The imputation of the "Attained Level of Education" in the base register of individuals: an experimentation using Machine Learning techniques

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Aim

Determine how and where Machine Learning techniques (ML) can give greater benefits in solving the imputation problems compared with classic statistical models.

Target variable: Attained Level of Education (ALE) for Italian resident population in 2018.

Data: The Base Register of Individuals (BRI) results from the integration of different sources (survey and administrative). A high amount of information on ALE is available, however, delay of information and coverage problems arise, hence micro data imputation/prediction is necessary.

Methods

Classic statistical model: Log-linear

Different imputation steps (due to the complexity of available information and different patterns).

A: $P(ALE_{18}| ALE_{17}, age_{18}, citiz_{18})$

B: $P(ALE_{18}| ALE_{17}, age_{18}, citiz_{18}, prov_{18}, gender)$

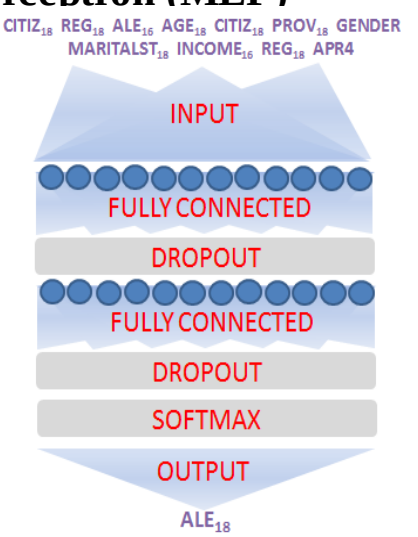
C: $P(ALE_{18}| age_{18}, gender, citiz_{18}, apr)$

ML technique: Multi Layer Perceptron (MLP)

One imputation step:

ALE_{17}, age_{18}, $citiz_{18}$, $prov_{18}$, gender, apr (no pre-treatment)

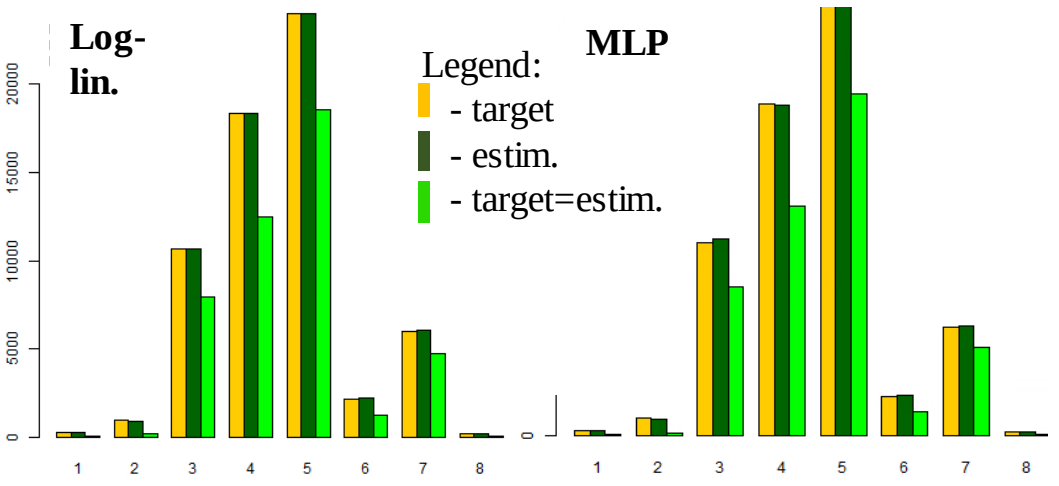
- Network composed by 2 hidden layer with 128 neurons fully connected.



The imputed value is a random value extracted from the probability distribution of correspondent pattern

Results

Graph 1: Comparison between target and estimated distributions



Graph 2: Estimated ALE distributions for individuals with a PhD (item 8)

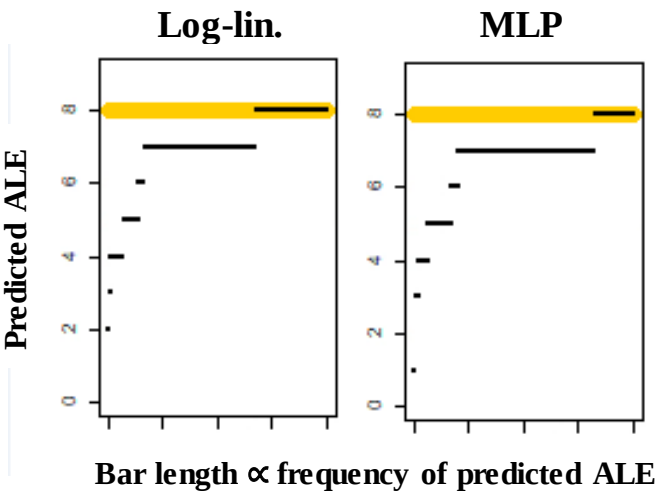


Table 1: Micro-level accuracy: Log-linear vs MLP

Fold	Target=estimated	
	Log-lin.	MLP
1	0,722	0,735
2	0,721	0,736
3	0,723	0,737
4	0,721	0,735
5	0,721	0,734
mean	**0,721**	**0,735**

Model accuracy is calculated using the 5-fold approach. Micro level accuracy of imputed ALE 2018 using ML technique is very similar to those originated from Log-Linear models: 73,5% vs 72,1% - variance of results is in both cases negligible.

Conclusions:

- The results of estimation with the two aproaches are completly comparable.
- For particular sub-population, such as extreme items (PhD – graph 2), Log-linear imputation is better.
- MLP approach dos not requires variable pre-treatment