Non-standard Quantum-like Models of Human Cognition

Introduction

Quantum-like' models use the mathematics of quantum mechanics without any of the physics. This includes quantum probability theory – a more general framework than classical probability theory. Because we can use the tools of quantum mechanics, in the context of human cognition we can think of perception states as quantum states and model human decisions and choices as quantum measurements.

Pictured on the right, the Lissajous curve is the main example investigated – a visual '3D knot'. This was chosen as when rotated, it is an example of a bistable perception – where one of two states may be observed at any time.

Methodology

Project aim – develop a quantum-like model to explain occurrences in human cognition.

The project had many similarities with my third-year final project, which was based on the mathematics of quantum mechanics. I prepared for this research by reviewing what I had done so far, including:

- Classical probability theory – probability and statistics module
- Quantum probability theory
- Projection operators
- Hilbert spaces

Other papers, including a study that assessed whether quantum-like models could account for the conjunction fallacy, were also useful and provided ideas to investigate. I decided to explore the Quantum Zeno effect model. I used the model of radioactive decay to approximate the decay of the bistable perception over small periods of time. Once a suitable mathematical model was found, I used Python to plot and compare the curves.

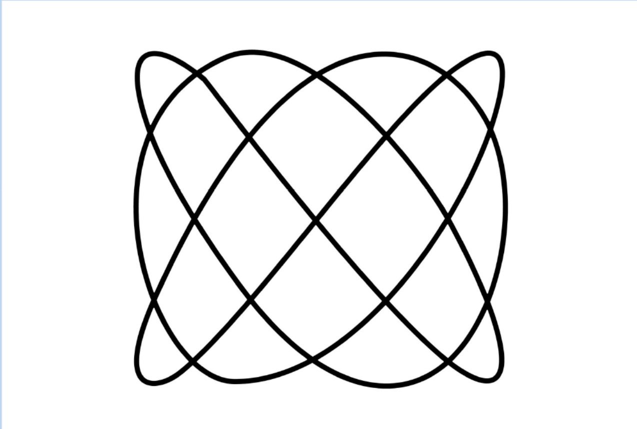

Figure 1 – a Lissajous curve.

Lissajous curves can have any number of lobes – the one pictured above has 3 horizontal and 4 vertical lobes.

Results and discussion

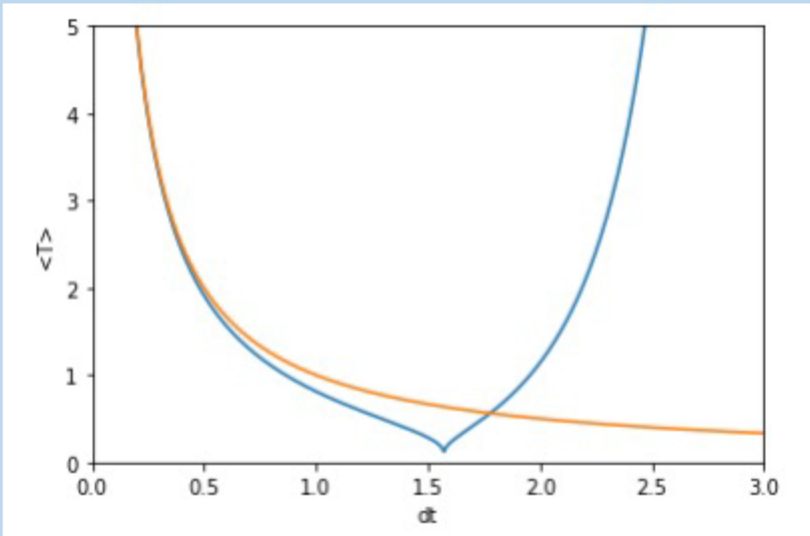

Figure 2 – plots generated in Python. The orange line represents the approximation valid for small values of t, the blue line represents the quantum Zeno effect model for all values of t.

From the results, the approximation works well for small values of t (up to around t = 0.5) but after this point the approximation no longer agrees with the quantum model. The model shows that the survival probability is revived after decay, and it is found that this cycle repeats infinitely. Future experiments and tests would hopefully confirm this theory.

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