Documentation and overview of materials for Wallis, Bethge & Wichmann

Tom Wallis, November 2015.

The following repository provides code and data used in the forthcoming paper "Testing models of peripheral encoding using metamerism in an oddity paradigm" by Wallis, Bethge & Wichmann. I understand that much of this process could be improved with the addition of a Makefile, but I haven't implemented this yet for my own workflow so I don't use it here.

Citation

If you use or modify this code or the data in an academic publication, please cite the paper (please update the citation accordingly once the manuscript is out):

Wallis, T.S.A., Bethge, M. & Wichmann, F. A. (under review). Testing models of peripheral encoding using metamerism in an oddity paradigm. *Journal of Vision*.

Directory structure

This distribution of materials is structured like so:

- `/code/` contains all code for running experiments and analyses
  - `/analysis` = data analysis code
  - `/experiment` = code to run experiments in psychtoolbox
  - `/stimuli` = code to generate stimuli
- `/raw-data/` contains all raw data (individual session files and eyetracking), subfolder for each experiment. Eyetracking data is in `/raw-data/experiment-N/eye_data_files/`.
- `/results` contains aggregated results files used for analysis and some analysis output. I have not provided the MCMC samples I report in the paper because they are stored as pickle files in python, which constitute a security risk for sharing. They are available upon request (or just re-run the sampling yourself).
- `/stimuli` contains the images shown to observers in the experiments.

Important note re: code labelling

I have run a number of related experiments that were not reported in the paper.These experiments tried and failed to make discrimination performance worse (i.e. to generate convincing metamers with the Portilla and Simoncelli texture syntheses), and should be considered unreported pilots.

Consequently, the data reported in the paper are labelled differently in the code. Sorry if this is confusing; I decided to keep it to maintain code compatibility.

- Paper "Experiment 1" = code "experiment 13"
- Paper "Experiment 2" = code "experiment 9"
- Paper blur supplement (Figure 11) = code "experiment 14"
- Paper appendix data ("scene scale vs patch size") = code experiment 10

In all documentation hereafter, the experiments are referred to by their numbers *in the code*.

Software used

- Texture stimulus generation:
  - Matlab 2014a
- Experiment presentation:
  - Matlab 2013b (experimental presentation)
  - Psychtoolbox (version 3.0.12)
  - iShow (internal library, available here))
- Stimulus generation:
  - Python 3.3.5 (Anaconda 2.0.1) — see log files in `code/stimuli` for package requirements. You will need a package called `psyutils`; it is available here.

Experiment documentation

Experiment 13 (paper Experiment 1; discriminating Gaussian blur)

Stimulus generation The files to reproduce the stimuli are in `/code/stimuli`. To generate stimuli, run `generate_stimuli_13.py`. You will need to change the `source_path` (line 32) to point to the Judd database directory containing ALLSTIMULI and ALLFIXATIONMAPS you want to use locally. This script reads in parameters from `generation_params_exp_13.yaml` and writes images out to `/stimuli/experiment-13/final_ims`.

Experiment The experiment script is `/code/experiment/metamers_experiment_13.m`. It will output new raw data to `/raw-data/experiment-13/`. It requires an appropriately configured Psychtoolbox installation to run. Because I use MATLAB's (new! amazing! Just like R only way clunkier!) Tables data type, you will need a recent version of Matlab.

Data analysis All data analysis scripts are located in /code/analysis/. To compile raw data files (located in /raw-data/experiment-13) into a single summary file (located in /results/experiment-13), run data_munging.py. This shouldn't be necessary since I've provided the compiled csv file in this repository.

Eye data was parsed using the script oddity_experiments_eyedata_parse.py. I'm not providing raw eye data here (too large; available upon request, or let me know about a better free hosting solution) but I've included the script for reference.

To fit the multilevel model using Stan, run fit_tanh_model_expt_13.py (assuming you've correctly installed pyStan). The model itself is specified in oddity_3AFC_tanh3_full.stan. I didn't include my model fits in this repository (too large; available upon request, or let me know about a better free hosting solution).

To generate the plots reported in the paper, run paper_plots_experiment_13.ipynb. To see the Bayesian ANOVA results, see the JASP file expt_13_anova.jasp.

To reproduce the analysis in Figure 6 (the comparison of spectral content), first run geisler_perry_blurring.m under Matlab with Jeff Perry's SVIS toolbox correctly installed. Then run spectral_content_analysis_2.ipynb to make the figures.

Experiment 9 (paper Experiment 2; discriminating PS textures)

Stimulus generation The files to reproduce the stimuli are in /code/stimuli. To generate stimuli, run

1. generate_stimuli_9a.py. You will need to change the source_path (line 28) to the Judd database directory as above. This script reads parameters from generation_parameters_exp_9.yaml and writes images to three directories in /stimuli/experiment-9/.
2. Now generate PS textures from the source images generated in step 1. I separated this into three separate scripts to make things go faster (distributing source patches across multiple CPU cores). Using a MATLAB installation with the PS texturesynth toolbox appropriately installed, run p_s_generation_expt_9_inner.m, p_s_generation_expt_9_middle.m and p_s_generation_expt_9_outer.m, changing numbers of cores and source paths appropriately.
3. Run generate_stimuli_9b.py, which assembles the final patches for the experiment and writes them to /stimuli/experiment-9/final_ims.

Phew! You're done.

Experiment The experiment script is /code/experiment/metamers_experiment_9.m. It will output new raw data to /raw-data/experiment-9/. It requires an appropriately configured Psychtoolbox installation to run. Because I use MATLAB's (new! amazing! Just like R only way clunkier!) Tables data type, you will need a recent version of Matlab.

Data analysis All data analysis scripts are located in /code/analysis/. To compile raw data files (located in /raw-data/experiment-9) into a single summary file (located in /results/experiment-9), run data_munging.py. This shouldn't be necessary since I've provided the compiled csv file in this repository.

Eye data was parsed using the script oddity_experiments_eyedata_parse.py. I'm not providing raw eye data here (too large; available upon request, or let me know about a better free hosting solution) but I've included the script for reference.

To fit the multilevel model using Stan, run fit_tanh_model_expt_9.py (assuming you've correctly installed pyStan). The model itself is specified in oddity_3AFC_tanh3_full.stan. I didn't include my model fits in this repository (too large; available upon request, or let me know about a better free hosting solution).

To generate the plots reported in the paper, run paper_plots_experiment_9.ipynb. To see the Bayesian ANOVA results, see the JASP file expt_13_anova.jasp.

Experiment 14 (blur supplementary experiment; paper Figure 11)

Stimulus generation Generate stimuli with generate_stimuli_14.py. This script reads in parameters from generation_params_exp_14.yaml and writes images out to /stimuli/experiment-14/final_ims.

Experiment The experiment script is /code/experiment/metamers_experiment_14.m. It will output new raw data to /raw-data/experiment-14/. It requires an appropriately configured Psychtoolbox installation to run. Because I use MATLAB's (new! amazing! Just like R only way clunkier!) Tables data type, you will need a recent version of Matlab.

Data analysis As above, compile raw files using data_munging.py. To generate the plots reported in the paper, run paper_plots_experiment_14.ipynb and expt_14_spectral_content_analysis.ipynb.

Experiment 10 (paper Appendix 6.3; downsampling instead of cropping)

The procedure here is almost identical to that for Experiment 9, above.

Stimulus generation The files to reproduce the stimuli are in /code/stimuli. To generate stimuli, run

1. generate_stimuli_10a.py.
2. Generate PS textures: p_s_generation_expt_10_batch_1.m ... p_s_generation_expt_10_batch_4.m.
3. generate_stimuli_10b.py.

Experiment The experiment script is `/code/experiment/metamers_experiment_10.m`.

Data analysis Having run `data_munging.py` and `oddity_experiments_eyedata_parse.py` above,

1. `fit_tanh_model_expt_10.py`
2. `plot_tanh_fits_experiment_10.ipynb`