stabm

Andrea Bommert

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Introduction

The `R` package **stabm** provides functionality for quantifying the similarity of two or more sets. The anticipated usecase is comparing sets of selected features, but other sets, e.g. gene list, can be analyzed as well. Quantifying the similarity of feature sets is necessary when assessing the feature selection stability. The stability of a feature selection algorithm is defined as the robustness of the set of selected features towards different data sets from the same data generating distribution (Kalousis, Prados, and Hilario 2007). Stability measures quantify the similarity of the sets of selected features for different training data sets. Many stability measures have been proposed in the literature, see for example Bommert, Rahnenführer, and Lang (2017), Bommert and Rahnenführer (2020), and Nogueira, Sechidis, and Brown (2018) for comparative studies. The `R` package **stabm** provides an implementation of many stability measures.

Usage

A list of all stability measures implemented in **stabm** is available with:

```
listStabilityMeasures()
```

```
##                            Name Corrected Adjusted Minimum Maximum
## 1                stabilityDavis     FALSE    FALSE       0       1
## 2                 stabilityDice     FALSE    FALSE       0       1
## 3              stabilityHamming     FALSE    FALSE       0       1
## 4   stabilityIntersectionCount      TRUE     TRUE    <NA>       1
## 5  stabilityIntersectionGreedy      TRUE     TRUE    <NA>       1
## 6     stabilityIntersectionMBM      TRUE     TRUE    <NA>       1
## 7    stabilityIntersectionMean      TRUE     TRUE    <NA>       1
## 8              stabilityJaccard     FALSE    FALSE       0       1
## 9                stabilityKappa      TRUE    FALSE      -1       1
## 10         stabilityLustgarten      TRUE    FALSE      -1       1
## 11           stabilityNogueira      TRUE    FALSE      -1       1
## 12         stabilityNovovicova     FALSE    FALSE       0       1
## 13             stabilityOchiai     FALSE    FALSE       0       1
## 14                stabilityPhi      TRUE    FALSE      -1       1
## 15           stabilitySechidis     FALSE     TRUE    <NA>      NA
## 16              stabilitySomol      TRUE    FALSE       0       1
## 17         stabilityUnadjusted      TRUE    FALSE      -1       1
## 18               stabilityWald      TRUE    FALSE     1-p       1
## 19                 stabilityYu      TRUE     TRUE    <NA>       1
## 20           stabilityZucknick     FALSE     TRUE       0       1
```

This list states the names of the stability measures and some information about them.

- Corrected: Does a measure fulfill the property *correction for chance* as defined in Nogueira, Sechidis, and Brown (2018)? This property indicates whether the expected value of the stability measure is independent of the number of selected features. Stability measures not fulfilling this property, usually attain the higher values, the more features are selected. For the measures that are not corrected for chance in their original definition, `stabm` provides the possibility to transform these measures, such that they are corrected for chance.
- Adjusted: Does a measure consider similarities between features when evaluating the feature selection stability? Adjusted measures have been created based on traditional stability measures by including an adjustment term that takes into account feature similarities, see Bommert and Rahnenführer (2020) for details.
- Minimum and Maximum: Bounds for the stability measures, useful for interpreting obtained stability values.

Now, let us consider an example with 3 sets of selected features

- $V_1 = \{X_1, X_2, X_3\}$
- $V_2 = \{X_1, X_2, X_3, X_4\}$
- $V_3 = \{X_1, X_2, X_3, X_5, X_6, X_7\}$

and a total number of 10 features. We can evaluate the feature selection stability with stability measures of our choice.

```
feats = list(1:3, 1:4, c(1:3, 5:7))
stabilityJaccard(features = feats)
```

```
## [1] 0.5595238
```

```
stabilityNogueira(features = feats, p = 10)
```

```
## [1] 0.4570136
```

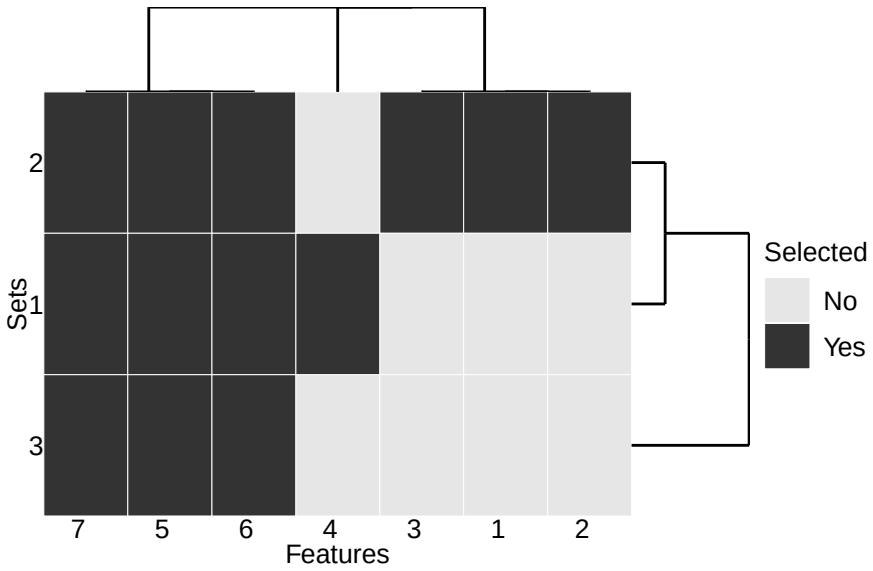
For adjusted stability measures, a matrix indicating the similarities between the features has to be specified.

```
mat = 0.92 ^ abs(outer(1:10, 1:10, "-"))
set.seed(1)
stabilityIntersectionCount(features = feats, sim.mat = mat, N = 1000)
```

```
## [1] 0.4138325
```

Finally, `stabm` also provides a visualization of the feature sets.

```
plotFeatures(feats)
```



References

Bommert, Andrea, and Jörg Rahnenführer. 2020. "Adjusted Measures for Feature Selection Stability for Data Sets with Similar Features." In *International Conference on Machine Learning, Optimization, and Data Science - LOD 2020, in Print*. https://arxiv.org/abs/2009.12075.

Bommert, Andrea, Jörg Rahnenführer, and Michel Lang. 2017. "A Multicriteria Approach to Find Predictive and Sparse Models with Stable Feature Selection for High-Dimensional Data." *Computational and Mathematical Methods in Medicine* 2017. https://doi.org/10.1155/2017/7907163.

Kalousis, Alexandros, Julien Prados, and Melanie Hilario. 2007. "Stability of Feature Selection Algorithms: A Study on High-Dimensional Spaces." *Knowledge and Information Systems* 12 (1): 95–116. https://doi.org/10.1007/s10115-006-0040-8.

Nogueira, Sarah, Konstantinos Sechidis, and Gavin Brown. 2018. "On the Stability of Feature Selection Algorithms." *Journal of Machine Learning Research* 18 (174): 1–54. http://jmlr.org/papers/v18/17-514.html.