**Information content analysis reveals desirable aspects of in vivo experiments of a synthetic circuit**

Here the scripts used to generate, analyse and visualise the data presented in the paper are made available.

Using the scripts requires the RStan Package, available at the link:

<https://cran.r-project.org/web/packages/rstan/index.html>

The data is organised in the following subfolders:

* Inference
  + ODE\_Model.stan, stan statistical model script used to perform Bayesian Inference of the experimental data from [1].
  + MultiExtractExp.R, script designed to access the experimental data and experimental schemes from [1] contained in the Data/ ExperimentalDataLugagneCSV folder to generate an appropriate list of the objects to be passed to the stan model to perform the inference.
  + masterRun.R, script to perform inference through RStan using the designed model ODE\_Model.stan and the list of data extracted from MultiExtractExp.R. The script allows to perform inference on single datasets in series or a multiexperimental inference at once.
  + masterRunOptim.R, script designed as the masterRun.R script but including an initial optimisation process for the initial guess on the 4 chains of the inference.
* PriorDefinition
  + ExtractingInitialPriorsLugagneLog.mat, matlab script to compute the mean and standard deviation of our priors (10 lognormal and 4 normal distributions) based on the results of the fit obtained in [1].
* InformationContent
  + VarCovarMatrix.R, function that extracts the all the post-burnin samples from a list of selected stanfit objects and computes the covariance matrix for the parameter samples, saving the determinant of the matrices of interest in a CSV file.
  + RelativeEntropyFunction.R, function used to approximate the joint posterior from the resultant samples of a stanfit object using Gaussian Mixtures and compute prior and approximate posterior entropy as presented in [2]. The function saves the Gaussian Mixture results as RDS objects and the summary of the entropies as a CSV file.
  + runRelativeEntropy.R, script to run RelativeEntropyFunction.R for a set of stanfit object results selected in series.
  + ReparamGaussMixt.R, script to compute the approximation by Gaussian Mixtures of the unparameterised samples from a stanfit object saving the results as a RDS file for analysis of the error in the approximation.
  + GaussMixtApproximCompPrior.R, script used to compute the approximation by Gaussian Mixtures of the unparameterised generated samples from the joint priors (10 lognormal, 4 normal priors) saving the results as a RDS file and generation of kernel density plots comparing the approximation for the marginal posteriors to the samples used for the clustering.
  + GaussMixtApproximComp.R, script used to visually analyse the results from ReparamGaussMixt.R or RelativeEntropyFunction.R by generation of kernel density plots comparing the Gaussian Mixture approximation for the marginal posteriors to the samples used for the clustering.
* Predictions&Analysis
  + CalculationRatiosSpeciesCloseZero.R, script used to assess the effect of the addition of 1e-7 into 0 input values for the inducers to avoid numerical issues in the simulations.
  + ODE\_Model\_Function.stan, stan script containing the ODE system studied and the implementation of the event based representation in order to be able to simulate the system for a determined input profile as used in the inference.
  + PostPredCheckSimul.R, function to simulate the ODE for a determined experimental profile selected using all the MCMC samples from a stanfit object result selected and save the results in CSV format.
  + ConfidenceIntervalsParam.R, function to generate a plot for each parameter of the model with the 95% confidence interval from the MCMC samples for a set of stanfit objects selected.
  + ConfidenceIntervalPlotsFunction.R, function to extract all the MCMC samples from a stanfit object and simulate a determined experimental profile, obtaining the 95% confidence interval and saving the plot of the simulation for checks.
  + AccuracyPredictions.R, Functions to compute the nRMSE distributions from the PostPredCheckSimul.R function and compute the Bhattacharyya distance between pairs nRMSEii and nRMSEij saving the results as a CSV matrix.
  + SampleExtract.R, Function to extract all the MCMC samples from a stanfit object result for a specific parameter indicated, saving the results in CSV files.
* Sensitivity
  + SensitivityAnalyses, PDF document specifying where to locate the sensitivity index calculation function.
  + SenseFileConv.R, function to convert the desired CSV prediction files obtained from PostPredCheckSimul.R and the MCMC samples from the associated simulation into compatible .mat files to be used by the function described in SensitivityAnalyses.
  + SensitivitiesSingle.mat, script to run the sensitivity index calculation for our set of MCMC samples and predictions extracted from SenseFileConv.R.
* Images

References:

[1] Jean-Baptiste Lugagne, Sebastián Sosa Carrillo, Melanie Kirch, Agnes Köhler, Gregory Batt & Pascal Hersen, 2017. Balancing a genetic toggle switch by real-time feedback control and periodic forcing. Nature Communications, 8 (1671), pp. 1-7.

[2] Huber, M. F., Bailey, T., Durrant-whyte, H. & Hanebeck, U. D., 2008. On Entropy Approxilllation for Gaussian Mixture Randolll Vectors. *2008 IEEE Int. Conf. Multisens. Fusion Integr. Intell. Syst.* pp. 181–188.