# Assignment: Risky Choice and CPT

Manos Konstantinidis, University of Warwick 03/03/2022

## The Data

You will be working with a dataset (`DATA_Study2_Rieskamp_2008.xls`) from a paper by Rieskamp (2008). The dataset contains choices between pairs of gambles. The file on Moodle contains all gambles and choices, plus some demographic information. The sheet `gambles` summarises all unique choice pairs. The key is provided but most gamble pairs consists of lotteries with two outcomes.

## The Modelling

Your objective will be to fit **three** different versions of Cumulative Prospect Theory (see Stott, 2006; Tversky & Kahneman, 1992) to the data. The stochastic choice rule should be the **logit** rule. All fitting must be done on the individual level. There are 30 participants in total (columns in sheet `choices`). You may still aggregate your model fitting results (e.g., model parameters, parameter recovery) to answer some of the questions below.

**Version 1**: Fit the model with the $\alpha$ parameter for the curvature of the value function for both gains and losses. In addition include parameter $\lambda$ for loss aversion:

$$\begin{aligned} U(x) &= x^{\alpha} \text{ for } x \geq 0 \\ U(y) &= -\lambda|y|^{\alpha} \text{ for } y < 0 \end{aligned} \tag{1}$$

**Version 2**: Include an additional parameter $\beta$ to capture the curvature of the value function for losses (in addition to $\alpha$ for gains). This model should also include $\lambda$ for loss aversion:

$$\begin{aligned} U(x) &= x^{\alpha} \text{ for } x \geq 0 \\ U(y) &= -\lambda|y|^{\beta} \text{ for } y < 0 \end{aligned} \tag{2}$$

**Version 3**: In addition to the value function in Equation 2, you should also include a **power** probability weighting function. This function is not cumulative.

$$w(p) = p^{\gamma} \tag{3}$$

Finally, the subjective valuation of a gamble $A$ with outcomes $x_m > ... > x_1 \geq 0 > y_1 > ... > y_n$ with corresponding probabilities $p_m...p_1$ and $q_1...q_n$ is:

$$V(A) = \sum_{i=1}^{m} w(p_i)U(x_i) + \sum_{j=1}^{n} w(q_j)U(y_j) \tag{4}$$

The logit function defining the probability of a gamble $A$ being selected (compared to a gamble $B$) is:

$$p(A) = \frac{1}{1 + e^{-\tau[V(A)-V(B)]}} \tag{5}$$

## The Task

Across your modelling attempts, you *must* illustrate the following tasks:

1. **Estimate the parameter** values for each model (i.e., model fitting). Summarise the results and comment on the findings. Do you find parameter values according to the literature (e.g., $\lambda > 2$)? Make sure that the model fits are not affected by local minima.
2. **Model Comparison**: Compare the 3 different models using appropriate methods. You should be able to answer questions such as "Is the subjective transformation of probabilities via the CPT probability weighting function a necessary component to explain risky choice?" You should compare the model using the AIC **and** the likelihood ratio test (LHR), if models are nested. Do the two methods give you the same results?
3. **Make scatter plots for each pairing of parameters**, with dots for each participant. You will see that some parameters are correlated over participants. For example, participants with low $\alpha$ have high bias (in the logit rule), and vice versa. Why is this? What does it tell us about the psychological processes underlying risky choice?
4. Simulate data based on the initial model fits (from a single set of starting parameter values, i.e., the best-fitting parameters). Then, re-fit all three models to assess whether the generating parameters can be **recovered.** Describe parameter **recoverability** across all three models. If recoverability is poor, explain why this might be the case.

## The Report

Implement the models in R. Think about how best to represent risky choices and think about the best way to express the psychology in code. Credit will be given for producing readable, annotated, simple, and clear code. Write the model as a function to which the choice attributes and model parameters are passed. The function should return choice probabilities. The examples from our seminars show how to do this for the standard EUT model. You can expand this code to capture different parameters of the CPT.

Include the source code as an appendix in your report. Be sure to include comments in your code, explaining how the code relates to your description. The code should be runnable as a complete, stand alone script. That is, I should be able to copy and paste your code into R in one chunk and have it reproduce your analysis. Be cognizant of the size of your grid. Do not make it too large to avoid long computing time (larger grid does not increase your grade).

The main body of your report, excluding the source code, should be fewer than 2,500 words. A good report might be much shorter. Plots supporting your arguments are highly recommended.

## References


Rieskamp, J. (2008). The probabilistic nature of preferential choice. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *34*(6), 1446–1465. doi: 10.1037/a0013646

Stott, H. P. (2006). Cumulative prospect theory's functional menagerie. *Journal of Risk and Uncertainty*, *32*(2), 101–130. doi: 10.1007/s11166-006-8289-6

Tversky, A., & Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty*, *5*(4), 297–323. doi: 10.1007/BF00122574