**Documentation on Running Experiments with WOLVES Model**

WOLVES model is implemented using the COSIVINA framework, a free object-oriented framework to construct and simulate dynamic field models in MATLAB 2016b and later versions (Note: in 2021, we also introduced a python-based version). WOLVES provides a graphical user interface to view the model looking behaviours in real-time, the activation time courses of different fields and to allow adjusting model parameters online.

To get started with WOLVES, follow the steps below. Here is a visual guide online <https://dynamicfieldtheory.org/dft_case_studies/wolves/>.

Step 1. Clone WOLVES\_PsychReview\_2021 folder from [GitHub](https://github.com/cosivina/cosivina_dft_projects/tree/master/WOLVES_PsychReview_2021). Alternatively, you can also download ***cosivina\_dft\_projects.zip*** and extract the folder onto your drive. Extracted ***WOLVES\_PsychReview\_2021*** folder contains the WOLVES model, experiment, and analysis code scripts.

Step 2. Make sure you have ***COSIVINA*** and ***jsonlab*** downloaded. ***COSIVINA*** is a library supporting the underlying DFT framework. (see <https://github.com/cosivina/cosivina> for more details on COSIVINA). You must run ‘*setpath.m’* file from the COSIVINA folder to add this library to your current MATLAB session. ***jsonlab*** support is required to support loading and saving parameter files in json format (see <https://github.com/fangq/jsonlab>).

Step 3: Inside MATLAB’s folder view, right click on the ***WOLVES\_PsychReview\_2021*** folder and select add to path the folder and its subfolders. The ***WOLVES\_PsychReview\_2021*** folder has four subfolders. Subfolder name ***wolves\_core*** contains the main scripts implementing the model. Subfolders ***experiments\_code*** and ***analysis\_code*** contain the scripts implementing the different experiments and corresponding analyses respectively. Subfolder ***support\_code*** contains some supporting functions called in scripts within ***experiments\_code*** and ***analysis\_code*** folders.

Step 4. Navigate into the ***wolves\_core*** subfolder inside the ***WOLVES\_PsychReview\_2021*** folder. This contains the following files:

1. *XSIT\_Manual\_run.m* : This is the main file used to instantiate and run the model.
2. *createComboSim.m* : This file creates the model and details its architecture (fields, interactions, and inputs). [Note for Kachergis, Yu, & Shiffrin (2012) task, use *createComboSimKachergis.m*]
3. *createComboGUI.m* : This file creates and initializes the GUI for the model
4. *createComboControls.m* : This creates and initializes GUI controls
5. *wolvesPaperPR.json* : This json file contains the parameter values for the model to use.

Step 5. Open the *XSIT\_Manual\_run.m*, push the *Run* button in MATLAB and you should see the model GUI up and running the canonical CSWL task!

**Further Details**

Inside *XSIT\_Manual\_run.m*:

* Make sure you have ***COSIVINA*** and ***jsonlab*** folders added to path by running *setpath.m* present in the ***COSIVINA*** folder.
* The model can be run in 3 modes: a GUI mode, non-gui *single-run* mode, non-gui *batch mode* that uses parallel computing (and can be run on an HPC). Set the **mode** variable to any of the following valid values (around line *5*).

Mode = 1 [*Default setting]*: Run a GUI to visualize the model behaviour in real time. The GUI shows real-time activity in different fields of the model as well as the looking behaviour of the model over time in the looking time plot. The model displays/records looking at 5 different spatial positions, these looking positions are specified as: Left (red solid curve in the looking time plot), Left-middle (red dotted curve), Middle (green curve), Right-middle (blued dotted curve) and Right (blue solid curve). The GUI mode gives you the ability to change and play with the parameters for behaviour evaluation and parameter optimization.

Mode = 2: Using an HPC or multi-core PC, run a batch a simulations/subjects in an experiment in the model without any GUI. This requires changing the ‘numSubjects’ ***for*** loop in the corresponding experiment file to ***parfor*** for parallel computation.

Mode = 0: runs one simulation at a time without GUI on a standalone CPU.

* **gui\_speed** variable determines how fast the GUI should update. Ideal values range between 1 to 20. The visualizations update only every *gui-speed* timesteps.
* To modify the memory *tau\_Build* and *tau\_Decay* parameters, change parBuild and parDecay on line 19.
* Enable noise parameters to run baby novelty tasks, Mather\_Schafer\_HoustonPrice\_2011 and Mather\_Plunkett\_2012 tasks [Child Dev SRCD, target journal]. Uncomment lines 32 and 33.
* Each empirical task has associated one or more corresponding scripts for simulation and a script for analyses of the simulation(s). Tasks and their corresponding simulation and analysis files are listed below. Tasks are ordered as per table 3 in the WOLVES Psych Rev paper. Baby novelty tasks are listed towards the end.
* All these experiments are listed from around line *38* in *XSIT\_Manual\_run.m*. To choose an experiment to run, use the experiment corresponding taskvar variable value (around line 36 in file) as indicated in the table below. Open the corresponding experiment script file and ensure the first loop (i.e., the subject loop) is a ***parfor*** loop if you set **mode=2** for parallel simulations. Else for a single run with GUI on i.,e mode 1, it should be an ordinary ***for*** loop.
* Switch to *XSIT\_Manual\_run.m*. Press the run button in MATLAB and your simulation should be running!
* Some tasks require multiple simulations to be run as mentioned in the table:

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| --- | --- | --- | --- |
| Exp. No. | Task/Experiment | Experiment/Simulation Script file (Inside ***experiments\_code*** folder) | Analysis Script file (Inside ***analysis\_code*** folder) |
| 1,2 | Smith & Yu (2008); Yu & Smith (2011) | Smith\_Yu\_2008\_2011.m  (use taskvar = 1) | dataAnalysis\_Smith\_Yu\_2008\_2011.m |
| 3 | Trueswell, Medina, Hafri & Gleitman (2013) | Trueswell\_Medina\_Hafri\_Gleitman\_2013.m  (use taskvar = 3) | dataAnalysis\_Trueswell\_2013.m |
| 4 | Yu & Smith (2007) | Three separate simulations are needed for this task. Three files for three task conditions/simulations are:  Yu\_Smith\_Two\_2007.m;  (use taskvar = 402)  Yu\_Smith\_Three\_2007.m;  (use taskvar = 403)  Yu\_Smith\_Four\_2007.m  (use taskvar = 404) | dataAnalysis\_Yu\_Smith\_2007.m |
| 5 | Yu, Zhong & Fricker (2012) | Yu\_Zhong\_Fricker\_2012.m  (use taskvar = 5) | dataAnalysis\_Yu\_Zhong\_Fricker\_2012.m |
| 6 | Yurovsky, Yu & Smith (2013) | Yurovsky\_Yu\_Smith\_2013.m  (use taskvar = 6) | dataAnalysis\_Yurovsky\_2013.m |
| 7 | Kachergis, Yu, & Shiffrin (2012) | Kachergis\_Yu\_Shiffrin\_2012\_11AFC.m  (use taskvar = 7) | dataAnalysis\_Kachergis\_11AFC.m |
| 8 | Smith & Yu (2013) | Smith\_Yu\_2013.m  (use taskvar = 8) | dataAnalysis\_Smith\_Yu\_2013.m |
| 9,10 | Vlach & Johnson (2013) ; Vlach & DeBrock (2019) | Vlach\_CSWL\_2013\_17\_19.m  (use taskvar = 9) | dataAnalysis\_Vlach\_2013\_2019.m  [Outputs results against all three age groups; a simulation will correspond to only one of these correctly; vary tau\_decay for different simulations as specified in the article] |
| 11 | Vlach & DeBrock (2017) | 2x6 separate simulations are needed for this task. Two files for two sub-task simulations are: Each sub-task needs to be run for 6 tau\_decay values: [800, 1200, 2000, 3000, 3500, 5000].  Name simulation files correctly as specified in the analysis file.    Vlach\_2013\_17\_19.m;  (use taskvar = 9)  Vlach\_DeBrock\_WOB\_2017.m  (use taskvar = 11) | dataAnalysis\_Vlach\_2017.m |
| 12 | Suanda, Mugwanya & Namy (2014) | Suanda\_Mugwanya\_Namy\_2014.m  (use taskvar = 12) | dataAnalysis\_Suanda\_2014.m |
| 13 | Fitneva & Christiansen (2015) | Fitneva\_Christiansen\_2015.m  (use taskvar = 13)  Three separate simulations are needed of this task corresponding to three age groups, varying memory parameters:  4-year olds:  (tau\_Build = 1200, tau\_Decay = 3000)  10-year olds:  (tau\_Build = 1200, tau\_Decay = 5500)  Adults:  (tau\_Build = 1000, tau\_Decay = 15000) | dataAnalysis\_Fitneva\_2015.m |
| 14 | Mather Schafer Houston-Price (2011) Experiment 1 | MSHP\_Exp1\_2011.m  (use taskvar = 14)  Enable noise parameters in *XSIT\_Manual\_run* file at line 32,33.  Two separate sims are needed of this task corresponding to each age group, one for silent condition,  (use Labelling\_condition\_ON= 0, at line 107) and another for labelling condition (use Labelling\_condition\_ON= 1)  This experiment uses two age groups, hence varying memory parameters:  9-14 month [Younger]:  (tau\_Build = 1200, tau\_Decay = 800)  15-19 month [Older]:  (tau\_Build = 1200, tau\_Decay = 4500) | dataAnalysis\_MSHP\_2011.m |
| 15 | Mather & Plunkett (2012) Experiment 1 | Mather\_Plunkett\_Exp1\_2012.m  (use taskvar = 15)  Enable noise parameters in *XSIT\_Manual\_run* file at line 32,33  and memory parameters are  (tau\_Build = 1200, tau\_Decay = 8000) | dataAnalysis\_Mather\_Plunkett\_Exp1\_2012 |
| 16 | Mather Schafer Houston-Price (2011) Experiment 2 | MSHP\_Exp1\_2011.m  (use taskvar = 16)  Enable noise parameters in *XSIT\_Manual\_run* file at line 32,33.  Two separate sims are needed of this task corresponding to each age group, one for silent condition,  (use Labelling\_condition\_ON= 0, at line 121) and another for labelling condition (use Labelling\_condition\_ON= 1)  This experiment uses two age groups, hence varying memory parameters:  16-month [Younger]:  (tau\_Build = 1200, tau\_Decay = 4500)  21-month [Older]:  (tau\_Build = 1200, tau\_Decay = 8000) | dataAnalysis\_MSHP\_2011.m |
| 17 | Metric Similarity Enhances Learning | Metric\_Variation.m  (use taskvar = 17)  Enable noise parameters in *XSIT\_Manual\_run* file at line 32,33.  Two separate sims are needed of this task corresponding to each condition, one for NEAR condition,  (use TASK\_CONDITION\_NEAR\_ON = 1, at line 121) and another for FAR condition (use TASK\_CONDITION\_NEAR\_ON = 0) | dataAnalysis\_Metric\_Variation.m |

* Once the simulation(s) necessary for a task are complete (for mode=2 only), analysis can be conducted. Open the ***analysis\_code*** folder. Look for the corresponding data analysis file as listed in the table above. Open the data analysis file, navigate back to the folder where your simulation mat file(s) is/are located.
* Inside the dataAnalysis file: Update the simName variable with the name(s) of your simulation(s) and press run. The script will produce an output excel file with RMSE and MAPE values for the simulation(s), display these values in command window as well as show plots associated with the task.