Modality and dynamical systems theory

Sigfrid Lundberg
sigfrid@sigfrid-lundberg.se

ABSTRACT

What I believe my spring 2026 essay will be about.

My points of departure

This document is about my points of departure for my spring 2026 essay. It takes the form of a handful of theses that I will use in the forthcoming text.

1. Modal reasoning appears everywhere in science, but usually not as modal logic

According to the writings of Williamson (2018) on modal logic and dynamic systems.[1] much theory in the natural sciences is modal, albeit they do not use modal logic *per se.* Maudlin (2020) shares Williamson's views on modality in the sciences, but does so from the point of view of the philosophy of physics.

Williamson introduces modality by listing modal auxiliary verbs like

a. can, could

b. may, might, must

c. able to, has to, needs to

All of them are related to possibilities, contingencies and necessities. Williamson introduces further distinctions:

metaphysical or *objective modality:* things that are necessary or possible in the real world.

nomic modality: a special case of metaphysical modality which is related to what necessities and contingencies is entailed by the laws of nature.

dynamical, epistemic or *subjective modality:* related to whether we know something for sure or just believes it. Subjective modality seems to be a special case of epistemic modality related to the strengths of beliefs. Dynamic epistemic logic is a collection of epistemic logics each of which requiring special operators (Baltag and Renne, 2016).
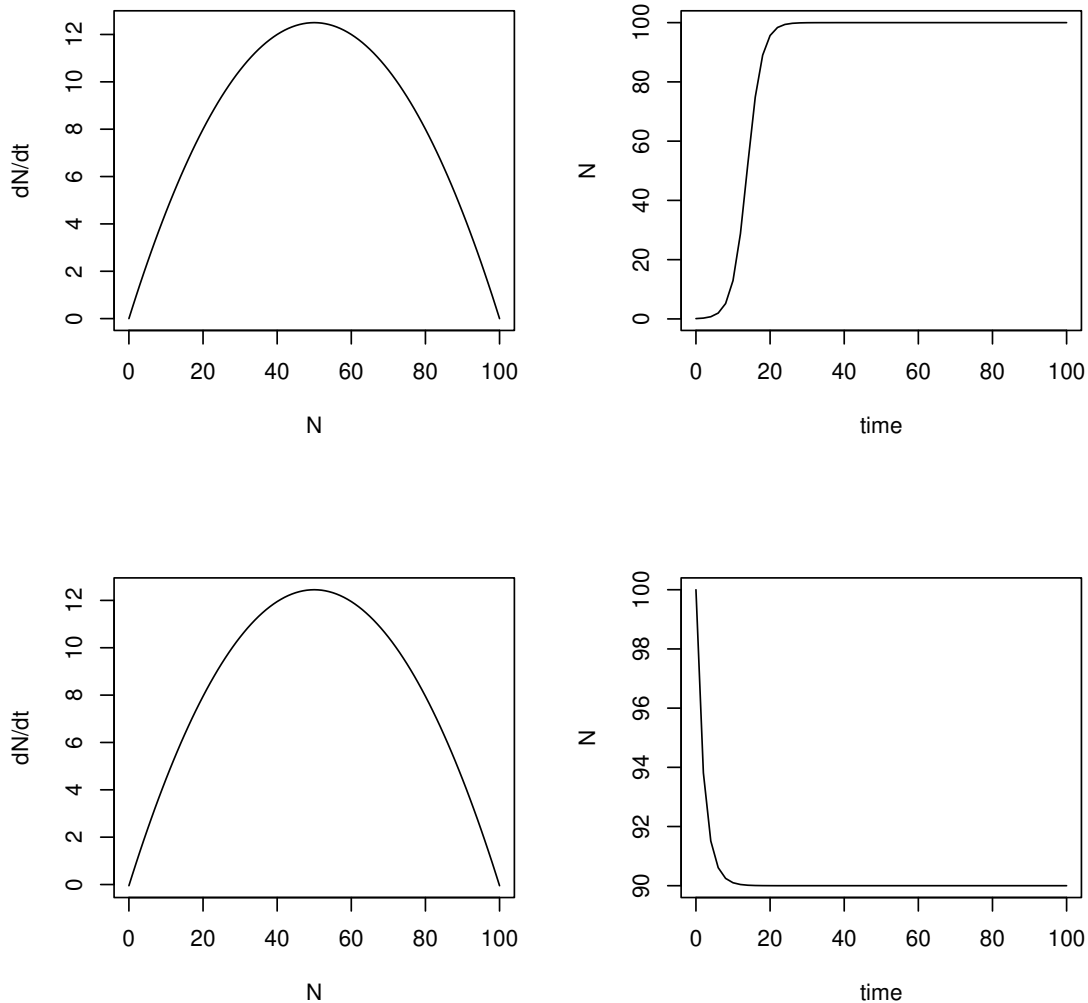
Objective and subjective modalities are Williamson's choice of terminology. He argues that this mirrors the vocabulary used for probability, where objective probability refers to truly stochastic processes and subjective probability refers to the strength of a conviction. I will follow him on this in the following, using objective and subjective as determinants for both probabilities and modalities.

Williamson spends a whole section on scepticism about objective modality. Early on that scepticism was due to the resistance agains aristotelian essentialism. That is, the idea that things have some inherent unchangeable essence that they cannot exist without, like the object o is essentially p *iff* o is necessarily p. Without p it would not exist. The scepticism of any

---

[1] The original lecture can be found on YouTube https://youtu.be/ZfaHf_TESEw

kind of essentialism this goes from Hume to Quine and beyond. It extends to virtually all kinds of objective modality, and, according to Williamson, it is not saved by nomic necessity and contingency. Thas is, one would need to show that the laws of nature entail full blown nomic modalities. This is not made easier by the fact that scientists seldom use formal logic.

Nomic modality is an obvious case where science is modal, but it is not really tractable for modal reasoning.

2. Modality and dynamical systems

The dynamical systems theory is a branch of mathematics widely used in the sciences: physics, chemistry and biology but also in social sciences and economics and more recently even in the humanities (for example in history). The study of chaos is a part of this theory. I used it extensively when working as researcher in population biology during the eighties and nineties.

A dynamical system consists of

1. a set of state variables, i.e., the variables needed to define the system such as the weights, positions and velocities of the planets in the solar system.

2. a set of equations defining the change in the state variables.

I'll give a number of concrete examples below.

The logistic equation with harvesting

The simplest system with nonlinear dynamics is the logistic equation.

3. Philosophy is the study of philosophical problem

Philosophers claim, perhaps starting with Bertrand Russell, that philosophy is defined by its problems. Russell gives an example in the first paragraph in the first page of the first chapter of his book *Problems of philosophy*

> Is there any knowledge in the world which is so certain that no reasonable man could doubt it? This question, which at first sight might not seem difficult, is really one of the most difficult that can be asked. When we have realized the obstacles in the way of a straightforward and confident answer, we shall be well launched on the study of philosophy—for philosophy is merely the attempt to answer such ultimate questions, not carelessly and dogmatically, as we do in ordinary life and even in the sciences, but critically, after exploring all that makes such questions puzzling, and after realizing all the vagueness and confusion that underlie our ordinary ideas (Russell, 1912, p. 1).

About a century later Floridi (2013) spends an entire essay on just this statement. In particular,

> The result is a definition of philosophical questions as questions whose answers are in principle open to informed, rational, and honest disagreement, ultimate but not absolute, closed under further questioning, possibly constrained by empirical and logico-mathematical resources, but requiring noetic resources to be answered.

4. The law of cause and effect are not a law of nature

5. Metaphysical grounding and ontological commitment

Quine and more

References

Baltag, Alexandru and Renne, Bryan, "Dynamic Epistemic Logic" in *The Stanford Encyclopedia of Philosophy,* ed. Zalta, Edward N. (2016). http://bit.ly/4sBdSSZ.

Floridi, Luciano, "What is a philosophical question?" *Metaphilosophy* **44**, pp. 195-221 (2013). https://doi.org/10.1111/meta.12053.

Maudlin, Tim, "A modal free lunch," *Foundations of physics* **50**, pp. 522-529 (2020).

Russell, Bertrand, *The problems of philosophy,* New York, Dover Publications (1912/1999).

Williamson, Timothy, "Spaces of Possibility" in *Royal Institute of Philosophy Supplement* **82** (2018). https://doi.org/10.1017/S135824611800019X.

Github project

Scan QR to get project at https://github.com/siglun/term-paper-spring-2026