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Commentary

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Advancing psychiatric nosology through philosophical inquiry

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Abstract

Here, we have utilised the concept of fuzzy logic and Karl Popper's notion of verisimilitude to advocate navigating the complexity of psychiatric nosology, emphasising that psychiatric disorders defy Boolean logic. We underscore the importance of embracing imprecision and collecting extensive data for a more nuanced understanding of psychiatric disorders, asserting that falsifiability is crucial for scientific progress. We encourage the advancement of personalised psychiatric taxonomy, urging the continual accumulation of data to inform emerging advancements like artificial intelligence in reshaping current psychiatric nosology.

Introduction

> "As complexity rises, precise statements lose meaning, and meaningful statements lose precision".
> ~ Lotfi A. Zadeh

In medicine, nosology and taxonomy are not solely utilised to classify and categorise diseases; they are beneficial implements for understanding the nature of such disorders and determining the best approaches to address them. This should similarly apply to psychiatry, a branch of medicine that deals with the human brain and mind. Therefore, the occupations with how psychiatric illnesses should be classified are immensely intertwined with inquiries on what psychiatric illnesses are (Aftab & Ryznar, 2020). This directs us to the notion that classification does indeed matter. However, the challenge lies in the fact that the classification systems currently employed in psychiatry, while venerable, lack the comprehensiveness needed to fully encompass the complexion and complexity of psychiatric illnesses and to satisfactorily address varied essential philosophical aspects of nosology (Clark *et al.*, 2017). After decades of relentless quests to fathom psychiatric illnesses, progress has been frustratingly sluggish; some explanations attribute this to our classification systems. Nonetheless, this does not signify a failure; instead, it signifies an endeavour towards realising the limitations and weaknesses that require addressing (Aftab & Ryznar, 2020). As an example, a recent study found a 25.4% diagnostic change rate for psychotic illnesses over time, with migration across serious conditions like schizophrenia and schizoaffective disorder (Wood *et al.*, 2021). This highlights the failure of binary categorical models in capturing heterogeneity and fluctuation in disease courses. Additionally, comorbid conditions such as anxiety and depression co-occur in up to 65% of patients (Groen *et al.*, 2020), representing a "fuzzy" boundary between purported disorders. Together, the poor prognostic ability and frequent diagnostic revisions reflect frameworks misaligned with the shape-shifting reality of psychiatric phenotypes.

The uncertainties and complications that psychiatric nosology faces are, in part, due to the inherent intricacy of psychiatric illnesses, but the way that they have been treated has been inclined to reductionism and deviated from pluralism (Jerotic & Aftab, 2021).

In Karl Popper's philosophy, truth is considered the fundamental aim of all scientific inquiry. Relying on verisimilitude or truthlikeness (Niiniluoto, 2014) (the degree of closeness to the truth), a concept that Karl Popper first introduced, there should be a proposition that is closer to the truth. Among all false propositions, there are also false propositions that are closer to the truth than the others. Ergo, a particular truth may be closer to the truth than another truth. The concept of verisimilitude should not, however, be mixed up with epistemic probability or vagueness, where probability manifests the degree of *seeming* to be true. In contrast, verisimilitude deals with the degree of *being* similar to the truth. Popper realised that the degree of informative content disfavours probability. Therefore, if we go for classification systems that *seem* true based on the evidence obtained, we are sacrificing those capable of making bold predictions. Considering the value of the content though, more logical content leads to greater verisimilitude. With this being said, classification systems with the greatest verisimilitude must

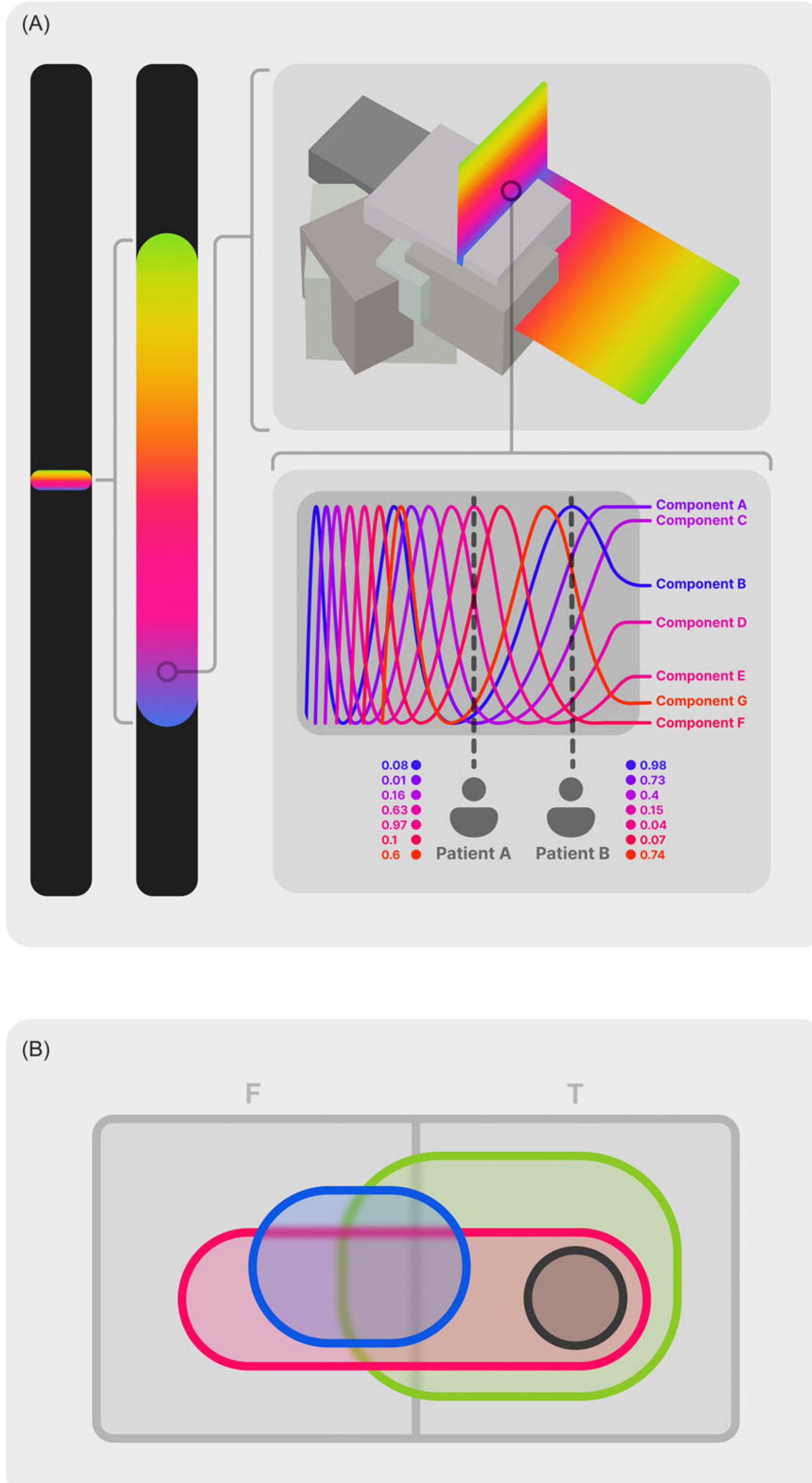

Figure 1. Fuzziness of psychiatric entities. According to physics, one definition of the black colour is when all wavelengths of the visible spectrum are absorbed. We used this concept to depict the fact that there are an infinite number of entities. If a particular entity is picked, it *per se* consists of different sets that have shaped it. Moreover, the sets themselves consist of some subsets (imagine intercalated cubes interacting with each other and having some parts shared or unshared). Other interacting components are naturally distinct but still influence the different subsets. A single entity chosen from the Universal set is made up of these interacting subsets. It is recognised as a unique entity by having a unique combination of common or union of subsets. A fuzzy inference system in a fuzzification process gives value to these subsets, determines some logical rules, and defuzzifies them to a single outcome as an answer. B: The concept of verisimilitude. T and F represent "the truth" and "the falsity". The black circle (classification system x) only contains truth but does not cover much of the truth but a very small part of it, while the green curve (classification system t) includes a small part of falsehood but entails a broader content of the truth. On the other hand, the blue and red curves (classification y and z) comprise both falsehood and truth, and the content of falsity is fairly more compared to the green curve. Therefore, the green circle is the closest (in this example) to the truth, and some false propositions are closer to the truth than others. The red circle is closer to the truth than the blue circle and is of more value than the black one because it is falsifiable and therefore more scientific.

have the smallest probability. An ideal classification system, therefore, is closer to the truth when it contains more relative truth content without falsity content and less relative falsity content without sacrificing truth content (Figure 1B).

Since there is no absolute true or false value, psychiatric illnesses are not amenable to be solved by Boolean logic. Such tautologies prove ineffectual in locating the truth of the complex system we are dealing with. One model could be the use of fuzzy logic-based inference systems. Unlike Boolean logic, fuzzy logic excels when it particularly comes to convoluted systems. Fuzzy logic copes with vague and imprecise information to describe the fuzziness of a multicomponent complex system whose underlying mechanisms are elusive (Vlamou *et al.*, 2019). Thus, a potential classification system that calls for embracing the complexity, ambiguity, and

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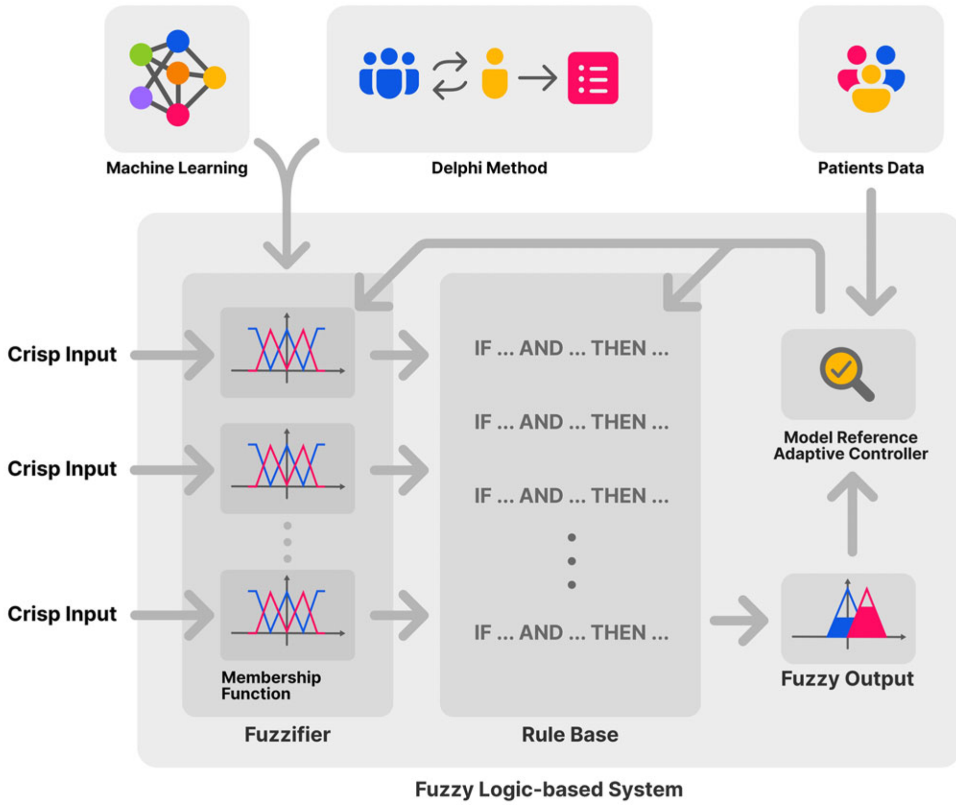

Figure 2. The proposed fuzzy logic framework contains multiple interconnected components for diagnostic modelling. Patient inputs like symptoms and genetics first pass through a fuzzification module, where membership functions (optimised by machine learning and clinician consensus) convert discrete data to fuzzy sets. These map to an extensive knowledge base of fuzzy IF-THEN rules that link fuzzy symptom patterns to graduated psychiatric diagnoses, formulated by experts to mimic clinical reasoning. The fuzzy rule execution produces spectral disorder outcomes reflecting heterogeneity. Finally, an adaptive control module continually monitors outputs, incorporates new patient data, and tunes the system to align with predefined illness models from population statistics or clinician specifications. This enables perpetual accuracy tuning and adaptation to atypical manifestations over time at both individual and group levels.

interactive multifactorial nature of elements influencing psychiatric illnesses can be built by employing fuzzy logic-based inference systems.

The proposed framework for fuzzy diagnostic modelling of psychiatric illnesses is fundamentally based on fuzzy logic systems. As an experience-driven approach, fuzzy logic facilitates the translation of clinical expertise into logical rule-based models without necessitating predefined models. Leveraging decades of research and current classification system as a knowledge base, fuzzy rules can relate multivariate symptom presentations to spectral diagnostic outcomes graded on a continuous scale – overcoming the limitations of binary categorisations.

Specifically, our framework first identifies key inputs like age-of-onset, genotype, symptoms severity/chronology, and functional impact to link with graduated diagnostic outputs (e.g., depression from 0 to 100). Clinical researchers then employ Delphi consensus methods to construct core membership functions mapping fuzzy sets of symptoms to these diagnoses. Additionally, machine learning techniques can complement this by datamining large patient cohorts to optimise predictive membership functions. These feed into a rule base encoding statements like “IF early-onset withdrawal and anhedonia THEN Depression = 85”.

Crucially, the system integrates adaptive control modules to continually adjust parameters based on divergence from reference models of expected diagnostic courses. By mining big data or expert specifications for disease prototypes, the framework perpetually tunes itself to classify even atypical presentments accurately. This combination of knowledge-driven fuzzy logic with data-derived machine learning and adaptive tuning thereby provides the necessary flexibility to capture individual variability while remaining aligned with complex real-world clinical phenotypes (Figure 2).

The outcome of such a fuzzy inference system then represents a diagnosis based on a degree of the actual truth of psychiatric illnesses. So, instead of having a binary yes or no, we will have an answer denoting a degree of truth (Figure 1A and B). This approach simulates the very decision processes psychiatrists utilise to make spectral, not binary, diagnoses that accommodate the diversity of mental illness.

Fuzzy logic-based classification of psychiatric illnesses is by no means impeccable and is, of course, a piece of a complete picture of the truth that edges us closer to the truth. Even if it entails some flaws, it presumably has the potential to approach closer to the truth of psychiatric illnesses than the other truths as it engenders the actual world and possesses more logical strength and a greater value of content for truths.

To have a classification system that is viable, reliable, valid, and consistent with the complex nature and reality of psychiatric symptomatology, we do need to benefit from the concept of verisimilitude to reconcile epistemic optimism with realism. This approach can be attained by using fuzzy inference systems to embrace the fuzziness of psychiatric entities. Such a classification system would consider each person a unique individual and covers various variations and manifestations of symptoms and associated biological and psychosocial correlates (Arjmand *et al.*, 2023). By detecting and valuing patients’ subgroups, a better classification system embracing the complex nature of psychiatric diseases should impact the diagnosis and result in improved prognosis and treatment strategies.

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