15 Oct 2020
Guy Berger
Bar-Ilan University
Mathematics Department

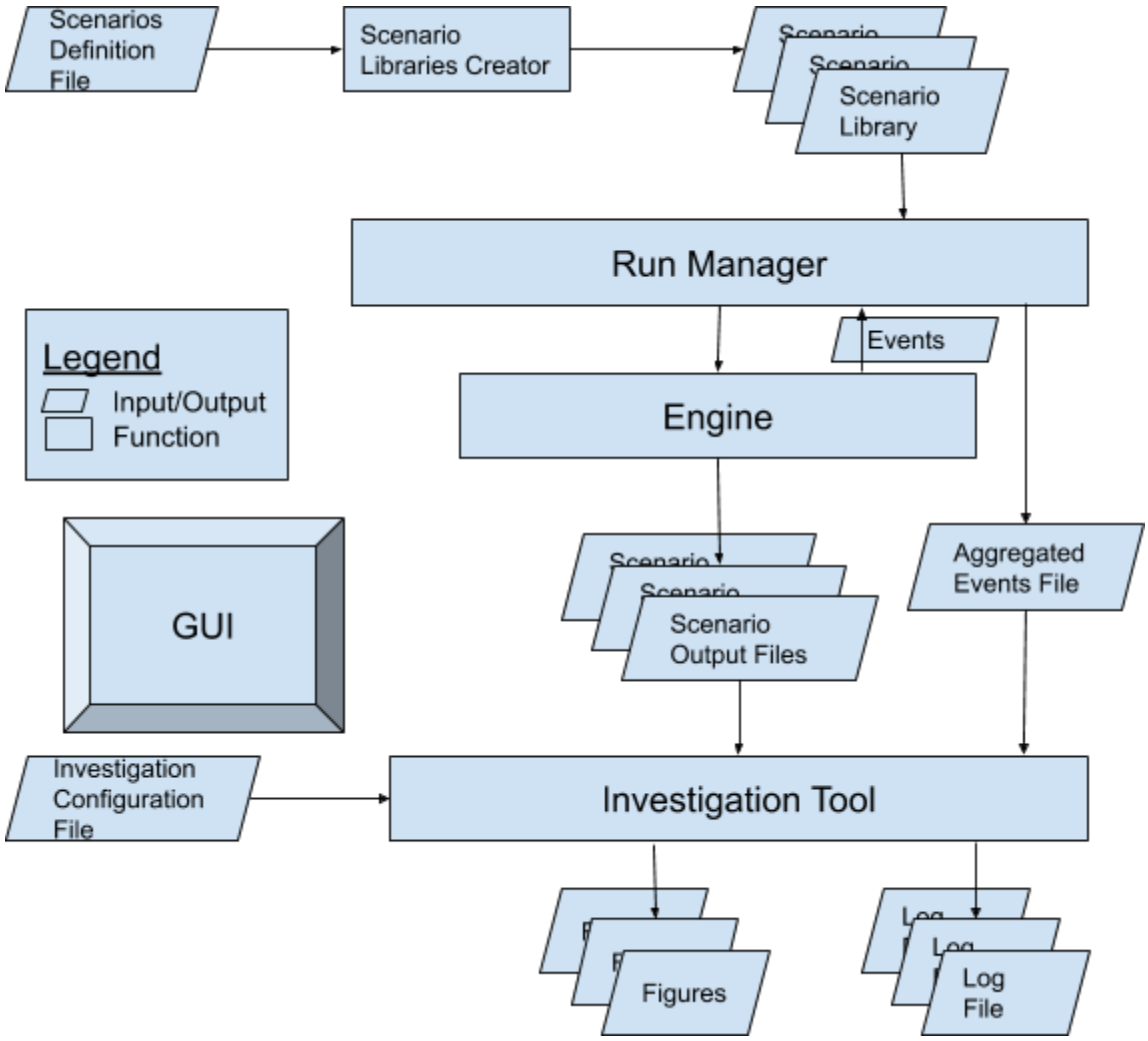
Complex Dynamic Systems Analysis Tool (CDSAT) Design Document

1. Document versions and updates:

Version	Release Date	Updates
v1	Oct 15 2020	NA

2. Reference Documents:
    a. CDSAT User Guide
3. Overview
   CDSAT is a tool for creating, solving, and analyzing complex network dynamics.
   It is coded in MATLAB R2020b with the following toolboxes: TBD.

4. General Description
    a. Main Block Diagram



    b. Scenarios Definition File
        i. A csv file containing the definitions for each scenario.
        ii. Scenario properties include:
            1. Scenario name
            2. Adjacency matrix file name
            3. Initial values file name
            4. Stop conditions
                a. Max time
                b. Derivative threshold
            5. Time step between ode solver calls
            6. Random seed
            7. Dynamic model:
                a. $M_0(x(t))$

b. $M_1(x(t))$
c. $M_2(x(t))$

8. Integration method:
    a. RK4
        i. Abs Tolerance
        ii. Rel Tolerance
    b. Euler
9. Sampling:
    a. Any of the above parameters (except scenario name) may be a single value, list of values, or distribution from which to sample
    b. Number of scenario copies (for random sampling)
10. Additional properties TBD

c. Scenario Libraries Creator Block
    i. Inputs
        1. Scenarios definition file
    ii. Outputs
        1. Scenario libraries
    iii. Description
        1. The purpose of this block is to create the individual libraries (folders) with their respective input files for each scenario to be run by the engine.
        2. The block consists of two major nested loops:
            a. The outer loop runs over each column in the definition file and creates a library containing an input file with only the definitions for that scenario (or set of scenarios in case of sampling).
            b. If sampling is defined for any parameter, the inner loop runs and creates a sublibrary with the individual scenarios, having their parameters sampled according to the definition.

d. Run Manager Block
    i. Inputs
        1. A set of scenario libraries.
    ii. Outputs
        1. Log of successful runs, runtimes, errors.
        2. In case of sampling, aggregated event log from all runs.
    iii. Description
        1. The Run Manager activates instances of the engine block to run each of the selected scenarios. For efficiency this can be done using parallelization (parfor loop).

e. Engine Block
    i. Inputs
        1. Scenario definitions

        2. Results path
    ii. Outputs
        1. Output file containing results (solution of the system).
        2. Error log.
        3. In case of sampling, a predefined event list for the individual scenario is returned to the run manager for aggregation.
    iii. Description
        1. The engine runs the ode solver until the stop condition is met.
        2. After each call to the ode solver, results are printed to the output file.
f. Investigation Tool Block
    i. Inputs
        1. Scenario output files
        2. Aggregated event log
        3. Investigation configuration file
    ii. Outputs
        1. Figures
        2. Log file
    iii. Description
        1. The investigation tool creates a predefined set of figures (TBD) for each scenario plotting the results from the scenario output file.
        2. In case of sampling, the investigation tool creates figures displaying aggregated events.
        3. A configuration file may be selected defining specific features to be added to each figure, such as analytic solution overlay (details TBD).
g. GUI
    i. Description
        1. The GUI facilitates in creating/editing the scenarios definition files and activating individual blocks on selected scenarios.

5. Tests
    a. Unit Tests - TBD
    b. System Tests - TBD
6. Implementation Notes
    a. Each block should be implemented as a stand alone class with methods that can be called independently of the other blocks.
    b. A main function will call all of the blocks in order.
7. Version Control
    a. GitHub Repository: https://github.com/guysmathphd/CDSAT
8. Implementation Plan
    a. V1
        i. Engine block with scenario output file, basic graph showing solution (to be moved to investigation tool in later version)
    b. V2

    i. Run manager
c. V3
    i. Scenario libraries creator
d. V4
    i. Investigation Tool
e. V5
    i. GUI
f. V6+
    i. Additional features added as needed