Sampling in Decisions from Experience

https://github.com/linushof/sampling-in-dfe

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October 11, 2021

Project Description

Starting Ideas

1. Description-experience gap (cf. Wulff et al., 2018)
2. Empirical samples that carry over to cognitive processes

Core Question

- May samples be generated in such a way that they produce systematic choice patterns?

Prospects and Sampling

- Standard paradigm: Choice between 2 or multiple prospects
- *Prospects*: Probability spaces $(\Omega, \mathcal{F}, P)$, where

$$\Omega = \{\omega_1, ..., \omega_n\}$$

and

$$P = \{p(\omega_1), ..., p(\omega_n)\}$$

- *Single sample*: Realization of a random variable:

$$X(\omega \in \Omega) = x$$

- *Sequential sampling*: Generating a sequence of single samples in discrete time:

$$X_i = X_1, ..., X_n$$

Difference between DfD and DfE

- Decisions from Description (DfD): Function of symbolical descriptions of prospects:

$$D := f((\Omega_1, \mathcal{F}_1, P_1), ..., (\Omega_k, \mathcal{F}_k, P_k))$$

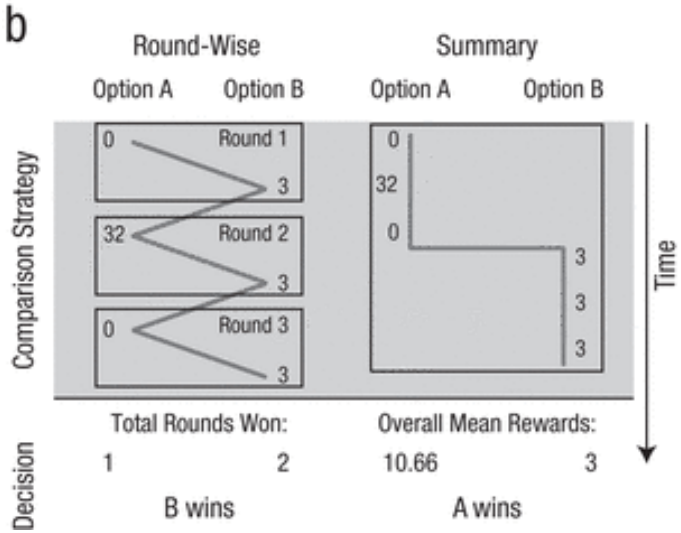
- Decisions from Experience (DfE): Function of sample sequences originating from prospects:

$$D := f(X_{i1}, ..., X_{ik})$$

- f informed by psychological theory and empirical protocols

Sampling and Decision Strategies

- Hills and Hertwig (2010): Assumption of a systematic link between sampling and decision strategies
- Sampling strategy: Succession of single samples in a sequence generated from multiple prospects
  - Piecewise: Single samples from **different** prospects
  - Comprehensive: Single samples from **same** prospect



Modeling the Assumptions of Hills & Hertwig (2010)

- Consider two prospects $(\Omega_X, \mathcal{F}_X, P_X)$ and $(\Omega_Y, \mathcal{F}_Y, P_Y)$ and the ground model for DfE

$$D := f(X_i, Y_i)$$

- f maps a comparison of $\overline{X}$ and $\overline{Y}$ on the set $\{0, 1\}$, with 0 (1) indicating a lost (won) comparison:

$$D := f(\overline{X} - \overline{Y}) = \begin{cases} 1 & \text{for} \quad \overline{X} - \overline{Y} > 0 \\ 0 & \text{else.} \end{cases}$$

- A series of ordinal comparisons $D_i = D_1, ..., D_n$ is a Bernoulli process where the number of won comparisons follows the binomial distribution

$$D \sim \mathcal{B}\left(p\left(\overline{X} - \overline{Y} > 0\right), n\right)$$

Predicting Choices from the Stochastic Model

- n and p of the binomial distribution are influenced by the sampling and decision strategies:

Comprehensive Sampling and Summary Decisions

- $n = 1$
- p: For $\lim_{N_X, N_Y \to \infty}$, $p(\overline{X} - \overline{Y} > 0) \approx p(E(X) - E(Y))$
- Choices should become *"normative"*, i.e., linear weighting and value function

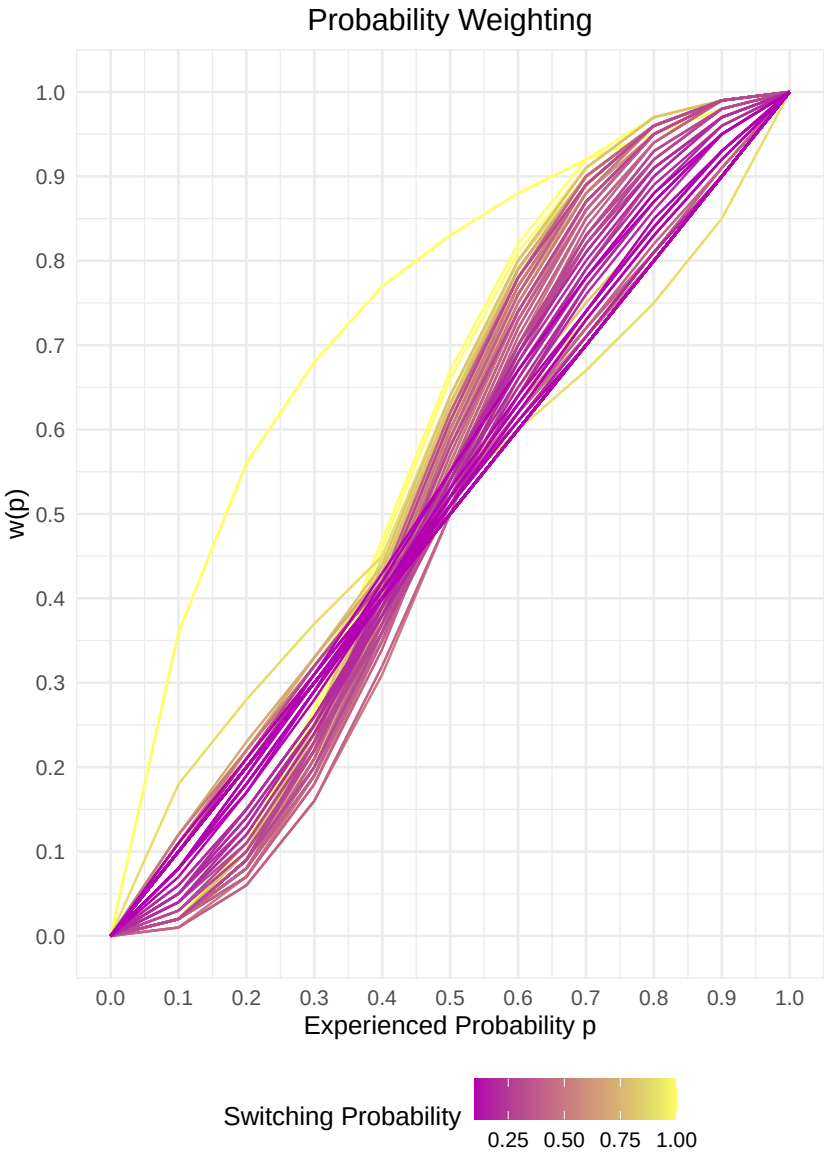
Piecewise Sampling and Round-wise Decisions

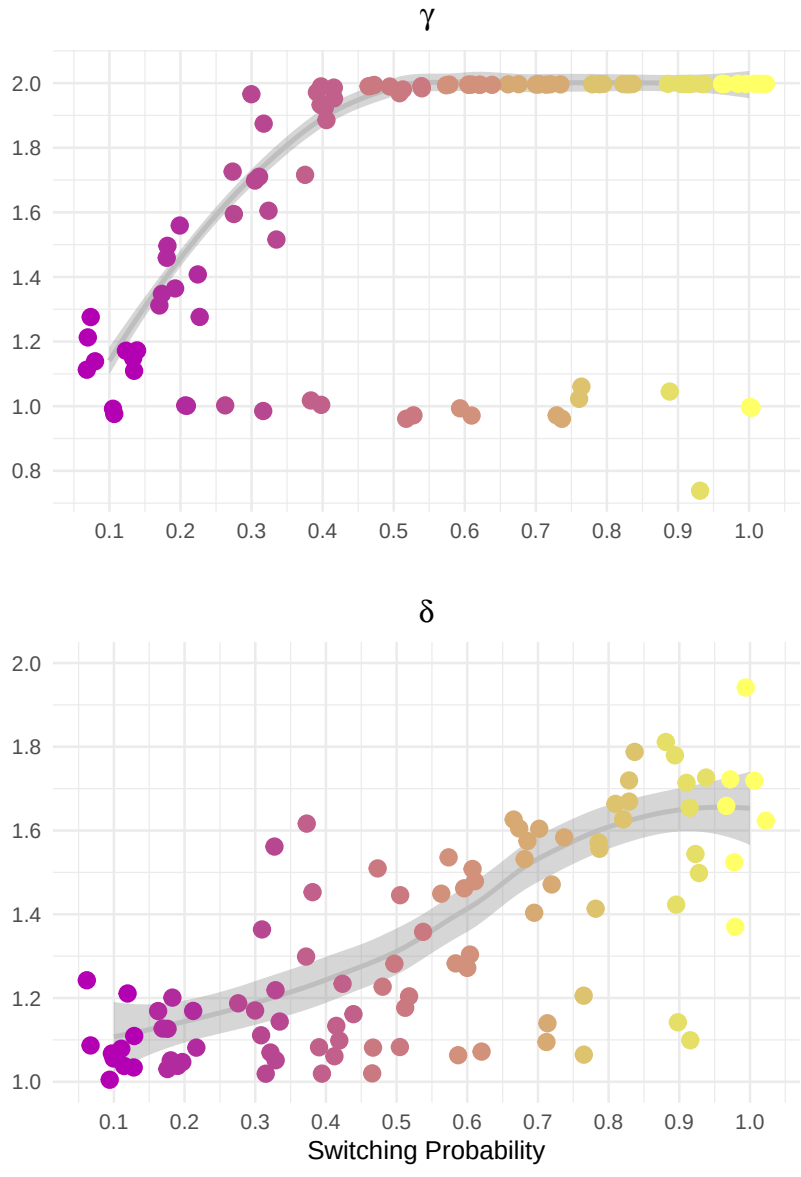
- $n \geq 1$ and $N_X, N_Y = 1$
- p: For $N_X, N_Y = 1$, $p(\overline{X} - \overline{Y} > 0) = p(\omega \in \Omega_X > \omega \in \Omega_Y)$
- Choices depend on probabilities in the mid-range, i.e., S-shaped weighting function and concave value function

Method

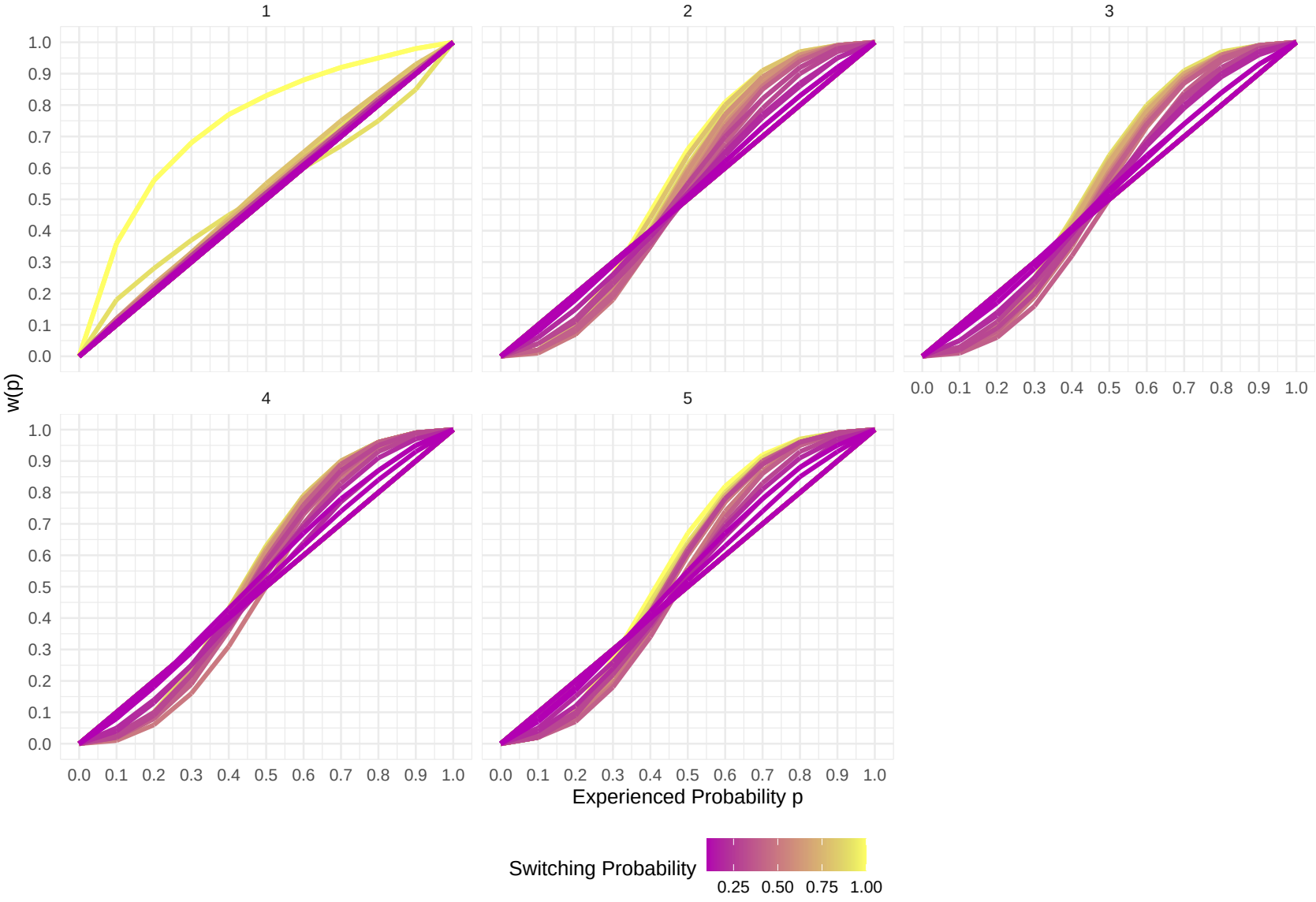
- 60 choices between a 2-outcome prospect and a safe prospect
- 100 synthetic agents
- Parameterization of the sampling and decision process
  - Probability of switching between prospects
  - Number of comparisons
- Description of simulated DfE in Cumulative Prospect Theory

Probability Weighting

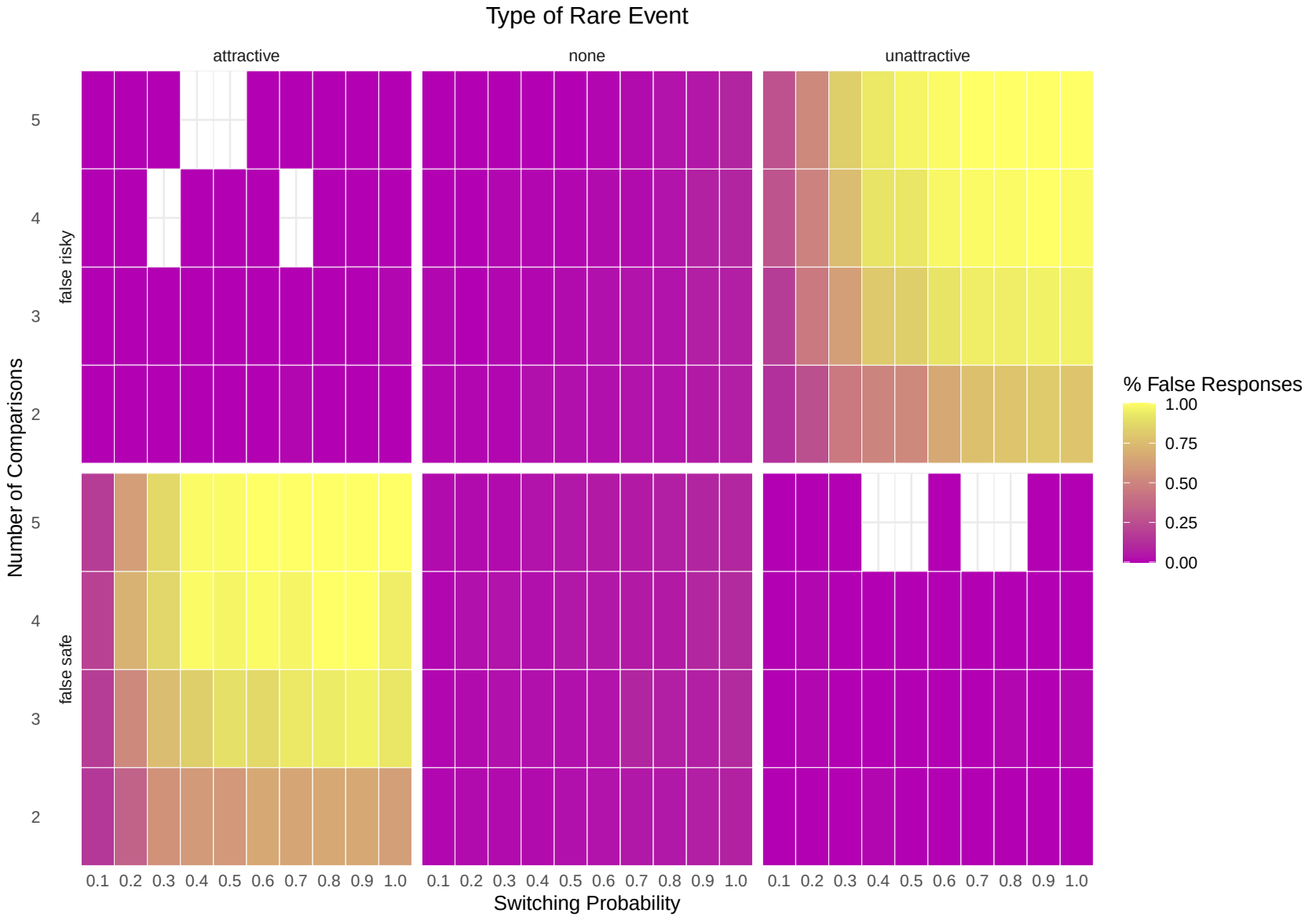




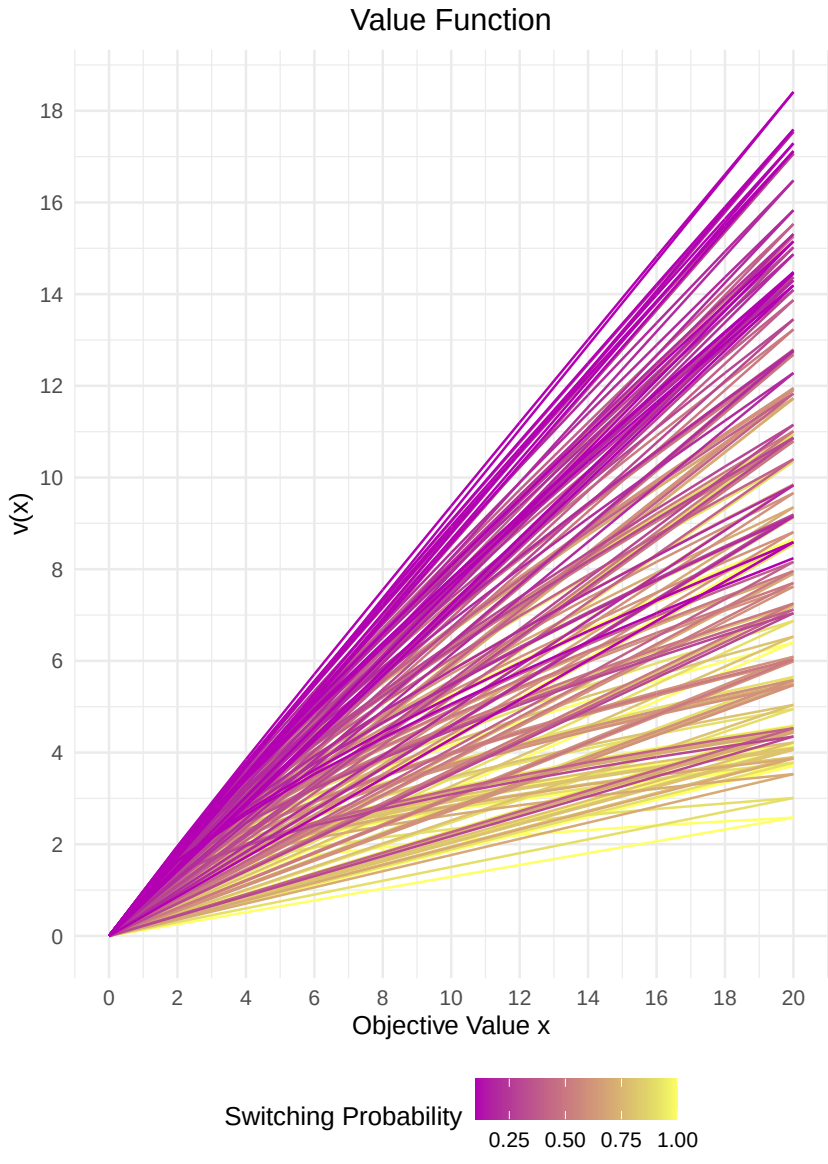
Probability Weighting: Multiple Comparisons

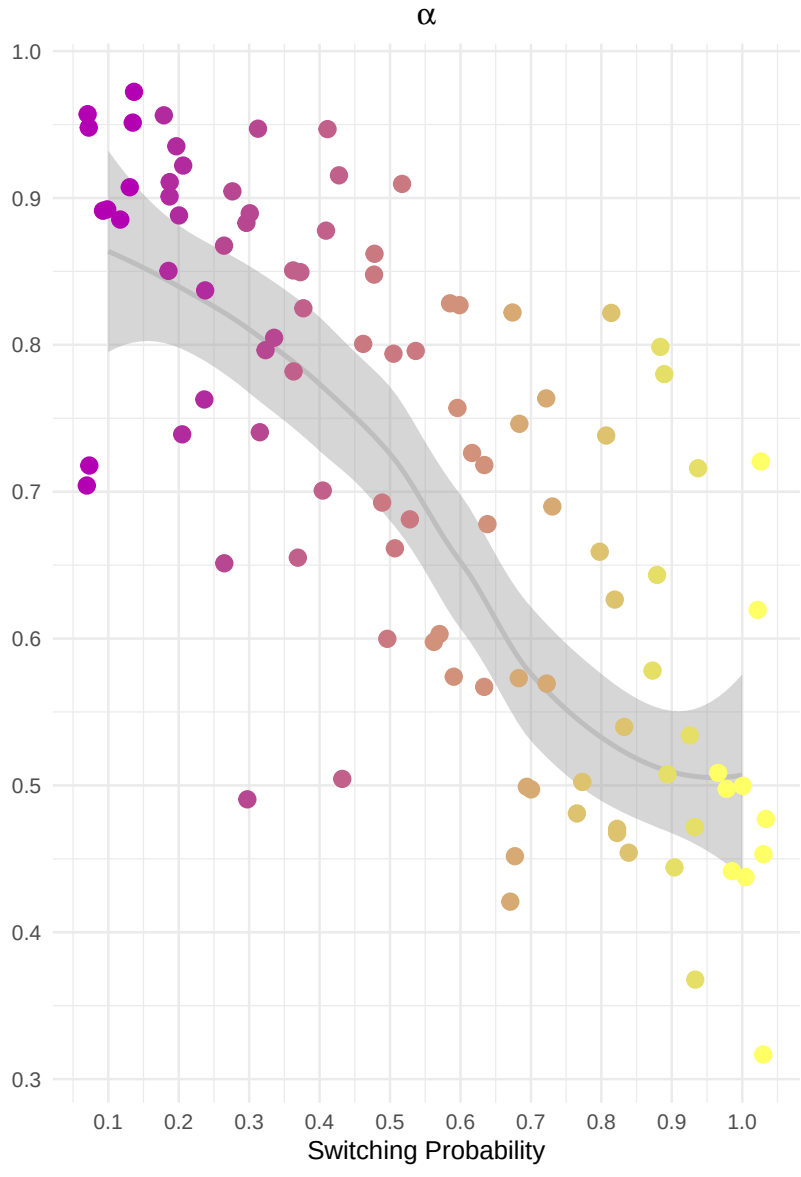


False Response Rates



Value Function





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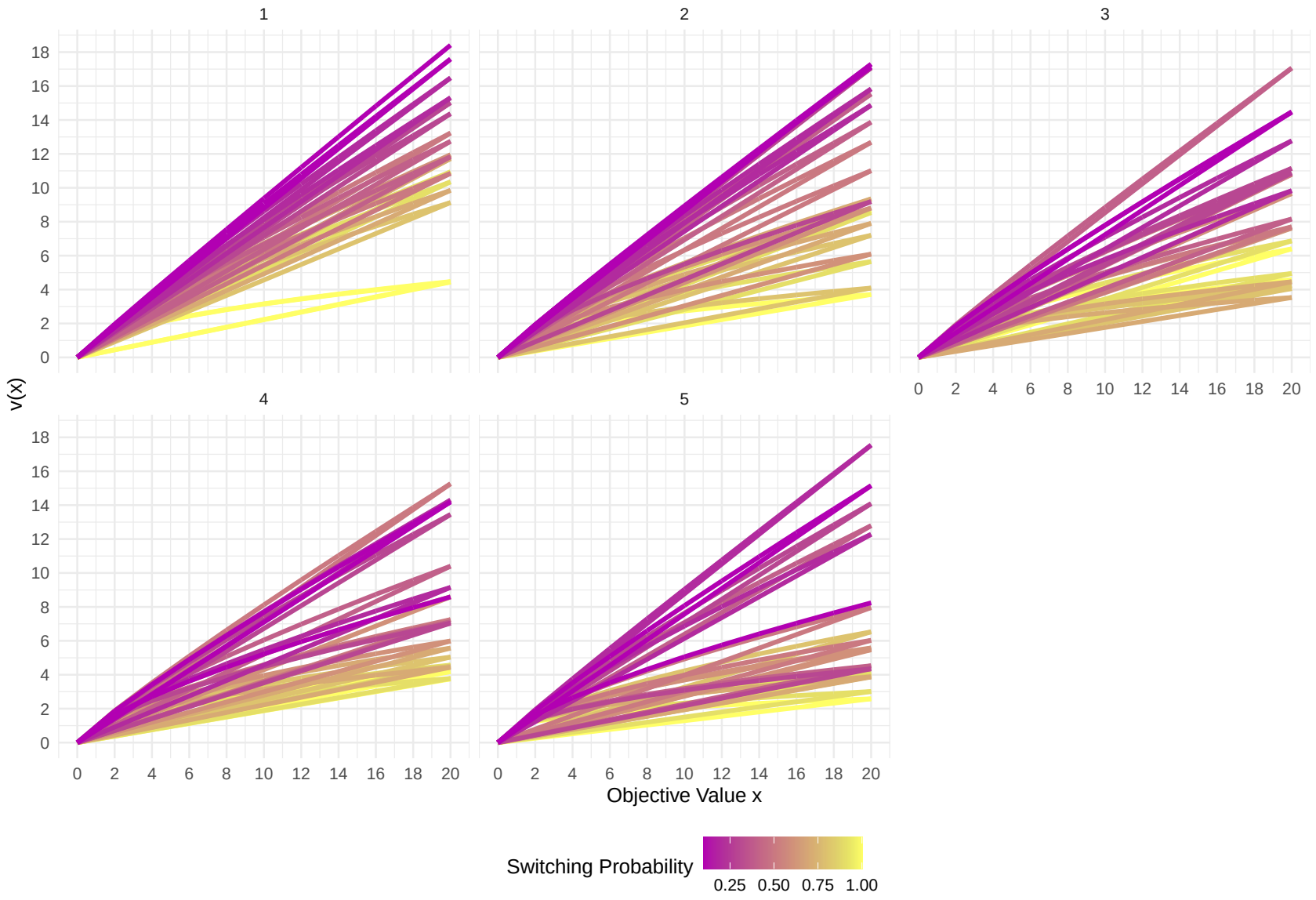

Summary and Q&A

Random processes underlying DfE . . .

- . . . can be modeled according to probability theory
- . . . can be integrated into current decision theories
- . . . could be shaped by sampling and decision strategies
- . . . could explain empirically observed choice patterns

I happily take your questions, comments and critique.

References

Hills, T. T., & Hertwig, R. (2010). Information search in decisions from experience: Do our patterns of sampling foreshadow our decisions? *Psychological Science*, *21*(12), 1787–1792. https://doi.org/10.1177/0956797610387443

Wulff, D. U., Mergenthaler-Canseco, M., & Hertwig, R. (2018). A meta-analytic review of two modes of learning and the description-experience gap. *Psychological Bulletin*, *144*(2), 140–176. https://doi.org/10.1037/bul0000115