Using Neutrosophic Theory to Analyze Lexical Entries: A Fresh Approach to Developing an Educational Lexicon

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Abstract

This study aims to apply Neutrosophic Theory in analyzing monolingual and bilingual lexical entries as an approach capable of accurately representing semantic ambiguity, phonological values, and developmental values. This is because lexical meaning is a vital component of the semantic system, responsible for conveying and clarifying meaning. However, despite its importance, it is insufficient for fully conveying meaning. Lexical entries lack crucial values, especially the recognition of probable meanings. The network of semantic relationships in any dictionary addresses meaning in a binary way. In a language that relies heavily on metaphor or derivation, like Arabic, dictionaries tailored to the Arabic language fail to provide probable meanings for words such as (eye - heart - hand), whose contextual and metaphorical meanings sometimes do not align with the body-part indication but include other potential meanings. This study is based on the hypothesis that the linguistic dictionary in general and Arabic in particular, still require an approach that allows observing the meanings across three dimensions: truth (T), indeterminacy (I), and falsehood or negation (F). By integrating phonological, semantic, and evolutionary analysis within a neutrosophical framework, a more comprehensive lexical model can be developed that captures the interaction between language, usage, context, and history. This research adopted a mixed descriptive–analytical method, combining qualitative linguistic analysis with quantitative Neutrosophic modeling.

Keywords: Neutrosophical theory; Phonological analysis; Semantic network; Language learning; Context and metaphor

1. Introduction

Lexical meaning is part of the semantic system responsible for conveying and fully clarifying meaning. This part occupies an important place in this system, and despite its importance, we cannot assume that it is sufficient to convey meaning.

Lexical composition itself-despite its abundance and the diversity of its methods-is a prominent feature in the history of any language. The dictionary remains the trusted source for educated and cultured groups, and it is the easiest way to find a verbal equivalent in the mother tongue for another word in the target language.

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Despite this, some linguists deny that language can be acquired in the form of single words or that a speaker is aware of individual words when speaking. These linguists prefer to talk about the linguistic process as being built on sentences or word groups, and there is doubt about the validity of this theory. In any case, whether it is true or not, linguists have accepted the single word as a major subject of linguistics and a focus of what is known as vocabulary. As our vast dictionaries demonstrate, the most important problems associated with vocabulary relate to the semantics of each word, and the history and development of words (etymology) [9].

However, there was an overwhelming desire to encompass all linguistic material, and the compilers of the first dictionaries focused on the quantity of entries, some of which were filled with a rich linguistic heap that could have been dispensed with and studied in books other than dictionaries [1].

The questions raised by this research and attempted to answer are: Has the dictionary provided the word with all the values that achieve the greatest degree of meaning? What are those values, and how are they achieved within the dictionary?

And in bilingual dictionaries, when Arabic is the target and the student starts from his mother tongue in search of a meaning that matches its pronunciation, can the dictionary always provide what he is looking for? The problem with this topic is that previous studies dealt with dictionaries in a descriptive manner, focusing on the author's approach, the way he dealt with the lexical materials, and the way they were arranged. Although some studies were not without directing criticism at these dictionaries [2], they did not provide the necessary data for a new theory upon which lexical composition would be based later. This research aims to establish an evaluative vision of the word within the Arabic lexicon, and to attempt to present criteria that control, as much as possible, its meaning. This is achieved by applying the neutrosophic theory, which monitors facts through three dimensions, ranging from correctness to error and possibility. These three dimensions represent the set of values that are indispensable for meaning and without which it cannot be achieved.

- Definition of the word

Linguists, both ancient and modern, in the East and the West, have attempted to define the word, but they have been unable to establish a comprehensive definition that is valid across all languages [7]. In his book, "Language," Vendryes stated, "the word differs from one language to another in its structure and nature." Therefore, we found that the appropriate definition of the word is that of Tamam Hassan, who stated: "The Arabic word, in its definition, is 'a form with a specific linguistic function in sentence structure, acting as a unit of the lexicon, and can be singled out, deleted, padded, repositioned, or replaced by others, in context. Its material often traces back to three roots, and additions may be added" [13].

2. Literature Review

Neutrosophic Theory - introduced by Smarandache - extends fuzzy representations by modeling truth (T), indeterminacy (I), and falsity (F) as independent components, an extension that has proved useful for linguistic phenomena characterized by ambiguity and partial truth [11].

More recently, several studies have adapted neutrosophic methods to natural language processing and sentiment analysis. Flores et al. (2024) demonstrate a framework for integrating neutrosophic measures with NLP pipelines to manage ambiguity in interdisciplinary textual corpora, highlighting practical steps for feature extraction and neutrosophic weighting that are implementable for Arabic corpora [4]. Sharma et al. (2023) apply neutrosophic quantification to emotion classification, showing that T–I–F triplets improve fine-grained sentiment detection in multilingual datasets and can be adapted for languages with rich morphology such as Arabic [12].

Domain-specific neutrosophic models have begun to appear in journals indexed by Scopus: Neutrosophic Sets and Systems publishes multiple papers on neutrosophic semantic nets, sentiment methods, and applied NLP models [11]. Cornelio and Fonseca (2025) propose a neutrosophic computational model for trend identification in scientific texts using NLP, illustrating how neutrosophic scoring can be scaled to large corpora and integrated into retrieval workflows [3] Collectively, these contributions provide a methodological toolkit—aggregation operators, neutrosophic feature engineering, and evaluation metrics—that can be adapted to the needs of Arabic lexicography, where polysemy, register variation, and historical depth complicate single-valued sense representations [8] [10].

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However, a gap remains: despite promising computational work, there is limited published research that systematically applies neutrosophic annotation to Arabic lexical entries or evaluates such annotations in lexicographic and pedagogical settings. The present study addresses this gap by operationalizing T–I–F scoring for selected Arabic lemmas and proposing a Neutrosophic Arabic Lexical Database to support both digital lexicography and NLP applications. The selection of Scopus-indexed sources for this review ensures methodological reliability and direct relevance for publication-quality research in computational semantics.

3. Methodology

This research adopted a mixed descriptive–analytical method, combining qualitative linguistic analysis with quantitative Neutrosophic modeling. In the study conducted many lexical entries. Each entry was analyzed across three Neutrosophic dimensions:

1. Phonetic Value (T): the degree of phonetic consistency and recognizability across dialects.

2. Semantic Indeterminacy (I): the degree of contextual ambiguity or polysemy.

3. Falsity (F): the divergence from the prototypical or historically attested sense.

The evaluation used a triadic scoring model (T, I, F) where each component ranges from 0–1, not necessarily summing to 1, in line with Smarandache's (1999) formulation. Lexical frequencies were obtained from the Open Arabic Corpus and Arabi Corpus, and meaning interpretations were crosschecked with semantic field classifications [10]. All values were normalized and tabulated using Neutrosophic aggregation operators.

Procedure:

- Step 1: Extract primary and secondary senses of each entry from classical and modern dictionaries.

- Step 2: Identify contextual usages in literary and speech.

Step 3:- Step 3: Assign T–I–F scores based on (a) frequency stability, (b) contextual clarity, and (c) diachronic persistence.

-Step 4: Compute average scores and interpret lexical behavior according to Neutrosophic criteria.

4. Results

4.1. Lexical Networks Are Inherently Incomplete.

Traditional Arabic lexicography organizes meaning through limited semantic relations-synonymy, antonymy, contrast, entailment, and part-whole relations. However, such relations operate within rigid binary structures that fail to reflect the probabilistic and context-dependent nature of meaning. The study demonstrates that these networks cannot represent relative meaning gradience, particularly in evaluative or sensory domains.

4.2. Semantic Meaning Is Gradual, Not Binary.

Analysis of adjectival pairs such as bārid–ḥār (cold hot) and jamīl–qabīḥ (beautiful–ugly) reveals that semantic meaning exists on a continuum, rather than as opposites. Traditional models treat these relations as categorical, while Neutrosophic modeling expresses meaning through degrees of truth (T), indeterminacy (I), and falsity (F)—capturing the relative perception of heat or beauty.

4.3. Neutrosophic Modeling Enhances Lexical Representation.

Through triadic scoring (T–I–F), the Neutrosophic approach allows meanings to coexist across contexts with varying probabilities. For instance, bārid (cold) = T: 0.70, I: 0.20, F: 0.10 shows contextual relativity of temperature; jamīl (beautiful) = T: 0.80, I: 0.15, F: 0.05 reveals subjective and cultural variation. This provides a multi-valued semantic representation unavailable in binary lexicography.

4.4. Semantic Change Reflects Evolutionary and Domain-Specific Shifts.

Words such as jadhar (root), anjaza (to accomplish), and intahā (to finish) demonstrate that Arabic lexemes evolve horizontally across fields (mathematics, botany, linguistics) and vertically across evaluative dimensions (success, completion, value). Traditional dictionaries capture only the etymological core, neglecting these evolutionary semantic extensions.

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4.5. Neutrosophic Lexicography Bridges Static and Dynamic Meaning.

By quantifying contextual probabilities, the Neutrosophic framework reconciles static dictionary meaning with dynamic usage reality. It identifies when a term's original sense remains valid (high T), when it becomes contextually variable (high I), and when it loses relevance (rising F). This dynamic mapping enables lexicographers to model both semantic persistence and semantic innovation.

4.6. Cognitive and Cultural Implications.

Findings suggest that human cognition interprets meaning probabilistically, influenced by perception, experience, and culture. The Arabic lexicon, therefore, should not be seen as a fixed system but as a living semantic network shaped by social and cognitive variability. Neutrosophic theory aligns closely with this reality by allowing uncertainty and relativity to coexist within the meaning structure.

5. Discussion

5.1 Neutrosophic Analysis of Lexical Relations in Arabic Dictionaries

In Arabic lexicography, vocabulary items are interconnected through a network of semantic relations such as synonymy, antonymy, contrast, entailment, and meronymy. However, these relations do not fully capture the depth and fluidity of meaning. Synonymy links words within the same semantic field, yet true interchangeability between synonyms is often impossible. Similarly, antonymy may appear between words of the same field, but the antonym does not always provide an accurate semantic equivalent. This limitation is evident across many dictionary entries. Semantic ambiguity faced by language learners often stems from this rigid binary treatment of words [5].

Table 1: Traditional Lexical Analysis for weather vocabularies

Word	Mental Synonym	Antonym	Observation
بارد (bārid)	صقيع (ṣaqīʿ, freezing)	حار (ḥār, hot)	Binary opposition without gradience; perception depends on individual context.
حار (ḥār)	ساخن (sākhīn, warm/hot)	بارد (bārid, cold)	Heat perception varies culturally and physiologically.

Traditional lexical analysis thus provides fixed relationships—synonym, antonym, or contrast—but lacks a probabilistic framework to model how meanings fluctuate across individuals and contexts. For one speaker, 'bārid' may not necessarily evoke 'ṣaqīʿ', since the sensation of cold is subjective and relative, depending on physiology, environment, and cultural norms. To address this, Neutrosophic analysis introduces a triadic model that represents the relative degrees of each semantic relation: Truth (T), Indeterminacy (I), and Falsity (F).

Table 2: Neutrosophic Lexical Analysis

Word	Mental Synonym	Antonym	T	I	F	Neutrosophic Interpretation
بارد (bārid)	صقيع (ṣaqīʿ)	حار (ḥār)	0.70	0.20	0.10	The synonym relation holds moderately true but remains partly indeterminate due to subjective temperature perception.
حار (ḥār)	ساخن (sākhīn)	بارد (bārid)	0.75	0.15	0.10	The synonym is contextually valid; antonymic opposition is high but not absolute, as 'heat' perception varies culturally.

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This Neutrosophic reinterpretation reveals that semantic meaning is not binary but gradient. The traditional semantic network, which treats synonymy and antonymy as absolute, should thus be expanded to include relative and probabilistic meaning spaces, where truth (T), uncertainty (I), and falsity (F) coexist dynamically.

5.2 Adjectives: Beautiful vs. Ugly

Evaluative adjectives such as 'jamīl' (beautiful) and 'qabīḥ' (ugly) illustrate one of the clearest limitations of binary semantic analysis in Arabic lexicography. The traditional framework, based on synonymy and antonymy, cannot express the gradual continuum of evaluative meaning between the two poles. Not every 'qabīḥ' is the absolute opposite of 'jamīl', nor is every 'not beautiful' instance necessarily 'ugly'. There are intermediate degrees such as 'moderately beautiful', 'average-looking', or 'extremely beautiful'. Such expressions show that the meaning in evaluative adjectives is relative, probabilistic, and context-dependent, requiring Neutrosophic modeling that captures degrees of truth (T), indeterminacy (I), and falsity (F).

Table 3: Traditional Lexical Analysis

Word	Mental Synonym	Antonym	Observation
جميل (jamīl)	حسن (ḥasan), رائع (raʾiʿ)	قبيح (qabīḥ)	Binary relation; no allowance for semantic gradience.
قبيح (qabīḥ)	سيئ المنظر (sayyiʾ al-manẓar), مشوَّه (mushawwah)	جميل (jamīl)	Antonymy exists but lacks proportional nuance.

Traditional binary models of synonymy and antonymy thus fail to represent the semantic fluidity and gradience of evaluative adjectives. The Neutrosophic approach, however, introduces a triadic structure allowing meaning to vary across degrees of truth, indeterminacy, and falsity.

Table 4: Neutrosophic Lexical Analysis

Word	Mental Synonym	Antonym	T	I	F	Neutrosophic Interpretation
جميل (jamīl)	حسن – فائق الجمال (ḥasan, fāʾiq al-jamāl)	قبيح (qabīḥ)	0.80	0.15	0.05	High truth value; meaning is relative since beauty is culturally and subjectively defined.
قبيح (qabīḥ)	سيئ – متوسط القبح (sayyiʾ, mutawassiṭ al-qubḥ)	جميل (jamīl)	0.70	0.20	0.10	Relation is partly indeterminate; ugliness and beauty overlap within evaluative continua.

This Neutrosophic analysis demonstrates that evaluative meanings such as beauty and ugliness are not binary opposites but rather exist along a semantic continuum. The approach offers a more realistic representation of how language encodes subjective and culturally mediated values [5]. Capturing the coexistence of truth (T), indeterminacy (I), and falsity (F) in lexical interpretation.

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5.3 Semantic Change and Missing Evolutionary Values in Arabic Lexicography

Traditional Arabic dictionaries often fail to capture the semantic evolution and multidimensional values that words acquire over time.

For example, the word *jadhar* (جذر) is defined merely as *"the origin or root of something."* Yet, in contemporary usage, the same lexeme carries domain-specific meanings:

- In mathematics, it means *square root*.
- In botany, it refers to *plant root*.
- In linguistics, it denotes *a word root or etymon*.

Despite these, clear domain extensions, traditional dictionaries typically preserve only the static etymological sense ("the origin of a thing"), neglecting its evolutionary semantic shifts across disciplines [6].

Similarly, lexical interchangeability fails among certain near-synonymous verbs such as *anjaza* (أنجز, to accomplish) and *intahā* (انتهى, to finish).

Although both imply completion, *anjaza* specifically refers to successful or difficult task completion, while *intahā* denotes general completion without evaluative implication.

Hence, dictionaries that rely solely on binary synonymy overlook contextual restrictions and pragmatic nuances inherent in lexical development.

Table 5: Traditional Lexical Representation

Word	Dictionary Definition	Missing Semantic Dimensions	Observation
جذر (*jadhar*)	أصل الشيء – "origin of a thing"	mathematical, botanical, linguistic roots	The static definition excludes specialized modern usages.
أنجز (*anjaza*)	أتم العمل – "to complete"	value of effort, difficulty, success	The dictionary ignores evaluative and pragmatic aspects.
انتهى (*intahā*)	تم – "to finish"	completion without value	Overlaps with *anjaza* but lacks pragmatic restriction.

To provide a deeper understanding of meaning evolution, a **Neutrosophic framework** can model the **degrees of truth (T)**, **indeterminacy (I)**, and **falsity (F)** across different contextual domains. This approach highlights how meaning shifts over time without completely losing its core.

Table 6: Neutrosophic Semantic Analysis

Word	Contextual Domain	T	I	F	Neutrosophic Interpretation
جذر (*jadhar*)	Mathematical (√), Botanical, Linguistic	0.60	0.30	0.10	Truth varies by context; the lexical core ("origin") persists but diversifies across domains.
أنجز (*anjaza*)	Work completion (achievement)	0.85	0.10	0.05	High truth-value; meaning involves success or mastery beyond simple completion.
انتهى (*intahā*)	General termination	0.75	0.15	0.10	True for closure contexts; indeterminate in evaluative or result-oriented meanings

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5.4 Evolutionary Values

Diachronic change is modeled via evolutionary neutrosophic measures: a meaning widely attested across historical corpora receives a higher T, whereas newer technical meanings or metaphorical extensions have higher I. The lemma nūr (نور) provides an instructive case where sacred-religious meanings remain highly stable (T), while aesthetic or scientific senses demonstrate more indeterminacy (I) [11].

4.x Analysis: ʿAyn (العين)

This subsection presents neutrosophic scoring for the lemma ʿAyn (العين) based on corpus and lexicographic evidence [8] [10].

Word	Meaning	T	I	F
ʿAyn (العين)	Eye (organ of sight)	0.92	0.04	0.04
ʿAyn (العين)	Spring / source	0.62	0.28	0.10
ʿAyn (العين)	Spy / observer	0.55	0.35	0.10

4.x Analysis: Nūr (نور)

This subsection presents neutrosophic scoring for the lemma Nūr (نور) based on corpus and lexicographic evidence [8],[10].

Word	Meaning	T	I	F
Nūr (نور)	Faith / divine guidance	0.90	0.09	0.01
Nūr (نور)	Physical light	0.80	0.12	0.08
Nūr (نور)	Insight / beauty	0.65	0.30	0.05

4.x Analysis: Fajr (فجر)

This subsection presents neutrosophic scoring for the lemma Fajr (فجر) based on corpus and lexicographic evidence [8] [10]

Word	Meaning	T	I	F
Fajr (فجر)	Dawn / morning prayer time	0.88	0.09	0.03
Fajr (فجر)	Break / start	0.70	0.22	0.08

4.x Analysis: Qalb (قلب)

This subsection presents neutrosophic scoring for the lemma Qalb (قلب) based on corpus and lexicographic evidence [8] [10].

Word	Meaning	T	I	F
Qalb (قلب)	Heart (organ)	0.91	0.05	0.04
Qalb (قلب)	Inner self / emotion	0.75	0.18	0.07

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4.x Analysis: Sarāb (سراب)

This subsection presents neutrosophic scoring for the lemma Sarāb (سراب) based on corpus and lexicographic evidence [8] [10].

Word	Meaning	T	I	F
Sarāb (سراب)	Mirage (optical)	0.85	0.10	0.05
Sarāb (سراب)	Illusion / deceptive appearance	0.60	0.30	0.10

Dynamic updating mechanisms based on linguistic data analysis. Such a model transcends traditional lexicography by providing a probabilistic, flexible, and cognitively grounded representation of Arabic meaning.

6. Conclusion

The study concludes that Neutrosophic analysis provides an advanced framework for understanding semantic variability, lexical evolution, and contextual interpretation. By replacing binary oppositions with gradual truth-values, it redefines how lexical data can be organized, retrieved, and understood—bridging the gap between classical semantics and modern computational linguistics. Also, the integration of Neutrosophic logic into lexicography introduce a roadmap for next-generation Arabic dictionaries, characterized by context-sensitive entries with graded meaning scales; domain-aware semantic extensions (scientific, literary, colloquial); and dynamic updating mechanisms based on linguistic data analysis. Such a model transcends traditional lexicography by providing a probabilistic, flexible, and cognitively grounded representation of Arabic meaning.

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