ESRA Conference 2019

Predictive Modeling and Machine Learning in Survey Research

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SHARE
SURVEY OF HEALTH, AGEING AND RETIREMENT IN EUROPE

UPDATE ON MACHINE LEARNING IN DATA ANALYSIS FOR SOCIAL RESEARCH

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ML tasks in substantive social research

Machine Learning Tasks

	Numerical outcome	Categorical outcome
Supervised outcome observed	**Regression task** • Predict the average fiancial wealth of migrants and non-migrants • Predict blood measures from dried blood spots	**Classification tasks** • Predict propensity scores to analyse the difference in health between migrants and non-migrants • Analyze the effect of education on old age poverty
Unsupervised outcome unobserved	**Factor analysis tasks** • Predict individual factor scores on the EURO-D scale • Predict movement intensity from accelerometry data	**Clustering tasks** • Find similar groups of labour market trajectories among SHARE individuals • Find typology of SHARE interviewers in order to identify suspicious clusters

Some algorithms/models

	Numerical outcome	Categorical outcome
Supervised outcome observed	**Regression tasks** • Ordinary Least Squares • Linear Models • Splines, Lasso, Ridge • Regression Trees, Random Forests • Support Vector Machines • k-Nearest-Neighbors • Neural Nets, „Deep learning“	**Classification tasks** • Generalized Linear Models (Logistic or probit, …) • Splines, Lasso, Ridge • Classification Trees, Random Forests • Support Vector Machines • k-Nearest-Neighbors • Neural Nets, „Deep learning“ • Naive bayes
Unsupervised outcome unobserved	**Factor analysis tasks** • Principal Components Analysis (PCA) • Exploratory Factor Analysis (EFA) • Confirmatory Factor Analysis (CFA)	**Clustering tasks** • Hierarchical clustering (k-Means, Linkage, Ward …) • Model based (Finite mixtures, …) • Latent Class Analysis (for ordinal outomes)

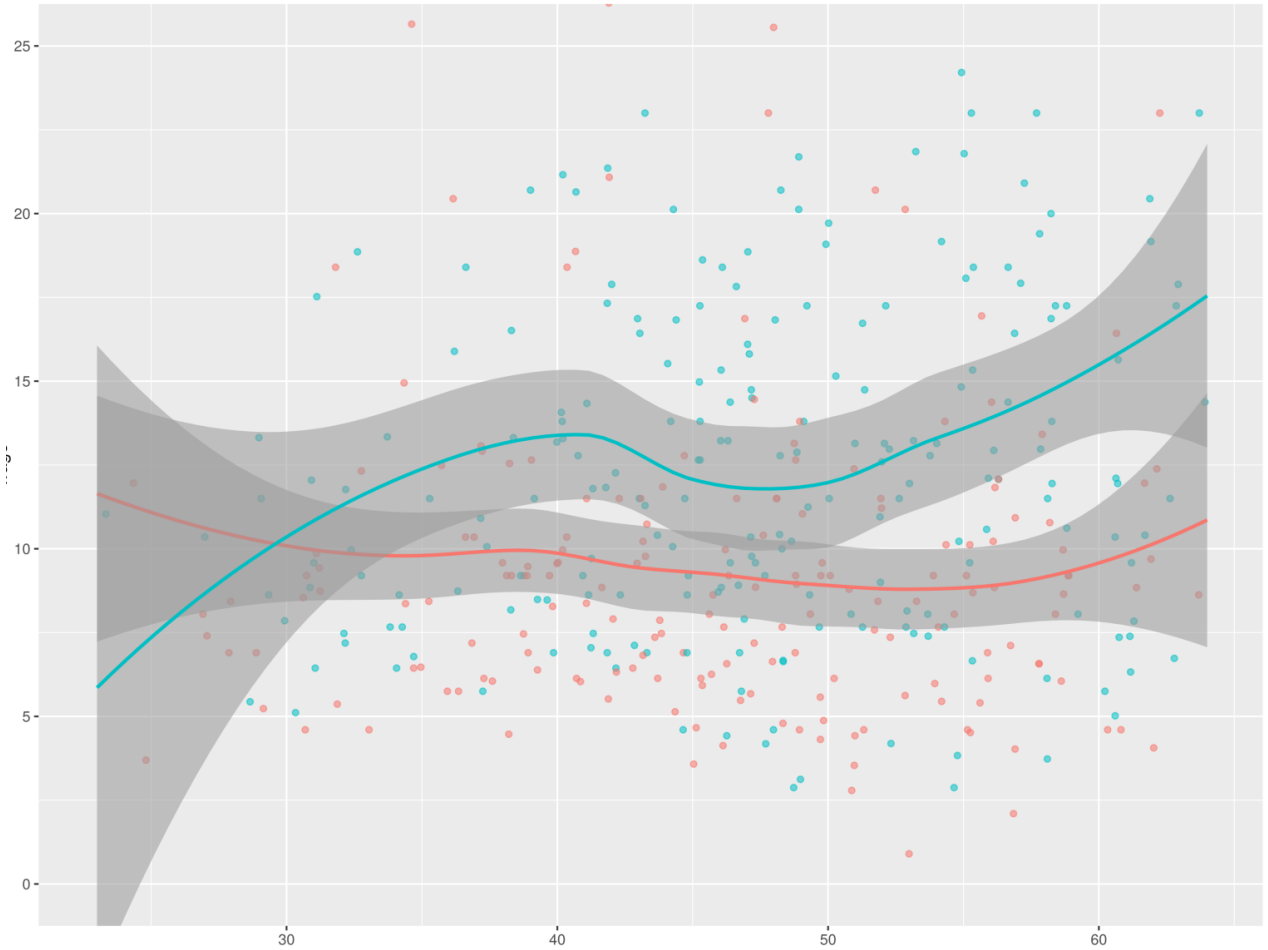
… among many others

Estimating effects as a regression tasks

- Estimate effect of variable on outcome
- Produce easily interpretable statistics
- Applicable to any (ML) model that yields individual predictions (i.e. model agnostic)

Regression tasks

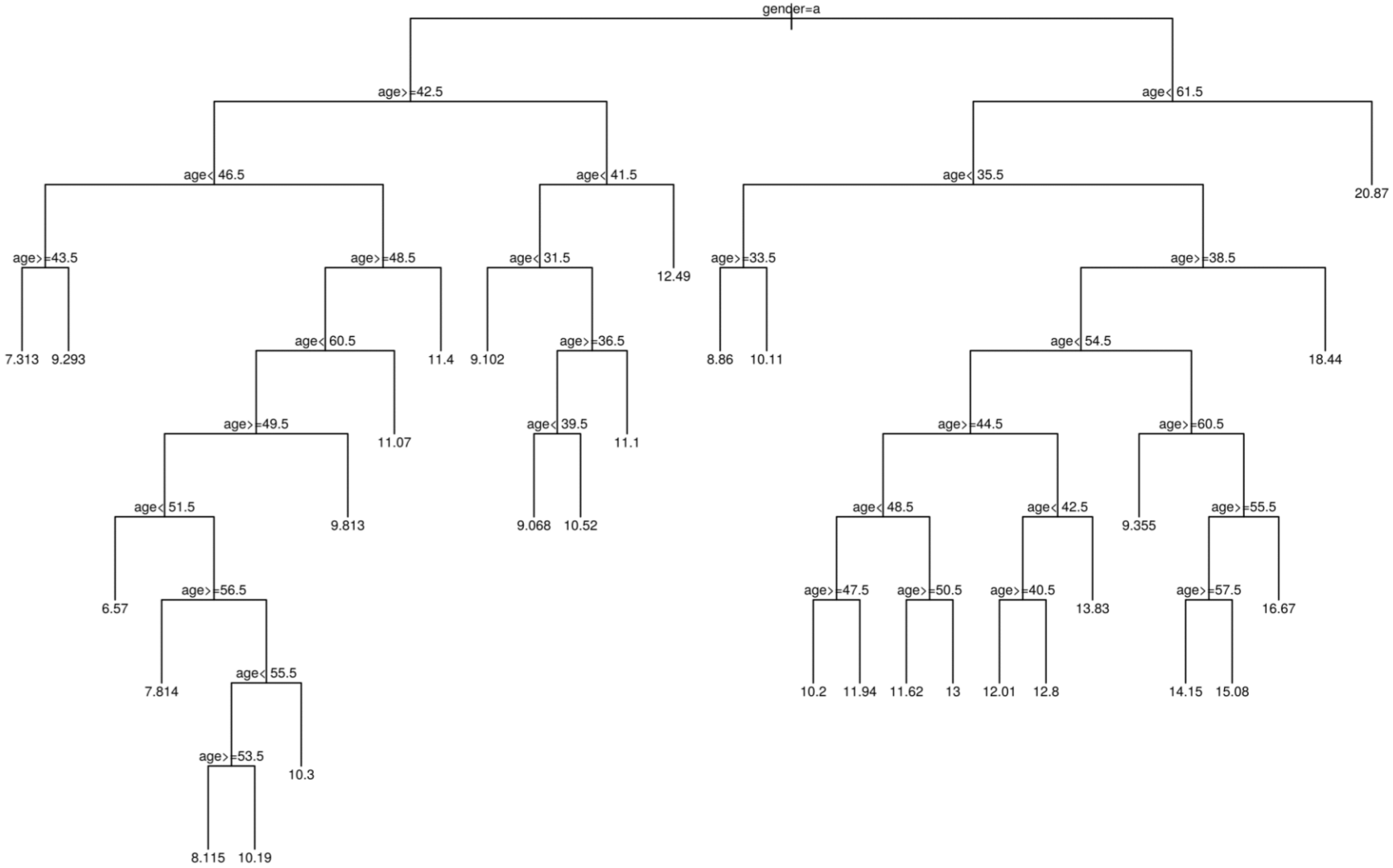
Example data



Hourly wage by gender and age (ISSP Germany 2012)

Regression tasks

Example learner/model: regression tree



Average marginal effects

1. Estimate (complex, multivariate) model
2. Set all cases in sample to first value for variable (e. g. gender = 0 “female”)
3. Predict response for all cases
4. Set all cases in sample to next value for variable (e. g. gender = 1 “male”)
5. Predict response for all cases – again
6. Calculate AME / APE as mean difference between two predictions for all cases

Average marginal effects

	Linear Model	Regression Tree
Gender (male vs. female)		
AME / APE	3.61 €	3.68 €
95 % CI Lower Bound	2.43 €	2.42 €
95 % CI Upper Bound	4.65 €	4.91 €
Age (per year)		
AME / APE	0.32 €	0.75 €
95 % CI Lower Bound	-0.05 €	0.09 €
95 % CI Upper Bound	0.66 €	1.32 €

Data: ISSP Germany 2012; CIs: bootstrap estimates

Recent and next steps

- **„ame“ R package (Average Marginal Effects)**

  Giuseppe Casalicchio (Comp. Statistics, LMU)

  https://github.com/compstat-lmu/ame

- Integrates with mlr – „Machine Learning in R“ – a very comprehensive ML framework

  Bernd Bischl et al. (*Comp. Statistics, LMU)*

  https://github.com/mlr-org/mlr

- (Still) Work in progress:

  Paper discussing approach and implementation (Beste, Bethmann & Casalicchio)

Pass by at our booth