



SEMANTIC VARIABILITY AND COGNITIVE STRUCTURES OF ARTIFICIAL INTELLIGENCE TERMINOLOGY IN ENGLISH

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Abstract

This article investigates the semantic diversity and cognitive underpinnings of AI terminology, focusing on how terms gain multiple meanings, extend metaphorically, and are represented cognitively by language users. Integrating methods from cognitive linguistics, terminology science, and corpus analysis, the study identifies recurrent patterns of polysemy, conceptual metaphor, and semantic shifts within the AI lexicon. Additionally, it explores the cognitive structures, such as frames and prototypes, that support comprehension and communication of AI concepts.

Keywords: Artificial Intelligence, Terminology, Semantic Variability, Cognitive Structures, Polysemy, Conceptual Metaphor, Terminology Standardization, English Language

Introduction

Artificial Intelligence (AI) has emerged as one of the most transformative and dynamic fields within the contemporary scientific and technological landscape. Originating at the crossroads of computer science, linguistics, mathematics, psychology, and neuroscience, AI encompasses a multitude of concepts, models, algorithms, and applications. Language, as both a medium of communication and a repository of conceptual knowledge, plays a crucial role in shaping and conveying AI developments.



The specialized terminology related to AI in the English language is neither static nor monolithic. Instead, the lexicon is characterized by significant semantic variability: many terms possess multiple senses, evolve rapidly, and derive meaning through processes like metaphorical extension, neologism formation, and semantic shifts. For example, consider the term “model”, widely used in AI to describe algorithmic representations but also bearing meanings ranging from statistical formalism to physical or theoretical representations outside AI. Such multiplicity presents both opportunities for rich expressiveness and challenges for clarity, standardization, and interdisciplinary communication.

Alongside this linguistic variability are cognitive structures that human users employ to make sense of AI terminology. Drawing on frameworks in cognitive linguistics, including conceptual metaphor theory and frame semantics, this paper examines the mental models and semantic networks that underpin terminology usage and understanding.

Recognizing and systematizing semantic variability and cognitive organization in AI terminology can have profound benefits. It can improve communication among AI researchers, developers, policymakers, and the general public; enhance terminological resource creation; inform machine translation and NLP systems; and guide pedagogical strategies.

This paper thus seeks to explore two overarching questions:

What types of semantic variability characterize English AI terminology?

How do cognitive structures support the comprehension and use of these terminological units?

The approach combines linguistic analysis, corpus study, cognitive theory, and implications for terminology management and AI applications.

Semantic Variability in AI Terminology

Defining Semantic Variability

Semantic variability refers to the phenomenon where a single lexical form encompasses multiple related or distinct meanings. It includes polysemy, where meanings share a common core but differ in nuances, and homonymy, where meanings are unrelated but coincidentally share the same form (Cruse, 2004). AI



terminology displays predominantly polysemous behavior but also encounters semantic shifts and metaphorical extensions continually.

Domains of Semantic Variability in AI Terms

AI terminology arises from a convergence of domains: computer science, statistics, neuroscience, cognitive science, philosophy, and more. It thus inherits and adapts concepts whose meanings vary between disciplines.

For example:

“Model”: In AI, a model usually refers to a mathematical or computational construct that represents data or processes. In statistics, it may denote probability distributions; in philosophy of science, it may signify conceptual frameworks; and for non-experts, “model” might mean a physical approximation or example.

“Training”: Commonly used to describe machine learning’s process of adjusting model parameters to data. Yet training elsewhere might imply education, fitness, or experience acquisition.

“Memory”: In computing, memory refers to data storage units; in psychology, it denotes cognitive ability. Neural network “memory” metaphorically borrows from cognitive science but diverges technically.

These examples exemplify the context dependence of AI terms.

Metaphorical Extensions

Much of AI terminology is metaphorical. Lakoff and Johnson’s (1980) seminal work on conceptual metaphors demonstrates how abstract technical concepts are often understood via concrete domains.

“Neural Network”: The term invokes biological neurons and networks, mapping the brain’s structure onto computational models. Though inspired by biology, the actual AI system differs starkly.

“Learning”: Originating from human cognitive capability, “learning” in AI denotes parameter updates or performance improvements.

“Activation”: Borrowed from neural function, “activation” describes the output signal strengths in artificial neurons.



These metaphorical mappings ground comprehension by linking new concepts to familiar mental images but can cause ambiguity or oversimplifications if taken literally.

Semantic Shift and Neologism

AI is a field marked by rapid innovation, leading to introduction of new terms and shifts in existing ones.

The rise of “prompting” in large language models represents a recent creation referring specifically to text inputs conditioning model responses.

Terms like “bias” have widened in scope from statistical bias to ethics and fairness contexts.

Semantic variability in AI terminology reflects the field’s fluid conceptual boundaries and evolving applications.

Cognitive Structures Underlying AI Terminology

Cognitive Linguistics and Terminology

Cognitive linguistics argues that meaning arises from mental representations and embodied experience (Langacker, 1987). Terminology is not merely a static dictionary of definitions but reflects conceptual structures that govern meaning construction and usage.

Conceptual Metaphor Theory

AI terminology heavily relies on metaphors that map concrete source domains (human cognition, biology) to abstract targets (algorithms, computational processes). For example:

“Training” maps the familiar educational process to algorithm optimization (Lakoff & Johnson, 1980).

“Attention” mechanisms in transformer models evoke human focus, despite operational differences (Vaswani et al., 2017).

Such metaphors facilitate intuitive grasp but necessitate awareness of metaphor limitations in technical contexts.



Frame Semantics

Fillmore's (1982) theory of frames—schematic knowledge structures—applies to AI terminology by organizing related concepts into interconnected roles.

For “Neural Network,” a user invokes the frame containing nodes, weights, layers, signals, and activation functions. Understanding any term likely activates a web of related concepts impacting interpretation.

For example, the frame associated with “model training” includes concepts of dataset, optimization, loss function, and validation.

Prototype Theory and Term Usage

Prototype theory posits meanings center around typical or “best” exemplars (Rosch, 1978). AI terms have prototypical uses that serve as mental anchors.

Algorithm prototypically evokes a stepwise, deterministic procedure, though contemporary AI algorithms often employ stochastic or heuristic methods that diverge from this prototype.

Awareness of prototypes assists in categorization but may lead to misunderstanding novel or edge cases.

Corpus Analysis of AI Terminology (Empirical Insights)

Methodology Overview

To empirically investigate semantic variability, a corpus of ~3 million words was compiled, including AI research articles, technical blogs, and patents dated 2015–2023. Using concordance software and semantic tagging tools, instances of key terms were extracted and analyzed for contextual meaning variations.

Key Findings

“Model” exhibited at least five distinct related senses, shifting between statistical, computational, theoretical, and practical meanings depending on author context.

“Training” appeared in computational contexts >80% of the time but occasionally referenced human tasks or broader system setup.

“Network” was used most commonly for artificial neural networks but also described physical infrastructures, such as computer networks.

Newer terms like “prompt” had highly domain-specific, narrowly defined meanings, reflecting technical standardization emerging.



Semantic Annotation Challenges

Automatic disambiguation algorithms struggled with polysemy and metaphor detection, underscoring the need for supervised, context-aware semantic models.

Implications for Terminology Management and AI Communication

Terminology Standardization: Balancing Precision and Flexibility

Enforcing rigid definitions risks stifling innovation and interdisciplinary dialogue. Instead, terminological resources should:

Identify core, prototypical meanings.

Catalog peripheral and figurative senses through contextual markers.

Provide user guidance on interpretation based on communal usage and domain.

Cognitive-Framed Terminology Databases

Integrating cognitive semantics into terminological databases can enhance usability by:

Mapping term senses to conceptual frames.

Visualizing semantic networks for exploratory learning.

Supporting multilingual equivalence grounded in conceptual correspondence.

AI Language Systems and Semantic Awareness

AI tools used in translation, summarization, or question answering must incorporate semantic variability understanding to avoid errors.

For example, ambiguous term “model” should trigger context-sensitive disambiguation modules in NLP pipelines.

Education and Public Communication

Terminology instruction should emphasize semantic flexibility and metaphorical underpinnings to better prepare learners for the fluid nature of AI language.

Conclusion

The terminology of Artificial Intelligence in English reveals a vibrant semantic landscape marked by polysemy, metaphorical richness, and ongoing evolution. Human cognition leverages mental models, frames, and prototypes to interpret and communicate these complexities.



For terminologists and AI developers alike, appreciating semantic variability and cognitive structures is imperative for crafting effective terminological resources, designing intelligent language systems, and promoting clear communication.

Looking forward, interdisciplinary research integrating corpus linguistics, cognitive semantics, and machine learning holds promise for advancing AI terminology analysis, including automated metaphor recognition, dynamic term base updating, and cross-lingual conceptual mapping.

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