There are four R-scripts that one can use to run a simulation

1. Simulation\_setting\_model\_MCG.R
2. Simulation\_setting\_model\_MCG\_cTAU.R
3. Simulation\_setting\_model\_MCG\_contCCM.R
4. Simulation\_setting\_model\_MCG\_contCCM\_cTAU.R

Each of these simulation scripts can be run starting from an empty environment, since it sources other R-scripts that are needed. Before running the simulation script one has first to create particular subfolders as described in the simulation script. In this way the results of the simulation are stored in .Rdata files in the subfolders. In each simulation script the user can specify the contamination scenarios for which to run a simulation.

The first R-script runs a simulation according to the model in Mason, Cantoni and Ghisletta (2021) for the MLE, S- and MM-estimators.

The second R-script runs a simulation according to the model in Mason, Cantoni and Ghisletta (2021) for the MLE, S, MM, and the cTAU estimators from Agostinelli and Yohai (2016).

The third R-script runs a simulation according to the model in Mason, Cantoni and Ghisletta (2021) for the MLE, S- and MM-estimators, but uses the central contamination model (CCM) to generate the contamination.

The fourth R-script runs a simulation according to the model in Mason, Cantoni and Ghisletta (2021) for the MLE, S, MM, and the cTAU estimators from Agostinelli and Yohai (2016), but uses the central contamination model (CCM) to generate the contamination.

The reason to have separate scripts including the cTAU estimator is that the computation of these estimators with varComprob are very slow.

* asympt\_norm\_constants.R

This script computes the constants involved in the limiting covariances of the S-estimators. See, e.g., Theorem 3 in Rousseeuw & Yohai (1984), Corollary 5.1 in Lopuhaä (1989), or Corollary 9.2 in Lopuhaä, Gares & Ruiz-Gazen (2023).

Expectations are exact and are computed by means of the Gamma-function.

* biweight\_functions.R

This script defines the biweight and the translated biweight rho functions and their derivatives needed in solving the fixed point equations.

* function\_data\_gen\_MCG.R

This script contains the code for the function data\_gen\_MCG. This function generates a datasets according to the model in Mason, Cantoni & Ghisletta (2021) with contamination generated according to the ICM (independent contamination model or cellwise contamination) in the measurement error and according to CCM (central contamination model) in the random effects. In addition, the function also generates contamination in the design matrix of the fixed effects according to ICM.

For each generated dataset the function also computes the MLE, S and MM estimates with the function Roblme and saves the estimates, the estimated asymptotic variances, and the number of outliers in a list MLESMM

* function\_data\_gen\_MCG\_contCCM.R

This script contains the code for the function data\_gen\_MCG\_contCCM. This function generates datasets according to the model in Mason, Cantoni & Ghisletta (2021) with contamination generated according to the CCM (central contamination model) in the random effects, in the measurement error, and in the design matrix of the fixed effects.

For each generated dataset the function also computes the MLE, S and MM estimates with the function Roblme and the estimates, the estimated asymptotic variances, and the number of outliers in a list MLESMM

* function\_MLESMM\_estimates\_MCG.R

This script contains the code for the function MLESMM\_estimates\_MCG. This function generates datasets according to the model in Mason, Cantoni & Ghisletta (2021) with contamination generated according to the ICM (independent contamination model or cellwise contamination) in the measurement error and according to CCM (central contamination model) in the random effects. In addition, the function also generates contamination in the design matrix of the fixed effects according to ICM.

For each generated dataset the function also computes the MLE, S and MM estimates with the function Robmle and saves the estimates, the estimated asymptotic variances and the number of outliers in a list MLESMM

* function\_MLESMM\_estimates\_MCG\_contCCM.R

This script contains the code for the function MLESMM\_estimates\_MCG\_contCCM. This function generates datasets according to the model in Mason, Cantoni & Ghisletta (2021) with contamination generated according to the CCM (central contamination model) in the random effects, in the measurement error, and in the design matrix of the fixed effects.

For each generated dataset the function also computes the MLE, S and MM estimates with the function Roblme and saves the estimates, the estimated asymptotic variances and the number of outliers in a list MLESMM

* function\_MLESMMcTAU\_estimates\_MCG.R

This script contains the code for the function MLESMMcTAU\_estimates\_MCG. This function generates datasets according to the model in Mason, Cantoni & Ghisletta (2021) with contamination generated according to the ICM (independent contamination model or cellwise contamination) in the measurement error and according to CCM (central contamination model) in the random effects. In addition, the function also generates contamination in the design matrix of the fixed effects according to ICM.

For each generated dataset the function also computes the MLE, S, MM, and cTAU estimates with the function Roblme and varComprob and saves the estimates, the estimated asymptotic variances and the number of outliers in a list MLESMMcTAU

* function\_MLESMMcTAU\_estimates\_MCG\_contCCM.R

This script contains the code for the function MLESMMcTAU\_estimates\_MCG\_contCCM. This function generates datasets according to the model in Mason, Cantoni & Ghisletta (2021) with contamination generated according to the CCM (central contamination model) in the random effects, in the measurement error, and in the design matrix of the fixed effects.

For each generated dataset the function also computes the MLE, S and MM estimates with the function Roblme and saves the estimates, the estimated asymptotic variances and the number of outliers in a list MLESMMcTAU\_CCM

* Robust\_lme.R

This script contains the code for the function Roblme. This function computes the MLE, the S- and MM-estimates for a single dataset, such as the ones in the output of the function data\_gen\_MCG\_contCCM.

* Simulation\_setting\_model\_MCG.R

This script prepares the setting for the simulation for the MLE, S and MM estimators with ICM contamination. It sources the required R-scripts. The user first specifies the contamination scenarios. The script runs the simulation for these scenarios using the functions MLESMM\_estimates\_MCG and data\_gen\_MCG. After the simulation for a scenario has been completed this script saves the results in .RData files containing a list MLESMM.

The .Rdata files are stored in designated subfolders. **BEFORE** running this script, first create subfolders

- Results\_Uncontaminated

- Results\_Epsilon\_contamination

- Results\_Random\_Effect\_contamination

- Results\_X\_contamination

* Simulation\_setting\_model\_MCG\_contCCM

This script prepares the setting for the simulation for the MLE, S and MM estimators with CCM contamination. It sources the required R-scripts. The user first specifies the contamination scenarios. The script runs the simulation for these scenarios using the function MLESMM\_estimates\_MCG\_contCCM and data\_gen\_MCG\_contCCM. After the simulation for a scenario had been completed this script saves the results in .RData files containing a list MLESMM\_CCM.

The .Rdata files are stored in designated subfolders. **BEFORE** running this script, first create subfolders

- Results\_Epsilon\_contamination/EpsilonCCM

- Results\_Random\_Effect\_contamination/RandomEffectCCM

- Results\_X\_contamination/XCCM

* Simulation\_setting\_model\_MCG\_cTAU.R

This script prepares the setting for the simulation for the MLE, S, MM and cTAU estimators with ICM contamination. It sources the required R-scripts. The user first specifies the contamination scenarios. The script runs the simulation for these scenarios using the functions MLESMM\_estimates\_MCG\_cTAU and data\_gen\_MCG\_cTAU. After the simulation for a scenario has been completed this script saves the results in .RData files containing a list MLESMMcTAU.

The .Rdata files are stored in designated subfolders. **BEFORE** running this script, first create subfolders

- Results\_Uncontaminated

- Results\_Epsilon\_contamination

- Results\_Random\_Effect\_contamination

- Results\_X\_contamination

* Simulation\_setting\_model\_MCG\_contCCM\_cTAU

This script prepares the setting for the simulation for the MLE, S, MM and cTAU estimators with CCM contamination. It sources the required R-scripts. The user first specifies the contamination scenarios. The script runs the simulation for these scenarios using the function MLESMMcTAU\_estimates\_MCG\_contCCM and data\_gen\_MCG. After the simulation for a scenario had been completed this script saves the results in .RData files containing a list MLESMMcTAU\_CCM.

The .Rdata files are stored in designated subfolders. **BEFORE** running this script, first create subfolders

- Results\_Epsilon\_contamination/EpsilonCCM

- Results\_Random\_Effect\_contamination/RandomEffectCCM

- Results\_X\_contamination/XCCM

boxplot\_epsilon\_contamination

ConfInterval\_CP\_epsilon\_contamination

ConfRegion\_CP\_epsilon\_contamination

Comparison\_Avar\_nrep=10000