ASSESSMENT OF LOCAL INFLUENCE FOR THE ANALYSIS OF AGREEMENT

FELIPE OSORIO AND CARLA LEAL

Description. Functions to perform estimation and local influence for Lin's (1989, 2000) concordance correlation coefficient and the probability of agreement

confint.ccc: Confidence intervals for the concordance correlation coefficient

Description.

It produces confidence intervals for the Lin's concordance correlation coefficient.

Usage.

```
confint.ccc(object, method = "z-transform", level = 0.95)
```

Argument.

`object` An object of class 'ccc' representing the estimation of the concordance correlation coefficient.
`method` a character string, indicating the method to be used. Options available are `"z-transform"` or `"asymp"`.
`level` the confidence level, must be a single number between 0 and 1.

Value.

It returns a matrix with the estimation, standard error and the lower and upper bounds for the CCC.

References.

Lin, L. (1989). A concordance correlation coefficient to evaluate reproducibility. *Biometrics* **45**, 255-268.

Lin, L. (2000). A note on the concordance correlation coefficient. *Biometrics* **56**, 324-325.

Examples.

```
  load("PSG.rda")
  fm <- fit.ccc(~ manual + automated, data = PSG)
  confint.ccc(fm, method = "asymp") # print asymptotic 95% CI
  # Output:
    parameter         SE     lower     upper
CCC 0.6744407 0.05626925 0.564155 0.7847264
```

confint.poa: Confidence intervals for the probability of agreement

Description.

It produces confidence intervals for the probability of agreement.

Usage.

```
confint.poa(object, level = 0.95, cad = 2)
```

Argument.

- `object` An object of class 'ccc' representing the estimation of the concordance correlation coefficient.
- `level` the confidence level, must be a single number between 0 and 1.
- `cad` clinically acceptable difference (CAD), defined as $CAD = (-c, c)$. By default, $CAD = (-2, 2)$.

Value.

It returns a vector with the estimation, standard error and the lower and upper bounds for the probability of agreement.

References.

Stevens, N.T., Steiner, S.H., MacKay, R.J. (2017). Assessing agreement between two measurement systems: An alternative to the limits of agreement approach. *Statistical Methods in Medical Research* **26**, 2487-2504.

Leal, C., Galea, M., Osorio, F. (2019). Assessment of local influence for the analysis of agreement. *Biometrical Journal.* doi: 10.1002/bimj.201800124

Examples.

```
load("PSG.rda")
fm <- fit.ccc(~ manual + automated, data = PSG)
confint.poa(fm, cad = 2) # print asymptotic 95% CI
# Output:
    parameter          SE     lower     upper
PoA 0.9753448 0.03410157 0.908507 1.042183
```

derivatives.ccc: Derivatives of the concordance correlation coefficient

Description.

Computes first- and second-order derivatives of CCC objective function, which is used as an influence function.

Note: this function is not pretended to be used directly by the user.

Usage.

```
derivatives.ccc(object, which = 1:2)
```

Argument.

- `object` an object of class ‘`ccc`’ representing the estimation of the concordance correlation coefficient.
- `which` integer vector, order of the required derivatives.

Value.

Funtion ‘`derivatives.ccc`’ returns first and/or second derivatives of the CCC objective function with respect to the *perturbation* parameter.

References.

Leal, C., Galea, M., Osorio, F. (2019). Assessment of local influence for the analysis of agreement. *Biometrical Journal*. doi: 10.1002/bimj.201800124

`derivatives.poa`: Derivatives of the probability of agreement

Description.

Computes first- and second-order derivatives of probability of agreement objective function, which is used as an influence function.

Note: this function is not pretended to be used directly by the user.

Usage.

```
derivatives.poa(object, cad = 2, which =  1:2)
```

Argument.

- `object` an object of class ‘`ccc`’ representing the estimation of the concordance correlation coefficient.
- `cad` clinically acceptable difference (CAD), defined as $CAD = (-c, c)$. By default, $CAD = (-2, 2)$.
- `which` integer vector, order of the required derivatives.

Value.

Funtion ‘`derivatives.poa`’ returns first and/or second derivatives of the probability of agreement objective function with respect to the *perturbation* parameter.

References.

Leal, C., Galea, M., Osorio, F. (2019). Assessment of local influence for the analysis of agreement. *Biometrical Journal*. doi: 10.1002/bimj.201800124

`fit.ccc`: Lin's concordance correlation coefficient

Description.

Calculates Lin's (1989, 2000) concordance correlation coefficient for evaluationg the degree of agreement between measurements generated by two different methods.

Usage.

```
fit.ccc(x, data, subset, na.action)
```

Argument.

- `x` a formula or a numeric matrix or an object that can be coerced to a numeric matrix.
- `data` an optional data frame (or similar: see `model.frame`), used only if `x` is a formula. By default the variables are taken from `environment(formula)`.
- `subset` an optional expression indicating the subset of the rows of data that should be used in the fitting process.
- `na.action` a function that indicates what should happen when the data contain `NA`s.

Value.

A list with class `'ccc'` containing the following components:

- `call` a list containing an image of the `fit.ccc` call that produced the object.
- `x` `data.frame` used in the estimation process.
- `xbar` estimate of the mean vector.
- `S` estimate of the covariance matrix.
- `ccc` estimate of the concordance correlation coefficient.
- `var.ccc` asymptotic variance of the concordance correlation coefficient estimate.
- `accuracy` estimate of the accuracy coefficient.
- `precision` estimate of the precision coefficient.

References.

Lin, L. (1989). A concordance correlation coefficient to evaluate reproducibility. *Biometrics* **45**, 255-268.

Lin, L. (2000). A note on the concordance correlation coefficient. *Biometrics* **56**, 324-325.

Examples.

```
load("PSG.rda")
fm <- fit.ccc(~ manual + automated, data = PSG)
fm
# Output:
Call:
fit.ccc(x = ~manual + automated, data = PSG)

Coefficients:
  estimate  variance  accuracy precision
   0.6744    0.0032    0.9430    0.7152
```

`INFLUENCE.CCC`: LOCAL INFLUENCE FOR THE CONCORDANCE CORRELATION COEFFICIENT

Description.

Computes influence measures for the concordance correlation coefficient.

Usage.

```
influence.ccc(object, method = "FI")
```

Argument.

- `object` an object of class ‘`ccc`’ representing the estimation of the concordance correlation coefficient.
- `method` character string specifying the ‘`method`’ to use. The default method is first order influence `"FI"` measure. Other possible values are `"SI"`, `"normal"` and `"conformal"` for second order influence measure, normal and conformal curvatures, respectively.

Value.

A list with class `'influence.ccc'` containing the following components:

- `hmax` direction of maximum local slope (`"FI"`) or largest curvature (`"SI", "normal"` or `"conformal"`).
- `vectors` (generalized) eigenvectors associated with the non-null (generalized) eigenvalues of the (relative) curvature matrix (only present if `method !="FI"`).
- `gradient` gradient of CCC objective function (only present if `method = "FI"`).

References.

Leal, C., Galea, M., Osorio, F. (2019). Assessment of local influence for the analysis of agreement. *Biometrical Journal.* doi: 10.1002/bimj.201800124

Examples.

```
load("PSG.rda")
fm <- fit.ccc(~ manual + automated, data = PSG)
z  <- influence.ccc(fm, method = "FI")
z
## Output:
Call:
influence.ccc(object = fm)

Cutoff: 0.2481488
Influential observations:
[1]  1 30 79

## index plot of maximum local slope
plot(z, idn = 3)
```

influence.poa: LOCAL INFLUENCE FOR THE PROBABILITY OF AGREEMENT

Description.

Computes influence measures for the probability of agreement.

Usage.

```
influence.poa(object, cad = 2, method = "FI")
```

Argument.

- `object` an object of class ‘`ccc`’.
- `cad` clinically acceptable difference (CAD), defined as $CAD = (-c, c)$. By default, $CAD = (-2, 2)$.
- `method` character string specifying the ‘`method`’ to use. The default method is first order influence `"FI"` measure. Other possible values are `"SI"`, `"normal"` and `"conformal"` for second order influence measure, normal and conformal curvatures, respectively.

Value.

A list with class `'influence.poa'` containing the following components:

- `hmax` direction of maximum local slope (`"FI"`) or largest curvature (`"SI", "normal"` or `"conformal"`).
- `vectors` (generalized) eigenvectors associated with the non-null (generalized) eigenvalues of the (relative) curvature matrix (only present if `method !="FI"`).
- `gradient` gradient of probability of agreement objective function (only present if `method = "FI"`).

References.

Leal, C., Galea, M., Osorio, F. (2019). Assessment of local influence for the analysis of agreement. *Biometrical Journal*. doi: 10.1002/bimj.201800124

Examples.

```
load("PSG.rda")
fm <- fit.ccc(~ manual + automated, data = PSG)
z  <- influence.poa(fm, method = "FI")
## index plot of maximum local slope
plot(z, idn = 3)
```

PSG: CLINICAL TRIAL ON TRANSIENT SLEEP DISORDER

Description.

Data from a clinical study to comparing automated and semi-automated scoring of Polysomnographic (PSG) recordings used to diagnose transient sleep disorder. The study considered 82 patients who were given a sleep inducing drug (Zolpidem 10 mg). Measurements of latency to persistent sleep (LPS: lights out to the beginning of 10 consecutive minutes of uninterrupted sleep) were obtained using six different methods.

Usage.

```
load("PSG.rda")
```

Format.

A data frame with 82 observations on the following 3 variables.

`manual` full manual scoring
`automated` automated scoring by Morpheus software.
`partial` automated scoring by Morpheus with partial manual review.

References.

Feng, D., Baumgartner, R., Svetnik, V. (2015). A robust bayesian estimate of the concordance correlation coefficient. *Journal of Biopharmaceutical Statistics* **25**, 490-507.

Svetnik, V., Ma, J., Soper, K.A., Doran, S., Renger, J.J., Deacon, S., Koblan, K.S. (2007). Evaluation of automated and semi-automated scoring of polysomnographic recordings from a clinical trial using zolpidem in the treatment of insomnia. *SLEEP* **30**, 1562-1574.

Lin, L. (2000). A note on the concordance correlation coefficient. *Biometrics* **56**, 324-325.

Departamento de Matemática, Universidad Técnica Federico Santa María, Chile

Current address: Departamento de Matemática, Universidad Técnica Federico Santa María, Av. España 1680, Casilla 110-V, Valparaíso, Chile

Orcid ID: https://orcid.org/0000-0002-4675-5201

E-mail address: felipe.osorios@usm.cl

Centro Regional de Inclusión e Innovación Social, Universidad Viña del Mar

Current address: Centro Regional de Inclusión e Innovación Social, Universidad Viña del Mar, Diego Portales 90, Viña del Mar, Chile

Orcid ID: https://orcid.org/0000-0003-1739-3456

E-mail address: cleal@uvm.cl