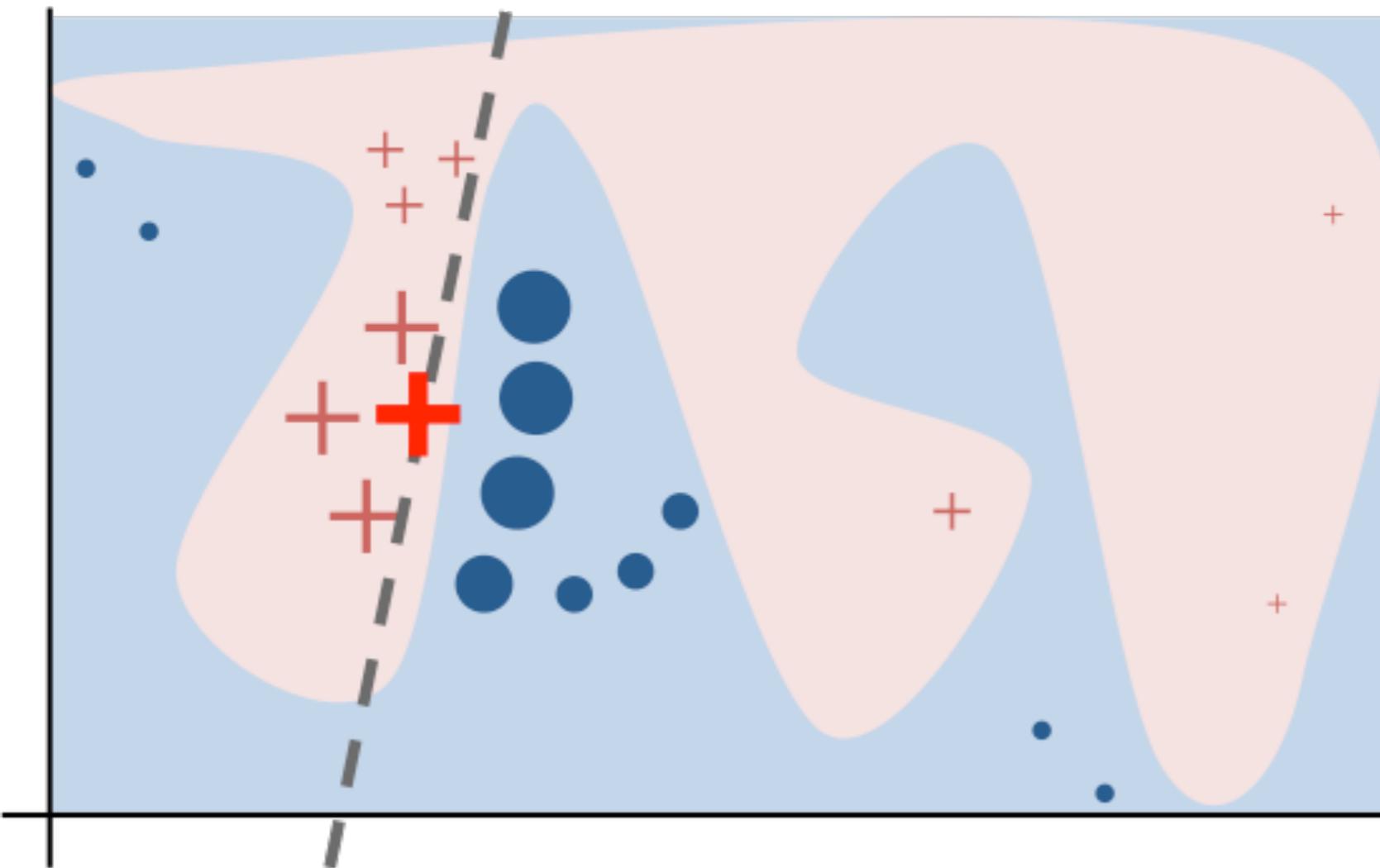
- 2) Understanding and trust - we need to understand models that makes important decisions for us.
- 3) Machine learning in regulated industry

"Why Should I Trust You?": Explaining the Predictions of Any Classifier  
Marco Tulio Ribeiro, Sameer Singh, Carlos Guestrin (2016)

# Lokalne wyjaśnienia

# LIME: Local Interpretable Model-agnostic Explanations

1. Generate a fake dataset around  $x$ .
2. Use black-box estimator to get target values  $y$ .
3. Train a new white-box estimator for  $(y, x)$ .
4. Check prediction quality of a white-box classifier.
5. Use white-box estimator as an explanation of black-box model.



"Why Should I Trust You?" Explaining the Predictions of Any Classifier.

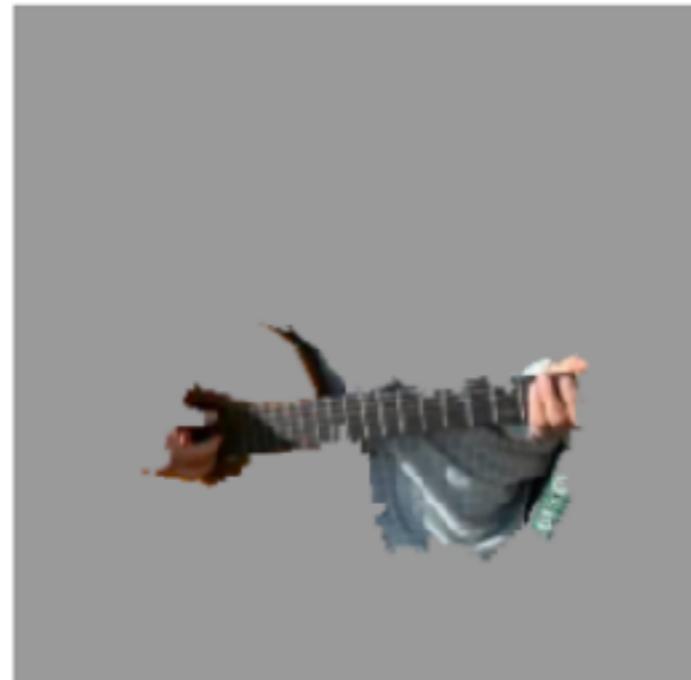
Marco Tulio Ribeiro, Sameer Singh, Carlos Guestrin (2016). <https://arxiv.org/pdf/1602.04938.pdf>

Port to R: Thomas Lin Pedersen (2017) <https://github.com/thomasp85/lime>

# LIME: Local Interpretable Model-agnostic Explanations

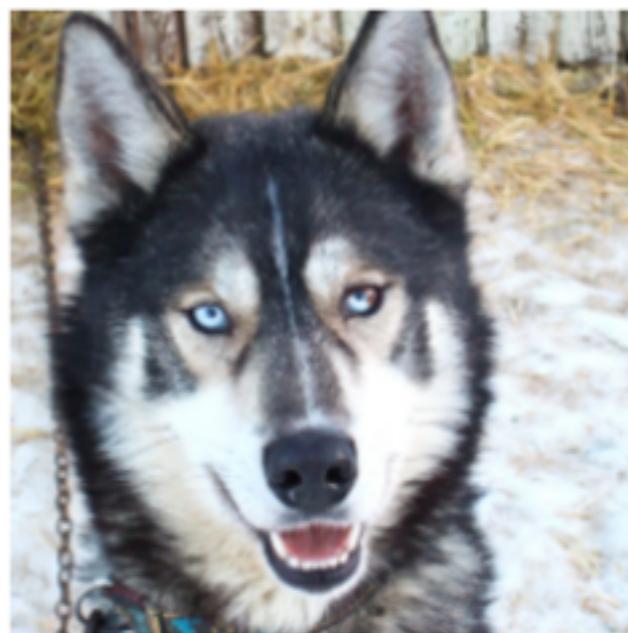


(a) Original Image



(b) Explaining *Electric guitar*

Co poszło źle?



(a) Husky classified as wolf



(b) Explanation

An R port <https://github.com/thomasp85/lime>

"Why Should I Trust You?" Explaining the Predictions of Any Classifier.

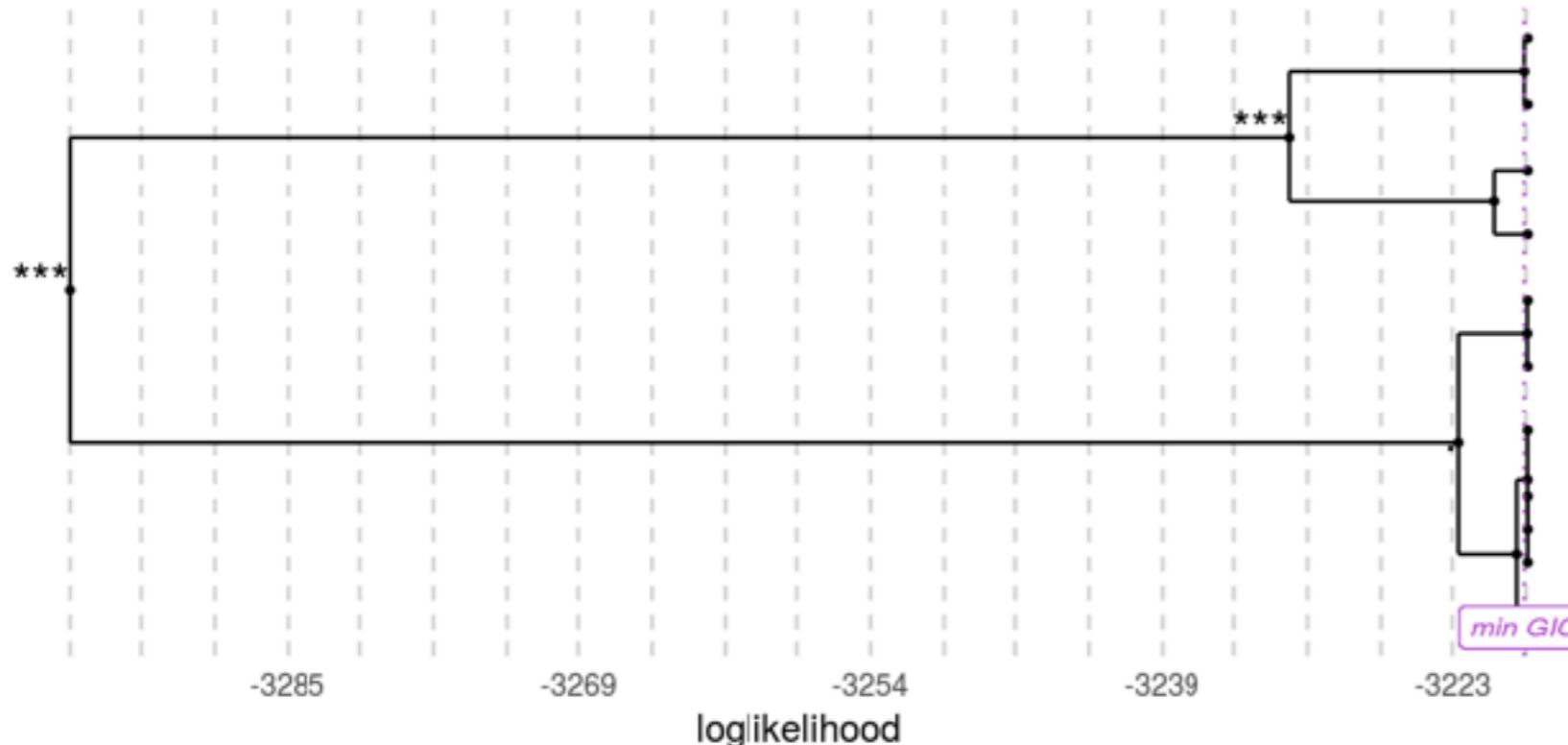
Marco Tulio Ribeiro, Sameer Singh, Carlos Guestrin (2016). <https://arxiv.org/pdf/1602.04938.pdf>

# Efekt pojedynczej zmiennej

# Pakiet factorMerger

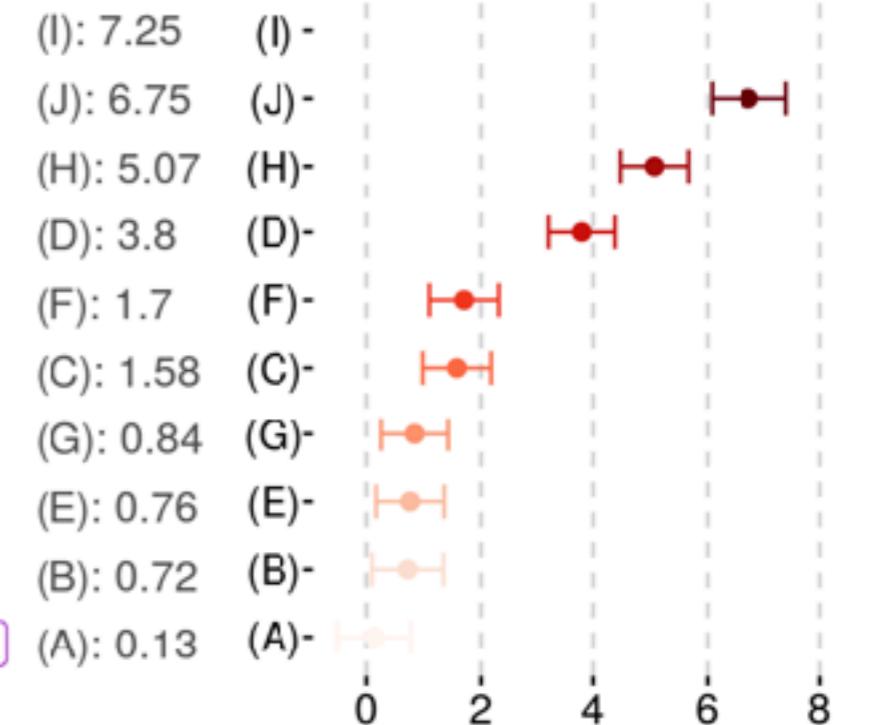
## Merging path plot

Optimal GIC partition: (A)(B)(E)(G):(C)(F):(D):(H):(J)(I)



## Summary statistics

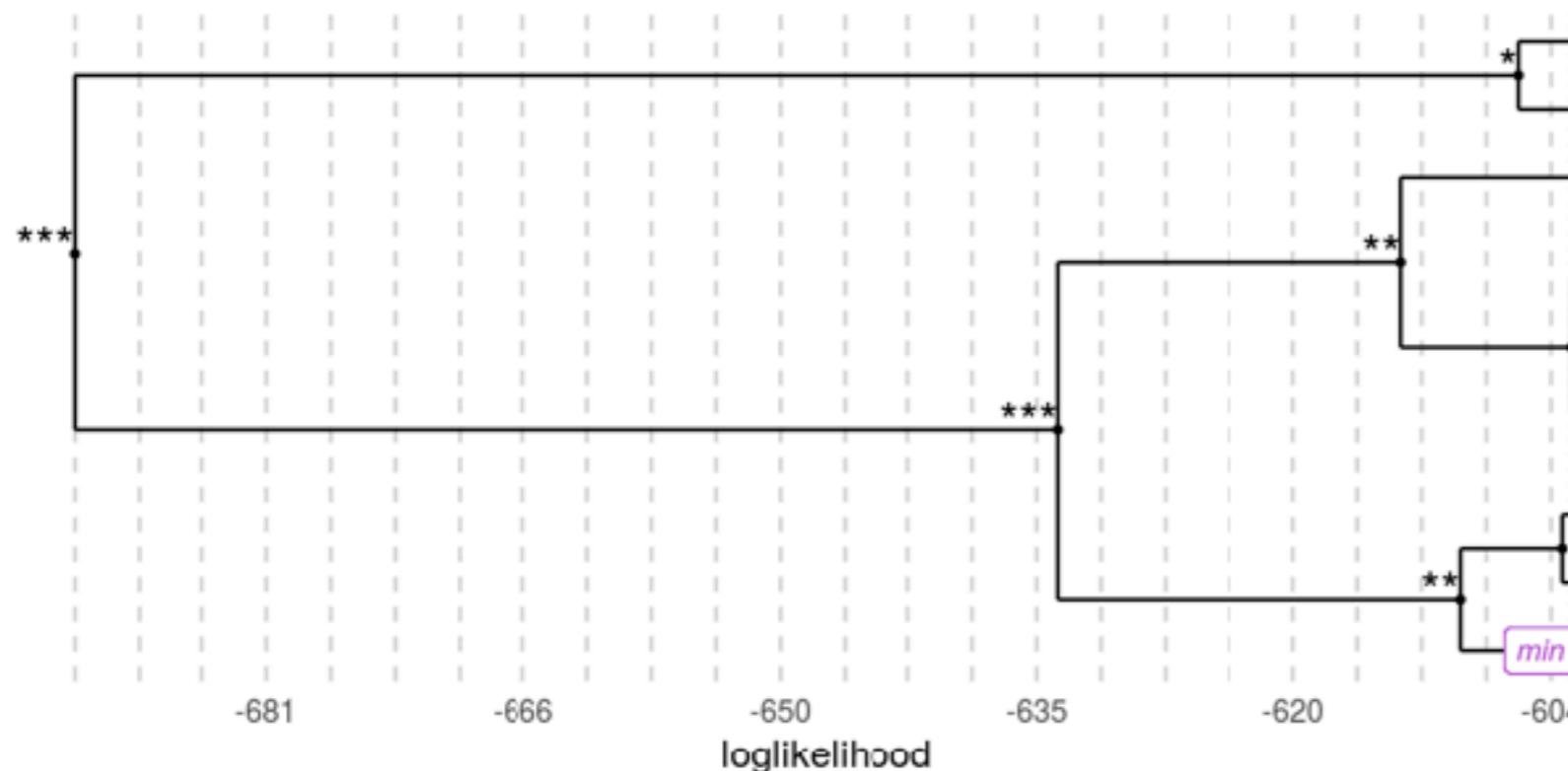
Means and standard deviation



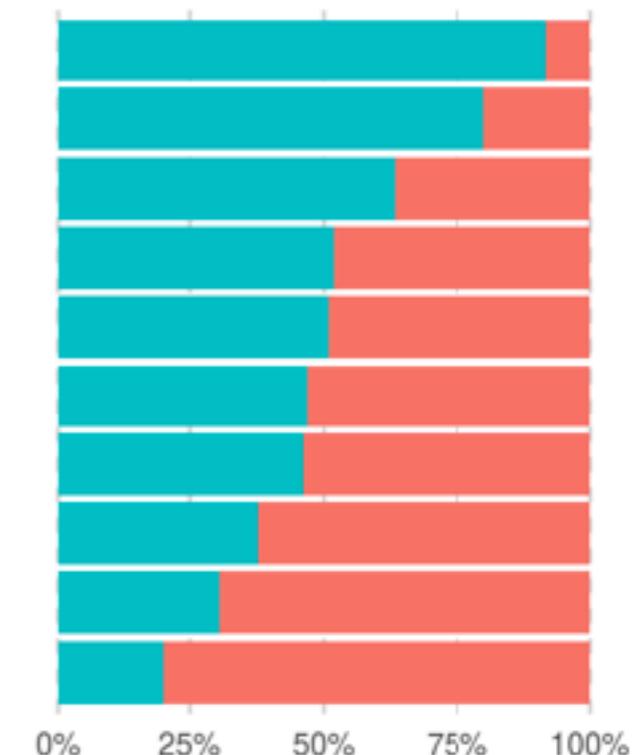
# Pakiet factorMerger

## Merging path plot

Optimal GIC partition: (I):(F)(A):(G)(H)(J)(E):(B):(C):(D)



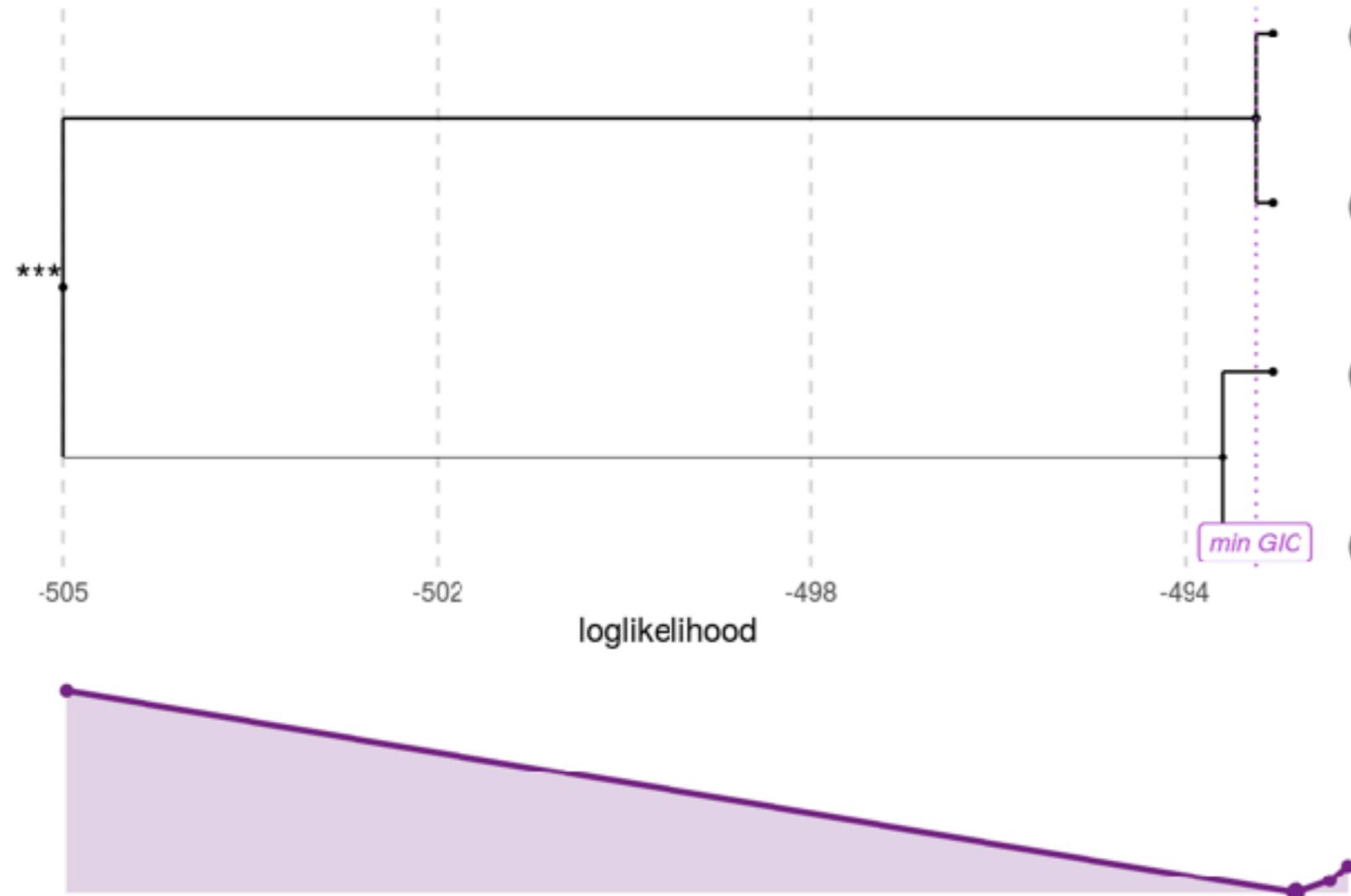
## Success ratio



# Pakiet factorMerger

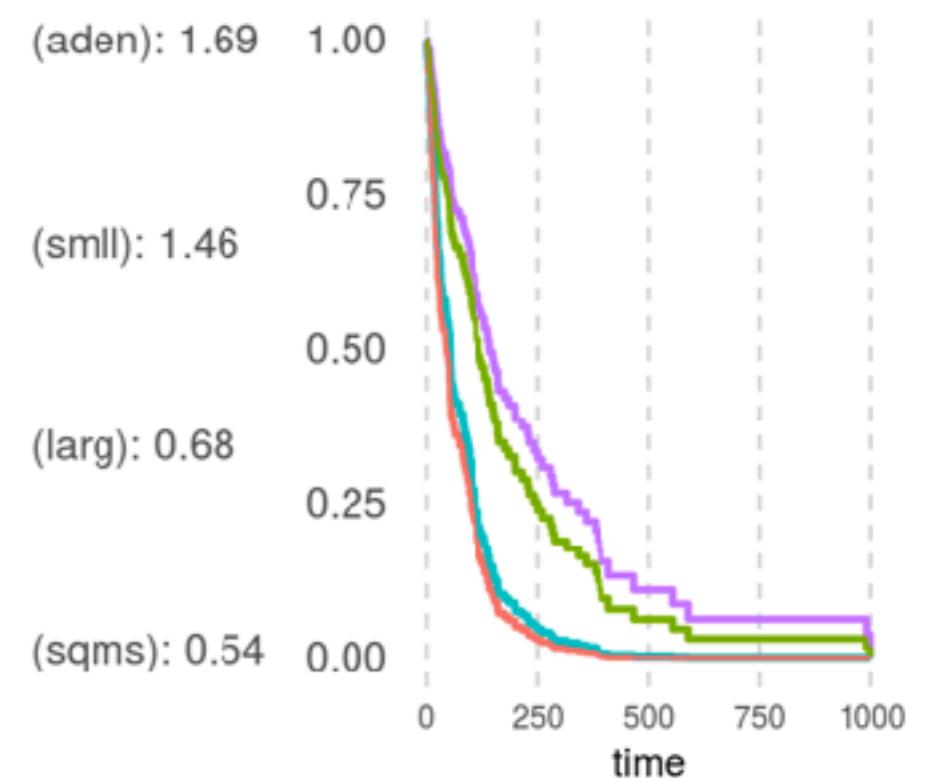
## Merging path plot

Optimal GIC partition: (sqms)(larg):(smll)(aden)



## Survival plot

Adjusted survival curves for

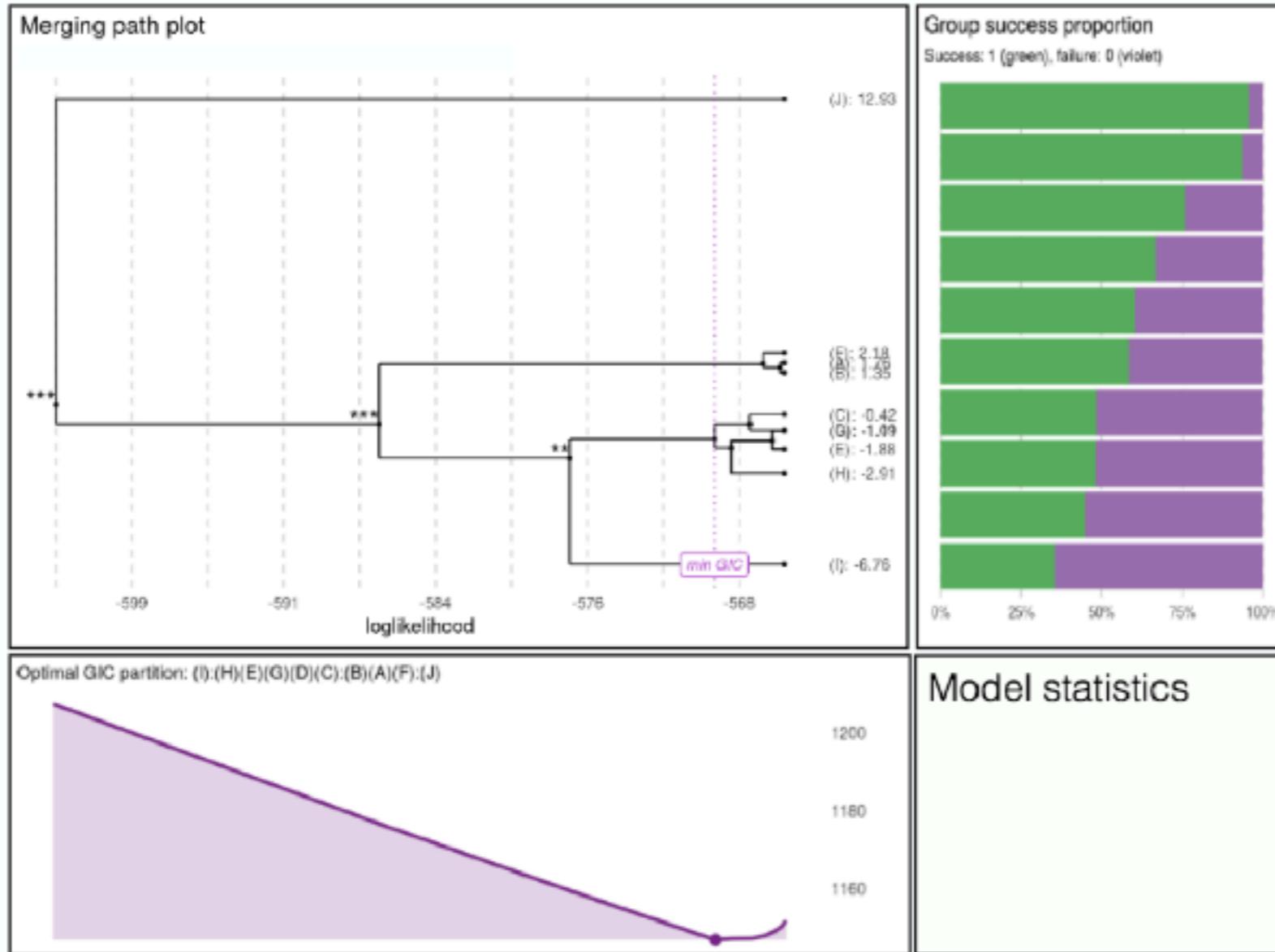


## Level fusing plot

The top-left plot shows level fusing paths (merging paths). With arguments **family=**, **show=**, **fuse=**, **spacing=**, one can select how to merge factors and what shall be presented on OX/OY axes.

| Argument          | Summary              |
|-------------------|----------------------|
| panel = "all"     | All panels           |
| panel = "left"    | Only left two panels |
| panel = "top"     | Only top two panels  |
| panel = "merging" | Merging path plot    |

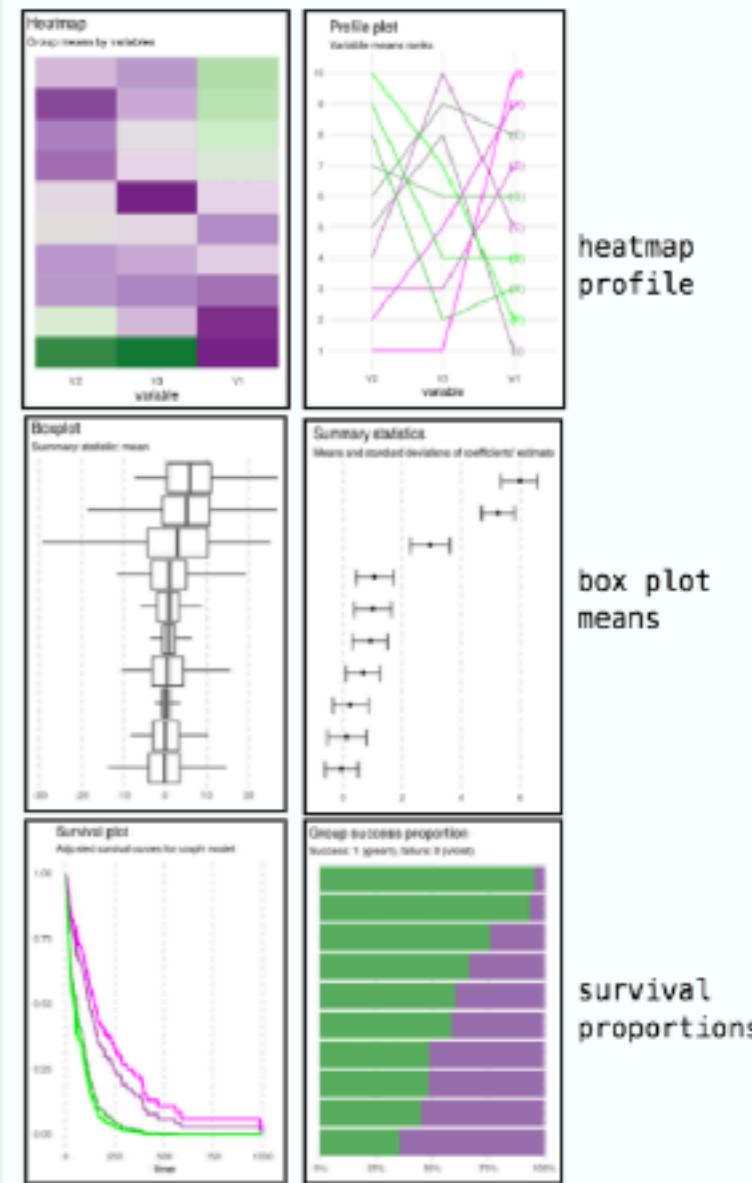
| Argument                | Summary                           |
|-------------------------|-----------------------------------|
| show = "likelihood"     | Plot likelihood on OX axis        |
| show = "p-value"        | Plot p-values on OX axis          |
| fuse = "allall"         | Compare all pairs of groups       |
| fuse = "nearby"         | Compare nearby groups             |
| fuse = "cluster"        | DMR4glm algorithm                 |
| spacing = "equidistant" | Levels equidistant on OY scale    |
| spacing = "effects"     | Levels according to their effects |
| family = "gaussian"     | For one-dimensional Gaussian      |
| family = "mgaussian"    | For multi dimensional Gaussian    |
| family = "binomial"     | For binomial regression           |
| family = "survival"     | For Cox regression                |



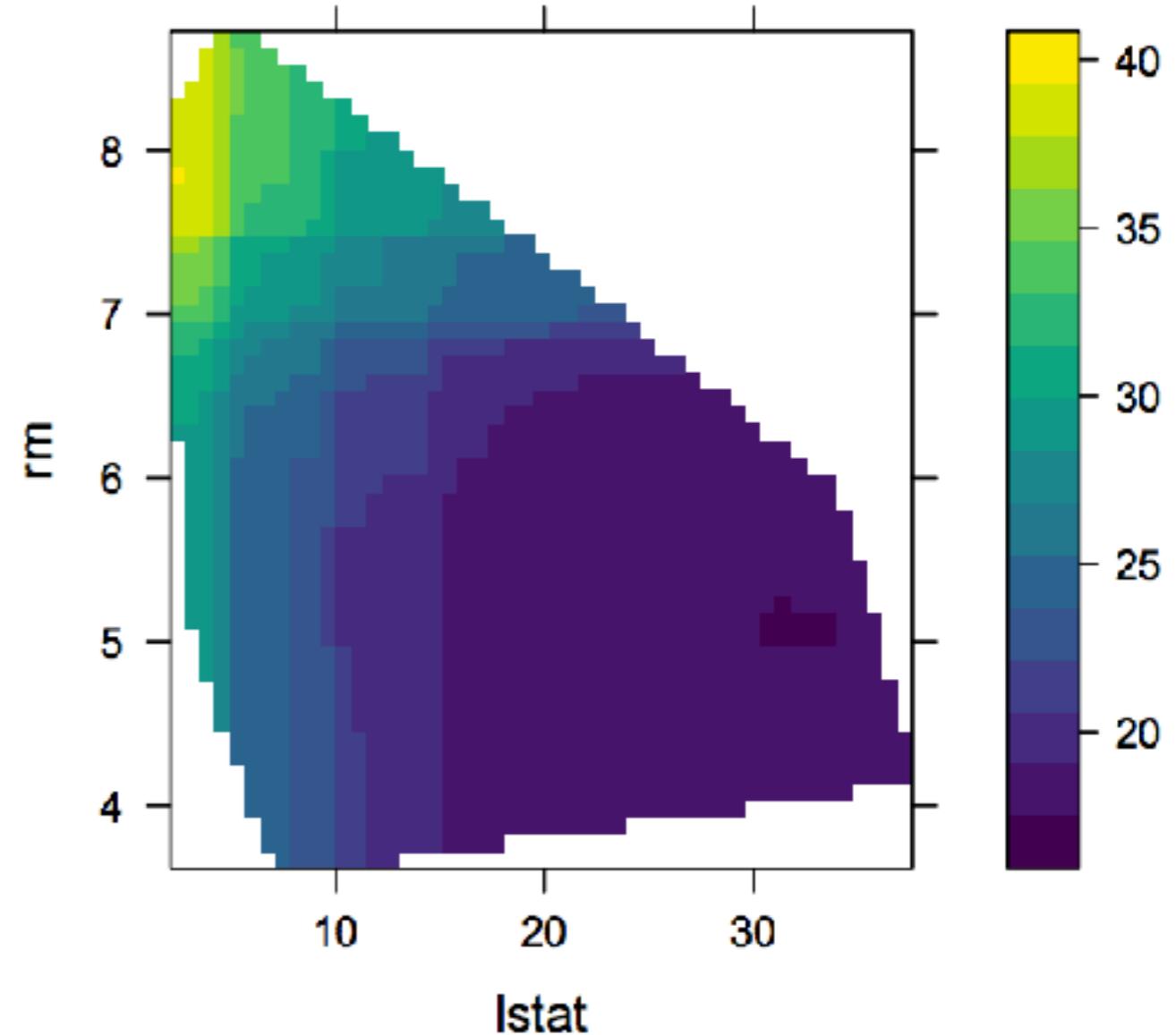
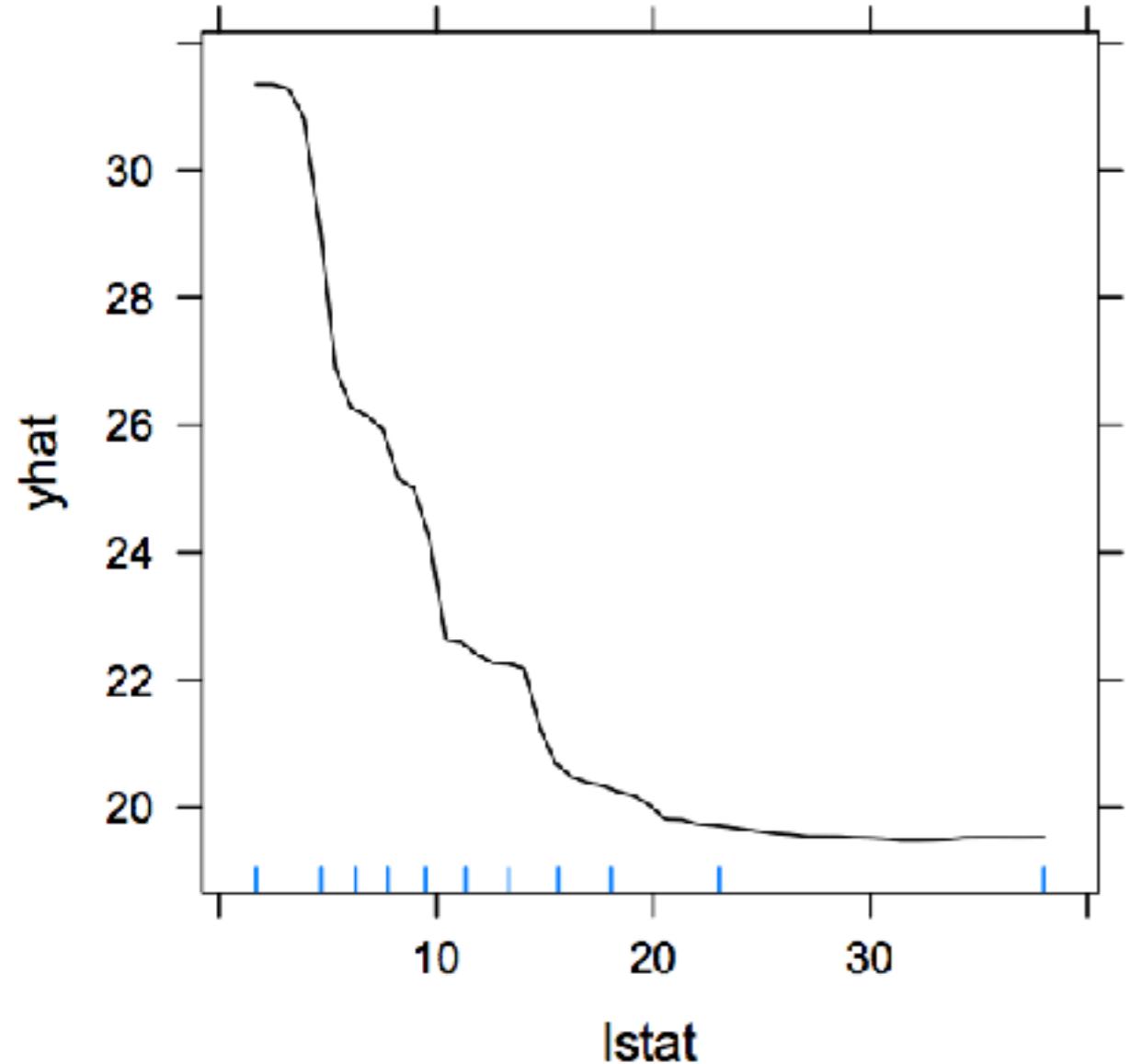
## Group summaries

The top-right panel shows group characteristics. Use the parameter **summary=** to select the most suitable presentation.

| Argument                | Summary                 |
|-------------------------|-------------------------|
| summary = "heatmap"     | For m gaussian          |
| summary = "profile"     | For m gaussian          |
| summary = "boxplot"     | For gaussian            |
| summary = "means"       | For gaussian            |
| summary = "survival"    | For Cox regression      |
| summary = "proportions" | For binomial regression |



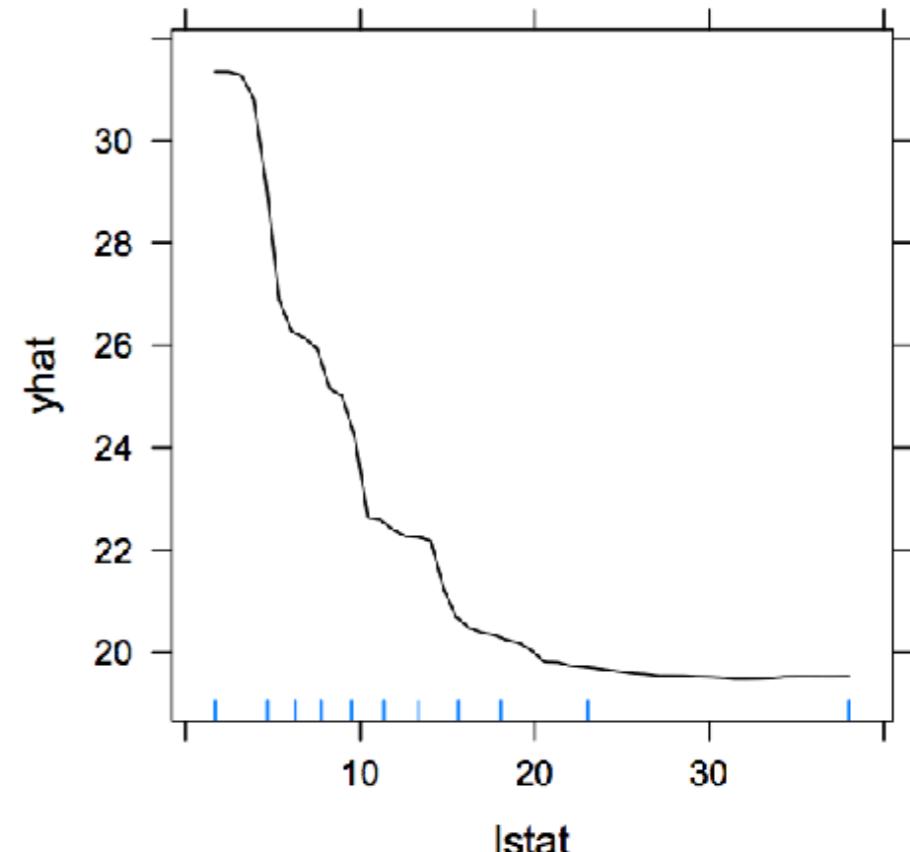
# Pakiet pdp - Partial Dependence Plots



pdp: An R Package for Constructing Partial Dependence Plots. Brandon M. Greenwell (2017)  
<https://journal.r-project.org/archive/2017/RJ-2017-016/index.html>

# Pakiet pdp - Partial Dependence Plots

| Type of model                                   | R package                               | Object class              |
|---|---|---------------------------|
| Decision tree                                   | <b>C50</b> (Kuhn et al., 2015)          | "C5.0"                    |
|   | <b>party</b>                            | "BinaryTree"              |
|   | <b>partykit</b>                         | "party"                   |
|   | <b>rpart</b> (Therneau et al., 2015)    | "rpart"                   |
| Bagged decision trees                           | <b>adabag</b> (Alfaro et al., 2013)     | "bagging"                 |
|   | <b>ipred</b> (Peters and Hothorn, 2015) | "classbagg",<br>"regbagg" |
|   |   | "boosting"                |
| Boosted decision trees                          | <b>adabag</b> (Alfaro et al., 2013)     | "gbm"                     |
|   | <b>gbm</b>                              | "xgb.Booster"             |
|   | <b>xgboost</b>                          | "cubist"                  |
| Cubist  | <b>Cubist</b> (Kuhn et al., 2014)       | "lda", "qda"              |
| Discriminant analysis                           | <b>MASS</b> (Venables and Ripley, 2002) | "glm", "lm"               |
| Generalized linear model                        | <b>stats</b>                            | "lm"                      |
| Linear model                                    | <b>stats</b>                            | "nls"                     |
| Nonlinear least squares                         | <b>stats</b>                            | "earth"                   |
| Multivariate adaptive regression splines (MARS) | <b>earth</b> (Milborrow, 2016)          | "mars"                    |
|   | <b>mда</b> (Leisch et al., 2016)        | "ppr"                     |
| Projection pursuit regression                   | <b>stats</b>                            |                           |
| Random forest                                   | <b>randomForest</b>                     | "randomForest"            |
|   | <b>party</b>                            | "RandomForest"            |
|   | <b>partykit</b>                         | "cforest"                 |
|   | <b>ranger</b> (Wright, 2016)            | "ranger"                  |
| Support vector machine                          | <b>e1071</b> (Meyer et al., 2015)       | "svm"                     |
|   | <b>kernlab</b> (Karatzoglou)            |                           |



pdp: An R Package for Constructing Partial Dependence Plots

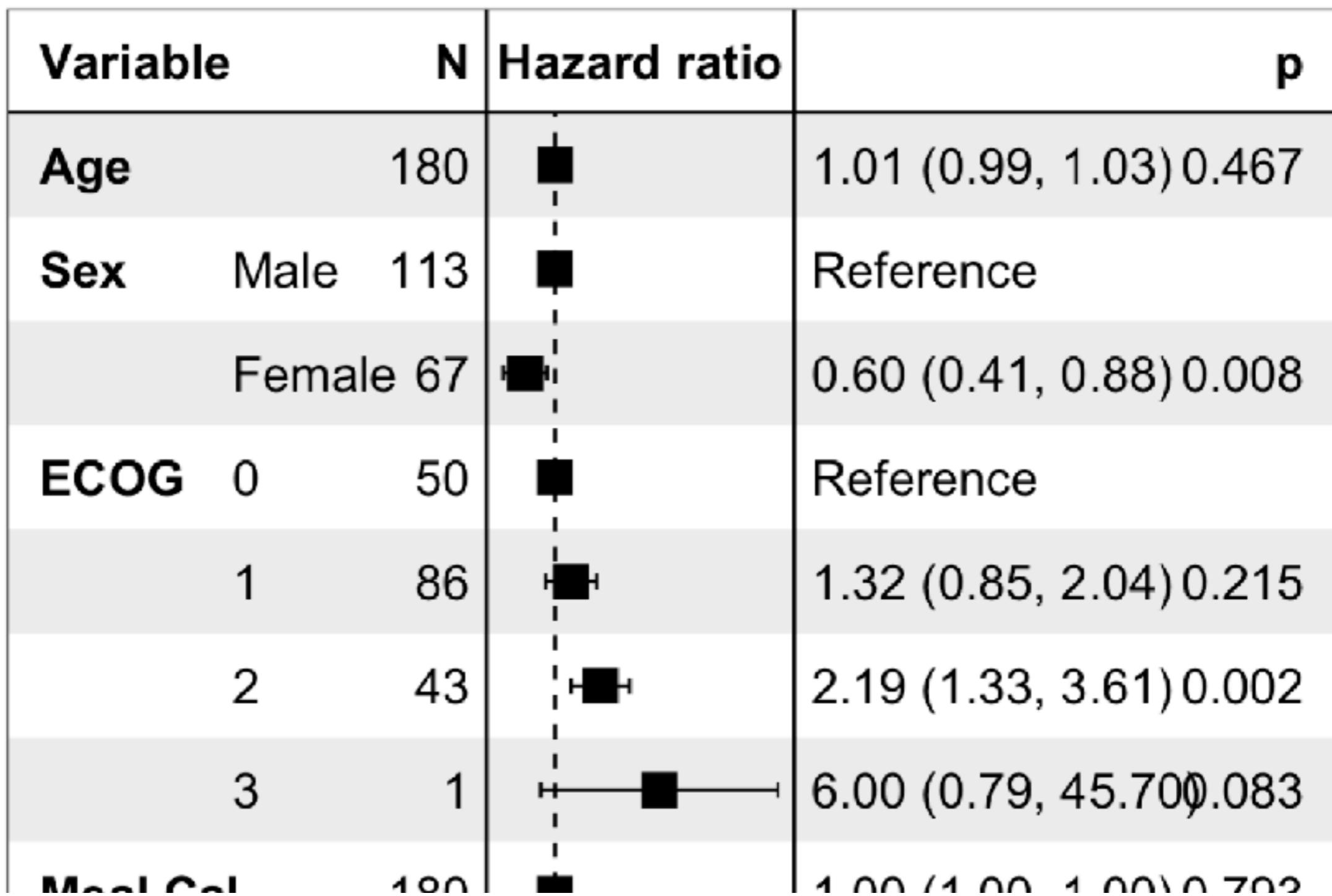
Brandon M. Greenwell (2017)

<https://journal.r-project.org/archive/2017/RJ-2017-016/index.html>

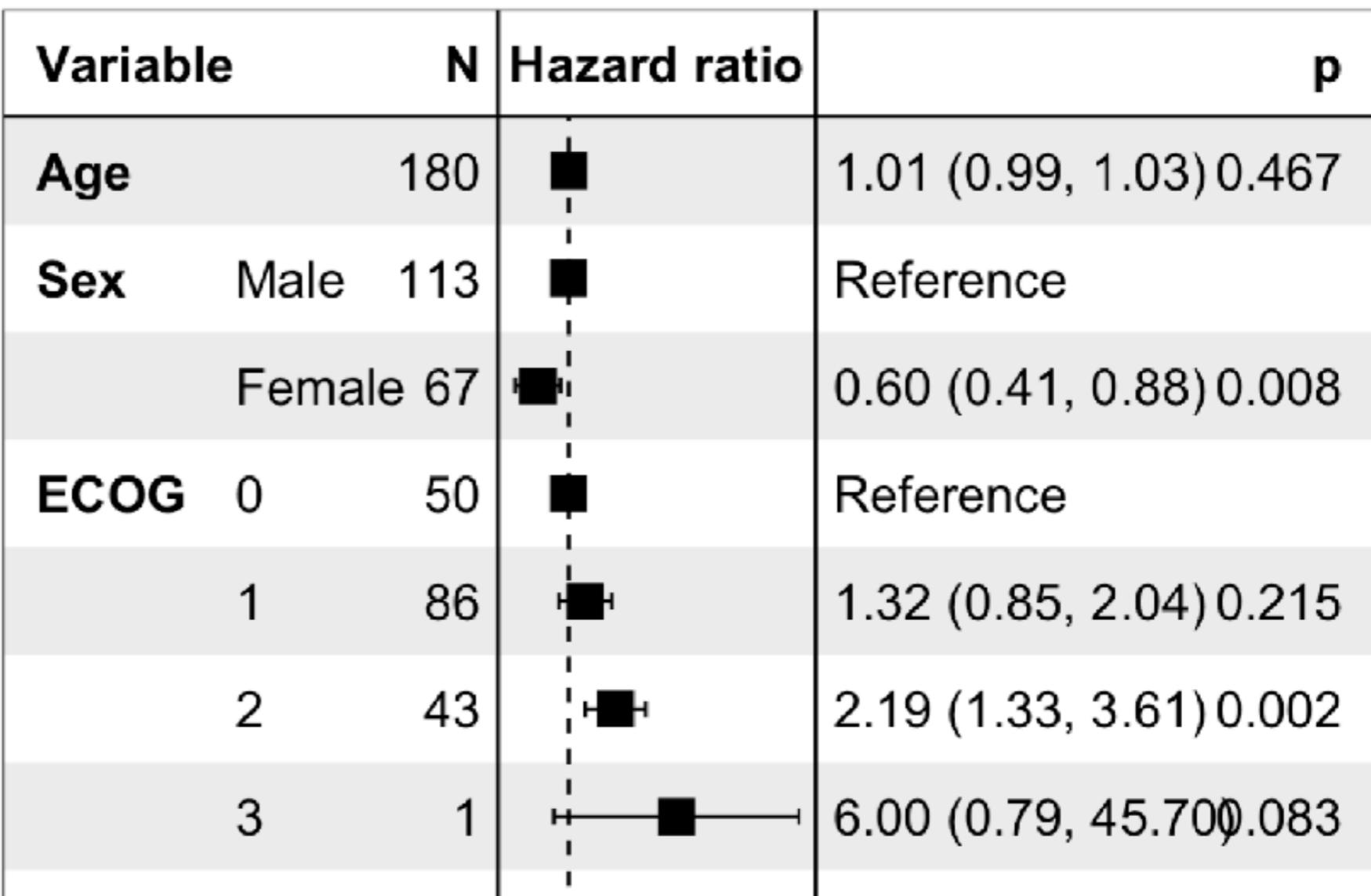
**Table 1:** Models specifically supported by the **pdp** pac  
may still need to supply additional arguments in the cal

# Struktura

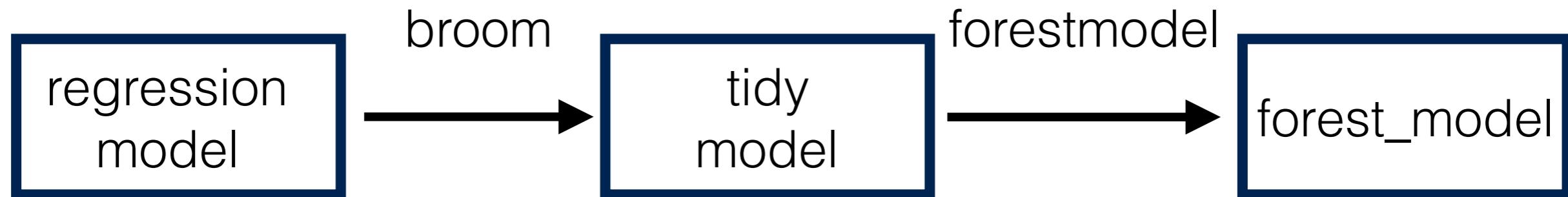
# Pakiet forestmodel



# Pakiet forestmodel



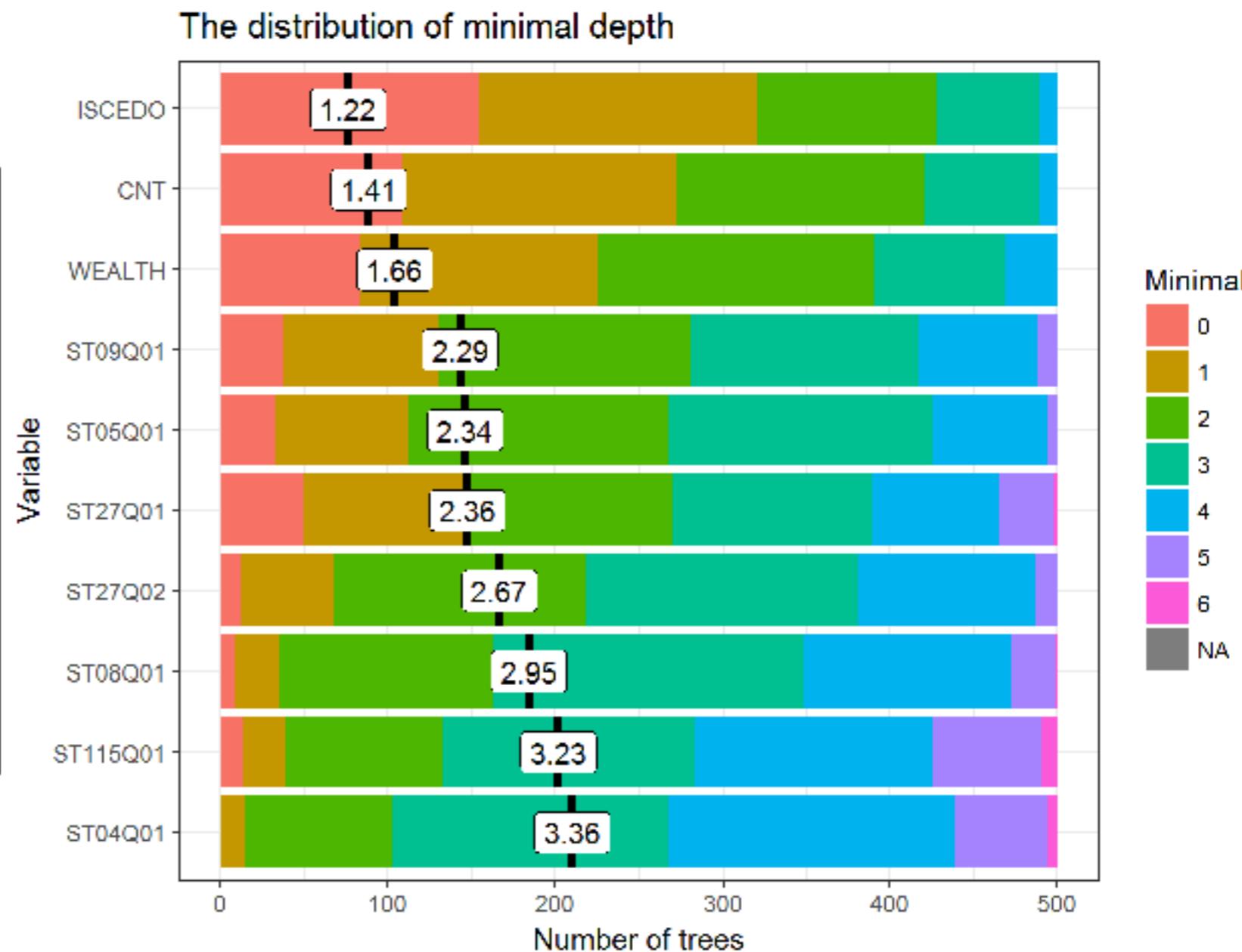
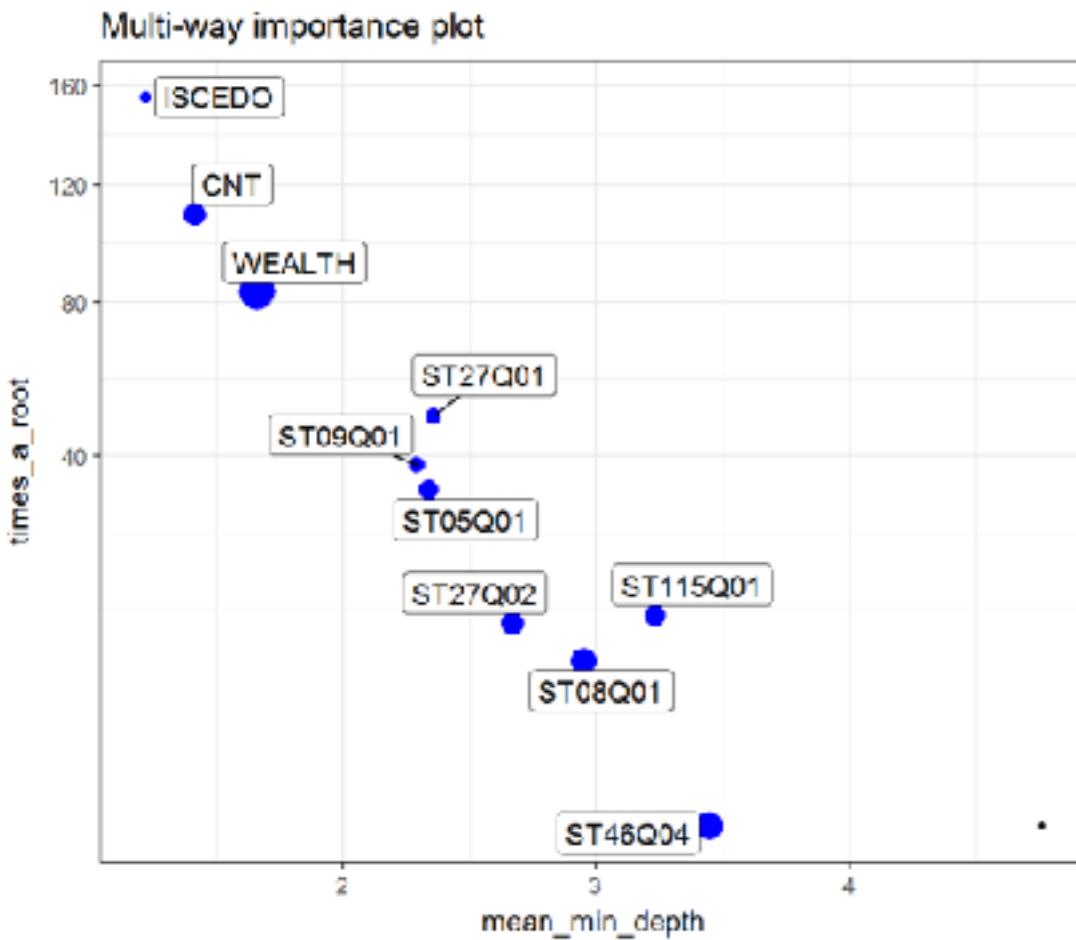
# Pakiet forestmodel



| Class   | tidy | glance | spec           | x |   |
|---------|------|--------|----------------|---|---|
| aareg   | x    | x      | stanfit        | x |   |
| acf     | x    |        | stanreg        | x | x |
| anova   | x    |        | summary.glht   | x |   |
| aov     | x    |        | summary.lm     | x | x |
| aovlist | x    |        | summaryDefault | x | x |
| Arima   | x    | x      | survexp        | x | x |
| betareg | x    | x      | survfit        | x | x |
| biglm   | x    | x      | survreg        | x | x |

# Pakiet randomForestExplainer

## Co się kryje w lesie?

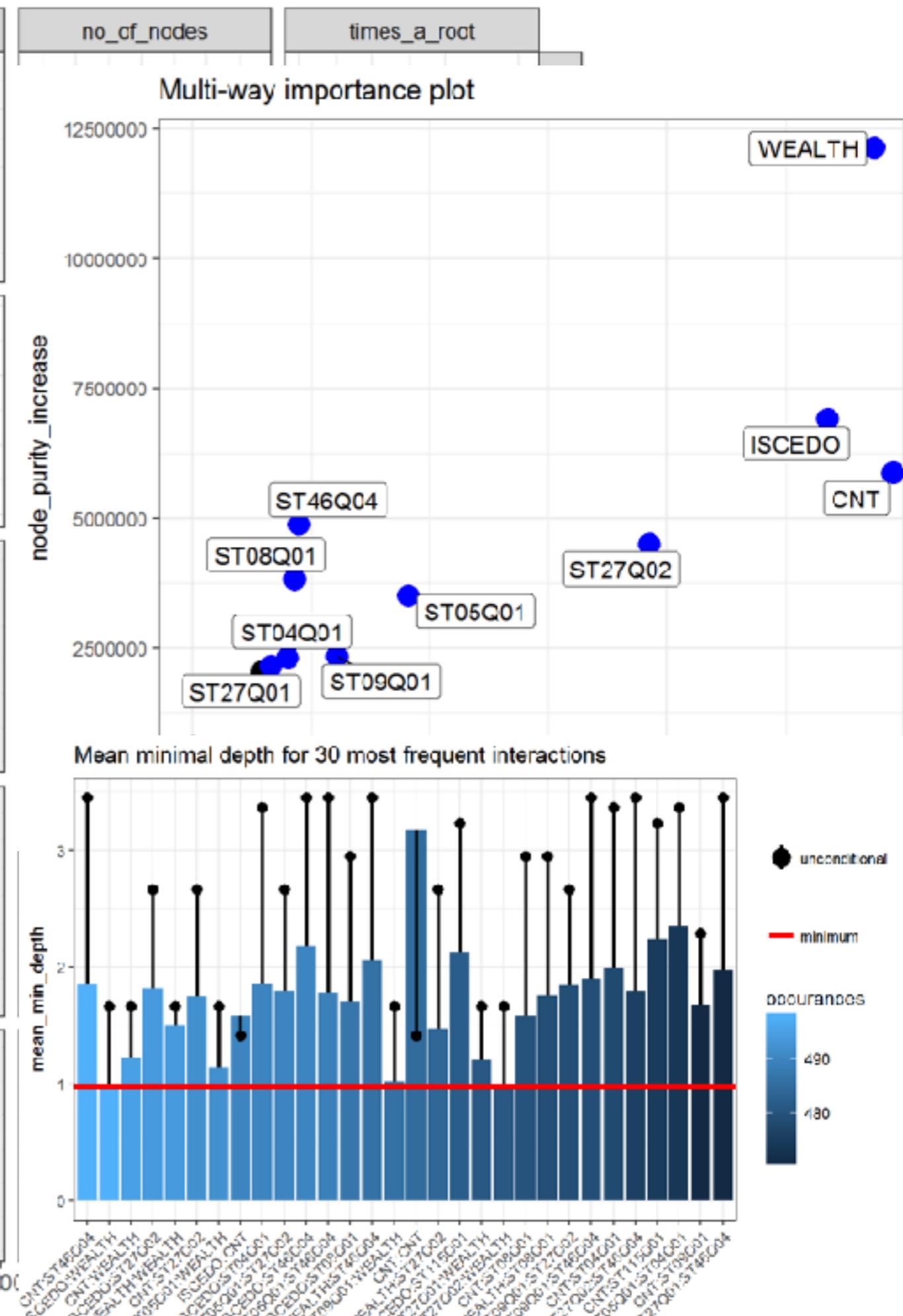
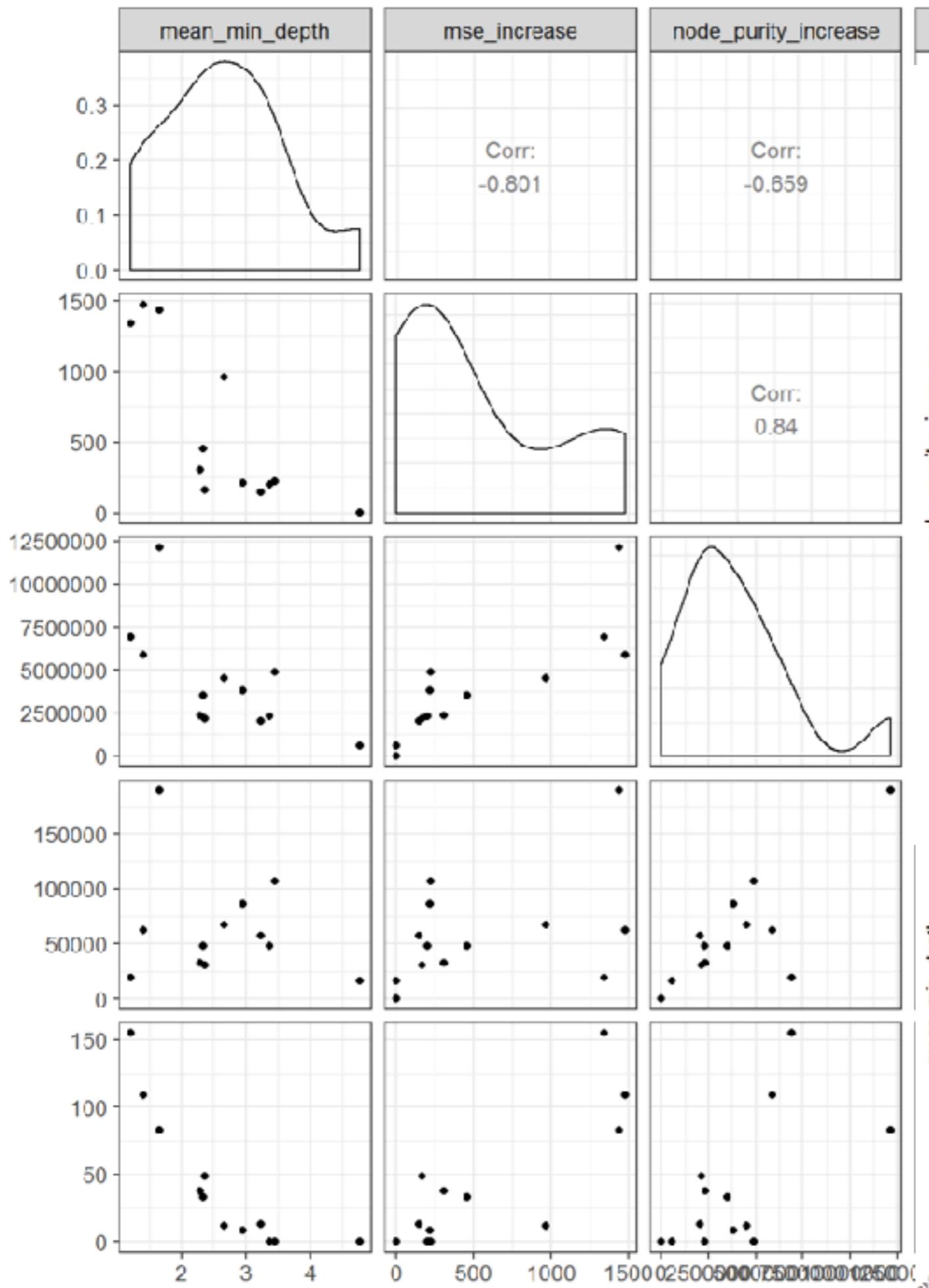


Aleksandra Paluszynska, Przemysław Biecek (2017)

<https://github.com/geneticsMiNlNg/BlackBoxOpener>

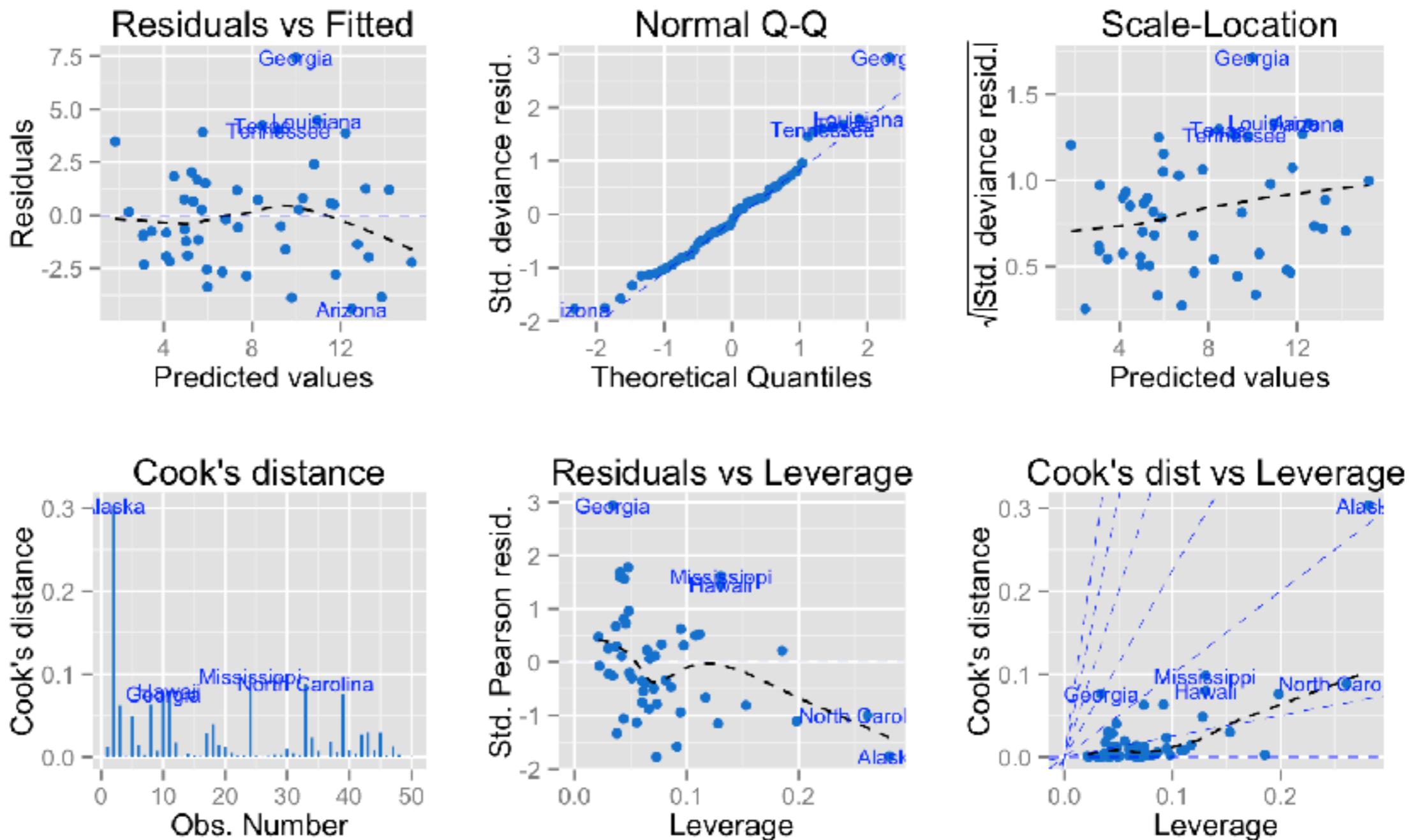
John Ehrlinger (2015) ggRandomForests: Random Forests for Regression

# Relations between measures of importance



# Diagnostyka

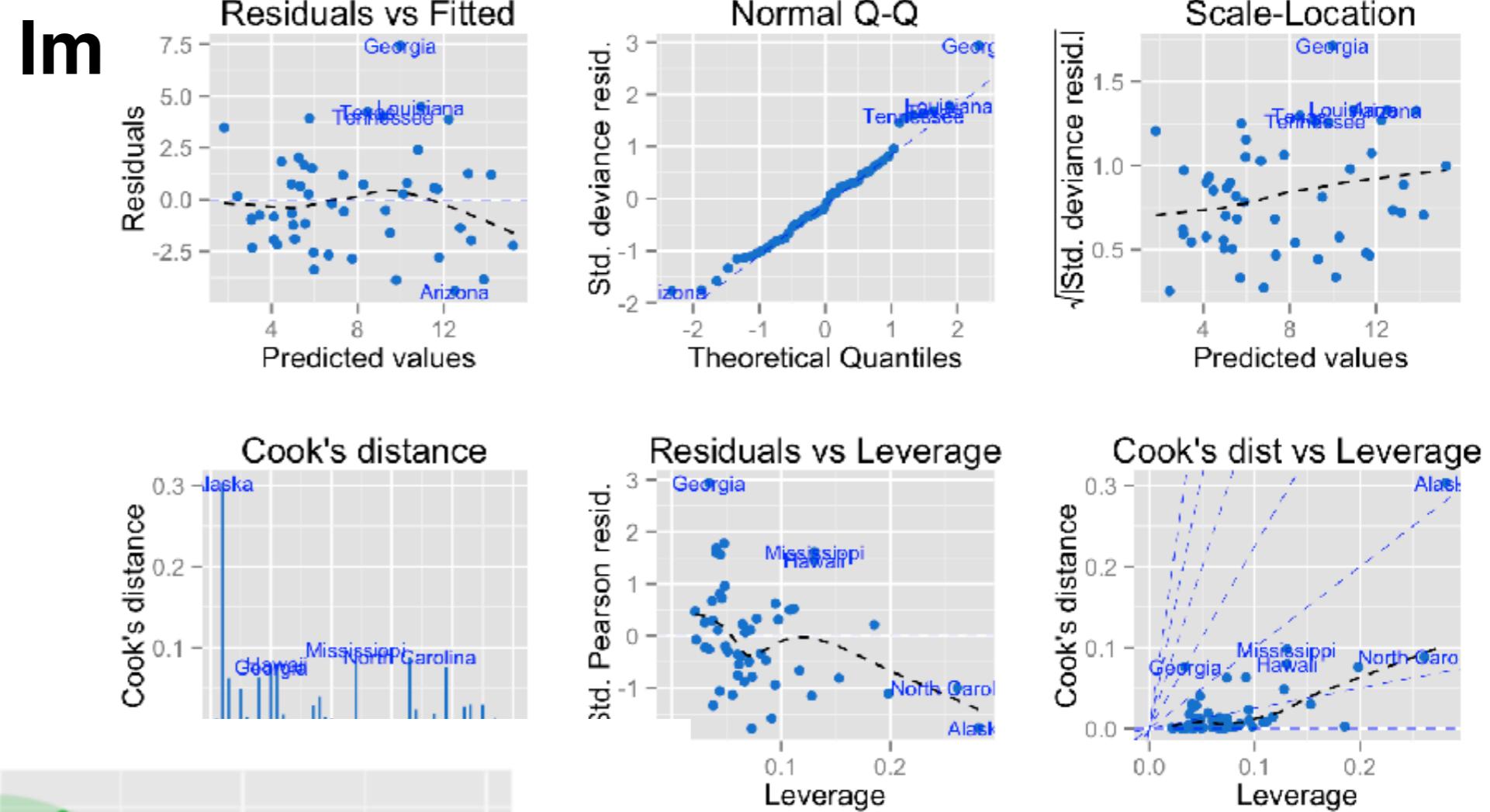
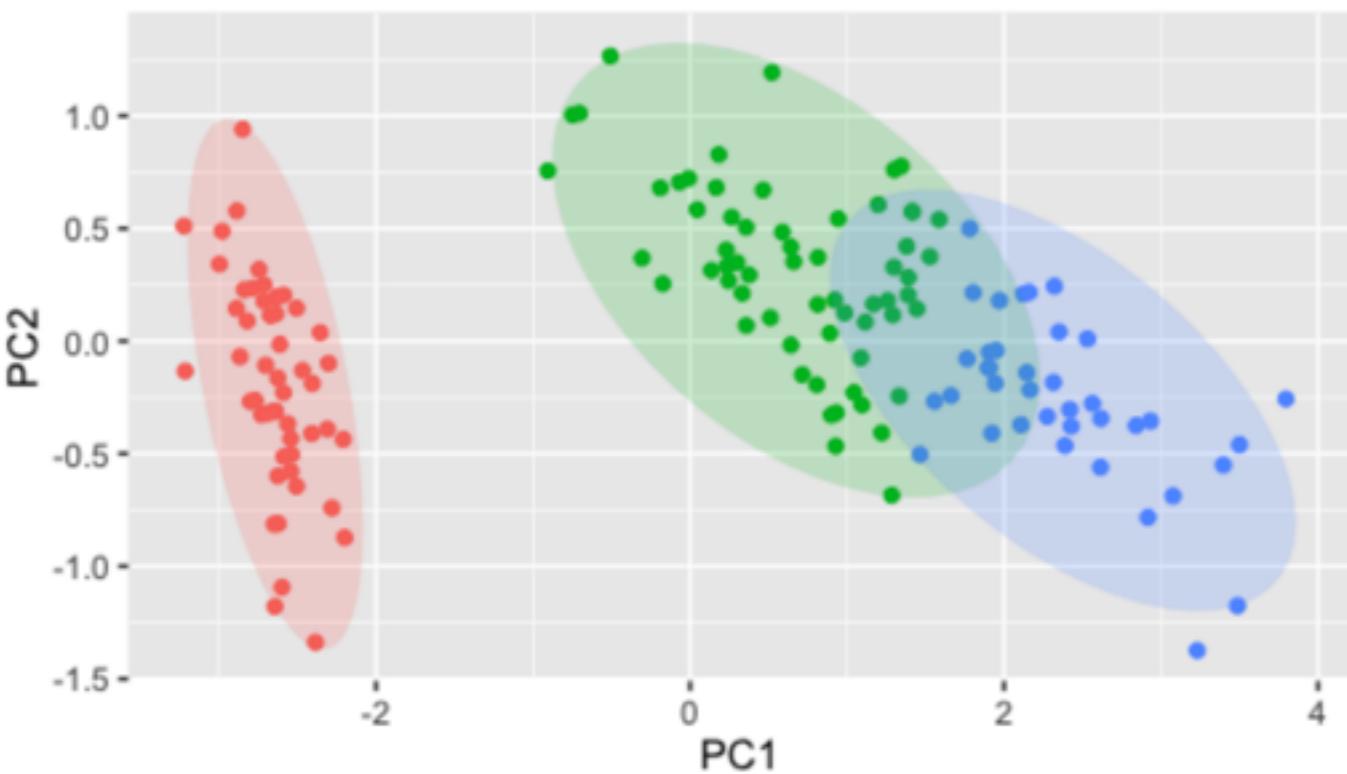
# Pakiet ggfortify



[Yuan Tang, Masaaki Horikoshi, and Wenxuan Li. "ggfortify: Unified Interface to Visualize Statistical Result of Popular R Packages." The R Journal 8.2 \(2016\): 478-489.](#)

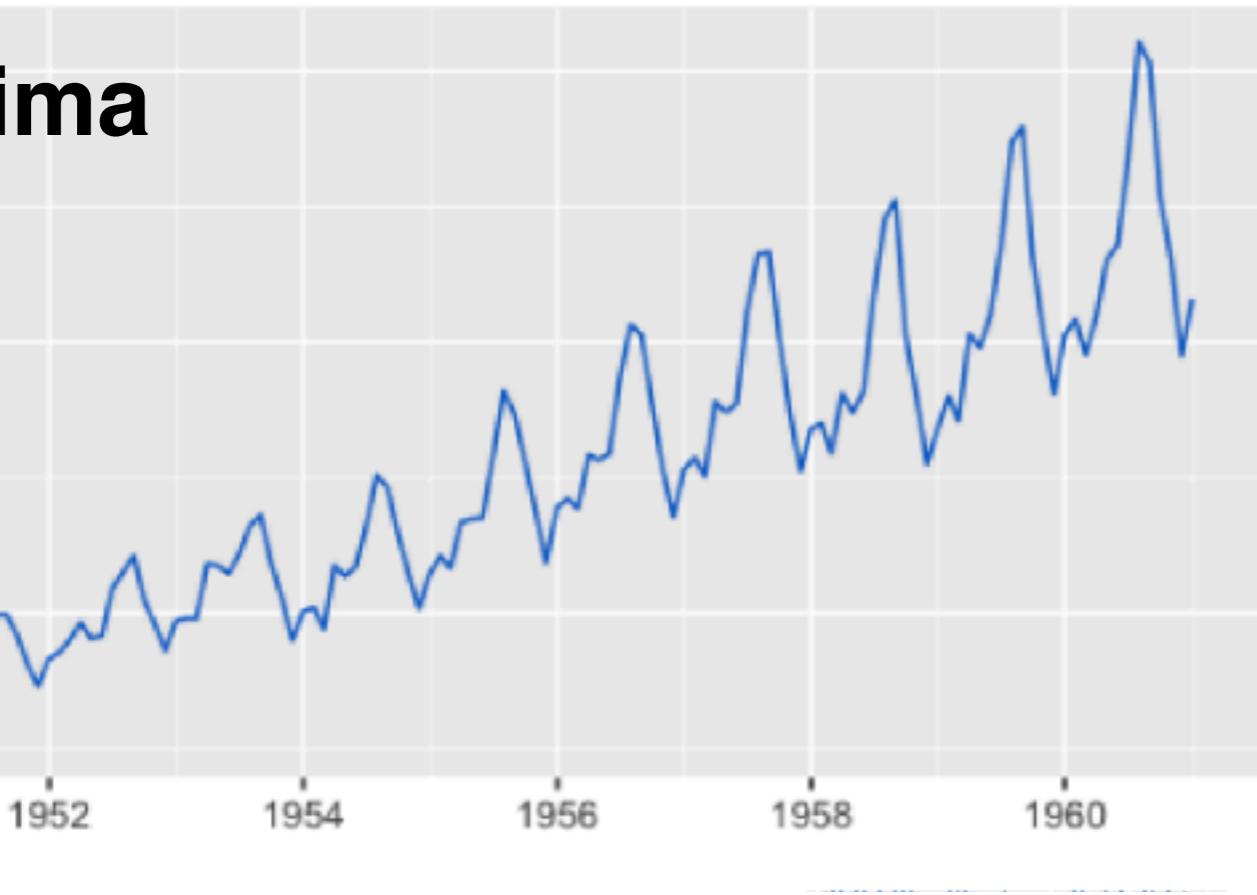
# Pakiet ggfortify

PAM

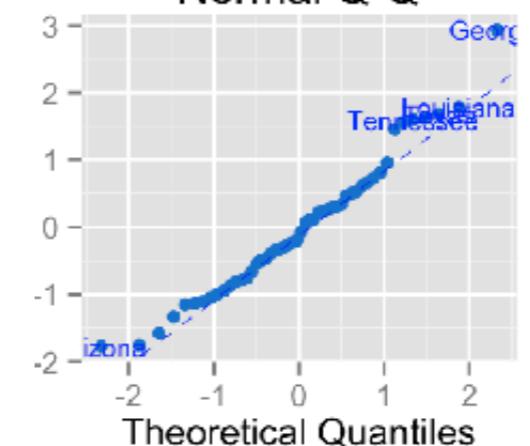


[Yuan Tang, Masaaki Horikoshi, and Wenxuan Li. "ggfortify: Unified Interface to Visualize Statistical Result of Popular R Packages." The R Journal 8.2 \(2016\): 478-489.](#)

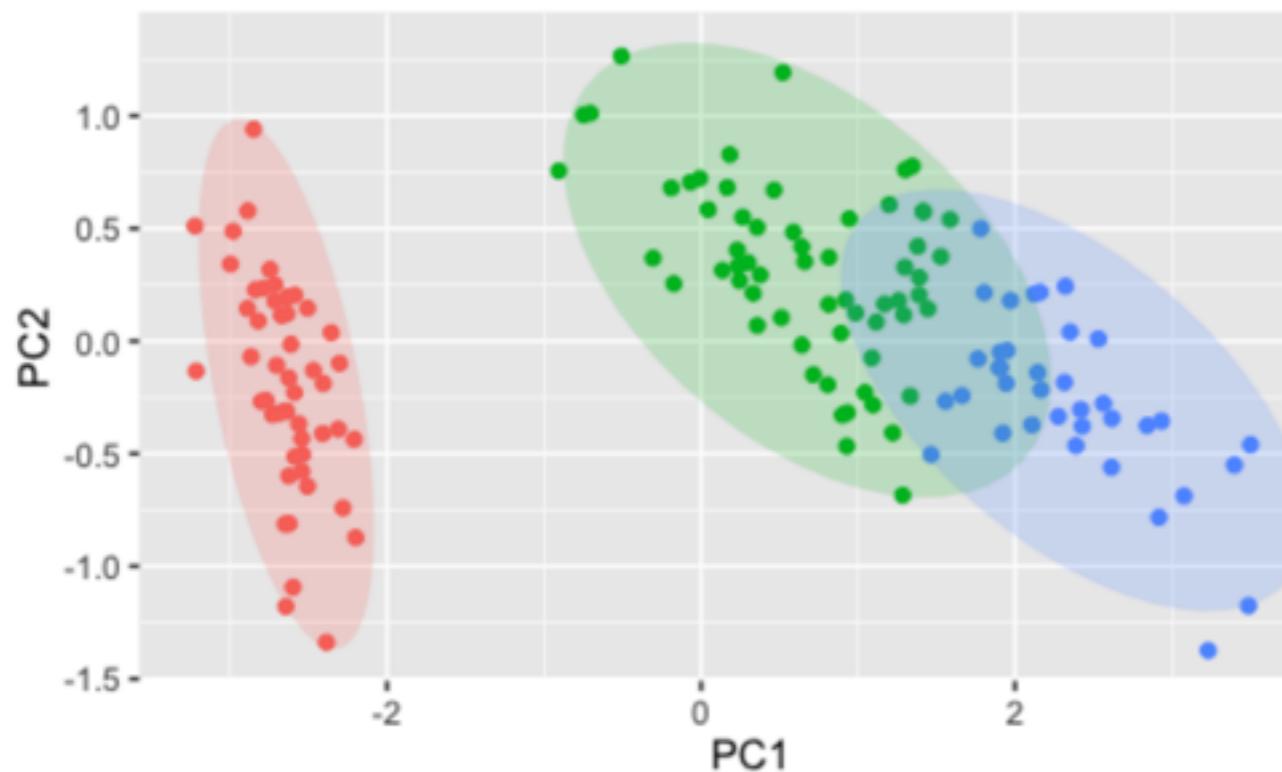
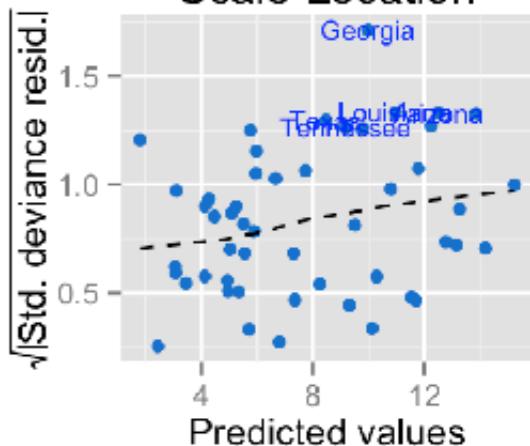
# arima



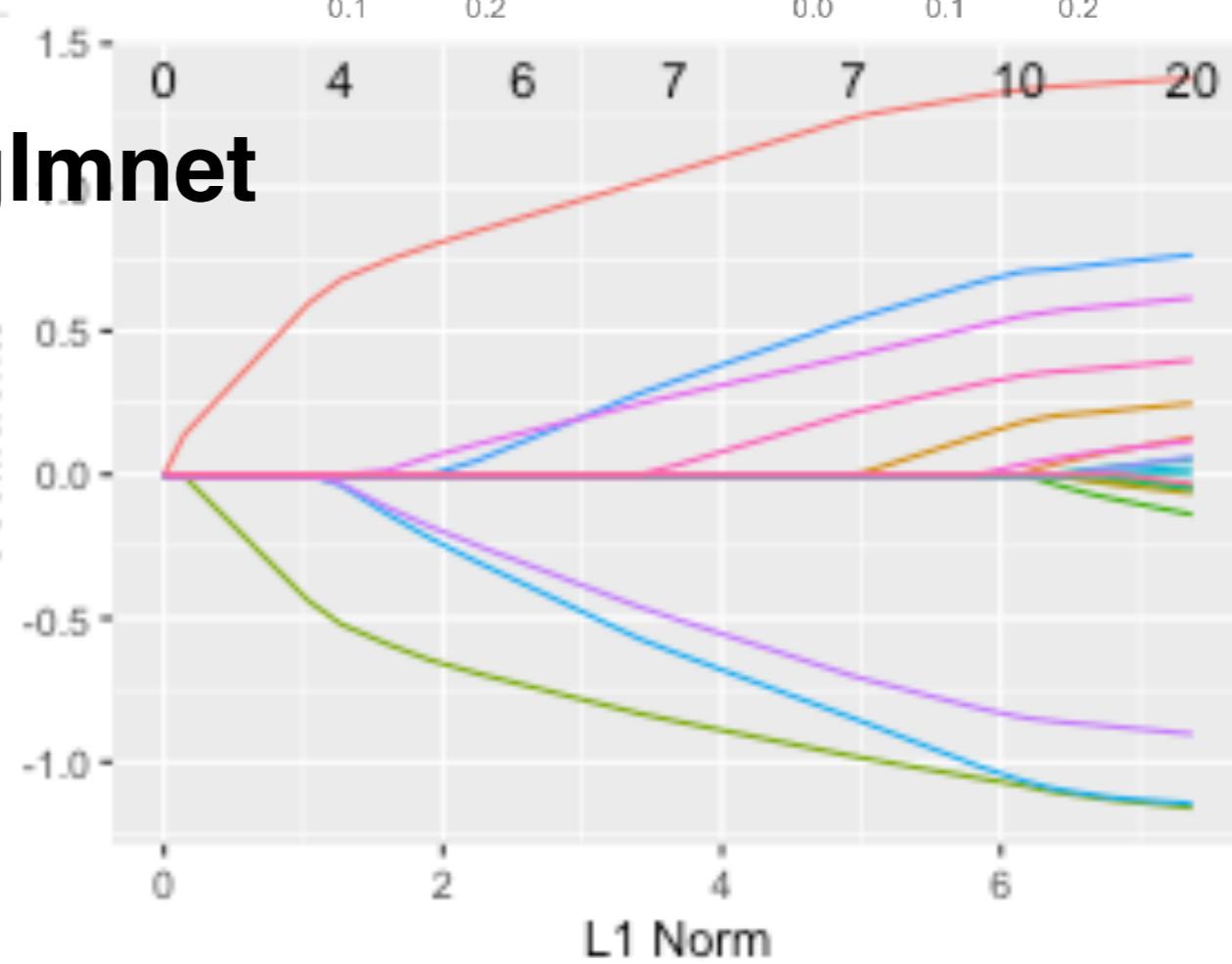
## Normal Q-Q



## Scale-Location



# glmnet



[Yuan Tang, Masaaki Horikoshi, and Wenxuan  
Statistical Result of Popular R Packages." Th](#)

# arima

# aareg

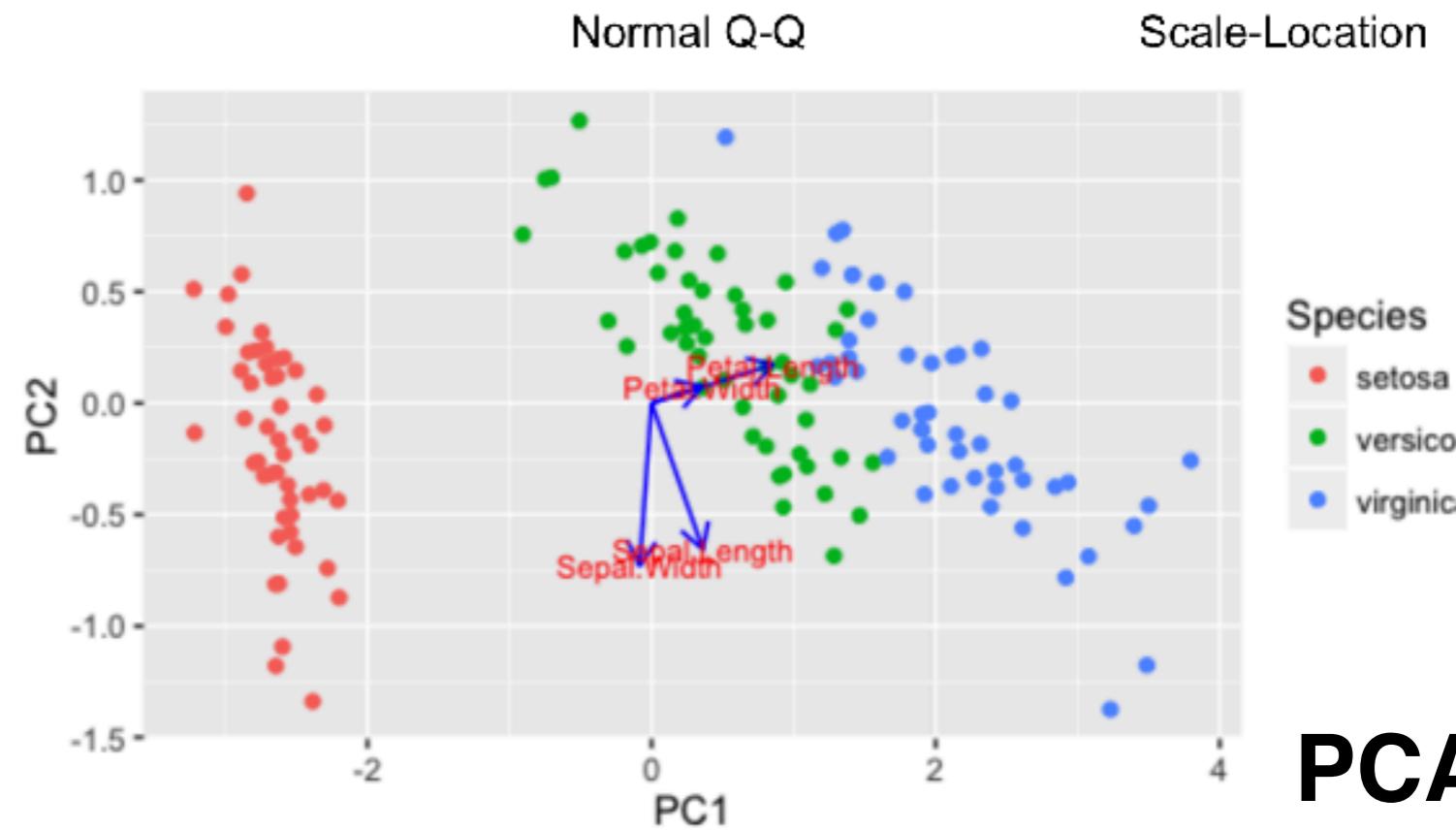
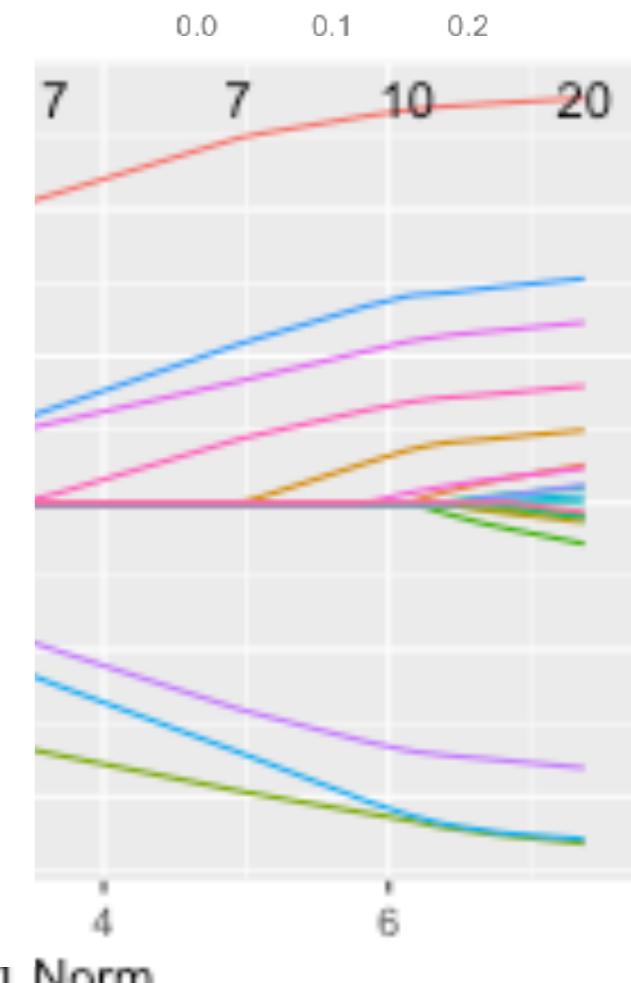


Figure 3: PCA with eigen-vectors and labels.



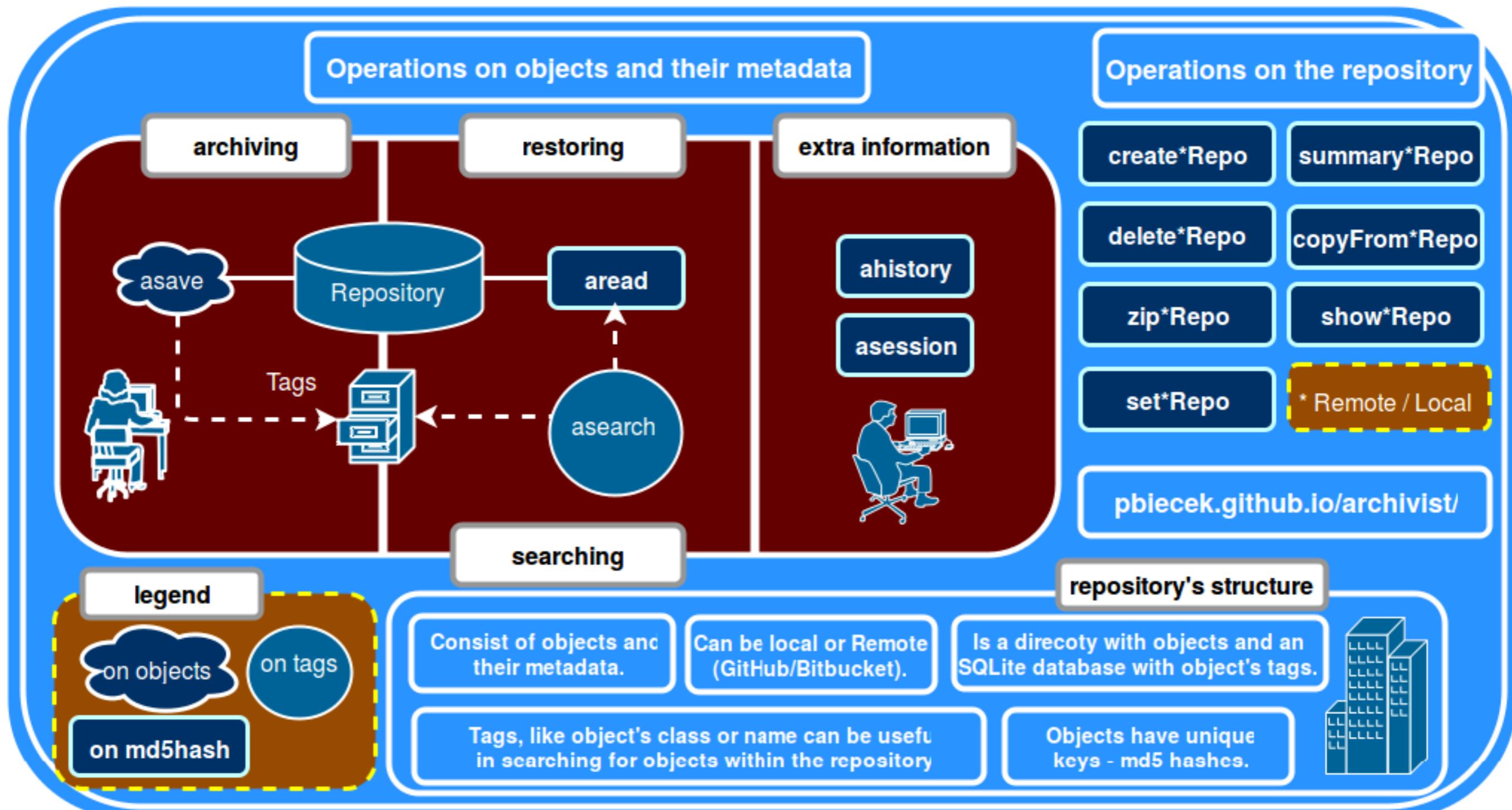
# Pakiet ggfortify

**Table 1:** Supported packages

| package            | supported types                        | package            | supported types   |
|--------------------|--|--------------------|---|
| <b>base</b>        | "matrix", "table"                      | <b>sp</b>          | "SpatialPoints",<br>"SpatialPolygons",<br>"Line", "Lines", "Polygon",<br>"Polygons", "SpatialLines",<br>"SpatialLinesDataFrame",<br>"SpatialPointsDataFrame",<br>"SpatialPolygonsDataFrame" |
| <b>cluster</b>     | "clara", "fanny", "pam"                | <b>stats</b>       | "HoltWinters", "lm",<br>"acf", "ar", "Arima",<br>"stepfun", "stl", "ts",<br>"cmdscale", "decomposed.ts",<br>"density", "factanal", "glm",<br>"kmeans", "princomp", "spec"                   |
| <b>changepoint</b> | "cpt"                                  | <b>survival</b>    | "survfit", "survfit.cox"  |
| <b>dlm</b>         | "dlmFilter", "dlmSmooth"               | <b>strucchange</b> | "breakpoints",<br>"breakpointsfull"   |
| <b>fGarch</b>      | "fGARCH"                               | <b>timeSeries</b>  | "timeSeries"  |
| <b>forecast</b>    | "bats", "forecast", "ets",<br>"nnetar" | <b>tseries</b>     | "irts"  |
| <b>fracdiff</b>    | "fracdiff"                             | <b>vars</b>        | "varprd"  |
| <b>glmnet</b>      | "cv.glmnet", "glmnet"                  | <b>xts</b>         | "xts"   |
| <b>KFAS</b>        | "KFS", "signal"                        | <b>zoo</b>         | "zooreg"  |
| <b>lfda</b>        | "lfda", "klfda", "self"                | <b>MASS</b>        | "isoMDS", "sammon"  |
| <b>maps</b>        | "map"                                  |                    |   |

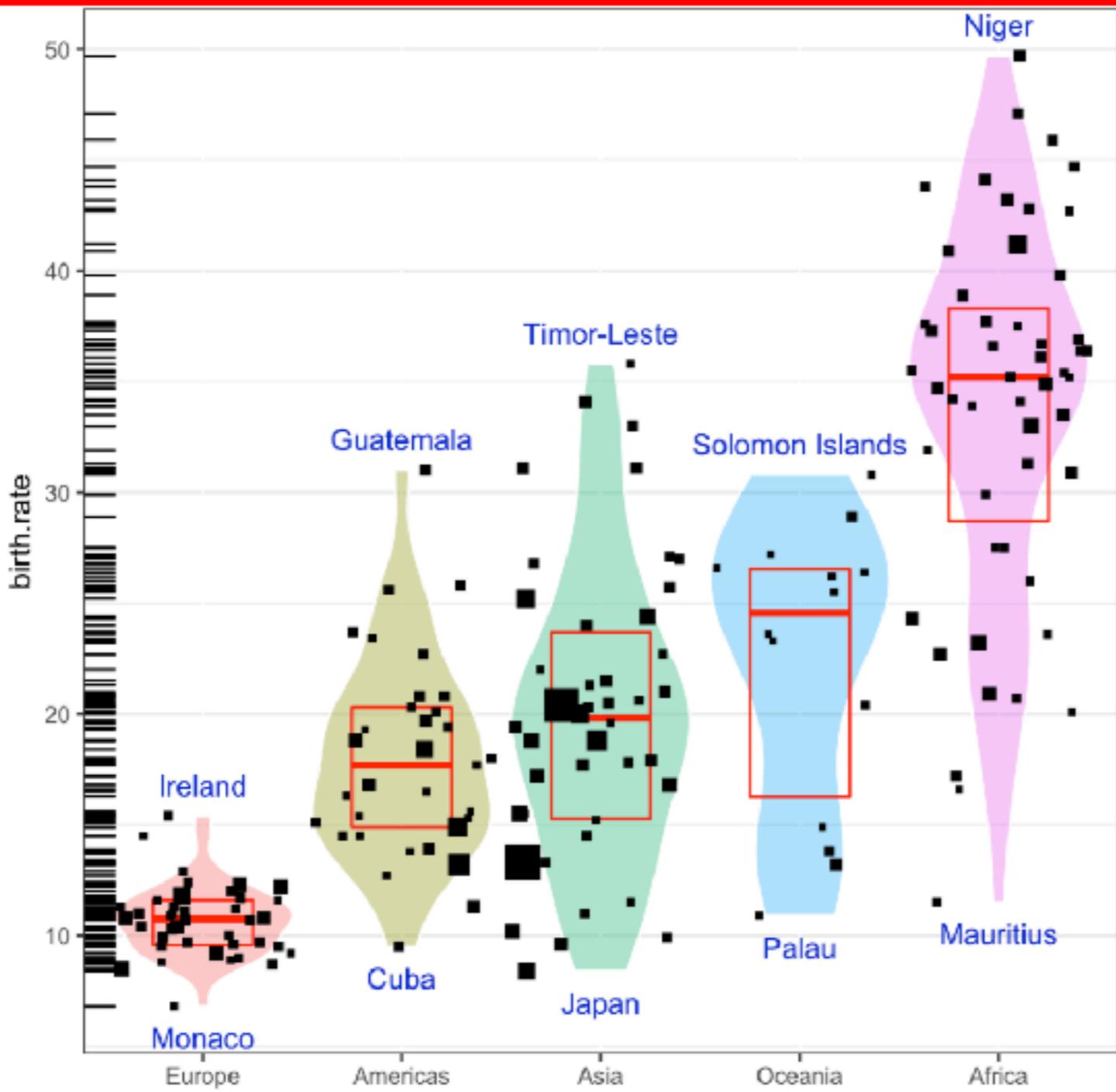
# Dostępność modeli

# archivist - reproducible and recordable research



```
ggplot(countries, aes(x=continent, y=birth.rate, label=country)) +  
  geom_violin(scale="width", aes(fill=continent), color="white", alpha=0.4) +  
  stat_summary(fun.data = "q3", geom = "crossbar",  
    colour = "red", width = 0.5) +  
  geom_jitter(aes(size=(population)^0.9), position=position_jitter(width = .45, height = 0),  
    shape=15) +  
  geom_rug(sides = "1") +  
  geom_text(data=countriesMin, vjust=2, color="blue3") +  
  geom_text(data=countriesMax, vjust=-1, color="blue3") +  
  theme_bw() + xlab("") + theme(legend.position="none", panel.grid.major.x = element_line(color="white"))
```

Load: archivist::aread('pbiecek/Eseje/arepo/ba7f58faf7373420e3ddce039558140')



# archivist - reproducible and recordable research

| [ write local ]       | [ read local ]          | [ read remote ]          | [ shortcuts ] |
|-----------------------|-------------------------|--------------------------|---------------|
| createLocalRepo(R)    |                         |                          |               |
| setLocalRepo(R)       | setLocalRepo(R)         | setRemoteRepo(R)         |               |
| saveToLocalRepo(A, R) |                         |                          | asave(A, R)   |
|                       | loadFromLocalRepo(H, R) | loadFromRemoteRepo(H, R) | aread(RH)     |
|                       | searchInLocalRepo(P, R) | searchInRemoteRepo(P, R) | asearch(RH)   |
| rmFromLocalRepo(A, R) |                         |                          |               |
|                       |                         |                          | asession(RH)  |
|                       |                         |                          | ahistory(RH)  |
|                       | summaryLocalRepo(R)     | summaryRemoteRepo(R)     |               |
|                       | showLocalRepo(R)        | showRemoteRepo(R)        |               |
| deleteLocalRepo(R)    |                         |                          |               |

A - artifact, any R object, like `data.frame`, `ggplot`, `Im`

H - md5hash, cryptographical hash of arbitrary R object

P - pattern, used to find artifacts with suitable tags

R - repository, a local repository is a folder, a remote repo is based on git or hg. Repository contains rda dumps, miniatures and data base with object's tags.

ELI5 is a Python library which allows to visualize and debug various Machine Learning models  
<http://eli5.readthedocs.io/en/latest/index.html>

Ideas on interpreting machine learning.  
Patrick Hall, Wen Phan, SriSatish Ambati (2017)  
<https://www.oreilly.com/ideas/ideas-on-interpreting-machine-learning>

Visualizing statistical models: Removing the blindfold.  
Hadley Wickham, Dianne Cook, Heike Hofmann (2015)  
Statistical Analysis and Data Mining  
<http://had.co.nz/stat645/model-vis.pdf>

 GitHub, Inc. [US] <https://github.com/MI2DataLab>



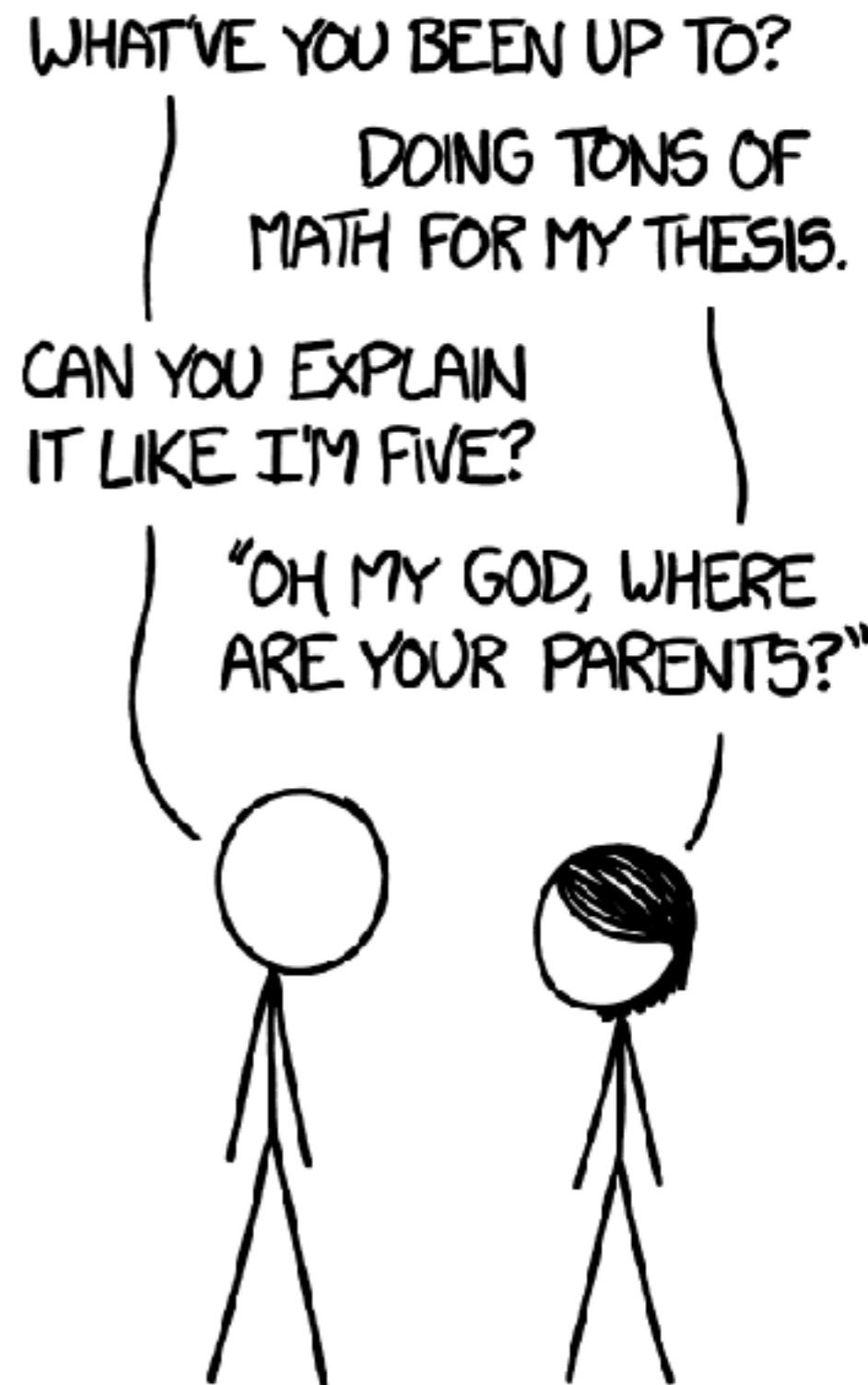
This organization

Search



MI<sup>2</sup> DataLab

 <http://mi2.mini.pw.edu.pl>



[https://imgs.xkcd.com/comics/like\\_im\\_five.png](https://imgs.xkcd.com/comics/like_im_five.png)