



UNIVERSITAT DE
BARCELONA

Grau de Llengües i Literatures Modernes

Treball de Fi de Grau

Curs 2022-2023

**EXPLORING FIGURATIVE LANGUAGE RECOGNITION:
A COMPREHENSIVE STUDY OF HUMAN AND MACHINE
APPROACHES**

NOM DE L'ESTUDIANT: Evgeniya Viskovatykh

NOM DEL TUTOR: Dra. Elisabet Comelles Pujadas



Barcelona, juny de 2023

ABSTRACT

ENG: Figurative language (FL) plays a significant role in human communication. Understanding and interpreting FL is essential for humans to fully grasp the intended message, appreciate cultural nuances, and engage in effective interaction. For machines, comprehending FL presents a challenge due to its complexity and ambiguity. Enabling machines to understand FL has become increasingly important in sentiment analysis, text classification, and social media monitoring, for instance, benefits from accurately recognizing figurative expressions to capture subtle emotions and extract meaningful insights. Machine translation also requires the ability to accurately convey FL to ensure translations reflect the intended meaning and cultural nuances. Therefore, developing computational methods to enable machines to understand and interpret FL is crucial. By bridging the gap between human and machine understanding of FL, we can enhance communication, improve language-based applications, and unlock new possibilities in human-machine interactions.

Keywords: figurative language, NLP, human-machine communication.

SINOPSI

CAT: El Llenguatge Figuratiu (LF) té un paper important en la comunicació humana. Per entendre completament els missatges, apreciar els matisos culturals i la interacció efectiva, és necessària la capacitat d'interpretar el LF. No obstant això, els ordinadors tenen dificultats per entendre la LF a causa de la seva complexitat i ambigüïtat. És crític que els ordinadors siguin capaços de reconèixer el LF, especialment en àrees com l'anàlisi de sentiments, la classificació de textos i la supervisió de les xarxes socials. El reconeixement precís del LF permet capturar emocions i extreure idees semàntiques. La traducció automàtica també requereix una representació precisa del LF per reflectir el significat previst i els matisos culturals. Per tant, és rellevant desenvolupar mètodes computacionals que ajudin els ordinadors a comprendre i interpretar el LF. Fer un pont entre la comprensió humana i màquina del LF pot millorar la comunicació, desenvolupar aplicacions de llenguatge i obrir noves possibilitats per a la interacció home-màquina.

Paraules clau: llenguatge figuratiu, processament del llenguatge natural, interacció home-màquina.

TABLE OF CONTENTS

1. INTRODUCTION.....	1
2. PART I: WHAT IS FIGURATIVE LANGUAGE?.....	2
2.1. <i>Exploring the Spectrum of Figurative Language</i>	2
2.2. <i>From Pragmatics to Technology</i>	3
3. PART II: HOW DO HUMANS UNDERSTAND FIGURATIVE LANGUAGE?.....	6
3.1. <i>Exploring the understanding of FL in humans</i>	7
3.1.1. Cognitive approach.....	8
3.1.2. Sociocultural approach.....	11
3.2. <i>Exploring sources of Figurative Language</i>	13
3.2.1. Literature.....	13
3.2.2. Social media.....	15
3.2.3. Oral speech.....	16
3.2.4. Pop music.....	17
3.2.5. Journalism	18
4. PART III: HOW DO MACHINES UNDERSTAND FIGURATIVE LANGUAGE?	20
4.1. <i>An overview of NLP and its fundamental principles</i>	20
4.2. <i>Machine learning methods for FL recognition</i>	22
4.3. <i>Application domains of FL recognition tools: social media analysis, advertising and machine translation</i>	24
5. PART IV: DISCUSSION ON COGNITIVE ABILITIES, CONTEXTUAL UNDERSTANDING AND ETHICS IN FIGURATIVE LANGUAGE RECOGNITION	26
5.1. <i>Cognitive abilities</i>	26
5.2. <i>Contextual understanding</i>	27
5.3. <i>Ethics</i>	28
6. CONCLUSION.....	30
7. WORKS CITED.....	32

List of acronyms (by appearance in text):

FL - Figurative Language

ML - Machine Learning

NLP - Natural Language Processing

MT - Machine Translation

CL - Cognitive Linguistics

CMT - Conceptual Metaphor Theory

DL - Deep Learning

AI - Artificial Intelligence

POS - Part-of-Speech

SL - Supervised Learning

FE - Feature Extraction

SE - Sentence Embedding

BERT - Bidirectional Encoder Representations from Transformers

LLM - Large Language Model

LaMDA - Language Model for Dialogue Application

ChatGPT - Chat Generative Pre-training Transformer

BART - Bidirectional Auto-Regressive Transformers

TF-IDF - Term-Frequency-Inverse-Document-Frequency

1. Introduction

Figurative Language (FL) has permeated human communication across various contexts, serving as a means to convey ideas and emotions with enhanced vividness and expressiveness. Its scope encompasses a diverse array of linguistic devices, including metaphor, simile, irony, sarcasm, and others. While FL is commonly associated with literary works and poetry, its presence extends to daily conversations, social media interactions, news articles, advertisements, and numerous other forms of communication. Despite the ease with which humans effortlessly recognize and comprehend FL, machines have faced considerable difficulties in achieving a similar level of understanding. The challenge in recognizing FL lies in its inherent complexity and ambiguity, as figurative expressions often harbour multiple interpretations and are heavily dependent on contextual cues. Researchers have thus endeavoured to equip machines with the ability to comprehend FL through various computational approaches, prominently including Machine Learning (ML) and Natural Language Processing (NLP) techniques. The recognition of FL holds significant importance in multiple domains such as sentiment analysis, text classification, and social media monitoring, given that figurative expressions often encapsulate crucial information and convey distinct emotional tones. However, the task of accurately recognizing FL remains arduous for machines, necessitating further research and development to enhance the precision of these systems.

This work encompasses an examination of diverse forms of figurative speech, employing a multifaceted framework that incorporates cognitive and sociocultural perspectives in the recognition of FL within human communication. Furthermore, it explores the application of FL in a range of contemporary contexts, highlighting its significance and relevance in today's society. Additionally, the paper investigates methods for recognizing FL in human-machine interactions, shedding light on the complexities and challenges encountered during the development process. Through this comprehensive exploration, the paper offers valuable insights into the multifaceted nature of FL and its implications for both human and technological communication systems. Part I provides a discussion on the nature of FL and a methodological framework for further computational investigation in the analysis and interpretation of FL. And, additionally, this part is followed by a discussion on human cognition and sociocultural and discourse analysis. Part II offers an examination of an

exploration of human understanding of FL, encompassing cognition, sociocultural factors and discourse analysis. Part III provides an overview of the machine approach to FL, including an introduction to NLP and its fundamental principles, an exploration of ML methods for FL recognition, and an examination of the application domains of FL recognition tools, such as social media analysis, advertising, and machine translation. In Part IV, the paper delves into a thorough discussion of cognitive abilities, contextual understanding and ethics associated with NLP for recognizing FL.

2. Part I: What is Figurative Language?

Abrams (1999) claims, that FL stands out as a deliberate deviation from the conventional meaning of words or the word order, aiming to convey a distinct meaning or create a specific impact. While figures of speech are often associated with poetry, they play a fundamental role in language and are essential across various forms of communication (Abrams, 1999). In other words, FL uses words or expressions that differ from their literal meaning to create a figurative or pictorial representation of an idea, object, or experience. Understanding FL is necessary because it is a fundamental part of human daily interactions. With FL, human communication can be embellished with deep and emotional language, can add nuance to language, and can make the language more memorable and engaging. It is also an important part of cultural identity, as different cultures may have their unique forms of FL. At the same time, FL in human communication poses significant challenges for NLP systems. Understanding and effectively processing FL is crucial for many NLP applications. Figurative expressions are pervasive in various domains, including social media, literature, advertising, and everyday conversations. They convey nuanced meanings, emotions, and cultural references that are often essential for accurate sentiment analysis, text classification, Machine Translation (MT), and other language-related tasks.

2.1. Exploring the Spectrum of Figurative Language

FL encompasses a diverse range of techniques, including metaphors, similes, hyperboles, personification and allusion that are aimed at imbuing language with richness and depth, enabling it to take on various forms and convey nuanced meanings. These techniques are important as they add creativity, and vividness to language, allowing for enhanced

communication, expression of emotions, and the conveyance of abstract concepts more engagingly. Adopting these techniques enables writers and speakers to evoke imagery, create connections between different concepts, and stimulate the imagination of the audience. It adds richness and complexity to literature, poetry, storytelling, advertising, and other forms of communication, making it an indispensable aspect of human expression. The metaphor is an FL technique that involves making a comparison between two unrelated objects or ideas by stating that one thing is another thing. It creates a vivid image and adds depth to the description. For example, “Her smile is a ray of sunshine” compares a smile to a ray of sunshine, implying that her smile is warm and bright. Also, simile is another technique employed in FL to draw comparisons between two objects, characteristics, or ideas. Typically, a simile involves the use of words such as “like” or “as” (Abrams, 1999). For instance, the phrase “He runs as fast as a cheetah” compares the speed of an individual’s running to that of a cheetah. Moreover, hyperbole is a technique that involves exaggeration for emphasis or dramatic effect. It is used to amplify a certain quality or situation beyond its literal meaning. An example of hyperbole is “I’ve told you a million times” when someone has repeated something only a few times. In addition, personification is a technique where human characteristics are attributed to non-human entities or objects. It gives them human-like qualities and helps in creating a more relatable and appealing description. Thus, “the flowers danced in the breeze” personifies the flowers by attributing the human action of dancing to them. Similarly, allusion is a literary device that refers to a person, event, or piece of literature indirectly. It relies on the reader’s familiarity with the referenced material to create a deeper meaning or connection. An example of allusion is “They are Romeo and Juliet,” alluding to Shakespeare’s characters from the play *Romeo and Juliet* to convey the idea of someone being in a romantic and charming relationship.

2.2. *From Pragmatics to Technology*

The study of FL embraces multiple fields and one of them is Pragmatics, a subfield of linguistics that focuses on the study of language in context and how meaning is constructed through communication. It explores how speakers use language to achieve specific goals. The pragmatic approach considers how context affects the meaning of language (Searle, 1986). According to this approach, the meaning of a word or expression is influenced by the surrounding communicative context. In the context of FL, the pragmatic perspective posits

that the intended meaning of a figurative expression is frequently veiled and not readily deduced from the literal interpretation of its constituent words (Searle, 1986). Instead, the speaker or writer relies on the context of the communication and the shared knowledge of the audience to convey the intended meaning (Gibbs & Matlock, 2008). For example, the figurative expression “break a leg” is commonly used in the context of theatre performances to wish someone good luck. The literal meaning of the words “break” and “leg” does not convey this intended meaning, but the shared knowledge of the theatre community and the context of the communication makes the meaning clear.

Pragmatics also emphasizes the importance of conversational implicature, which refers to the additional meaning that can be inferred from a statement based on the context of the conversation (Grice, 1975). For example, if someone says “It’s cold in here” while gesturing towards the thermostat, the conversational implicature may be that they want someone to adjust the temperature. To sum up, the pragmatic approach to studying FL highlights the importance of context, shared knowledge, and conversational implicature in interpreting the intended meaning of figurative expressions (Carston, 2002; Wilson & Sperber, 2012). In NLP, understanding the context and intention behind language is crucial for the accurate interpretation of a text. So, the pragmatic approach to FL provides useful ideas and techniques for NLP tasks, among which may be sentiment analysis, where an understanding of context and intent greatly enhances the accuracy of the analysis. Furthermore, pragmatics is the basis for developing NLP models for later use in interpreting human language, as well as taking into account the broader social and cultural context in which language is used.

One of the methodologies used to explore pragmatics and FL is Corpus Linguistics since it enables researchers to effectively capture the complexities and variations of figurative expressions. Thus, using corpus linguistics for the study of pragmatics involves gathering and analysing a large and diverse collection of authentic language data that reflects natural language use in various contexts. In the context of FL recognition, this corpus would specifically focus on capturing instances of figurative expressions, such as metaphors, similes, and idioms (Lakoff and Johnson, 2003), in their natural communicative settings to identify patterns and regularities (Stefanowitsch & Gries, 2006). Lakoff and Johnson (2003) explored metaphorical expressions in everyday language, using corpus linguistics, for instance, the phrase like “time is money” in English, where it means the notion of time being

perceived as a valuable commodity. So, to create such a corpus, researchers would collect texts from various sources, like literature, social media, news articles, and spoken conversations, that contain a wide range of FL examples. These texts would then be carefully annotated to identify and label the specific FL used, along with contextual information. This corpus would serve as a valuable resource for training and evaluating ML models for FL recognition in NLP. The large and diverse dataset would allow the models to learn and derive patterns of FL use, improving their ability to accurately identify and interpret figurative expressions in real-world text data.

Corpus linguistics techniques were originally adopted to analyze vocabulary and grammatical structures. However, recently, these techniques have been expanded to encompass diverse fields such as discourse analysis, translation studies, language learning, and various other disciplines in the humanities and social sciences (Dancygier, 2017). This methodology is particularly useful for understanding FL, as they allow for the analysis of large amounts of data and the identification of patterns in which FL is used. Besides, this methodology helps to examine the contexts in which FL is adopted and to analyze how the expressions are interpreted by different speakers or readers. This involves the identification of the various senses of words and phrases, and determining the contexts in which particular senses are most likely to be used (Steen et al., 2010).

The corpus linguistics methodology is an indispensable technique for developing models and algorithms for NLP to tackle specific tasks, such as text classification, named entity recognition, sentiment analysis, or MT, as the methodology provides the necessary foundation for building comprehensive linguistic resources and analyzing vast collections of language data. Finally, the corpus is essential for the ML models training to learn patterns and regularities in language use, and then use these models to make predictions or classifications on new language data. Such insights can contribute to the advancement of NLP models and algorithms, enabling them to achieve higher accuracy in recognizing and comprehending FL within textual data. Some advantages of the methodology include its ability to analyze large amounts of data quickly and efficiently, reveal patterns and trends in language use, and identify variations in language use across different genres and contexts. Nonetheless, there are certain limitations associated with corpus linguistics methodology. These include the need for meticulous selection and preparation of the corpus, as well as the potential challenge of

not capturing the intricacies and subtleties of language usage in authentic discourse (Stefanowitsch & Gries, 2006).

Once the corpus has been appropriately prepared, it can serve as a valuable resource for computational analysis, enabling machines to gain a deeper understanding of human language. By leveraging the corpus in computational processes, machines can enhance their language processing capabilities, paving the way for more accurate and effective natural language understanding and communication. Furthermore, this integration of corpus linguistics with computational analysis sets the stage for the field of Computational Linguistics, which plays a crucial role in NLP tasks related to FL recognition. Computational linguistics is an interdisciplinary science that combines computer science, statistics, and linguistics to study computational aspects of human language (Jurafsky & Martin, 2009). It uses algorithms, models, and statistical methods to develop systems for automatically processing and interpreting linguistic data.

Within the context of FL, computational linguistics offers the potential to enhance the accuracy and sophistication of NLP models in recognizing and comprehending the nuanced and often context-dependent nature of figurative expressions. The study of FL and the development of algorithms and models for its automatic detection and interpretation in the text is one of the main directions of computational linguistics. This involves using supervised and unsupervised ML techniques to train models on annotated FL data sets (Veale et al., 2016). For example, researchers can develop NLP systems that can generate metaphors, similes, and other types of FL in response to specific prompts or contexts (Gargett & Barnden, 2015). There are also studies devoted to the development of tools for the automatic translation of FL into different languages and the identification of cross-lingual differences in its use. (Steen, 2007). Computational linguistics provides insight into the nature of language for subsequent programming and finds practical applications in areas such as automatic language translation, sentiment analysis, and natural language generation for chatbots.

3. Part II: How do humans understand Figurative Language?

The understanding of FL from a human perspective encompasses various dimensions, including cognitive processes and sociocultural factors. This part of the paper delves into how

humans comprehend and interpret FL, disclosing the underlying cognitive mechanisms involved, the influence of sociocultural aspects, and the role of discourse analysis in unravelling the meaning embedded within figurative expressions. It is noteworthy that FL is not limited exclusively to literature, but also extends to various forms of human communication in modern society. The sources of FL, *enter alia*, may include social media interactions, everyday conversations, pop music lyrics, and journalistic texts. Exploring these diverse sources can gain a comprehensive understanding of how FL permeates different facets of human communication, reflecting and shaping our perception and interpretation of the world.

3.1. Exploring the Understanding of Figurative Language in Humans

When facing FL, it becomes necessary to move beyond the literal meaning of the words and delve into the intended meaning conveyed by the author or speaker. This entails recognizing the specific type of FL employed and identifying the precise words and phrases employed to create the figurative meaning. To comprehend FL fully, one must consider its contextual usage, the connotations of the words employed, and cultural or historical references that may hold relevance. Additionally, the audience for whom the FL is intended must be taken into account, as the meaning can vary based on the cultural background and experiences of the reader or listener. Proficiently understanding FL necessitates a blend of analytical skills, creative thinking, and cultural knowledge. From a cognitive perspective, the comprehension of FL relies on several essential concepts related to its recognition and understanding. These concepts encompass conceptual mapping, conceptual metaphor, image schemas, conceptual blending, and conceptual adjustment (Gibbs, 2008; Fauconnier & Turner, 2002). This cognitive framework provides insight into how people mentally process and interpret figurative expressions, revealing their underlying mechanisms. Furthermore, a sociocultural viewpoint recognizes the influence of social and cultural factors on the production and interpretation of FL. Language use is inherently intertwined with social norms, values, and practices, shaping the meaning and effectiveness of FL within specific cultural communities. Examining FL through a sociocultural lens enriches our understanding of how its meaning and impact are socially constructed and negotiated. The discourse perspective allows us to investigate FL within the broader context of communication. By analyzing FL as it functions in various discourse genres, such as literature, advertisement, or

everyday conversations, we can uncover the nuanced ways in which FL operates to convey meaning, evoke emotions, and achieve rhetorical purposes. This part aims to explore the multifaceted nature of FL understanding, drawing insights from cognitive, sociocultural, and discourse approaches. By integrating these perspectives, we can gain a comprehensive understanding of how humans process and interpret FL, paving the way for advancements in the development of NLP models and algorithms that can accurately recognize and comprehend FL in text.

3.1.1. Cognitive approach

Studying how the human brain understands FL is a task of Cognitive Linguistics (CL). According to this approach, for humans, language is a reflection of the world around them and how people perceive it (Lakoff and Johnson, 2003). Cognitive processes such as conceptual metaphor, image-schemas, conceptual mapping, conceptual confusion and conceptual adaptation are central to understanding, knowledge acquisition and effective communication and allow people to navigate the complexities of language, comprehend abstract concepts and adapt their understanding to specific contexts.

The Conceptual Metaphor Theory (CMT) proposed by Lakoff and Johnson (2003) underscores the significance of conceptual structure in shaping the meaning of linguistic expressions. According to CMT, one crucial notion is that of conceptual metaphor, which posits that individuals comprehend one domain of experience in terms of another. This conceptual metaphor serves as a central concept within the field of CL, which postulates that language reflects underlying cognitive structures and processes. The essence of conceptual metaphor lies in the human capacity to comprehend abstract or intricate concepts by mapping them onto more tangible, sensorimotor experiences (Lakoff & Johnson, 2003). In simple words, humans use their physical experience to understand abstract concepts. Revealing the cognitive structures underlying the use of metaphorical language can provide insight into how people understand and make sense of the world around them (Gibbs, 2008). For instance, Gibbs (2008) explores the concept of “love” which is often understood in terms of a “journey” or a “physical force”. Therefore love as a combination of intimacy, passion and commitment in a relationship is not fixed and unchanging, but rather is constantly changing and adaptable. Expressions such as “head over heels in love” or “taking the next step” in a

relationship exemplify how our comprehension of physical journeys is invoked and extended to interpret the abstract notion of love (Gibbs, 2008).

Another important concept in CL is image-schemas. According to Lakoff and Johnson (2003), the notion of image-schemas is a recurring pattern of perceptual and motor experiences that gives rise to a conceptual structure. These patterns are considered to be fundamental building blocks of thought and language, and they underlie the formation of more complex concepts (Hampe et al., 2005, pp.15-33). Hampe et al. (2005) explore image-schemas and claims that they are not mental pictures or visual images in the traditional sense, but rather they are basic structures of mental representation that can be experienced through a variety of sensory modalities, including vision, touch, and kinaesthesia. According to Hampe et al., (2005) image-schemas include container, path, source-path-goal, balance, and centre-periphery. The container image-schema involves a bounded region that contains or constrains something, such as a box or a room, while the path image-schema refers to a trajectory through space, which can be used to conceptualize not only physical movement but also more abstract ideas like the progression of time or the development of an argument (pp. 35-55). The source-path-goal image-schema is frequently used to talk about abstract concepts like achieving goals or the trajectory of a life (pp. 57-91). The balance image-schema involves the conceptualization of two or more entities in opposition that are balanced or counterbalanced against each other (pp. 113-135). This can be seen in metaphors in common idiomatic expressions such as “finding a balance between work and life” or “walking a tightrope between success and failure”. The image of balance can be used to understand a wide range of concepts, from physical objects to abstract ideas. Lastly, the centre-periphery image-schema involves the conceptualization of a central entity surrounded by a peripheral entity or entities (285-311). This can be seen in metaphors such as “the heart of the matter” or “the outskirts of the city”. The image of centre-periphery can be used to understand concepts related to hierarchy, power, and importance, among others (Lakoff & Johnson, 2003). All these image-schemas are used to understand and convey abstract ideas through metaphorical language (Lakoff & Johnson, 2003).

Conceptual mapping is another cognitive process that plays a vital role in identifying and representing the relationships between concepts or ideas and it allows individuals to organise and visualise the connections between different concepts, thereby enhancing their

understanding of complex ideas (Gibbs, 2008). Mental models and metaphors are commonly employed in conceptual mapping to facilitate this process. Mental models serve as cognitive representations of the world, drawing upon previous knowledge and experiences, while metaphors enable the comparison of seemingly unrelated elements to establish novel associations and connections between concepts (Fauconnier & Turner, 2002).

Besides, in the realm of cognitive processes, conceptual blending emerges as a mechanism for integrating multiple conceptual domains into a coherent mental space. This blending process facilitates the exploration of new ideas and the discovery of fresh insights (Fauconnier & Turner, 2002). By enabling reasoning about complex or abstract concepts, conceptual blending allows for the generation of innovative knowledge and understanding through the integration of information from diverse sources and domains. This intricate process entails the identification of distinct mental spaces representing specific domains or concepts, which are subsequently mapped onto a newly formed blended space incorporating elements from each of the original spaces (Fauconnier & Turner, 2002). Conceptual blending proves invaluable in fostering creativity, problem-solving, and idea generation. For instance, the metaphorical expression “time is money” involves the blending of the mental spaces associated with “time” and “money,” resulting in a novel understanding of time as a valuable resource that can be expended or squandered (Gibbs, 2008).

On the other hand, conceptual adjustment constitutes a process whereby the meaning of FL is adapted or modified based on the specific context in which it is employed. This process draws upon our knowledge and experiences to interpret the meaning of FL in different situations (Gibbs, 2008). Conceptual adjustment shares close ties with contextual adjustment, which refers to the adaptation of language meaning based on the surrounding context (Gibbs, 2008). While both processes involve drawing upon our knowledge and experiences to comprehend language in diverse situations, conceptual adjustment specifically pertains to FL. The dynamic interplay between conceptual blending and conceptual adjustment as cognitive processes allows for the creation of new knowledge, enhanced understanding, and the ability to adapt our comprehension of language according to the specific context in which it is used. These processes serve as fundamental components of effective communication and contribute to our ability to navigate and make sense of the intricate complexities of the world around us.

To sum up, all these cognitive processes interact in complex ways to facilitate the recognition and comprehension of FL, which allows us to communicate complex or abstract ideas more vividly: conceptual metaphor enables the understanding of complex concepts by relating them to concrete experiences, aiding comprehension of abstract ideas; image-schemas serve as foundational elements of thought and perception, allowing individuals to categorise and comprehend the world around them; conceptual mapping facilitates the identification and representation of connections between concepts, enhancing understanding; conceptual blending integrates multiple domains, fostering creativity and problem-solving; conceptual adjustment adapts the meaning of FL based on specific contexts, ensuring accurate interpretation.

3.1.2. Sociocultural approach

In addition to the cognitive approach discussed above, the socio-cultural perspective highlights the role of social and cultural factors in understanding and use of FL. This approach accentuates the social and cultural factors that are fundamental for use and interpretation of FL and adjusts with the social context, which includes the general cultural knowledge, beliefs and values of a particular community (Wierzbicka, 1992). Thus, FL reflects the features of cultural values and can also serve to reinforce or challenge them. For example, certain metaphors or idioms may be more commonly used within certain communities or cultures, reflecting their shared experiences and perspectives (Gibbs, 2008). Similarly, FL in literature can convey cultural and historical knowledge and challenge or reinforce dominant cultural narratives (Gibbs, 2008). Understanding these metaphors and idioms requires knowledge of the cultural context in which they are used, including the history, traditions and cultural values of the community. In addition, the socio-cultural approach recognises the power dynamics of language use. FL can be used to boost existing power structures or to confront them, depending on the context and the speaker's intentions. For example, a marginalized group may use FL to reclaim power and subvert dominant cultural narratives. In the song *Respect* by Aretha Franklin (1967), she sings to her partner, "What you want? Baby I got it. What you need? You know I got it. All I'm asking for is a little respect when you come home." Although the lyrics could be sung by anyone, Aretha's rendition gives them a particular significance. Patricia Collins (2002) says the song functions as a metaphor for the state of African Americans in a racist society, but Aretha's identity as a

black woman adds a layer of meaning to that song. When listening to the song, the African American women in the audience perceive a sense of collective identity, leading to the metaphorical use of the pronoun “we” (pp.116). This allows the lyrics to carry a powerful message for a marginalized group reclaiming their rights through music. The socio-cultural approach to FL is applicable in various fields, including linguistics, anthropology and communication studies. It provides a framework for understanding how language use is shaped by social and cultural factors and how FL can serve as a tool to reinforce and challenge cultural values and power structures.

Furthermore, the sociocultural approach emphasizes how societal norms, power dynamics, and cultural ideologies shape the production and reception of discourse. Building upon this perspective, discourse analysis delves deeper into the specific linguistic features, structures, and discursive strategies employed within social contexts. By examining the intricacies of language in use, discourse analysis uncovers the underlying meanings, ideologies, and social practices embedded in discourse. The analysis based on sociocultural factors focuses on how figurative expressions function within larger communicative contexts. The analysis emphasizes that FL is not just a matter of individual words or phrases, but also involves the social and cultural context in which it is used (Ferrando et al., 2019). Discourse analysis does not consider FL as an isolated linguistic category, but rather as an integral part of language use within a larger discourse, where discourse analysts examine its contextual usage and effectiveness in achieving specific communicative purposes.

Dongman Cai and Alice Deignan (2019) analysed an example from *The China Daily*, a Chinese English-language newspaper, “... More remarkable is China’s readiness to dance with “wolves” fed by the global free trade system” (Ferrando et al., 2019, p. 57). In the given example, employing a discourse analysis would entail analyzing the usage of the idiom “dance with wolves” within the specific context of China’s involvement in international trade, focusing on its meaning, connotations, and communicative purpose. Notably, corpus evidence indicates that the idiom “dance with wolves” is rarely employed apart from its association with the 1990 film by Kevin Costner. However, the idiom carries an established connotation of exhibiting courage and expertise when dealing with unpredictable and potentially perilous forces. Within this particular context, China’s expansion of trade relations with influential developed nations, who possess expertise in international trade regulations,

could be seen as an act of bravery (Ferrando et al., 2019). This example shows that discourse analysis is a valuable tool for examining the use of FL in different contexts and for understanding how it is used to achieve specific communicative objectives. By integrating the sociocultural approach with discourse analysis, researchers can gain a deeper understanding of how FL is situated within specific social and cultural contexts. This combination allows for a more nuanced analysis of figurative expressions, considering not only their cognitive aspects but also their sociocultural meanings and functions. It helps reveal the social dynamics and power relations at play in the use of FL and enables a more comprehensive recognition and interpretation of figurative expressions in different communicative settings.

3.2. *Exploring sources of FL*

FL, with its vivid and imaginative expression, plays a crucial role in various forms of human communication. Understanding its presence and usage in different sources is essential for comprehending the richness and nuances of language. This subpart explores the sources of FL, focusing on its manifestation in literature, social media, oral speech, pop music, and journalism. Examining these diverse sources provides valuable insights into the prevalence and significance of FL in different contexts.

2.2.1. Literature

Literature serves as a treasure trove of FL, offering an extensive array of metaphors, similes, and other “poetic devices”¹. It showcases the artistic and creative use of language, enabling authors to evoke emotions, create vivid imagery, and convey complex ideas. The analysis of FL in literature not only enhances our appreciation of literary works but also deepens our understanding of human expression and storytelling. For example, in Act 5, Scene 5 of William Shakespeare’s play *Macbeth*, there is a notable example of metaphor when the Macbeth delivers the lines:

*”Life’s but a walking shadow, a poor player
That struts and frets his hour upon the stage
And then is heard no more. It is a tale
Told by an idiot, full of sound and fury,
Signifying nothing” (5.5.23-27).*

¹ “poetic devices” is a metaphor applied by the author of this paper referring to the variety of FL forms

Here, Macbeth upon hearing the news of his wife's death, reflects on the fleeting nature of life and the inevitability of death, employing metaphors and repetition to convey the meaning. The analysis of this passage through various literary lenses, such as historical, cultural, and formalist approaches, further enhances our understanding of its significance (Bradley & Bayley, 2005). In the ongoing exploration of FL application in literature, Ezra Pound's poem *In the Station of the Metro* emerges as an indispensable focal point where similes are employed. The lines "The apparition of these faces in the crowd; / Petals on a wet, black bough" create a vivid image of the ephemeral and ghostly nature of the faces observed in a Parisian subway station. The simile comparing the faces to "apparitions" captures their fleeting quality, while the comparison to "petals on a wet, black bough" suggests fragility, impermanence, and beauty (Kenner, 1971). Through these similes, Pound conveys the transience of human experience and the interconnectedness of individuals.

James Stephens also adapts FL in his poetry, skilfully employing the technique of personification in his poem *The Wind*. The wind as a natural phenomenon is personified as a living being, standing up, giving a shout, whistling on its fingers, and kicking the withered leaves about. This personification breathes life into the wind, making it relatable and easier to imagine. Another example of FL is hyperbole, widely used in Franz Kafka's novella *The Metamorphosis*. In the story, hyperbole is employed to emphasize the absurdity and surreal nature of the protagonist Gregor Samsa's transformation into a giant insect. Gregor's desperate hunger is exaggerated when he anxiously says, "I'd like to eat something, but not anything like they're eating. They do feed themselves. And here I am, dying!" (Kafka, 2023). The use of hyperbole "dying" intensifies the extreme nature of Gregor's condition. Additionally, hyperbole is also used by Gregor's sister, who refers to him as a "monster," highlighting the drastic change he has undergone and emphasizing the horror and isolation he experiences.

These examples of FL in literature not only disclose its capacity to enrich meaning, elicit emotional responses, and conjure vibrant imagery but also highlight the significance of studying and analyzing its presence across diverse sources. This exploration of FL in literature and poetry works does not only deepen our comprehension of language, culture, and the human experience, but it also holds relevance in the field of NLP by providing

insights into how language is employed creatively and metaphorically, thus enhancing the development of language models and computational interpretation of linguistic data.

3.2.2. Social media

In the virtual space of social media, FL is omnipresent, shaping the way we communicate and interact with others. The brevity and immediacy of platforms like Twitter and Instagram have given rise to innovative and concise forms of figurative expression, such as hashtags and emoji. The study of FL in social media allows us to unravel its evolving nature, its role in shaping online discourse, and its impact on digital culture. Social media users often use FL to briefly and memorably express emotions, opinions, and ideas. For example, figurative expressions are used to describe feelings as well as to express opinions or criticism. Moreover, social networks have recently become a limitless source of data for analyzing and developing computational tools for NLP.

FL in social media is often expressed through the use of hashtags. These are keywords or phrases preceded by the “#” symbol. Hashtags are quite common on social media and serve to express certain ideas, emotions or social issues, as well as to connect with other users who share similar interests or opinions. They are used to convey meaning beyond the literal interpretation of individual words or an association of concepts. Hashtags often incorporate wordplay, puns, or cultural references to convey humour, irony, sarcasm, or emotions. For example, the hashtag #tbt (Throwback Thursday) is often used to share old photos or memories, while #ootd (Outfit Of The Day) is used to showcase fashion choices. During the COVID-19 pandemic, many people started growing beards while in quarantine. The hashtag #quarantinebeard became popular on social media as people shared photos of their facial hair. Another interesting hashtag is #кактебетакоеилонмаск, a Russian hashtag that translates to “How do you like this, Elon Musk?” It is a popular hashtag on Russian social media, particularly on Twitter, where users speculate and discuss Elon Musk’s latest activities and projects and mock the nonsensical inventions. This can be considered FL in that it uses the name of a famous person, Elon Musk, as a shorthand for discussing a broader topic or trend, in this case, technological innovation and entrepreneurship. Hashtags are also used for solidarity with some social or political movements. For instance, #MeToo is used to express support to victims of sexual harassment, and the hashtag #BlackLivesMatter or #BML (#bml)

is used to protest against police brutality and racial injustice. The use of hashtags as FL allows individuals to express themselves in creative and meaningful ways.

Another characteristic of FL in social networks is the use of emojis, which are pictograms or ideograms that represent emotions, objects, or concepts. Emojis are often used to complement or replace text, and they can convey complex meanings in a simple and visually appealing way. For example, the “face with tears of joy” emoji is often used to indicate laughter or amusement, while the “folded hands” emoji is often used to express gratitude or prayer.

Social media communication using figurative speech allows users to convey the meaning of messages effectively and creatively. Since social media operates in a fast-paced environment, users have to adapt quickly to changes and trends, so using FL allows them to keep up the pace and connect with others. In addition, FL creates a sense of togetherness based on shared experiences, thoughts and values. Thus, FL has become an integral part of social networking culture and is likely to continue to evolve and shape online communication.

3.2.3. Oral Speech

Oral speech, including daily conversations, short talks, speeches, and presentations, provides a rich source of FL. People employ metaphors, idioms, and other figurative devices to convey meaning, add emphasis, and establish rapport. Investigating FL in oral speech enhances our understanding of how language is used in real-time interactions, revealing the intricacies of communication and the social dynamics involved.

FL is ubiquitous in English-speaking environments, particularly in colloquial speech. One of the most common figures of speech is the idiom, which is “a group of words in a fixed order that has a particular meaning that is different from the meanings of each word on its own” (McIntosh, 2013). FL is not limited to written communication, but it also permeates oral speech in various forms. In everyday conversation, certain phrases have become so commonplace that they are used almost unconsciously. These expressions often convey a deeper meaning beyond their literal interpretation. Here are some examples of common phrases in English-speaking environments and their meanings. A casual greeting “How’s it going?” inquires about someone’s well-being. It can be used simply as a greeting or as a way

to ask about someone's current state. Another common greeting that serves a similar purpose is "What's up?" This phrase can also be used to ask what someone is doing or what is new in their life. These phrases are commonly operated in informal conversations and their figurative meaning differs from their literal meaning.

By incorporating the analysis of FL in daily conversation, NLP researchers and developers can improve the accuracy and effectiveness of language processing models. This includes tasks such as chatbot interactions, where capturing the intended meaning of figurative expressions plays a crucial role. Therefore, by considering the presence and impact of FL in daily conversations, NLP systems can better capture the subtleties and contextual nuances in human communication, leading to more accurate and meaningful language understanding and generation.

3.2.4. Pop music

Pop music has long been recognized as a powerful medium for figurative expression. Song lyrics often employ metaphors, similes, and other rhetorical devices to evoke emotions, convey messages, and capture the human experience. An analysis of FL in pop music enhances our appreciation of its artistic and expressive impact, as well as its role in shaping popular culture.

Pop music is a common form of popular culture, and can be seen as a reflection of the language of a particular social group. Song lyrics often include colloquialisms and cultural references specific to a particular time, place, or cultural background. In addition, pop music is composed to be accessible and understandable to a wide audience, which further strengthens its connection to everyday communication. Metaphors are especially common in pop music lyrics because they allow performers to compare one thing to another in a way that creates a strong image or feeling. For example, in Taylor Swift's song *Love Story*, she uses a metaphor to compare her love to a fairytale: "Cause you were Romeo, I was a scarlet letter / And my daddy said stay away from Juliet." Here, Romeo and Juliet represent the idea of perfect, tragic love, while the "scarlet letter" (Hawthorne, 1850) represents the societal disapproval that Swift feels she faces. The phrase "a dime a dozen" used in the song *Hard to Handle* by The Black Crowes is another example of the use of FL in pop music. The full phrase in the song is "Boys will come along, a dime by the dozen". The phrase "a dime a

dozen” is a common idiom in English that means something is abundant and easy to find or very common (McIntosh, 2013). In this case, the songwriter has slightly altered the idiom to “a dime by the dozen” to fit the rhyme scheme of the song. The use of FL in pop music is often intended to create a catchy and memorable phrase, as well as to add depth and meaning to the lyrics. In this case, the use of the idiom “a dime a dozen” or “a dime by the dozen” suggests that the speaker views boys or men as being easily accessible and common, but perhaps not particularly valuable or special.

The use of FL in pop music is important in the field of NLP due to its widespread popularity and cultural significance. Analyzing the presence of FL in pop music lyrics contributes to the advancement of NLP systems by enhancing their ability to understand and generate natural language. Additionally, the study of FL in pop music allows for insights into cultural and social dynamics. Pop music reflects contemporary trends, attitudes, and societal issues, providing a rich source of linguistic and cultural data. By analyzing FL in pop music, NLP researchers can gain a deeper understanding of the evolving nature of language, cultural references, and the connection between language and popular culture. This understanding is valuable for developing more culturally-sensitive and context-aware NLP models that accurately capture the nuances of language used in different cultural contexts.

3.2.5. Journalism

Finally, journalism presents a unique context for the use of FL. Journalists employ metaphors, allusions, and other figurative devices to engage readers, simplify complex topics, and convey editorial perspectives. Examining FL in journalism enhances our critical reading skills, helps us discern biases, and underscores the influence of language in shaping public discourse.

FL in journalism to add interest and color to news stories, and to make them more captivating for readers. One example of FL in journalism is the use of metaphors to describe complex issues or events in a more relatable way. For example, a journalist might use the metaphor of a “ticking time bomb” to describe a situation that is on the verge of becoming a major problem or crisis. For instance, the use of the phrase “ticking time bomb” as a title in *The Daily Star’s* article written by Helemul Alam about the emergency condition of septic tanks in Dhaka, Bangladesh is an example of FL in journalism. This phrase is known and

used to describe a potentially dangerous situation that could suddenly arise and cause significant damage if not dealt with in advance. In the context of the article, the use of “time bomb” emphasizes the urgency and seriousness of the situation in Dhaka, where the lack of proper maintenance and infrastructure has led to a high risk of accidents, disease outbreaks, and environmental pollution (Helemul Alam, 2022). The phrase creates a vivid image in the reader’s mind, emphasizing the need for immediate action to prevent a potential disaster.

Another example is the use of personification, where inanimate objects or concepts are given human-like qualities. For instance, *Daily News* and *New York Post* described Storm Irene as “angry” or “monstrous” in August 2011 (McGeveran, 2011). Journalists also frequently use similes, where one thing is compared to another using “like” or “as”. For example, the common phrase “grow like a weed” can be used to describe the outstanding profits of some companies in a financial press. The title of the article on the *NBC* news webpage reads “Growing like a weed? California marijuana market off to slow start” (White, 2018). The title employs the metaphor of “growing like a weed” to describe the current state of the California marijuana market. Although the metaphorical phrase is usually used about rapid growth, in this case, it takes on a more literal meaning, as it refers to the cultivation of marijuana plants. In addition, the use of the word “weed” in the context of the article is noteworthy, as it is a common slang term for marijuana. Finally, journalists also use hyperbole, which involves exaggerating for effect. For instance, the title of the article in the *Washington Post* from September 2019 “Even as President Trump slams the door on refugees, there is reason for hope” employs a hyperbole, a FL device used to amplify a point. In this title, hyperbole is found in the expression “slams the door,” which exaggerates the intensity of President Trump’s stance towards refugees (Young, 2019). This hyperbolic language serves to underscore the writer’s, Julia G. Young’s, negative opinion of Trump’s policy and implies that the circumstances are exceedingly difficult for refugees. FL is frequently used in journalism to convey complex ideas and engage readers emotionally. It can help create a sense of urgency and importance, as well as give the story some depth and subtlety.

Journalism, as a form of human communication, is a great source of linguistic data. By examining the presence of FL in journalism, NLP researchers can gain insights into the biases, perspectives, and implicit meanings that influence news reporting. This understanding

helps in developing more context-aware and culturally-sensitive NLP models, facilitating the detection of subtle nuances and potential biases within news articles. And overall, understanding the presence and use of FL in these diverse sources is crucial for NLP applications. NLP models and algorithms need to accurately recognize and interpret FL to ensure effective communication and comprehension. Moreover, studying FL in various sources enhances the development of NLP systems that can generate and analyze language with the same level of nuance, creativity, and expressiveness as humans.

4. Part III: How do machines understand Figurative Language?

This part offers a comprehensive overview of NLP and its fundamental principles, with a specific emphasis on the recognition of FL. The core concepts and techniques of NLP are examined, emphasizing their importance in language comprehension and analysis. Subsequently, an exploration of rule-based, probabilistic and Deep Learning (DL) methods employed for the recognition of FL is undertaken, encompassing an examination of the diverse approaches and algorithms used in this field. The subsequent focus shifts to the application domains of FL recognition tools, encompassing social media analysis, advertising, and MT. These domains serve as platforms to demonstrate the practical implications of FL recognition in real-world scenarios, revealing its influence on sentiment analysis, targeted marketing strategies, and cross-lingual communication. Through this comprehensive study, valuable insights into the advancements and challenges associated with recognizing and interpreting FL across various contexts and domains are gained, ultimately illuminating the evolving landscape of NLP research and its broad-ranging applications.

4.1. An overview of Natural Language Processing and its fundamental principles

Since one of the main goals of Artificial Intelligence (AI) was and is to develop machines and computer programs that can perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making and natural language understanding, the figurative speech understanding at the cognitive human level remains an ongoing challenge for researchers in the field of AI and NLP. NLP originated in the 1940s, post-World War II, to automate language translation. However, the complexities of this task became evident, challenging initial expectations. By 1958, researchers, including Noam

Chomsky, raised concerns regarding the development of NLP, particularly the treatment of nonsensical yet grammatically correct sentences compared to rational and ungrammatical sentences (Chomsky, 2007). This highlighted the need for a deeper understanding and analysis of language beyond surface-level grammar. Despite significant advancements in recent years, machines still struggle to fully grasp the complexities and nuances of FL in the same way as humans do (Reddy, 1988). FL is an important task for NLP because it often goes beyond the literal meaning of words and requires an understanding of context, cultural references, and social norms.

NLP adopts a combination of techniques taken from linguistics, computer science, and cognitive psychology to process, analyze, and generate human language. The three areas of linguistics - pragmatics, syntax and semantics - are central components to comprehend and interpret human language by machines. Syntactic analysis captures the grammatical structure of a sentence and breaks it down into its constituent parts. NLP employs semantic analysis to discern the meaning of the text and extract relevant information. And the pragmatic analysis is employed to enable NLP systems to comprehend the intended meaning of a text and determine the most appropriate response.

Due to its inherent complexity, FL typically occupies a prominent position at the later stages of the NLP pipeline analysis. This complex analysis aims at comprehensively understanding and interpreting FL and involves multiple stages, like Part-of-Speech (POS) tagging, which assigns grammatical categories to words, syntactic analysis to understand the grammatical structure, and semantic analysis to extract meaning and infer relationships between words and phrases. The computational performance of the analysis employs various methodologies, encompassing rule-based approaches, and statistical methods techniques (Jurafsky & Martin, 2009), each offering distinct advantages and considerations in tackling the complexities of FL. These different approaches offer distinct advantages and can be employed based on the specific requirements and objectives of the NLP task at hand. Rule-based systems use predefined rules and patterns to analyze texts, while statistical methods rely on probabilistic models to capture the likelihood of different language patterns and make predictions based on observed data.

DL has emerged as a powerful approach in NLP to address the challenges posed by FL detection (Goodfellow et al., 2016). Unlike traditional methods, rule-based and statistical, that assume simultaneous availability of input data and ignore temporal aspects, DL considers the dynamic nature of language (Jurafsky & Martin, 2009) and the intended meaning beyond literal interpretation. By training neural networks on large-scale data, DL models can capture complex patterns and dependencies in the language in general and FL in particular. Recurrent Neural Networks (RNNs) (Goodfellow et al., 2016) are commonly used in NLP to model sequential data by maintaining a hidden state that captures previous inputs and context. Convolutional Neural Networks (CNNs) (Goodfellow et al., 2016) excel in tasks involving fixed-length inputs, such as text classification, by learning local patterns and features. DL models are trained using optimization algorithms like gradient descent to minimize a loss function, enabling them to make predictions on new data. Thus, DL has significantly impacted various NLP tasks, including language modelling, MT, sentiment analysis, and named entity recognition (Goodfellow et al., 2016). With its ability to recognize and generate FL, DL plays a crucial role in advancing the understanding and processing of nuanced language expressions.

4.2. Machine Learning Methods for Figurative Language Recognition

Various methodologies prove particularly advantageous for the recognition of FL. Among these, Supervised Learning (SL) emerges as one of the extensively employed techniques, constituting a subset of ML approaches. In SL, the model is trained on labelled data to recognize patterns in the data. For FL recognition, labelled data would include examples of sentences or phrases that contain FL, along with labels indicating the type of FL used (Reled & Reichart, 2017). Later, labelled data is used to develop a dataset for specific purposes. For example, the Sarcasm SIGN dataset, created by Peled and Reichart (2017), includes SIGN a sarcasm interpretation algorithm that targets sentiment words, a defining element of textual sarcasm. The evaluations conducted by the research indicate that the interpretations generated by SIGN receive high scores in terms of adequacy and sentiment polarity (Reled & Reichart, 2017).

Feature Extraction (FE) is another crucial step in the process of ML for FL recognition (Goodfellow et al., 2016). FE methods for FL recognition might include techniques such as

word embeddings which can capture the semantic relationships between words (Goodfellow et al., 2016). For instance, several features can be used for irony detection and including lexical features, punctuation marks or/and interjection counts, sentiment lexicon scores, emotional scenarios, POS patterns and semantic relatedness (Van Hee et al., 2018). Besides, irony detection typically involves binary classification, where instances expressing the opposite of their intended meaning are labelled as ironic. Van Hee et al.'s (2018) research based on an annotated training corpus of English-language tweets arranged into two groups of binary and fine-grained irony features, shows a higher classification score for binary irony detection, while fine-grained irony in tweets results to be more challenging.

In addition, FL recognition must include certain datasets created for the purpose. For instance, Affective Tweet is dataset that has been created for analyzing emotion and sentiment in tweets and this package forms part of the collection of algorithms for data mining tasks WEKA (Bravo-Marquez, 2019). As WEKA is open-source software, the AffectiveTweet package is effectively used in various researches. Another example of a dataset is Understanding Ironic Meaning (IMeaning), a parallel dataset that consists of 15,000 pairs of tweets that included both verbal irony and their non-ironic rephrasings (Chakrabarty et al., 2021). The annotators were given the option to either copy the original tweet or paraphrase it, depending on whether the ironic intent was immediately apparent or not (Chakrabarty et al., 2021). Another parallel dataset, also created by Chakrabarty et al., (2021), includes both speakers' ironic messages (Sim) and hearers' interpretations (Hint) of the speaker's intended meaning. This dataset, referred to as Sim-Hint contains 4,761 pairs of ironic-literal examples.

Another technique used in NLP for FL recognition is called Sentence Embedding (SE) and it involves representing a sentence as a fixed-length vector of numbers (Artetxe & Schwenk, 2019). There are various methods for generating SE. Artetxe & Schwenk's (2019) work focuses on developing a universal language-agnostic SE technique that can represent sentences from multiple languages in a fixed-length vector format. They train a single BiLSTM (Bidirectional Long Short-Term Memory) (Yulita, 2017) encoder with a shared byte-pair encoding vocabulary for 93 languages, using publicly available parallel corpora. The resulting embeddings are shown to be effective in various tasks, including cross-lingual natural language inference, cross-lingual classification, bitext mining, and multilingual

similarity search (Artetxe & Schwenk, 2019). Additionally, the Bag-of-words is a method that represents a sentence as a vector of word frequencies, where each element of the vector corresponds to the frequency of a particular word in the sentence (Jurafsky & Martin, 2009). Besides, the word embeddings method shows each word in a sentence as a vector of numbers that captures its semantic meaning (Jurafsky & Martin, 2009). In addition, transformer models are DL models that use attention mechanisms to capture the relationships between words in a sentence (Vaswani, 2017). These models can generate high-quality SE that captures a wide range of linguistic features (Vaswani, 2017).

4.3. Application Domains of Figurative Language Recognition Tools: Social Media Analysis, Advertising, and Machine Translation

The practical applications of FL recognition tools in social media analysis, advertising, and MT demonstrate their importance in addressing real-world challenges and enhancing communication across different domains. By effectively identifying and interpreting FL in these contexts, these tools enable deeper insights, and accurate language understanding, contributing to improved decision-making, persuasive communication, and cross-cultural understanding.

FL detection is essential in social media analysis due to the prevalence of figurative expressions in online communication. Social media platforms are rich sources of user-generated content that often include various forms of FL. Figurative expressions can convey subtle nuances of emotions, attitudes, and opinions that may not be captured by literal language alone. By recognizing and interpreting FL, sentiment analysis tools can provide more refined insights into the sentiment and attitudes expressed in social media content. Additionally, FL detection in social media can help improve the effectiveness of automatic dialogue systems and customer relations. Recognizing and responding to figurative expressions in real-time interactions can enhance the naturalness and relevance of automated responses, improving user engagement and satisfaction. Besides, the inclusion of idiosyncrasies specific to social media languages, such as intentional and unintentional misspellings (e.g., gr8, lovin, coul, holys**t), elongations (e.g., yesssss, mmmmmmm, uuggghh), and abbreviations (e.g., lmao, wtf) (Kiritchenko et al., 2014), and unconventional associations between words and emotions, is essential for accurate sentiment analysis in this

domain. FL detection algorithms need to account for these unique linguistic features to ensure reliable and precise analysis of sentiment and emotional content in social media posts.

The sentiment analysis technique used widely on social media analysis is also useful for marketing purposes to automatically determine the emotional tone or evaluative nature of a piece of text, such as a product review, tweet or Facebook post (Kiritchenko et al., 2014). Its applications include tracking sentiment towards products, politicians, and movies, improving customer relations, detecting happiness and well-being, and enhancing automatic dialogue systems. For example, brand monitoring refers to the practice of actively tracking and analyzing online conversations, social media mentions, reviews, and other forms of user-generated content related to a brand (Patil et al., 2021). FL recognition in brand monitoring is crucial in capturing the nuances of consumer attitudes and opinions. It allows advertisers to gain insights into how consumers perceive their brand and identify opportunities for improvement. Besides, brand monitoring involves analyzing the impact of multimodal figurative information on consumers' attitudes towards products (Perez-Sobrinio et al., 2018).

Perez-Sobrinio et al.'s research on the role of FL in advertisement (2018) has shown that the application of metaphorical rhetoric enhances the creation of a positive attitude towards the brand. By incorporating FL recognition in brand monitoring, advertisers can gain deeper insights into the effectiveness of their metaphorical communication strategies. They can identify which metaphors resonate with their target audience and modify consumer beliefs, allowing them to refine their advertising campaigns accordingly (Perez-Sobrinio et al., 2018). In the same manner, the NLP tools for sentiment analysis focused on determining the sentiment or emotional tone expressed in a piece of text. In the context of advertising, sentiment analysis is particularly valuable as it enables advertisers to gain insights into how consumers perceive and react to their advertisements, products, and brands (Patil et al., 2021). By analyzing consumer feedback reviews, social media posts, and other forms of user-generated content that *inter alia* might include FL, sentiment analysis helps advertisers gauge the overall sentiment towards their brand and advertising campaigns.

When it comes to MT, detecting FL presents challenges because of its non-literal nature and dependence on context. While MT systems excel at translating literal and straightforward text, capturing the nuances and intended meaning of FL is more complex (Mao et al., 2021).

However, BERT (Devlin et al., 2019), which stands for Bidirectional Encoder Representations from Transformers, is a popular and influential transformer-based model and has proven to be effective in NLP studies, which adopts large-scale unlabelled training data and generates enriched contextual representations (Cui et al., 2019). The use of BERT can enhance the process of paraphrasing a specific word within a sentence by leveraging a constrained missing word prediction approach (Mao et al., 2021). This is predominantly attributed to the superior modelling capabilities of BERT, which is based on the transformer architecture, enabling a more effective representation of long-term dependencies and word orders present in sentences. Mao et al. (2021) claim that the results of their research indicate that by paraphrasing English metaphors into their literal equivalents, it is possible to enhance the accuracy of a MT system in rendering these metaphors into target languages that are more easily understood by the recipients.

5. Part IV: Discussion on cognitive abilities, contextual understanding and ethics in Figurative Language recognition

This section delves into a critical discussion surrounding cognitive abilities, contextual understanding, and ethical considerations in the recognition of FL. As humans, we possess intricate cognitive processes that enable us to comprehend and appreciate the nuanced meanings conveyed through FL. However, replicating this level of cognitive understanding in computational models presents numerous challenges. We explore the limitations and advancements in current FL recognition systems, emphasizing the importance of contextual understanding for accurate interpretation. Furthermore, ethical implications associated with FL recognition are examined, considering issues such as cultural sensitivity, bias, and potential misuse. By engaging in this discussion, this last part of the paper aims to clarify the complex interplay between cognition, context, and ethics in the development and deployment of FL recognition technologies.

5.1. Cognitive abilities

Cognitive abilities play a vital role in the comprehension and interpretation of FL. Human beings possess inherent cognitive capabilities that enable them to grasp the subtleties and metaphorical expressions employed in language. Additionally, consciousness, an integral

component of human cognition, pertains to subjective awareness and experience and allows humans to integrate common knowledge. It is intertwined with the overall cognitive functioning of individuals. Regarding outstanding AI abilities, there exists an argument advocating for the consciousness of pre-trained Large Language Models (LLMs), exemplified by models like LaMDA (Thoppilan et al., 2022), a Language Model for Dialogue Applications, and LLM-based chatbots such as ChatGPT (Radford et al., 2018). However, debates surrounding the potential risks associated with these models have emerged, triggered by an article featuring Blake Lemoine's work with LaMDA at Google, underscoring the importance of considering the ethical implications associated with the use of ChatGPT (Shardlow & Przybyła, 2022). Notwithstanding these statements, it is imperative to acknowledge the ethical implications associated with the use of ChatGPT.

The release of ChatGPT has provoked a wider awareness of the capabilities of LLMs among the public. The model has no innate cognitive capabilities other than the structured vocabulary model on which it is trained. And even though the model is modelled to resemble human neurones, the resemblance to real human cognition is exaggerated, which leads to misunderstanding (Shardlow & Przybyła, 2022). In their investigation, Shardlow and Przybyła (2022) find insufficient evidence supporting claims of ChatGP's consciousness. The current capabilities of modern LLMs are inadequate to generate consciousness, with no significant architectural innovations facilitating the development of feelings or consciousness akin to human cognition. The assumption that a machine should possess the ability to solve a problem if a human can do so necessitates reconsideration. Modelling human input and cognitive systems remains limited, potentially causing machines to be unaware of certain phenomena perceived by humans (Shardlow & Przybyła, 2022). As a result, language models continue to exhibit a deficiency in the realm of recognizing FL due to a lack of human cognitive capabilities.

5.2. Contextual understanding

Context is key for the comprehension of idiomatic expressions. FL often relies on context for its interpretation. Words or phrases can have different meanings based on the surrounding context, and understanding this contextual information is essential for accurate FL recognition. For MT, the consideration of context goes beyond mere word or phrase

meanings. It involves understanding the broader linguistic and cultural context in which a sentence or text is embedded. Contextual factors such as the topic, genre, intended audience, and cultural references play a significant role in accurately translating idiomatic expressions and capturing their intended meaning. Moreover, MT also involves the larger context of the entire sentence, paragraph, or whole discourse. Sentences are not isolated units of meaning but are influenced by the preceding and succeeding linguistic elements.

An understanding of the context helps in disambiguating polysemous words, resolving syntactic ambiguities, and producing coherent and fluent translations. Take, for example, the phrase “breaking the ice”, while it figuratively means “initiating a conversation,” its literal interpretation, such as breaking ice cubes for a drink, is also valid (Santing et al., 2022). These idiomatic expressions create additional difficulty for models to accurately translate sentences. Achieving contextual understanding at the level of human language users is still an ongoing research area. While there have been advancements in improving the accuracy of MT, the same level of progress has not been attained in the domain of idiomatic translation (Santing et al., 2022). The accuracy of FL recognition systems is of utmost importance. ML models need to be trained on vast amounts of data by employing contextual embeddings to capture and comprehend contextual cues effectively. Despite the successful application of models like BERT, BART (Lewis et al., 2019) and T5 (Raffel et al., 2020) in almost every NLP task, there is scarce research focused on idiomatic translation using these models (Santing et al., 2022). To effectively recognize and interpret FL, systems should be trained on diverse and representative datasets. Santing et al. (2002), for instance, propose to enrich the English-German IdiomTranslationDS dataset (Fadaee et al., 2018), which includes only 1733 pairs of idiom translations, by including paraphrases of idioms in English and German. Improving the accuracy of FL recognition systems involves the continuous refinement of algorithms and techniques, considering the complex nature of language and its figurative aspects. Besides, the integration of context in MT is a promising area of research that aims to enhance the accuracy and fluency of translations, particularly when dealing with idiomatic expressions and capturing the intended meaning in diverse linguistic and cultural contexts.

5.3. *Ethics*

Ethical considerations also come into play in FL recognition, as humans employ FL in communication including dialogue systems. FL can be culturally specific, and recognizing and interpreting it accurately requires sensitivity to cultural nuances and potential biases. Care must be taken to ensure that FL recognition systems do not perpetuate stereotypes, offensive language, or discriminatory content. The detection of ethical misunderstandings in FL entails considering three key aspects (Bender et al., 2020). Firstly, it involves the recognition of the potential for irony or sarcasm to harbour ambivalence, which can lead to harm or negative outcomes. Secondly, it necessitates an understanding of the diverse ways in which bias influences linguistic data, including its manifestation through figurative expressions. Lastly, and most importantly, it involves upholding the confidentiality of individuals who employ idiomatic expressions within their texts.

Indeed, the design of dialogue systems should incorporate measures to address potential ethical misunderstandings arising from figurative speech, identify bias in individuals' statements, and ensure the preservation of conversational confidentiality. Therefore, ethical guidelines and frameworks should be established to ensure the responsible development and deployment of FL recognition tools. For example, Wikipedia articles addressing gender and racial minorities, in contrast to other articles, exhibit distinct characteristics and incorporate social biases, which can manifest in various forms, including the use of FL (Field et al., 2022). Lack of control over covariates can lead to different conclusions and veiled biases. Thus, the platform of shared knowledge carries the risk of social and cultural prejudice. Anjalie Field and other researchers developed Pivot-Slope TF-IDF (Field et al., 2022), an approach that can help to identify systematic differences between article sets, facilitate analysis of specific social theories, and provide recommendations to reduce bias in corpora and it shows good results.

Recognition of sarcasm presents quite a difficulty in contrast to other forms of FL. Sarcasm is a form of irony that commonly characterized by its intent to mock or dismiss someone or something in a sarcastic or insulting manner. It can also serve as a form of aggressive humour and even be used to convey praise (Moore & Mago, 2022). For example

“Oh, you’re so punctual! And never mind² showing up when the meeting started 30 minutes ago!” The speaker uses sarcasm to mock the other person’s lack of punctuality by praising it and pointing out the fact of being late. However, the mocking and offensive nature of sarcasm can have detrimental effects on individuals, leading to emotional distress and psychological harm. It can induce feelings of humiliation, shame, and belittlement, negatively impacting one’s self-esteem and overall well-being. Moreover, sarcastic remarks that rely on stereotypes or derogatory language can contribute to the marginalization and devaluation of specific individuals or social groups. This, in turn, perpetuates prejudice and discrimination, resulting in social division and unequal treatment.

The usage of sarcasm poses challenges for sentiment analysis in NLP as it can lead to inaccuracies and misinterpretations when models solely rely on literal expressions of sentiment rather than capturing the intended meaning (Moores & Mago, 2022). According to Moores and Mago, detecting sarcasm using existing methods is difficult due to various factors. These include a lack of consensus on evaluation metrics, variation or inaccuracies in annotated datasets. Also, difficulties may arise both, from long social media messages and lack of context, and potential biases in researcher-labelled data. To resolve these issues and ensure ethical considerations, it is crucial to establish standardized assessment protocols and incorporate comprehensive baseline data. This approach will facilitate meaningful comparisons between different methods and advance research on sarcasm detection that align with ethical considerations (Moores & Mago, 2022).

6. Conclusion

This paper provided a comprehensive examination of FL recognition, encompassing both human-centred and ML approaches. The comprehension of FL holds significant importance as it constitutes an intrinsic component of human communication, permeating both literary expressions and everyday discourse. FL serves the purpose of conveying emotions, imbuing language with depth and subtlety, and rendering it more memorable and captivating. Moreover, it assumes a crucial role in shaping cultural identities, as diverse cultures exhibit their distinct repertoire of FL forms. The study of FL assumes indispensability in facilitating

² idiom, used to tell someone not to worry about something because it is not important (McIntosh, 2013)

a profound comprehension of language and its intricate nuances. It encompasses multifaceted perspectives and methodologies that are instrumental in the development of novel machine technologies, thereby enabling unfettered communication between humans and machines.

The first part of the paper focused on different perspectives on FL, including pragmatics, corpus linguistics, and computational approaches. Pragmatics explores the contextual and pragmatic aspects of language use. The data gathered in this study will be incorporated into a linguistic corpus, providing a fundamental basis for subsequent computational analysis and algorithm development focused on the detection, analysis, and interpretation of FL. The second part of the paper focuses on the human approach to FL, looking at cognitive, sociocultural, and discursive factors. The cognitive approach examines how people process and understand FL, exploring mental processes such as metaphor understanding and conceptual confusion. Sociocultural factors emphasize the influence of cultural and social context and its integration with discourse analysis for a deeper understanding of FL. Part three provided an overview of how FL is approached by machines, focusing on NLP and its fundamental principles, which include the development of computational models and algorithms that allow computers to understand, and interpret FL. It encompasses a range of techniques and methods, including rule-based and statistical models, as well as DL approaches. ML algorithms are trained on extensive datasets to recognize and classify various types of FL. Through exposure to examples and patterns, these algorithms continuously enhance their accuracy and performance. The paper also discusses applications of FL recognition tools, including social network analysis, advertising, and machine translation. Social media analysis involves extracting and analyzing figurative vocabulary from user-generated content on platforms such as Twitter. In advertising, figurative vocabulary is used to create compelling and appealing messages. Machine translation aims to accurately translate figurative vocabulary into different languages, which poses unique challenges to automatic translation systems.

The discussion of human and machine approaches emphasised the importance of cognitive abilities, contextual understanding, and ethical considerations. Cognitive abilities play an important role in understanding and interpreting FL as people rely on their knowledge, experience, and reasoning processes. Contextual understanding is critical to accurate interpretation because words and phrases can have different meanings depending on

the surrounding context. Ethical considerations arise in the development and application of FL recognition tools, such as fairness, inclusivity, and avoidance of harmful biases.

To sum up, the study of figurative speech recognition involves an interdisciplinary approach that combines ideas from linguistics, psychology, computer science, and other related fields. Both human and machine approaches contribute to our understanding of FL and its various aspects. By studying cognitive processes, sociocultural influences, and computational methods, we gain valuable insights into the complexity of FL and its impact on communication and understanding. Developments in NLP and ML methods offer promising opportunities for further research and practical applications in a variety of fields, enabling improved recognition and interpretation of FL in literature, social media, spoken language, pop music, journalism, and beyond.

7. Works cited

- Abrams, M. H. (1999). *A glossary of literary terms*. Harcourt, Brace College Publishers.
- Artetxe, M., & Schwenk, H. (2019). Massively multilingual sentence embeddings for zero-shot cross-lingual transfer and beyond. *Transactions of the Association for Computational Linguistics*, 7, 597–610. https://doi.org/10.1162/tacl_a_00288
- Bender, E. M., Hovy, D., & Schofield, A. (2020). *Integrating ethics into the NLP curriculum*. ACL Anthology. <https://doi.org/10.18653/v1/P17>
- Bradley, A., & Bayley, J. (2005). Lecture IX Macbeth. In *Shakespearean tragedy* (pp. 306–351). essay, Penguin.
- Cai, D., & Deignan, A. (2019). *Metaphors and evaluation in popular economic discourse on trade wars*. <https://www.researchgate.net>. <https://doi.org/10.1515/9783110629460-004>
- Carston, R. (2002). *Thoughts and utterances: The pragmatics of explicit communication*. Blackwell.
- Chakrabarty, T., Ghosh, D., Poliak, A., & Muresan, S. (2021). Figurative language in recognizing textual entailment. *Findings of the Association for Computational Linguistics: ACL-IJCNLP*. <https://doi.org/10.18653/v1/2021.findings-acl.297>
- Chomsky, N. (2007). *On Certain Formal Properties of Grammars*. *Information and Control* 9., 137-167 (1959). <https://www.sciencedirect.com/science/article/pii/S0019995859800176>
- Claws part-of-speech tagger for English*. CLAWS part-of-speech tagger. (n.d.). <https://ucrel.lancs.ac.uk/claws>

- Collins, P. H. (2002). *Black feminist thought knowledge, consciousness, and the politics of empowerment*. Routledge.
- Cui, Y., Che, W., Liu, T., Qin, B., & Yang, Z. (2021). *Pre-training with whole word masking for Chinese Bert*. arxiv.org. <https://arxiv.org/abs/1906.08101>
- Dancygier, B. (2017). *The Cambridge Handbook of Cognitive Linguistics*. Cambridge University Press.
- Devlin, J., Chang, M.-W., Lee, K., & Toutanova, K. (2019). *Bert: Pre-training of deep bidirectional Transformers for language understanding*. arXiv.org. <https://arxiv.org/abs/1810.04805>
- Fadaee, M., Bisazza, A., & Monz, C. (2018). Examining the Tip of the Iceberg: A Data Set for Idiom Translation. *Proceedings of the Eleventh International Conference on Language Resources and Evaluation (LREC 2018)*. <https://aclanthology.org/L18-1148>
- Fauconnier, G., & Turner, M. (2002). *The way we think: Conceptual blending and the mind's hidden complexities*. Basic Books.
- Ferrando, I. N. i, Cai, D., & Deignan, A. (2019). Metaphors and evaluation in popular economic discourse on trade wars. In *Current approaches to metaphor analysis in discourse* (pp. 57–76). essay, De Gruyter Mouton.
- Field, A., Park, C. Y., Lin, K. Z., & Tsvetkov, Y. (2022). *Controlled analyses of social biases in Wikipedia bios*. arXiv.org. <https://arxiv.org/abs/2101.00078>
- Gargett, A., & Barnden, J. (2015). Gen-META: Generating metaphors by combining AI and corpus-based modelling. *Web Intelligence, 13*(2), 103–114. <https://doi.org/10.3233/web-150313>
- Gibbs, R. W., & Matlock, T. (2008). Metaphor, Imagination, and Simulation. In *The Cambridge Handbook of Metaphor and Thought* (pp. 161–176). essay, Cambridge University Press.
- Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep learning*. Deep Learning. <https://www.deeplearningbook.org/>
- Grice, H. P. (1975). Logic and Conversation. In *Syntax and semantics: Speech Acts* (Vol. 3, pp. 41–58). essay, Academic Press.
- Hampe, B., & Grady, J. E. (2005). *From perception to meaning: Image Schemas in Cognitive Linguistics*. De Gruyter Mouton.
- Helemul Alam, S. M. (2022). *A ticking time bomb?* The Daily Star. <http://www.thedailystar.net/news/bangladesh/accidents-fires/news/ticking-time-bomb-3136201>

- Jurafsky, D., & Martin, J. H. (2009). *Speech and language processing: An introduction to natural language processing, computational linguistics, and speech recognition, second edition*. Pearson-Prentice Hall.
- Kafka, F. (2023). *Metamorphosis*. The Project Gutenberg eBook of Metamorphosis, by Franz Kafka. <https://www.gutenberg.org/cache/epub/5200/pg5200-images.html>
- Kenner, H. (1971). *The Pound Era: By Hugh Kenner*. Pimlico.
- Kiritchenko, S., Zhu, X., & Mohammad, S. M. (2014). Sentiment analysis of short informal texts. *Journal of Artificial Intelligence Research*, 50, 723–762. <https://doi.org/10.1613/jair.4272>
- Lakoff, G., & Johnson, M. (2003). *Metaphors we live by: With a new afterword*. University of Chicago Press.
- Lewis, M., Liu, Y., Goyal, N., Ghazvininejad, M., Mohamed, A., Levy, O., Stoyanov, V., & Zettlemoyer, L. (2019). *Bart: Denoising Sequence-to-Sequence Pre-Training for Natural Language Generation, Translation, and Comprehension*. <https://doi.org/10.48550/arXiv.1910.13461>
- Mao, R., Guerin, F., & Lin, C. (2021). *Interpreting verbal metaphors by paraphrasing*. www.arxiv.org. <https://arxiv.org/abs/2104.03391v1>
- McGeveran, T. (2011). “*Monster*” Hurricane Irene is headed right for us, pretty much, almost! www.politico.com. <http://www.politico.com/states/new-york/albany/story/2011/08/monster-hurricane-irene-is-headed-right-for-us-pretty-much-almost-000048>
- McIntosh, C. (Ed.). (2013). *Cambridge Advanced Learner’s Dictionary* (4th ed.). Cambridge University Press.
- Moores, B., & Mago, V. (2022). *A survey on automated sarcasm detection on Twitter*. [arXiv.org](http://arxiv.org). <https://arxiv.org/abs/2202.02516>
- Patil, P., Waghmode, S., Singh Dhoot, H., & Patil, M. (2021). *Brand Monitoring System*. ISSN 2395-0056 (Online) | International research journal of engineering and technology (IRJET). <https://portal.issn.org/resource/issn/2395-0056>
- Peled, L., & Reichart, R. (2017). SARCASM sign: Interpreting sarcasm with sentiment based monolingual machine translation. *Proceedings of the 55th Annual Meeting of the Association for Computational Linguistics*, 1. <https://doi.org/10.18653/v1/p17-1155>
- Pérez-Sobrino, P., Houghton, D., & Littlemore, J. (2018). *The role of figurative complexity in the comprehension and appreciation of advertisements*. *Applied Linguistics* 2018: 1–36. <https://doi.org/10.1093/applin/amy039>
- Radford, A., Narasimhan, K., Salimans, T., & Sutskever, I. (2018). *Improving language understanding by generative pre-training*. *OpenAI*. <https://openai.com>. https://cdn.openai.com/research-covers/language-unsupervised/language_understanding_paper.pdf

- Raffel, C., Shazeer, N., Roberts, A., Lee, K., Narang, S., Matena, M., Zhou, Y., Li, W., & Liu, P. J. (2020). *Exploring the limits of transfer learning with a unified text-to-text transformer*. *Journal of Machine Learning Research*, 21:1–67. <https://arxiv.org/abs/1910.10683>
- Reddy, R. (1988). Foundations and Grand Challenges of Artificial Intelligence. *AI Magazine*, 9(4), 9–21. <https://doi.org/10.1609/aimag.v9i4.950>
- Santing, L., Sijstermans, R., Anerdi, G., Jeuris, P., Thij, M. ten, & Batista-Navarro, R. T. (2022). *Food for thought: How can we exploit contextual embeddings in the translation of idiomatic expressions?* *ACL Anthology*. <https://aclanthology.org/2022.flp-1.14>
- Searle, J. R. (1986). *Expression and meaning: Studies in the theory of speech acts*. Cambridge University Press.
- Shardlow, M., & Przybyła, P. (2022, November 21). *Deanthropomorphising NLP: Can a language model be conscious?* arXiv.org. <https://arxiv.org/abs/2211.11483>
- Steen, G. J., Pasma, T., Krennmayr, T., Kaal, A. A., Herrmann, J. B., & Dorst, A. G. (2010). *Method for linguistic metaphor identification: From MIP to MIPVU*. John Benjamins Publishing Co.
- Stefanowitsch, A., & Gries, S. (2006). *Corpus-based approaches to metaphor and metonymy*. Mouton de Gruyter.
- Tapanainen, P., & Voutilainen, A. (1994). Tagging accurately. *Proceedings of the Fourth Conference on Applied Natural Language Processing*, 47–52. <https://doi.org/10.3115/974358.974370>
- Thoppilan, R., De Freitas, D., Hall, J., Shazeer, N., Kulshreshtha, A., Cheng, H.-T., Jin, A., Bos, T., Baker, L., Du, Y., Li, Y., Lee, H., Zheng, H. S., Ghafouri, A., Menegali, M., Huang, Y., Krikun, M., Lepikhin, D., Qin, J., ... Le, Q. (2022). *LAMDA: Language models for dialogue applications*. arXiv.org. <https://arxiv.org/abs/2201.08239>
- Ucrel Claws7 Tagset. (n.d.). <https://ucrel.lancs.ac.uk/claws7tags.html>
- Van Hee, C., Lefever, E., & Hoste, V. (2018). Semeval-2018 task 3: Irony detection in English tweets. *Proceedings of The 12th International Workshop on Semantic Evaluation*. <https://doi.org/10.18653/v1/s18-1005>
- Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., Kaiser, L., & Illia, I. (2017). *Attention is all you need*. arxiv.org. <https://arxiv.org/pdf/1706.03762.pdf>
- Veale, T., Klebanov, B. B., & Shutova, E. (2016). *Metaphor: A computational perspective*. Morgan & Claypool.
- Voutilainen, A., & Tapanainen, P. (1994). *Tagging accurately - don't guess if you know*. *ACL anthology*. <https://aclanthology.org/A94-1008.pdf>

- White, M. C. (2018). *Growing like a weed? California marijuana market off to slow start*. NBCNews.com. <https://www.nbcnews.com/business/business-news/growing-weed-california-marijuana-market-slow-start-n867871>
- Wierzbicka, A. (1992). *Semantics, culture, and cognition: Universal Human Concepts in culture-specific configurations*. Oxford University Press.
- Wilson, D., & Sperber, D. (2012). *Meaning and relevance*. Cambridge University Press.
- Young, J. G. (2019). *Perspective | Even as President Trump slams the door on refugees, there is reason for hope*. The Washington Post. <http://www.washingtonpost.com/outlook/2019/09/29/even-president-trump-slams-door-refugees-there-is-reason-hope>
- Yulita, I. N., Fanany, M. I., & Arymuthy, A. M. (2017). Bi-directional long short-term memory using quantized data of deep belief networks for Sleep Stage Classification. *Procedia Computer Science*, 116, 530–538. <https://doi.org/10.1016/j.procs.2017.10.042>