Online Misinformation Analysis and Information Quality Theory

(A Wittgensteinian Approach)

Uyiosa Omoregie*

Abstract

Online platforms initially left content consumers to discern for themselves whether information online was true or false. Censoring of content by online platforms and fact-checking are presently the two prominent interventions. We propose here that misinformation analysis should aim to make clear what is stated by clarifying the propositions and claims in such content (declarative language/factual discourse). The early work of Ludwig Wittgenstein is relevant for such analysis. Presented here is an online content information quality check model for written (non-graphical) content. This hypothesis-driven intervention (content rating) can be applied to Web browsers (as extensions) and online social media platforms. This model is inspired by Wittgenstein's book *Tractatus Logico-Philosophicus*. Our hypothesis is that rating and labelling online content this way will help users discern content qualitatively (avoid being misinformed) and engage better with other users. This Wittgensteinian model (set of rules/quality check/algorithm) can also be viewed as a tentative theory of information quality anticipating future natural language processing (NLP) technology more effective against online misinformation. We introduce two new concepts: "off-information" and "non-information" as distinct information disorder variants.

Key words: Wittgenstein, Misinformation, Off-information, Non-information

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*Avram Turing Research, Guelph, ON, Canada. Email: uyiosa.omoregie@avramturing.com

INTRODUCTION

We divide all truths that require justification into two kinds: those for which the proof can be carried out purely by means of logic and those for which it must be supported by facts of experience

-- Gottlob Frege, *Begriffsschrift* (1879)

We propose in this paper that a model based on insights from the early philosophical work of Ludwig Wittgenstein could provide a framework for effective online misinformation analysis. The works of Ludwig Wittgenstein (1889-1951) are usually divided into two: the early and the later philosophy. Wittgenstein's book *Tractatus Logico-Philosophicus* [1] is regarded as his early masterpiece. Another book *Philosophical Investigations* [2] is representative of his later philosophical work. In *Philosophical Investigations* (*PI*), Wittgenstein refutes important theses he made in *Tractatus Logico-Philosophicus* (*TL-P*). Great works develop a life of their own independent of the creator's intentions or vicissitudes. *TL-P* has its own merits and one of the aims of this paper is to demonstrate this book's continual relevance.

Lackey [3] presents results of a poll of 414 philosophy teachers, in North America (the United States and Canada), revealing *TL-P* to be among the top five books of philosophy written in the twentieth century.

The poll requested respondents rank the five philosophy books they rated highest. The five books with the highest ratings:

- 1) 179 *Philosophical Investigations* (L. Wittgenstein, 1953) 68
- 2) 134 *Being and Time* (M. Heidegger, 1927) 51
- 3) 131 *A Theory of Justice* (J. Rawls, 1971) 21
- 4) 77 *Tractatus Logico-Philosophicus* (L. Wittgenstein, 1922) 24
- 5) 64 *Principia Mathematica* (B. Russell and A. Whitehead, 1910) 27

The number on the left shows the total number of citations (mentions in respondents' top five). The number on the right shows the total number of first-placed rankings (number of respondents who regarded the book as *the* best of the twentieth century). *PI* was the clear winner of the poll. *TL-P* was highly rated: regarded by 24 teachers as the best philosophy book of the twentieth century. Not bad for a book later described by its author as inadequate, despite the fact that *TL-P* is a finished work and *PI* is not [4].

In this paper, we present an online content information quality check model for written (non-graphical) misinformation analysis and prevention. This model is inspired by the framework of the *early* philosophy of Ludwig Wittgenstein (revealed in *TL-P*). We discuss some crucial theses of *TL-P* applied to online content misinformation analysis. We found no previous work that use Wittgenstein's *early* philosophy for misinformation analysis. Giulietti [5] used Wittgenstein's *later* philosophy of language (presented in *PI*) to reveal how a popular politician successfully changed "the language game of politics" with devastating effects on truth and democracy. In Giulietti's analysis this politician played the language game using irony, sarcasm and outright lies successfully. This was possible because, according to Wittgenstein's *PI*, the meaning of language depends strictly on context. One man's "fact" could be another man's lie

if the game is played skilfully. For example, the expression “I do not hate my political enemies, I love them too much” could mean one thing for the speaker’s allies and mean something else to his competitors. For misinformation analysis however, the *PI* would not be adequate as a framework, we must instead turn to *TL-P* for insights. In *TL-P*, Wittgenstein states that philosophy should aim for nothing more than “the logical clarification of thoughts.” The *TL-P* is concerned with clarity [6], the link between thoughts and reality provided by language [7], this was central to the ‘linguistic turn’ that influenced a new direction in philosophy [8].

Key theses in Tractatus Logico-Philosophicus

TL-P is composed of seven main theses and accompanying remarks (or sub-theses) on these theses. Within the seven main theses, Wittgenstein tries to get at the heart of the problems of philosophy by explaining how language really works. He does not succeed in this ambitious quest. His theory in *TL-P* cannot apply to language as a whole (unlike the theory in *PI*). But, during his ambitious project, Wittgenstein provides insights into the nature of the world of communication and information. In *TL-P* we find a useful theory of factual language or discourse [9], about declarative sentences and propositions [10]. Some principal theses (relevant to this paper) in *TL-P* can be summarised thus:

I. *Facts are the real world*

The thesis number “1” is the first of seven major theses (1-7). Three of its propositions:

1. The world is everything that is the case.
- 1.11 The world is determined by the facts, and by these being all the facts.
- 1.2 The world divides into facts.

Wittgenstein states that facts divide the world: they determine everything that exists or does not exist in the world. Facts are derived from ‘states of affairs’. States of affairs that exist prove those states that do not exist.

II. *Language consists of propositions which could represent the world*

- 2.19 The logical picture can depict the world.
3. The logical picture of the fact is the thought.
4. The thought is the significant proposition.
- 4.001 The totality of propositions is the language.

Wittgenstein declares that the world can be pictured or represented by propositions. Every proposition is either true or false. All language is made up of propositions and it can only represent the world correctly when its propositions are true. A logical picture of a fact is a thought and thoughts find expression through propositions. Every proposition has only one complete analysis and a fact has only one correct analysis. Only factual discourse contains reasoning.

III. *Logic fills the world and limits it*

Wittgenstein describes the importance of logic in some sub-theses/remarks:

- 5.61 Logic fills the world: the limits of the world are also its limits.
- 6.124 The logical propositions describe the scaffolding of the world, or rather they present it.
- 6.13 Logic is not a theory but a reflection of the world.

Logic aims to present clearly what can be inferred from a proposition. What cannot be inferred from a proposition is regarded as not valid.

IV. *Some things are better left unsaid and cannot be analysed rationally*

Wittgenstein's last thesis consists of just one line with no sub-theses or remarks:

- 7. Whereof one cannot speak, thereof one must be silent.

Wittgenstein implies here that there are certain things/phenomena which cannot be properly expressed through language. These things can be described as mystical/mysterious or simply unsayable. They can be known or shown but not properly articulated. The rules described by Wittgenstein in the preceding six major theses cannot apply to such unspeakable things/phenomena.

In summary, there are four issues in Wittgenstein's *Tractatus Logico-Philosophicus* that are of relevance to online misinformation analysis: 'Facts' 'Propositions' 'Logic/Analytical' and the 'Unspeakable'.

This paper is divided into three parts. In the first part we discuss the current misinformation epidemic and solutions proffered. We then introduce a Wittgensteinian online content analytical check model. In the second part of the paper, we suggest a new theory of information quality based on a Wittgensteinian framework, while introducing two new concepts: "off-information" and "non-information." The third and last part of the paper reviews the current state and future possibilities of natural language processing /artificial intelligence technology applied to online misinformation prevention and analysis.

PART I: ONLINE MISINFORMATION AND RESPONSE

1. Misinformation online

Online social media has brought together billions of people from around the world. The impact of diverse platforms such as Facebook, WeChat, Reddit, LinkedIn, Signal, WhatsApp, Gab, Instagram, Telegraph etc. has been transformational. The number of active users of the six most popular online social networks combined is estimated at about 10 billion [11]. The World Wide Web (the Web) is a place where online written non-graphical content can be created, consumed and diffused without any real intermediary. This empowering aspect of the Web is

generally a force for good: people, on the whole, are better informed and participation in online discussion is more inclusive (barriers to participation are reduced).

As online activity has grown, however, research has revealed a darker side to online social media and its ability to influence behaviour in the real world. The general absence of intermediaries online allows a free-for-all direct path from producers of questionable content to consumers. Two disturbing trends have been highlighted: ‘information disorder’ and ‘echo chambers’. Misinformation (false or misleading information *not necessarily* intended to deceive), disinformation (false and misleading information with *intention* to deceive) and malinformation (*authentic* information with intent to cause harm) are common types of information disorders [12]. Disinformation is particularly insidious as it can be transformed by social media into misinformation [13]. This occurs, for example, when deliberate nefarious propaganda is released (disinformation) but subsequently shared through social media innocently (misinformation). Highlighting disinformation as a special form of misinformation is important: it’s a matter of motive. Sunstein cautions that not all falsehood are lies [14]: falsehood could result from recklessness, genuine mistake or a deliberate lie.

The World Economic Forum highlighted information disorder as a threat to society [15]. There are now online spaces (echo chambers) where people are only exposed to content created or shared by like-minded users of the platform. Similar to echo chambers are filter bubbles, spaces artificially created by algorithms using the user’s online history to further suggest or recommend other content. Echo chambers and filter bubbles reduce the quality of discourse online and can directly and indirectly lead to the creation and diffusion of biased and unsubstantiated content.

Researchers have studied the spread of conspiracy theories within echo chambers and filter bubbles [16]. One study discovered that on the Twitter platform, untruth was retweeted quicker and by more people than truthful content (70 percent more retweets) [17]. Some analysts see online misinformation as a national security challenge: equipped with cybersecurity tools, they track misinformation the way they would track malware, to prevent “the hacking of people’s beliefs” [18]. Without a collective respect for facts and evidence there is no basis for a liberal democratic society [19]. A foundation of facts secures any civilization. False information online usually serves one of two (or both) purposes: for *clickbait* (to draw attention and hence attract Web traffic for financial gain) or to influence/mould beliefs and major events [20].

2. Three different responses to online misinformation

Three different responses to the problem of information disorder and echo chambers have been applied online. The initial response was to do nothing and leave content consumers to discern for themselves. It was argued that the Web is a place for free expression: online liberty should not be stifled [21]. As misinformation became more widespread online, the next response was to censor harmful content (removal of content that was deemed not fit for public consumption)

[22]. More recently, third-party actors have created websites that use a set of criteria to fact-check trending online content or certify the credibility (trustworthiness) of popular online news websites [23] [24]. These third-party arbiters of truth and credibility use prescriptive tools to help sanitize online content. Researchers have revealed the limitations of fact-checking as a misinformation prevention strategy [25]. Particularly when deeply-held beliefs are involved, providing ‘facts’ alone may not change beliefs. Sometimes the opposite effect of strengthening the false belief occurs. This has led to the strategy of trying to prevent or neutralize misinformation through ‘inoculation’ or ‘prebunking’ [26]. Prebunking or inoculation involves exposing the flawed argumentation techniques of misinformation to prepare online content consumers against future misinformation. The importance of timing when correcting ‘fake news’ has been emphasized in a study to demonstrate the effectiveness of ‘debunking’. ‘Debunking’ was defined as fact-checks *after* misinformation exposure, ‘labeling’ (fact-checks of information presented *during* exposure) and ‘prebunking’ (fact-checks before exposure).

3. The online content information quality analytical check model

The global quality check system for online content analysis, described here, is a descriptive tool (see figure 1 below). This tool aims to clarify thoughts and propositions in content analysed. In this Wittgensteinian model, Web-based written non-graphical information (articles, commentary etc.) is analysed then scored based on criteria designed to evaluate the quality of analytical content. Post-analysis, the written content is then categorised as ‘analytical’ or ‘non-analytical’. Further labelling of the intrinsic nature of the content (e.g. ‘satire’ ‘political’ ‘scientific’) and users’ (content consumers) ratings completes the process. When applied to Web browsers and online social media platforms, the rating produced by the analytical quality check system can help users discern content qualitatively and engage more analytically with other users.

At the heart of this online quality check solution is the belief that analytical thinking, (clarification of thoughts and propositions), is essential for combating information disorder and the lure of echo chambers [27][28]. This model applies the four aspects of the Wittgensteinian framework (mentioned in section 2 above) consisting of: (a) *facts* (b) *propositions* (c) *logical/analytical thinking* (d) *labelling unanalysable content*.

Online written content is first fact-checked. The second step is to screen content for propositions. The third step scores the content as ‘analytical’ or ‘non-analytical’: the score depends on the coherence and logical validity of the content’s propositions. The final step is labelling of the content as a whole. This step is important because conspiracy theories and other such beliefs are not analysed but labelled. Such beliefs are regarded as mysterious, they can only be made manifest or shown and are better left unspoken, in line with the Wittgensteinian philosophy (*LT-P* thesis 7).

Figure 1: The global online content analytical quality check flowchart [\[31\]](#)

Monthly trending written content on the Web (articles, speeches, tweets etc.) is researched. Content that has been selected and analysed is scored between 0.0 (not analytical) and 10.0 (highly analytical). Table 1 below provides examples of such analysis. Web browser extensions can be offered to users that automatically reveal the analytical rating of a trending article, tweet or other written content. This rating is activated once a link to the content is accessed. Search engines will display search results that include a score for any trending written content found in the search results. Users of social media platforms like Facebook, Twitter etc. will see the global analytical quality score of trending content posted on their newsfeeds. These features will encourage the promoting of quality content online. Hopefully, as more users recognise quality content and discern its features, they would re-post, re-tweet and forward such content more. User engagement with quality content should increase. Sharot [29] suggests that more incentives from social media platforms are required for online content consumers to engage more with ‘truth’ online. More ‘carrots’ are needed to compliment ‘sticks’. A visible high rating (explained above) displayed for quality content can act as a carrot for the creation of more quality content and increased engagement with such content. As Donovan emphasizes, it is important that ‘authoritative content’ is elevated online [69]. The approach to misinformation prevention and analysis explained in this paper does this by targeting the virality of content, which is a priority for social media platforms [70]. Research shows that interventions that help shift people’s attention towards a measure of the accuracy (quality) of content they encounter online encourages them to share higher quality news, thereby reducing the chance of others being misled by misinformation [71]. Another study reveals that social media algorithms could reduce the spread of misinformation by elevating (‘up-ranking’) content from trusted media websites, and ‘down-ranking’ content from websites with low trustworthiness (low information quality) ratings [72].

Table 1: Examples of online articles analysed using the information quality model

	Article	Category	Label	Score
1	DMX Received COVID Vaccine Days Before Heart Attack [73]	RUMOR	Non-Analytical	2.0
2	Canada Resettled More Refugees Than Any Other Country in 2018 [74]	NEWS	Analytical	9.0
3	The NWO, Freemasonry & Symbols on the Dollar Bill [75]	THEORY	Un-Analysable	N/A
4	3,100 Inmates to be Released as Trump Administration Implements Criminal Justice Reform [76]	NEWS	Analytical	7.0
5	Race is a Social Construct, Scientists Argue [77]	SCIENCE	Analytical	8.5
6	Ben Carson Says He has No Memory of Running for President [78]	SATIRE	Un-Analysable	N/A

PART II: QUANTITATIVE AND QUALITATIVE INFORMATION THEORY

4. Shannon's quantitative (20th century) Information theory

Shannon, the father of information theory, described a *quantitative* (mathematical) theory of communication [30]. In Shannon's theory, the fundamental challenge of communication (hence information), is the need for reproduction at one point, the exact or approximate message produced at another point. Shannon's theory led to technologies that encode, transmit, decode and store information. This is central to the information age. The 'meaning' of the information, however, was a secondary issue for Shannon. The mathematical theory of information is a *quantitative* theory: more about engineering than linguistics:

Frequently the messages have *meaning*; that is they refer to or are correlated according to some system with certain physical or conceptual entities. These semantic aspects of communication are irrelevant to the engineering problem. The significant aspect is that the actual message is one selected from a set of possible messages [30].

The Wittgensteinian analytical check system we propose is *qualitative*. Provoked by the problem of misinformation, disinformation and malinformation, it is focused on 'meaning'. All content viewed through this quality check device is recorded as either analytical or non-analytical. Statements with no meaning (no semantic content) possess no information. This analytical check is restricted to factual language/declarative sentences.

The algorithms built into some social media platforms play important roles in the virality of content online. Some of these algorithms appear more focused on the *quantity* of user engagement with content than the *quality* of the content and the engagement. One study of the Twitter platform revealed algorithmic amplification of content that was polarizing [68]. This current paper introduces the concepts "off-information" and "non-information" and can be viewed as an attempt to construct a tentative theory of information quality for online (written) content.

Shannon introduced the concept of the "bit" or "binary digit" as a quantitative measure and unit of information. His theory was concerned with "the channel capacity" of information (data) transmission. An analogy would be designing a bus for a postman to carry letters and parcels: the content of the letters/parcels are irrelevant if you are only interested in providing a bus with capacity to transport as many letters and parcels as possible. Shannon's paper has been described as one of the "canonical readings" in the information science field [49]. Chomsky has argued that Shannon used the term "information" in his paper in a narrow technical sense. In this technical sense it didn't matter whether the content transmitted by the communication channel is valid, misinformation or contradictory [43]. But, as Conway and Siegelman explain, this became problematic after Shannon's famous paper was published [44]. Carnap and Bar-Hillel called the exclusion of semantic aspects by Shannon a "theoretical restraint" and further explained that "great care has been taken to point out that this theory is not interested in the semantic aspects of communication." [45] Norbert Wiener is the founder of the field of cybernetics and his work influenced Shannon's paper. Unlike Shannon, Wiener

emphasised semantic aspects as critical to cybernetics. Today, Wiener should be recognized as the co-founder of information theory [44]. His work is gaining increasing relevance today as advances in machine learning emphasize the brain-machine interface mediated by information that Wiener envisioned in the 1940s [46]. Shannon cited Wiener's work in his paper, acknowledged his indebtedness to him for "the basic philosophy and theory [of Shannon's paper]" and for Wiener's paper that contained the "first clear-cut formulation of communication theory as a statistical problem." [30].

5. A qualitative Information theory (for the 21st century)?

Life in the "information age", requires that the issues of information disorder (misinformation, disinformation and malinformation) be taken seriously.

If, according to Shannon, the "semantic aspects" are irrelevant in the theoretical communication engineering solution (data transmission), then what really is 'information'? Information scientists have adopted a general definition of information (GDI). According to the GDI, information is data that is well-formed and meaningful [32]. Misinformation and disinformation are not genuine information because they are false, although they may have semantic content. Semantic *factual* content is what distinguishes authentic information from false information [32][33] (in declarative language). Russell claims that facts are central to any language: the primary use for language is to put forth facts or try to deny facts [1].

Information quality is an issue primarily about meaning. the semantic aspects are more relevant than engineering efficiency or grammatical accuracy. A sentence can be grammatically correct but have no meaning and an engineering solution can transmit more data quantity at the expense of information quality. Language functions properly only when it expresses meaning [1]. Chomsky, however, showed that the grammar of a language is really the theory of a language and "autonomous and independent of meaning" [34]. Chomsky further states:

To understand a sentence, we must know much more than the analysis of this sentence on each linguistic level. We must also know the reference and meaning of the morphemes or words of which it is composed; naturally, grammar cannot be expected to be of much help here [34].

Chomsky's famous examples:

- (1) Colorless green ideas sleep furiously.
- (2) Furious sleep ideas green colorless.

Both sentences are meaningless but sentence (1) is grammatical. Taken through our global analytical check device, none of these two sentences would pass the information quality test. These two sentences have no semantic content, we propose to label such content "non-information". Likewise, in the examples in Table 2 below, all sentences are grammatical but only sentence 4 contains authentic information. Sentences 1 and 2 are meaningless (non-information) and 3 is a hypothesis.

Table 2: Grammatical sentences with different levels of information content

	Sentence	Semantics	Information
1	That man, the human next door, he is actually a reptile.	Meaningless	None
2	He murdered that innocent man, but because he didn't really kill him, the victim is dead	Meaningless	None
3	The sun will rise tomorrow	Hypothesis	Low
4	That tomato you are holding in your hand is a fruit.	Meaningful	high

Unless further evidence is given (or the presuppositions made clear [35]) to support the claim made in sentence 1 of Table 2 above, an organism cannot simultaneously be human and a reptile. It is possible that the writer of this sentence has some secret knowledge about humans and reptiles and the belief expressed could be justified. Knowledge can only convey information when it is made concrete and articulated through the mind [36], and background information (explicit or implicit) is required for comprehension of most sentences [42]. If there is tacit knowledge hidden, in the mind of the writer, it is not expressed coherently: no information is communicated. If belief in this sentence could be justified, that would not make the statement necessarily true [37]. Sentence 2 in Table 2 above could be further clarified but as it stands is meaningless (non-information). The claim in sentence 4 may appear strange to many people (a tomato is generally thought of as a vegetable), but, even without support (clarification in the sentence), the statement is authentic because it is scientifically correct. Stating that a tomato is a fruit is different from saying that the sun will rise tomorrow. The claim in sentence 3 is not fact but a hypothesis because what is asserted is really speculation based on historical antecedent [1]. Information can be regarded as the product from data processed through a filter of facts, logic and semantics (see figure 2 below).

Figure 2: A device/filter separating information from data

Imperative (or instructional) content contains no propositions. Such content differs from declarative content because it cannot be analysed as true or false. Truth and falsity can only be found in propositions [10] [38] [39]. In figure 2, instructional content would only be checked for logic/coherence and semantic issues but cannot be fact-checked. We propose that instructional content be analysed using the ‘harm principle’ [40] and by the legal system

operating where the content is being analysed. In such analysis moral norms are important but are distinct from legal systems [41]. For content that is instructional and meaningful but illegal or potentially harmful, we propose the label “off-information” (see figure 3 below). Of the four sentences below, only sentence (b) would be considered off-information: it is an instructional sentence with potential to cause harm if obeyed. Sentence (a) is meaningful but not realistic, (c) is wrong advice but not misinformation and (d) is meaningless hence non-information (no evidence of extra-terrestrial visitors on Earth yet!):

- (a) Let’s eat all the food in every restaurant in this city today.
- (b) Swallow arsenic when you feel depressed.
- (c) Do not believe anything a teacher or professor tells you.
- (d) You should listen to extra-terrestrials from Venus who live in the apartment next to ours.

Some sentences can be categorized as mis-information *and* non-information: they do not make sense and are false. Frege proposed two distinct aspects of meaning: the sense of the statement and the object the statement refers to. Truth (or falsehood) according to Frege is contained in a sentence’s reference. [47]. Russell criticised Frege’s theory of meaning and showed that some statements refer to non-existing objects (no reference) hence false statements [48]:

- (e) The present King of France is bald.

Russell labels the sentence above as ‘false’ because there is no King of France, this is ‘mis-information’. We propose a better category for sentence (e) is ‘non-information’. It is irrelevant whether the King is bald or not because such a King does not exist today. The statement does not make sense. If the King exists, then we could verify if he is bald or not.

Figure 3: Categories of information quality of online content

PART III: ARTIFICIAL INTELLIGENCE AND MISINFORMATION

6. Boolean Logic, Fregean Logic, Wittgensteinian Logic and the processing of natural language

Gottlob Frege (1848-1925) transformed the field of logic from what it had remained since the days of Aristotle. He is regarded as the founder of modern logic and much of modern philosophy [43]. Frege laid the foundations of predicate logic, first-order predicate calculus and quantificational logic – formal systems central to computer science and mathematics (also modern philosophy and linguistics). Charles Sanders Peirce also independently made foundational contributions similar to Frege's [50]. Frege was stimulated by the ambiguity and imprecision of ordinary language, he launched a project to overcome this hinderance. He brought rigor to 'analysis' and laid the foundation for 'analytical philosophy' [51]. He did this by creating a new 'formula language' with elaborate symbols and definite rules, focused more on conceptual content than rhetorical style. He called this formula language *Begriffsschrift* – a formal language for 'pure thought' [52]. This *Begriffsschrift* and its use of quantified variables in sentences is a pillar of all systems of modern man-made computation and automation.

Before Frege, George Boole (1815-1864) created what later became known as 'Boolean logic'. Boole was concerned about "those universal laws of thought which are the basis of all reasoning, and which, whatever they may be as to their essence, are at least mathematical as to their form." [53]. Boolean logic is the system behind the operations of modern computers. Claude Shannon applied Boolean logic (algebra) to solve problems using two symbols "1" and "0". This formulation first appeared in Shannon's 1937 master's thesis, "A Symbolic Analysis of Relay and Switching Circuits." [54]. This thesis is credited with launching modern switching theory – the foundation for digital computers today. It has been described as "possibly the most important, and also the most famous, master's thesis of the century." [55]

Our hypothesis is that *Wittgensteinian logic* applied in natural language processing technology, (if possible) via automation, could transform the quality of information online. *Wittgensteinian logic*, described in this paper, could help filter authentic information from inauthentic information disorder (non-information, off-information, mal-information and mis-information).

The processing of human language by computers has been an important goal of informatics research from the beginning. This research challenge (artificial computing capability to deal effectively with the complexity of human language) has been described as the "Holy Grail" of the field [66]. Algorithms used by machine learning systems are a major focus of natural language processing (NLP) research. There are generally two approaches: rules-based modeling and statistical modeling. Noam Chomsky transformed the field of linguistics with his rules-based approach, he is a co-founder of the cognitive science field which has applications to artificial intelligence (AI), specifically NLP. Chomsky criticized the popular statistical approach to AI, specifically machine learning:

It's true there's been a lot of work on trying to apply statistical models to various linguistic problems. I think there have been some successes, but a lot of failures.

There is a notion of success ... which I think is novel in the history of science. It interprets success as approximating unanalyzed data [57]

Chomsky has argued that focusing too much on big data using statistical modeling will be bereft of explanatory insight – this is not the way science has traditionally been conducted. What is needed: go beyond data mining and prediction to general principles about intelligent life, about cognition, that can service as the basis for a science of artificial intelligence [58]. Norvig, an artificial intelligence researcher devoted to a statistical modeling approach, disagreed with the rules-based approach favoured by Chomsky:

Statistical language systems are used successfully by hundreds of millions of people every day, and have come to completely dominate the field of computational linguistics. For the first three decades, the field used techniques that were more in line with Chomsky’s recommended approach, but starting in the mid-1980s, some researchers started to experiment with statistical models. Their success convinced over 90% of the researchers in the field to switch to statistical approaches [57].

One way of looking at the Chomsky’s rules-based/Norvig’s statistical approach to AI saga, is that it represents a conflict between engineering and science. “Good old-fashioned AI” was influenced strongly by the formalisms introduced by Frege and new AI is more influenced by big data and new technology [58]. According to Chomsky, there has been a shift in AI research focus to engineering with a lot of technological success. This technological success has sacrificed the quest for understanding scientific principles and answering scientific questions in AI research. Chomsky believes the principles of AI research should be no different from other scientific investigations conducted in the theoretical manner pioneered by Galileo [58] [59].

To automate a misinformation filter (based on *Wittgensteinian Logic*), like that described in figure 2 above, a *device* or *machine* (a set of rules/quality check/algorithm) capable of human-like reasoning is required. Pinker [56] explains how English and other natural languages are “hopelessly unsuited to serve as our internal medium of computation.” Internal language “mentalese” for internal expression or thought is distinct from external expression through words [56]. Carnap also lamented the “unsystematic and logically imperfect structure” of natural languages [65]. Other scholars have explained that communication (expression through words) is not the primary purpose of language, instead, language is a distinct human instrument for the expression of thought [64]. ‘Thought’ carries more information than ‘words’ and the speaker may not be able to fully articulate to the receiver the full intentions of his thoughts through words alone: the receiver has to decode what she believes the speaker is trying to articulate [56]. Some challenges of a natural language like the English include: “ambiguity”, “lack of logical explicitness”, “co-reference”, “deixis” and “synonymy” [56].

Wolfram also emphasizes the connection between human thought and language as the major challenge for the development natural language processing systems:

By the 1980s it became clear – notably through the failure of attempts to automate natural language understanding and translation – that language cannot in most cases (with the possible exception of grammar-checking software) meaningfully be isolated from other aspects of human thinking [67].

The whole concept of artificial ‘intelligence’ could be called into question: one AI researcher believes that ‘automated decision making’ is a better description of what we today call artificial

intelligence [62]. Baker [63] argues that although AI has achieved success in tasks that most people regard as requiring high intelligence, like mastering chess, no AI system can today match a five-year old child's mastery of the English language (a task most people regard as not requiring much intelligence).

The crux of the Wittgensteinian approach, (a set of rules/quality check/algorithm) to misinformation analysis, is about making clear what is stated in online content. This is done by clarifying the propositions and claims in the written content. For the time being only human analysts (not artificial intelligence) can consistently and reliably filter authentic information from the inauthentic. This was made clear in a testimony to the U.S. House of Representatives, by the Vice President of the online social media platform Facebook:

We also use machine learning to assist in our fight against misinformation. Algorithms cannot fundamentally tell what content is true or false, but they do help in the process. Our machine learning models use various signals to identify content which might be false or partly false. Comments expressing disbelief are one signal that helps inform our prediction, as well as feedback from our community when people mark something as false news [79].

Pearl [60] believes that developing machines with human-like reasoning is possible. Pearl is one of the pioneers of AI and was at the forefront of research that led to statistical approaches to machine learning decades ago. Pearl, like Chomsky, now urges researchers to focus more on teaching machines to use causal reasoning in addition to reasoning with association (statistical/probabilistic) [61].

7. Conclusion

The Wittgensteinian online content analytical quality model, proposed here, is another tool that, we hypothesize, should help improve the quality of engagement with written content online. Its focus is the analysis of online content containing factual language or declarative discourse. Using the early philosophy of Ludwig Wittgenstein as the framework: (a) facts (b) propositions (c) logic/analytical thinking and (d) labelling. The clarification of thoughts and propositions in online content is achieved. It builds upon existing tools that fact-check written content shared online to provide a more nuanced and in-depth examination of content. Rather than a laissez-faire approach or outright censoring of content, this information quality check system takes a middle road that informs the user of the analytical quality of content, but still leaves the user free to decide whether or not they concur. It is a descriptive tool. This also removes the common argument made by those spreading misinformation deliberately to online users that the misinformation spreaders are the victims of a 'cancel culture' when content is removed completely. We also hypothesize that, with this model, the likelihood of online content consumers being mis-informed, dis-informed, mal-informed (or off-informed or mal-informed) by written content will be greatly reduced. This might be achieved by the scoring and labelling system of this quality check system. Empirical work could gather data to confirm this. The analytical system described in this paper, when put to use can also be tested to see if it improves the quality of discourse and interaction online. These are further research questions

we propose here. When this system is proactively taught (to students and online content consumers for example) it may work as a form of ‘prebunking’ or inoculation against misinformation. Ultimately, the hope is that effective NLP applications will be developed to analyze online content and filter out misinformation effectively (as shown in figure 2). This is an area of further research, within the AI field and neighbouring disciplines, that should be carried out with a sense of urgency.

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Author Information

Uyiosa Omoregie, is the principal analyst at Avram Turing, a research organization focused on online content analysis and misinformation prevention, in Guelph, Canada. He is a member of the Royal Institute of Philosophy (UK), the IEEE Information Theory Society, the Association of Internet Researchers (AoIR) and the Canadian Academy of Independent Scholars (CAIS).