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An automated machine-learning pipeline for statistical matching

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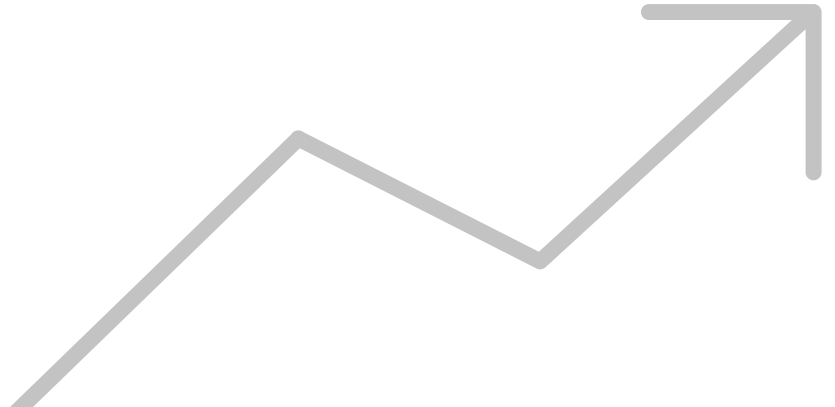

Statistical Matching? Pipeline?

Statistical Matching …

- is a technique to add variables to a data set that are initially only available in a second data source.
- allows to enrich data sets without the need for additional data collection.
- requires the estimation of a suitable model.

The statistical matching pipeline …

- enables automated and fast execution of statistical matching,
- while complying with methodological standards (e.g. nested resampling, standard hyperparameter search spaces).

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Methods and Technology

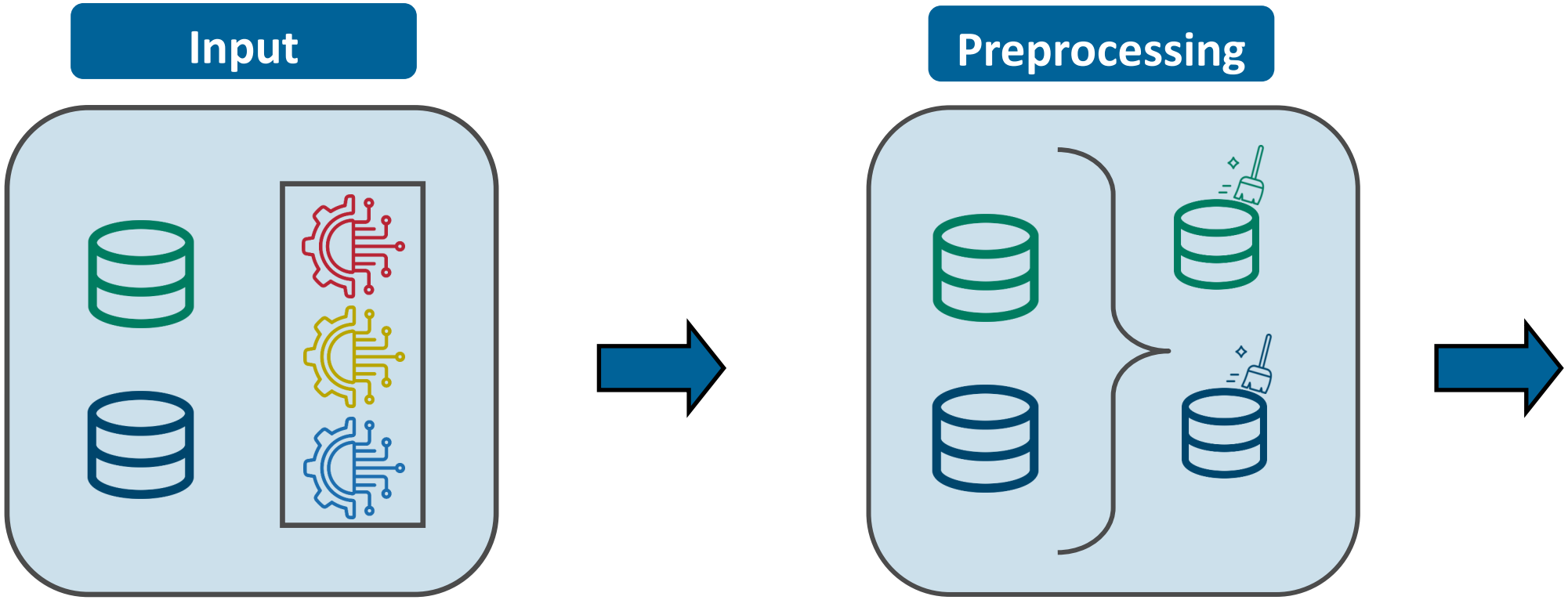
Implementation using mlr3 (Lang et al. 2019) to ensure a highly flexible pipeline

Implementation of standard hyperparameter search spaces (Becker 2023)

Selection of the best-fitting algorithm via nested resampling (Bischl et al. 2023; Simon 2007)

Icons: freepik.com / edited; Logos: r-project.org/logo, mlr3book.mlr-org.com, github.com/ropensci/targets, github.com/ropensci/tarchetypes, github.com/Rdatatable/data.table, github.com/tidyverse/ggplot2, github.com/tidyverse/tibble, github.com/tidyverse/dplyr, github.com/tidyverse/tidyr

The Statistical-Matching-Pipeline 1



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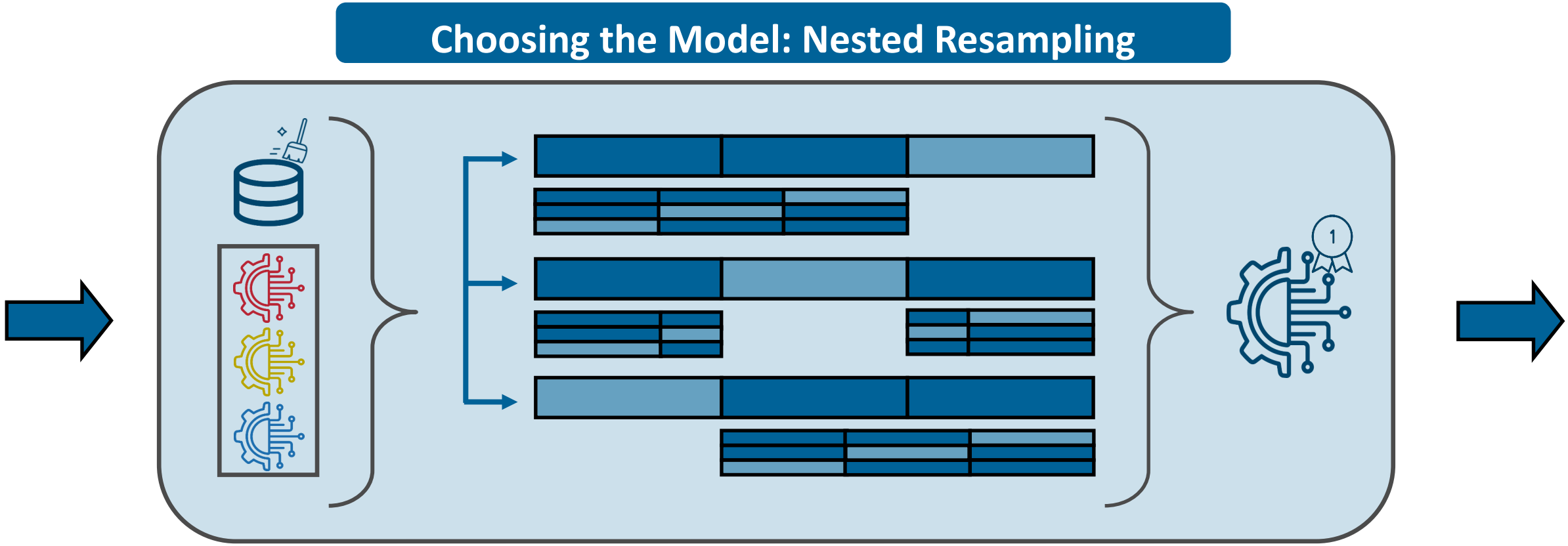
The Statistical-Matching-Pipeline 2



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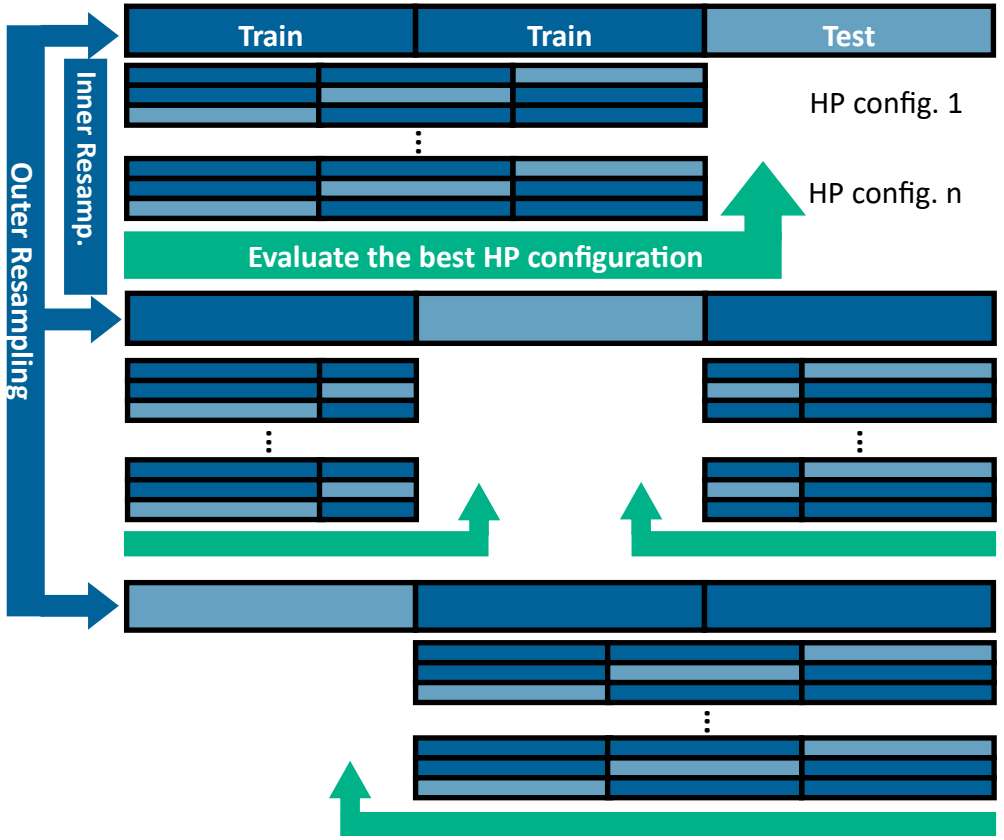
Zoom: Nested Resampling

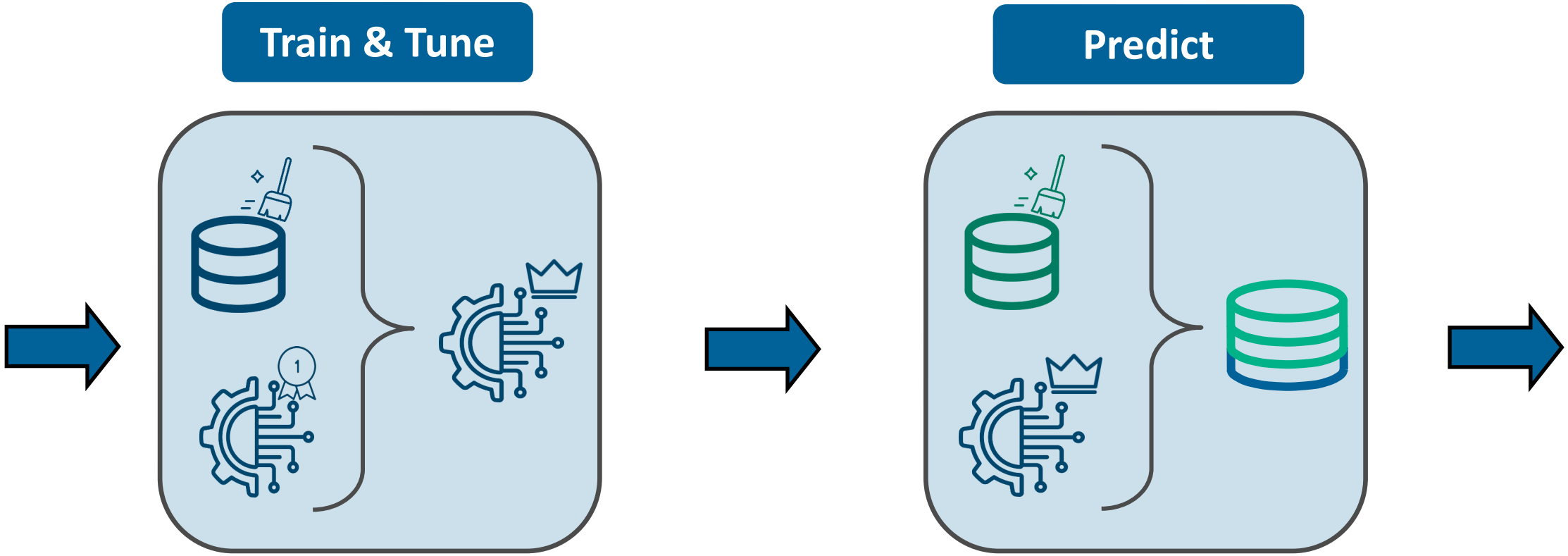
1. **Outer resampling: Split data in k folds**
2. **Inner resampling: Split outer training sets again in k folds**
3. **Optimize hyperparameters (HP) on each inner resampling (e.g. via grid search)**



4. **Evaluate each top HP-configuration with outer test set**
5. **Performance estimate: Average perfomance estimate on outer test sets**
6. **Repeat for each algorithm**

Figure after Bischl, B. et al (Eds.) (2024). "Applied Machine Learning Using mlr3 in R". CRC Press., Figure 4.5.
Bischl, B. et al. (2023). "Hyperparameter Optimization: Foundations, Algorithms, Best Practices, and Open Challenges". Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery, e1484.

The Statistical-Matching-Pipeline 3



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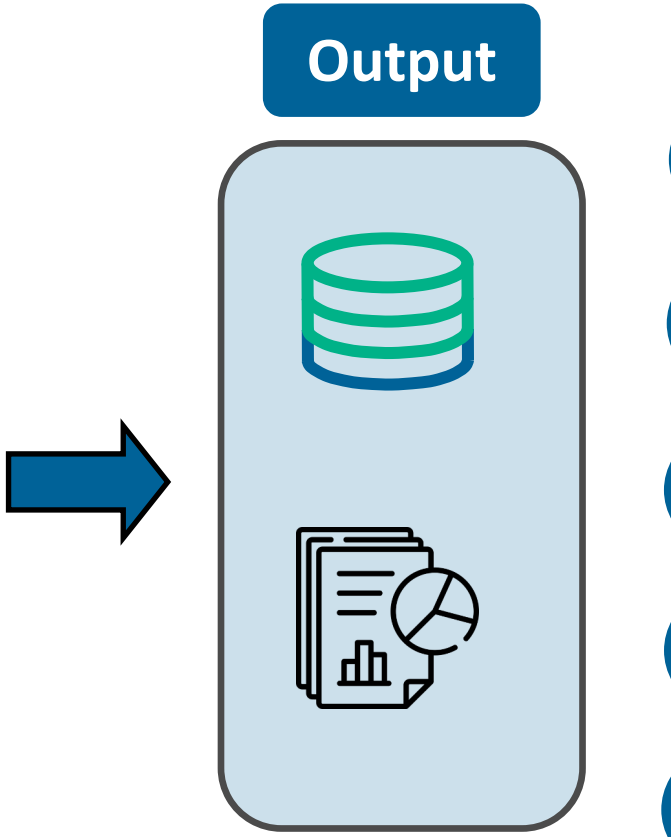
The Statistical-Matching-Pipeline 4



- Numbers of observations and variables, variable types, missings, correlations
- Comparisons: Differences in distributions, correlations
- Inner resampling: Hyperparameters and performance measures
- Outer resampling: performance measures
- Plot of relationship of interest

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Next Up:

- Additions to the report
- Testing … developping … testing …
- Move to an R-package

Appendix

Foundations and Advances of Machine Learning in Official Statistics

International Conference

- 3rd to 5th April, 2024 in Wiesbaden (Germany)
- Topics:
  - Mathematical and statistical questions surrounding the use of ML in official statistics
  - Practical experiences and pilot projects
  - Overarching questions (ethical, legal, technical, organizational)

Call and Info: www.destatis.de/ml-conference

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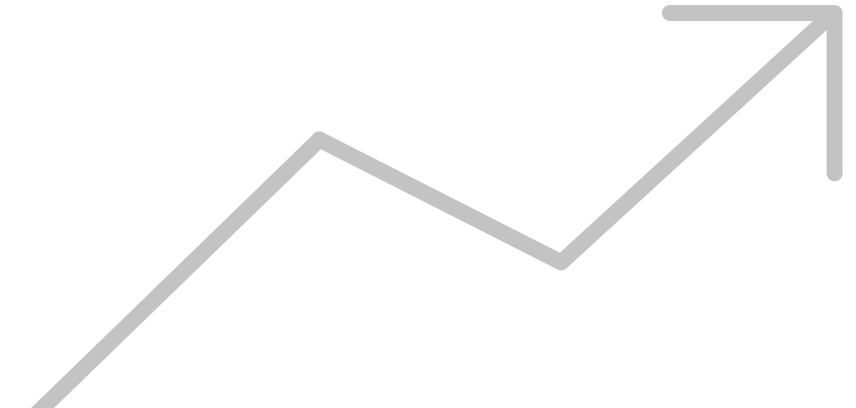

References

Becker, M. (2023). “mlr3tuningspaces: Search Spaces for 'mlr3'”. https://mlr3tuningspaces.mlr-org.com, https://github.com/mlr-org/mlr3tuningspaces.

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Simon, R. (2007). “Resampling Strategies for Model Assessment and Selection”. In Fundamentals of Data Mining in Genomics and Proteomics, edited by Werner Dubitzky, Martin Granzow, and Daniel Berrar, 173–86. Boston, MA: Springer US.