

# Teleological Information Processing and Natural Language: A Formal Exploration with Quantum Parallels

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## Abstract

We propose a novel framework for understanding language and natural language processing (NLP) that draws upon the principle of teleological information processing. Teleological systems, by definition, function with an intrinsic end or goal-directedness. In classical computational frameworks, language models are frequently understood probabilistically, mapping from words to syntactic and semantic domains via distributional parameters. However, languages exhibit characteristics that may not be purely probabilistic but appear to be driven by context-dependent goals or intentions. Building on Wittgenstein’s maxim that “language is context, and context is meaning,” we adopt a perspective in which linguistic communication is fundamentally teleological. We compare this perspective to quantum information processing, suggesting that classical frameworks may need to be extended similarly to the way quantum mechanics extended classical mechanics. Motivated by these parallels, we propose a modification to the Schrödinger equation to incorporate teleological terms, providing a speculative but systematically motivated avenue for further mathematical and conceptual exploration.

## Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
<b>2</b>	<b>Teleological Information Processing</b>	<b>2</b>
2.1	Mathematical Foundations . . . . .	3
<b>3</b>	<b>Language, Context, and Teleology</b>	<b>3</b>
3.1	Formalizing Teleological Language Models . . . . .	4
<b>4</b>	<b>Quantum Parallels and Information Processing</b>	<b>4</b>
4.1	Quantum Information as a Bridge . . . . .	4
<b>5</b>	<b>Toward a Teleological Schrödinger Equation</b>	<b>5</b>
5.1	The Standard Schrödinger Equation . . . . .	5
5.2	Introducing a Teleological Term . . . . .	5
5.3	Interpretational and Conceptual Challenges . . . . .	6

<b>6</b>	<b>Discussion and Future Directions</b>	<b>6</b>
6.1	Implications for NLP . . . . .	6
6.2	Broader Philosophical Overlaps . . . . .	6
6.3	Quantum-Like Models of Cognition and Language . . . . .	6
<b>7</b>	<b>Conclusion</b>	<b>7</b>

# 1 Introduction

Language, in its most essential form, is a mechanism of information exchange. Traditional theories of language, such as those that spawn from generative grammar and distributional semantics, rely heavily on probabilistic structures and statistical correlations in large corpora. Despite the great success of these methods in natural language processing (NLP), they face perennial difficulties in capturing deeper contextual or goal-oriented aspects of linguistic meaning. The quest for *teleological information processing* arises from the observation that language users often direct their utterances toward specific aims or ends, and such ends might not be easily encapsulated in mere probability distributions.

There is a wide range of philosophical grounding for this perspective, notably Ludwig Wittgenstein’s *Philosophical Investigations*, where he emphasizes that “language is context, context is meaning.” If context is a dynamic interplay of goals, intentions, speaker-listener relationships, and shared knowledge, then a purely probabilistic model might fail to capture the teleological nuance of how language is created and interpreted in real, goal-driven scenarios. Teleological elements can be likened to constraint satisfaction or potential-based guidance, reminiscent of physical systems that follow a path determined by minimizing (or extremizing) an action functional.

In quantum mechanics, systems evolve according to the Schrödinger equation, a linear wave equation that underlies probabilistic interpretations but does not, in its standard form, admit *goal-directed* or *end-driven* influences. Yet, interestingly, certain interpretations of quantum mechanics (e.g., retro-causality, path integral formulations) highlight or allow for structures in which future boundary conditions may play a conceptual role. This invites the question: could a teleological principle be meaningfully incorporated into quantum or quantum-like dynamics, paralleling the introduction of such a principle into language theory?

In this paper, we develop the concept of *teleological information processing* in the context of natural language and propose a parallel extension to quantum mechanics. Specifically, we seek:

1. To formalize the notion of teleological information processing, with language as a principal example.
2. To ground this notion in Wittgenstein’s philosophical view of meaning, emphasizing context and goal-directedness.
3. To draw analogies with quantum information processing, highlighting how classical mechanics needed extension to quantum mechanics, and in a similar vein, how existing NLP frameworks might require an extension for truly context-driven and goal-oriented language use.
4. To present a speculative but formally motivated update to the Schrödinger equation that includes teleological terms, providing a blueprint for how goal-directed influences might be consistently incorporated into a quantum-like formalism.

The structure of the paper is as follows. Section 2 lays out the general concept of teleological information processing. Section 3 applies these ideas to language, guided by Wittgenstein’s “context is meaning” principle. Section 4 draws the parallel with quantum mechanics and discusses why teleological frameworks might be beneficial for capturing contextual nuances in quantum information. Section 5 proposes our modified Schrödinger equation, including teleological terms. Finally, Section 7 offers our conclusions and suggestions for future work.

## 2 Teleological Information Processing

The idea of teleology is historically tied to Aristotle’s concept of final causation. A system exhibits teleological behavior if its trajectory is guided by an endpoint or goal. Classical physics is *not* teleological in this sense; events evolve according to initial conditions and local deterministic or stochastic laws. However, in *teleological information processing*, we posit that the system is guided by constraints or potentials that inherently encode the endpoint or the intended result. For instance:

- In optimization theory, a system is driven to find minima or maxima of a given cost function—this can be described by a teleological impetus if the system’s dynamics can be seen as orchestrated by the final goal (i.e., the minimal cost).
- In certain formulations of machine learning, especially reinforcement learning, an agent modifies its actions based on a reward function. The environment plus the agent’s architecture can be viewed as teleologically oriented to maximize future rewards.

This perspective can be generalized. Instead of deriving the system’s behavior purely from initial conditions and local dynamics, we incorporate functional or goal-oriented constraints that describe the *final cause* or *target state*. In the context of natural language, the final cause could be an intended communicative effect or a shared mental model with the recipient of the communication.

### 2.1 Mathematical Foundations

From a mathematical standpoint, teleological processes can be captured by action principles that incorporate boundary conditions at both initial and final times. In classical mechanics, the action is usually specified by:

$$\mathcal{S} = \int_{t_i}^{t_f} L(q, \dot{q}, t) dt, \quad (1)$$

where  $L$  is the Lagrangian. Teleological systems might extend or modify this principle to include a term that reflects the system’s *final aim*. Symbolically, we might write:

$$\tilde{\mathcal{S}} = \int_{t_i}^{t_f} L(q, \dot{q}, t) dt + \Phi(q(t_f)), \quad (2)$$

where  $\Phi(q(t_f))$  encodes the teleological contribution—the dependence on the final state  $q(t_f)$  explicitly.

In teleological information processing, if  $q(t)$  corresponds to the state of the process (e.g., a linguistic representation or the mental state of a speaker), then  $\Phi$  is the added potential capturing the system’s desired end. This end might be:

- A semantic or pragmatic goal in language exchange,
- A problem solution in a computational process,
- A reward in a learning agent’s environment.

### 3 Language, Context, and Teleology

Ludwig Wittgenstein’s later philosophy highlights that the meaning of words arises from their use in particular contexts. He famously said, “the meaning of a word is its use in the language” and suggested that “language is context, and context is meaning.” This implies that to truly understand a linguistic utterance, we must consider:

1. The speaker’s intention,
2. The shared knowledge of the speaker and listener,
3. The pragmatic function of the utterance,
4. The social or conversational norms governing the situation.

Current NLP models (e.g., large language models trained on vast datasets) approximate meaning using *distributional* clues. They are effective in many tasks, but they can be stymied in contexts where purely statistical correlation fails to capture the *goal-directed* nuance of language. For instance, consider:

- *Indirect speech acts*: “Can you pass the salt?” is literally asking about the listener’s ability, but functionally it is a polite request.
- *Sarcasm or irony*: The intended meaning often directly contradicts the literal, surface-level interpretation.
- *Goal-oriented tasks in conversation*: When an interlocutor says, “We need to finish this by Tuesday,” the teleological (goal-oriented) dimension is that the utterance is motivating or pressuring to accomplish something by a deadline.

A purely distributional model might fail to incorporate these teleological contexts without post-hoc annotation or carefully engineered features. By contrast, in a *teleological information processing* model of language, we would treat an utterance as an action constrained not only by the grammar or statistical distribution of words but also by the intention or purpose behind uttering them.

#### 3.1 Formalizing Teleological Language Models

To formalize this, we can introduce a state space of possible linguistic acts  $L$ , and a potential function  $U : L \times C \rightarrow \mathbb{R}$ , where  $C$  is the space of contexts. Each possible utterance  $l \in L$  has an associated teleological “value”  $U(l, c)$  when deployed in context  $c$ . Suppose an agent’s language faculty operates by selecting  $l$  to maximize  $U(l, c)$  given the context  $c$ . Then:

$$l^*(c) = \arg \max_{l \in L} U(l, c). \quad (3)$$

This is reminiscent of game-theoretic or decision-theoretic approaches to language use, but here we emphasize that  $U(l, c)$  could encode *intentions* or *goals* that define the teleological impetus.

An alternate but related perspective would incorporate a dynamic evolution of states (e.g., conversation states) from an initial context to a final, desired context, with the teleological drive embedded in the transformation rules. One might define:

$$U_{\text{total}} = U_{\text{ling}} + U_{\text{goal}}, \quad (4)$$

where  $U_{\text{ling}}$  is an internal measure capturing coherence, grammaticality, or distributional plausibility, and  $U_{\text{goal}}$  measures the degree to which the utterance satisfies the speaker’s aim or modifies the shared context in a desired way.

## 4 Quantum Parallels and Information Processing

Quantum mechanics famously departs from classical mechanics by allowing probability amplitudes to interfere, leading to phenomena like entanglement and non-local correlations. Teleology is not a standard part of quantum mechanics; the Schrödinger equation,

$$i\hbar \frac{\partial}{\partial t} \Psi(\mathbf{x}, t) = \hat{H} \Psi(\mathbf{x}, t), \quad (5)$$

governs the evolution of states from an initial wavefunction at  $t_i$  to a final wavefunction at  $t_f$ , without direct reference to a *goal* or *endpoint* in the future. However, certain interpretations or formulations (e.g., the two-state vector formalism, path-integral approach with advanced actions, etc.) do incorporate boundary conditions at both initial and final times.

### 4.1 Quantum Information as a Bridge

Teleological approaches might find a natural testing ground in *quantum information* contexts. For instance:

- In quantum computing, we often design algorithms to achieve a *target* unitary transformation or measurement outcome.
- Entangled states can be viewed as resources that allow correlated measurement outcomes across spacetime, evoking speculation about whether future boundary conditions might influence the present.

Though mainstream quantum physics does not typically attribute such correlations to teleological effects, the *mathematical* structures hint that it is not inconceivable to incorporate teleological constraints in some extended formalism.

Our motivation for drawing parallels is twofold. First, *quantum mechanics* overcame the limitations of classical frameworks by fundamentally redefining the nature of physical reality and information. In a similar manner, *teleological language models* seek to overcome purely probabilistic or correlation-based approaches by introducing a goal-directed dimension. Second, the mathematical formalisms of classical and quantum physics revolve around action principles, wavefunctions, or operators that could, in principle, be extended to capture final boundary conditions encoding a teleological impetus.

## 5 Toward a Teleological Schrödinger Equation

A speculative next step is to propose a *teleological Schrödinger equation*, in which the state evolution depends not only on the Hamiltonian  $\hat{H}$  and the initial wavefunction but also on a future-oriented potential or constraint. We do so with caution, acknowledging the conceptual leaps needed to motivate such a modification.

### 5.1 The Standard Schrödinger Equation

In standard quantum mechanics, the Hamiltonian operator  $\hat{H}$  encodes all dynamical information. The equation is:

$$i\hbar \frac{\partial}{\partial t} \Psi(\mathbf{x}, t) = \hat{H} \Psi(\mathbf{x}, t). \quad (6)$$

This is typically solved with initial condition  $\Psi(\mathbf{x}, t_i)$ , and the solution at later times is fully determined by  $\hat{H}$  and that initial condition.

## 5.2 Introducing a Teleological Term

Let us suppose there exists a *teleological potential*  $\hat{T}(t)$ , which can depend on time or be implicitly defined by boundary conditions at  $t_f$ . We propose the modified equation:

$$i\hbar \frac{\partial}{\partial t} \Psi(\mathbf{x}, t) = \left( \hat{H} + \hat{T}(t) \right) \Psi(\mathbf{x}, t). \quad (7)$$

The operator  $\hat{T}(t)$  is designed such that the wavefunction at  $t_f$ ,  $\Psi(\mathbf{x}, t_f)$ , converges to a desired target state  $\Phi(\mathbf{x})$  or satisfies certain boundary conditions. Symbolically, one could define an action:

$$\mathcal{A}[\Psi, \Psi^*] = \int_{t_i}^{t_f} \left\langle \Psi \left| \left( i\hbar \frac{\partial}{\partial t} - \hat{H} \right) \right| \Psi \right\rangle dt + \mathcal{G}[\Psi(t_f)], \quad (8)$$

where  $\mathcal{G}[\Psi(t_f)]$  encodes the teleological objective at the final time  $t_f$ . Varying this action with respect to  $\Psi^*$  could yield an effective Schrödinger equation with an additional term that enforces or nudges the wavefunction toward the teleological target. For example, a penalty for deviating from  $\Phi(\mathbf{x})$  at  $t_f$  might produce:

$$\hat{T}(t)\Psi(\mathbf{x}, t) \approx \delta(t - t_f) \cdot \alpha(\Phi(\mathbf{x}) - \Psi(\mathbf{x}, t_f)), \quad (9)$$

where  $\alpha$  is a coupling constant. This is a schematic notion, reminiscent of how Lagrange multipliers might enforce constraints at boundary times.

In more continuous or smoothed-out forms,  $\hat{T}(t)$  could be designed to gradually guide the wavefunction toward  $\Phi(\mathbf{x})$ . The idea is that the system’s evolution is not exclusively determined by  $\hat{H}$  and the initial condition but also by the requirement to *end up* in or near a final target state.

## 5.3 Interpretational and Conceptual Challenges

Clearly, such an approach challenges standard quantum interpretations. Is the final boundary condition fundamental or emergent? How does one physically implement a teleological potential that depends on a future state? One possibility is that this formalism simply recasts certain advanced-time or retro-causal frameworks in more teleological language, without requiring modifications to standard quantum mechanics.

Nonetheless, if we are to treat teleological systems rigorously, we must face the conceptual puzzle that cause-and-effect is typically viewed as forward in time, whereas teleology introduces a final cause. The motivation for exploring these challenges is not to overhaul quantum mechanics but to illustrate that teleological frameworks might deepen our understanding of how certain phenomena—including advanced knowledge, goal-directed system design, or macroscopic intelligence—could operate within or parallel to quantum theory.

## 6 Discussion and Future Directions

### 6.1 Implications for NLP

The teleological perspective in language is not intended to replace existing probabilistic or distributional methods, which have proven remarkably successful in practice. Rather, it aims to offer a complementary viewpoint that might explain aspects of language use resistant to purely statistical accounts, especially those involving intention, context, and creative goal-directed communication.

Future work could integrate teleological constraints into large language models by introducing a fine-tuning or conditioning mechanism that encodes user goals, conversation endpoints, or social

constraints. In effect, these teleological constraints could steer generative models toward more contextually coherent and purposeful outputs.

## 6.2 Broader Philosophical Overlaps

Wittgenstein’s emphasis on context resonates with the concept of final causation in teleology. Both highlight that meaning emerges from the interplay of agent, environment, history, and future aims. The teleological impetus might be viewed as an emergent property of complex adaptive systems, rather than a fundamental rewriting of physical laws. However, exploring fundamental rewriting has heuristic value in clarifying potential conceptual frontiers.

## 6.3 Quantum-Like Models of Cognition and Language

Researchers in quantum cognition have already proposed that certain mental phenomena may be better modeled by quantum probability rather than classical probability (e.g., violation of classical probability axioms in human decision-making). Extending such quantum-like models to incorporate teleological constraints could be a next frontier, bridging quantum cognition, teleological philosophy of mind, and computational linguistics.

## 7 Conclusion

We have outlined a framework for *teleological information processing*, using language as a canonical example. We have argued that purely probabilistic approaches to natural language may fail to capture the essential role of goals and context as emphasized by Wittgenstein. By integrating teleological principles, one can systematically account for how language is used and understood in context-driven, purposeful communication.

Drawing parallels with quantum information processing, we have speculated on how to extend the Schrödinger equation to include teleological terms. This is a radical step meant to illustrate how a well-established formalism might accommodate *final* boundary conditions, analogous to the role of goals or ends in teleological language use. While the physical viability of such an approach remains highly speculative, it underscores that mainstream theoretical frameworks, be they classical or quantum, might find extended expression in teleological formulations.

We hope that this conceptual synthesis opens new vistas in computational linguistics, philosophy of mind, and physics. In all these fields, the recognition that systems—from speaking agents to quantum states—may sometimes evolve with an *eye to the future* rather than just the *momentum of the past* could lead to transformative insights.

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