Guide to the Script

This guide describes cell-by-cell the analysis of the pigeon VI contingency data gathered by Andrew Craig in the laboratory of Tim Shahan

%% Cell 0: Establishing search paths to the folders containing relevant code

In order, for the code in this script to execute, the TSlib toolbox folder (TSlib) must be on Matlab’s search path and so must the folder ‘CraigShahanHelperFunctions’, which contains the custom helper functions created in the course of this analysis. When run in its entirety, that is, when called from Matlab’s command line, this script will (attempt to) load the file named ‘CraigShahanWonlyData.mat’, which contains an already created Experiment structure, into which the raw data have been loaded into the TSData fields at the Session level of the Experiment structure and run the entire analysis, in the course of which it creates and saves the completed Experiment structure ‘VIContingencyStructure.mat’ and generates many figures, including the 5 figures that appear in the *Psychological Review* paper ‘Contingency, Contiguity and Causality in Conditioning: Applying Information Theory and Weber’s Law to the Assignment of Credit Problem’, authored by C.R. Gallistel, Andrew Craig and Tim Shahan. It is anticipated that this script will rarely in fact be run in its entirety. Doing so serves to confirm that the trail from the raw data to the published results is intact. More often, specialists will want to examine and perhaps manipulate aspects of the code. In that case, they should open the script in Matlab’s editor and use this guide to find the cell(s) that contain the code of interest, e.g. the code that computed a given contingency or that generated a given figure. They should begin their scrutiny by calling TSexperimentbrowser. That call opens a browser that gives quick access to all levels and fields of the Experiment structure. All of the code in this script presupposes the existence in the workspace of a Matlab structure with the name ‘Experiment’. The TSsystem© contains commands that read data from fields in this structure, execute operations on those data and return the results to other fields in this structure—in accord with the “keep it all together” principle that underlay the design of the TSsystem toolbox.

%% Cell 1: Peck Times

% Creates a field at the Session level containing the session times of all

% the pecks.

%% Cell 2: Reinforcement Times

% creates a a field with all the reinforcement times

%% Cell 3: Numbers of Pecks & Reinforcements in each Session

%% Cell 4: Rates of Reinforcement

%% Cell 5: Reinforcement Rates by Session (Figure 1 in first version of Psych Review MS)

%% Cell 6: Peck Rates by Session (Fig 2 in first version of MS)

%% Cell 7: Peck Rate vs Reinforcement Rate Plot

% CONTAINS CODE FOR FIGURES NOT PUT IN PAPER BUT WHICH WERE USEFUL IN PRELIMINARY EXAMINATION OF THE DATA. SUGGEST SKIPPING NOW TO CELL 9

%% Cell 8a: Computing IRI and iri Distributions

%% Cell 8b: Carrying iri & IRI Results Up to Phase-Specific Fields at Subject Level

%% Cell 8c: Plotting Interpeck Interval Distributions (not in paper, but of some interest)

%% Cell 8d: Plotting the Cumulative Distributions of IRIs (also not in paper but important in showing that variations in birds’ pecking patterns have no effect of the distributions of inter-reinforcement intervals)

%% Cell 9: Computing prospective contingency: Very important cell with extensive documentation

%% Cell 10: Graphing the 2 distributions for the first experiment (Figures 3-5 in the first MS)

% In every case but 1 (Phase 165, S6), the distribution of intervals measured from each peck to the next reinforcement superimposes on the distribution of intervals measured from randomly chosen points in time to the next reinforcement. Because the distributions are the same, they have the same entropy. Therefore, there is no prospective contingency between a response and a reinforcement. In other words, knowing that the bird has just made a response does not reduce by any measurable amount the uncertainty about when the next reinforcement will occur.

%% Cell 11(a % b): Preliminaries to computing the contingency between rate of pecking and rate of reinforcement: creating IRI "trials" and computing basic stats

%% Cell 12: Correlation Coefficients (Phases 30, 165 & 300) Important cell

%% Cell 13: Computing iri-IRI Contingencies in Experiment 1. Very important cell, with extensive documentation

%% Cell 14: Scatter Plots with Correlation Coefficients & Contingencies (Figures 6-8 in first MS)

%% Cell 15 Reality check: Cumulative Distributions from vertical tranches. There is mutual information between two variables if the distribution of values for one variable depends on the value of the other variable. One can examine this graphically by plotting the cdfs of the IRIs in the above plots for data from vertical tranches through the scatter plot (the joint distribution) made at different values for the peck rate (the rate of pecking within an IRI).

%% Cell 16: Pecks per Minute vs Session in Gratis Reinforcement Experiment (Figure 9 in first MS)

%% Cell 17: Retrospective Intervals in Gratis R experiment Preliminaries to Figures S4 & S5 in original Supplementary Material)

%% Cell 18: Reality check: Plotting reinf rate & peck rate over the 0 contingency sessions to be sure that peck rate had no feedback effect on reinforcement rate

%% Cell 19: Fitting Exponentials to r<-rndT Data in Gratis R Experiment Figures S4 & S5 in original Supplementary Material

%% Cell 20: Computing Retrospective Contingencies Phase56 & Phase28 (67% & 87% Gratis) Important cell

%% Cell 21: Mean Gratis R Peck Rates

%% Cell 22: Graphing Normalized Mean Peck Rates Against Contingencies in Gratis R Experiment (Figure 10 in Research Gate MS; Figure 1 in Psych Review)

%% Cell 23: Graphing the r<-R & r<-rndT Distributions at Different Scales in Gratis R Experiment (Figure 15 in the first MS)

%% CELL 24: Graphing Pecks/s vs Session for the Delay of Reinforcement Sessions (Figure 11 in first MS)

%% Cell 25: r<-R Intervals in the Delay of Reinforcement Condition

%% Cell 26: Histograms for estimating RbcktoP entropies (last fig is Fig 12 in first MS. Fig 2 in Psych Rev paper) Important cell

%% Cell 27: Computing r<-R Contingencies in Delay Experiment 4 different ways. Very important cell

%% Cell 28: Normalized Mean Peck Rates in Delayed R Experiment

%% Cell 29: Figures 3 & 4 in Psych Review:

Double-y axis figures, with left axis plotting mean peck rate (not normalized!) against hang-fire delays (on x axis) and right axis plotting contingency vs those delays. Each figure is 8 rows x 3 columns, one row for each bird and one column for each VI. First figure plots linear contingency; second plots logarithmic contingency. 3 bits (8 bins) in both cases

%% Cell 30: Graphing the r<R & r<-rndT distributions for S1 at different delays & different scales to illustrate the effect of scale on contingency (Figure 14 in the first MS; Figure 5 in Psych Review)

%% Simulations w 30s Resetting Delay (Figure 16 in first MS)