**Documentation on Running Experiments with WOLVES 2.0 Model**

The WOLVES 2.0 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; see <https://github.com/cosivina>). WOLVES provides a graphical user interface to view the model 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 the WOLVES-2.0\_DevelopmentalReview repository from [GitHub](https://github.com/developmentaldynamicslab/WOLVES-2.0_DevelopmentalReview).

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-2.0\_DevelopmentalReview*** folder and select ‘add to path the folder and its subfolders’. The ***WOLVES-2.0\_DevelopmentalReview*** folder has five subfolders. Subfolder name ***wolves\_core*** contains the main scripts implementing the model. Subfolder ***experiments\_code\_2.0*** contains the scripts implementing the different experiments and corresponding analyses respectively. Subfolder ***support\_code*** contains some supporting functions called in scripts. The ***experiments\_code*** and ***analysis\_code*** folders allow you to run all the original cross-situational word learning experiments captured by the original WOLVES model. Finally, the ***replication\_results*** folder contains output files from a replication run we did to confirm all the final code was working correctly and that the model results were robust.

Step 4. Navigate into the ***wolves\_core*** subfolder inside the ***WOLVES-2.0\_DevelopmentalReview*** folder. This contains the following files:

1. *XSIT\_Manual\_run\_DCCS.m* : This is the main file used to instantiate and run the 2.0 model.
2. *createComboSim\_DCCS.m* : This is the model 2.0 description
3. *createComboGUI\_paper.m* : This file creates and initializes the GUI for the model
4. *wolvesPaperPR.json* : This json file contains the parameter values for the model to use.

The other files in this folder are copies of the original files from the WOLVES *Psychological Review* paper that can be handy for comparison.

Step 5. Open the *XSIT\_Manual\_run\_DCCS.m*, push the *Run* button in MATLAB and you should see the model GUI up and running the standard DCCS task. The code is set up to run one trial of each task for each age group. This will take a long time. Simply hit ‘quit’ when you are done viewing each task. You’ll have to hit quit multiple times to fully exit as the code will loop through 9 different tasks (6 for the ‘young’ model and 3 for the ‘old’ model).

**Further Details**

Inside *XSIT\_Manual\_run\_DCCS.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 *27*).

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. For the different versions of the DCCS task and the dimensional label comprehension task, the behaviour of the model is reflected by the location of peak formation in the spatial field of the scene WM system. For the dimensional label production task, the behaviour of the model is reflected by the label being activated in the word field of the word-object learning system of the model.

Mode = 2: Using an HPC or multi-core PC, run a batch a simulations/subjects in an experiment in the model without any GUI (the number of subjects is specified on line 123 – the default is 96 as we had 96 cores when running this on the HPC at UEA). To run a batch of simulations using parallel computing, you must also change the ‘numSubjects’ ***for*** loop in the corresponding experiment file to ***parfor*** for parallel computation. For instance, in DCCS\_Basic.m (in the ***experiments\_2.0*** folder), change line 48 so the ‘***for***’ becomes ‘***parfor***’. This same line occurs in the other experiments as well, always around line 48 (e.g., line 33 in Production.m, line 34 in Comprehension.m, line 56 in DCCS\_NovelSimuli.m, and so on…)

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

* **gui\_speed** variable (line 28) determines how fast the GUI should update. Ideal values range between 1 to 20. The visualizations update only every *gui-speed* timesteps.
* As mentioned above, the code is set to run 9 tasks – 6 for the ‘young’ model and 3 for the ‘old’ model. This is done by looping over age groups on line 33 (age = 1 is ‘young, age = 2 is ‘old’). Each age group gets run through the set of tasks specified in the ‘tasklist’ variable on line 39 for young and line 43 for old). These tasklist numbers match up with the different tasks listed at lines 49-61.
* If you run a batch of simulations using mode = 2, the code will automatically analyse the results for you. The analysis code is on lines 283 – 346. You can see that we call a few separate ‘ComputeAccuracy’ functions for analyses of the different tasks. The functions are all in the ***experiments\_2.0*** folder.
* If you want to run the original XSit tasks we simulated in the paper, do the following:
  + Comment line 33 and uncomment line 34
  + Comment line 46 and uncomment line 47
  + Comment line 139 and uncomment line 140
  + Hit ‘Run’
  + This will generate 3 .mat files with the results (which should be saved to your ***wolves\_core*** folder).
  + To analyse these simulations, open ‘dataAnalysis\_Smith\_Yu\_2008\_2011.m’, change line 14 to match the name of your .mat results file, and hit ‘run’. You will get a set of plots, including the plots reported in our paper.
  + For the Vlach et al. simulations, open ‘dataAnalysis\_Vlach\_2013\_2019.m’, change line 15 to match the name of your .mat results file, and hit ‘run’. You will get a set of plots, including the plots reported in our paper.
  + For the Suanda et al. simulations, open ‘dataAnalysis\_Suanda\_2014.m’, change line 11 to match the name of your .mat results file, and hit ‘run’. You will get a set of plots, including the plots reported in our paper.

Enjoy! Have fun. Play around. If you have questions, you are welcome to email John Spencer at [j.spencer@uea.ac.uk](mailto:j.spencer@uea.ac.uk) or Aaron Buss at [abuss@utk.edu](mailto:abuss@utk.edu).