MentalDisOnt: An ontology for describing different types of mental disorders.

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1. **Abstract**

Semantic descriptions of mental disorders, offered in a machine-understandable form, can provide useful information benefit in the diagnosis of disorders. In this paper, we explain the development process made to build mental disorder ontology, for describing different types of mental disorders. It could be used as a model for the development of other ontologies for developing a knowledge graph.

The terms of the MentalDisOnt ontology provide different types of information related to a mental disorder, which is reflected in distinct modules that constitute the ontology. Thus, it contains classes and properties for expressing information about disorders diagnosed till now, comorbidity, symptoms, age group, ICD codes, risk factors, and finally level of intensity of that particular disorder. The ontology development process has been carried out in close collaboration with a domain expert.

**Keywords**: Ontology, Mental Disorder, Disorders Ontology, Mental Health

1. **Introduction**

A mental disorder is characterized by a clinically significant disturbance in an individual’s cognition, emotional regulation, or behavior [1].  It is usually associated with suffering or damage in important areas of functioning. There are many different types of mental disorders. There are nearly300 mental disorders listed in the DSM-5 [2]. In 2019, about 970 million people around the world were living with a mental disorder, with anxiety and depressive disorders as the most common [3]. During the COVID-19 pandemic, these numbers increased even higher, with a 25% increase in the prevalence of mental disorders around the world [4]. Numerous studies have been conducted in the domain of mental disorders to define their symptoms, causes, and cures. Thus, to assist doctors and patients we will develop an ontology for providing a detailed description of a mental disorder. We have not found any other ontology that provides a detailed description of all the mental disorders but other existing ontology related to a single disorder will contribute significantly to our ontology.

The purpose of this paper is to present MentalDisOnt ontology. It includes terms to describe 1) Classification 2) comorbidity (disorders that can be present in a person at once) 3) symptoms 4) ICD code 5) risk factors 6) age group and 7) levels of intensity

The MentalDisOnt ontology has been implemented using OWL and Protégé [5] development environment. MentalDisOnt is in line with the classification and information of mental disorders provided in DSM-V [6] (Diagnostic and Statistical Manual of Mental Disorder). MentalDisOnt incorporates concepts given in several ontologies: Bipolar Disorder Ontology [7], which explains the main concepts related to bipolar disorder; Schizophrenia Ontology [8], which explains symptoms and types of schizophrenic disorders; Mental Disorder Classification Ontology [9], provides classification/types of mental disorder; Posttraumatic Stress Disorder Ontology [10], classifies PTSD according to causal approach; Sleep Domain Ontology [11], explain different types of sleep medicines; and Autism Spectrum Disorder Ontology [12], provides phenotype for diagnosis of the autism spectrum.

Apart from the interest in MentalDisOnt ontology in itself, the main contribution of MentalDisOnt ontology is as follows: 1) Reusability, its structure facilitates the task of developing other ontologies on different types of mental disorders and diseases. Information related to Mental Disorders that are described in this ontology could be replaced by information about any other disorder/disease; 2) Expressiveness of relation between different disorders, it incorporates a hierarchical classification of possible disorders and their relations with different factors that help in describing a mental disorder. Dealing with all this detailed description a fine-grained result could be provided for the questions related to mental disorders.

Finally, the use of MentalDisOnt ontology as the core element for the ontology-based system, developed for Smart Diagnosis, can bring several benefits. For example, the development of a Visual Query System (Expert System) will bring the following benefits to different types of users of this Mental Disorder Ontology:

* Mental health Professionals. Description of Mental Disorders will help mental health professionals in providing a diagnosis. It will speed up the process of diagnosing a mental disorder.
* Patients. This ontology will help patients with mental issues in understanding their mental conditions. It will also be able to provide an answer they might have related to different symptoms they might have noticed in themselves.

In the rest of this document, we present the first, distinct approaches that have been defined in the literature, related to the development of ontologies related to mental disorders: existing ontologies and ontology evaluation techniques. Then, we show some methodologies that have been proposed to adequately develop ontologies. Next, we illustrate the steps that we will follow to develop the MentalDisOnt ontology using the NeOn methodology [[13]](#_bookmark83) and the modules that constitute MentalDisOnt. We finish with some conclusions and future work.

1. **Related work**

In the specialized literature several ontologies related to mental disorder domain can be found. Those ontologies were defined with distinct purposes and therefore describe different types of information related to that specific area of domain. For example, Bipolar Disorder Ontology [7] describe fundamental concepts related to bipolar disorder. Fundamental elements of the core of Bipolar Disorder Ontology are two main classes: continuent, occurrent. Bipolar Ontology is based on Mental Function Ontology for the description of bipolar disorder. Disease Ontology [15] is a standardized ontology to describe human disease terms, phenotype characters and related medical vocabulary. The Disease Ontology semantically integrates disease and medical vocabularies through extensive cross mapping of DO terms to MeSH (Medical Subject Headings), ICD (International Classification of Diseases), NCI’s (National Cancer Institute) thesaurus, SNOMED (Systematized Nomenclature of Medicine Clinical Terms) and OMIM (Online Mendelian Inheritance in Man). The main classes of Disease Ontology are: Anatomy, Cell, chebi, disease, disease driver, evidence, food material, inheritance pattern, ncbitaxon, omim\_susceptibility, onset, phenotype, sequence, symptoms, and transmission process. Schizophrenia ontology [8] was explained in “Ontologies, Mental Disorders and Prototypes” [9] in the IACAP 2016 Proceedings Schizophrenia Ontology describe different concepts related to Schizophrenia disorder like types and symptoms. Mental Disorder Ontological classification [9] provide classification and definition of different mental disorders according to ICD [18] and NIH [19] respectively. Mental Function Ontology [20] describes the function of human mind. Its primitive classes are continuent and occurrent. Posttraumatic Stress Disorder Ontology [10]

1. **Design Methodologies**

Different methodologies such as On-To-Knowledge [[14],](#_bookmark84) Diligent [[15],](#_bookmark77) and NeOn [[13]](#_bookmark83) can be found in the literature to develop ontologies. **On-To-Knowledge** proposes a knowledge meta-process consisting of five steps: a feasibility study to determine whether to begin the actual development of the ontology; kickoff, where the requirements are specified and a semi-formal ontology description is developed; refinement, where the target ontology is obtained by refining and formalizing the semi-formal one; evaluation, where the evaluation of the ontology is done; and application and evolution, where the ontology is applied in the target system and maintained. On-To-Knowledge suggests reusing ontologies in the kickoff step if available but does not provide any guidelines for it. Moreover, it does not deal with non-ontological resources or other ontological resources such as ontology design patterns. **Diligent** proposes a process for a distributed development of ontologies that comprises five main steps: build, where an initial version of the ontology is built by different stakeholders such as domain experts, users, and knowledge and ontology engineers; local adaptation, where users adapt the ontology for their purposes; analysis, where a control board analyses the local versions to detect similarities and decide which changes and requests are added to the next shared version of the ontology; revision, where the board revises the new version of the shared ontology; and local update, where users can update their local ontologies with information from the new version. This methodology does not detail the series of activities that should be followed during the build step, and it does not include guidelines for using either ontological or non-ontological resources in the development process. **The NeOn methodology** describes a set of nine scenarios that may occur when building an ontology, along with a list of activities that should be carried out in each scenario. Tightly related to those scenarios, it presents two ontology network life cycle models (waterfall and iterative-incremental) with several versions. The basic version is the Four phase model, which includes the following phases: initiation, where the requirements are specified; design, where both an informal and a formal model of the ontology are created; implementation, where the formal model is implemented in an ontology language; and maintenance, where the ontology is used until errors or missing knowledge are detected. The NeOn methodology places special emphasis on reusing and re-engineering both ontological and non-ontological knowledge resources. Thus, more detailed versions of the basic model (e.g Five-phase model, Six-phase + Merging model) include as well one or more of the following phases, resulting in a variety of paths to develop an ontology: reuse, where existing ontological or non-ontological resources are added to the model; reengineering, where those resources are modified to serve to the intended purpose; and merging, where ontologies are merged or alignments are established among ontological resources. The methodology includes thorough guidelines on how to perform all the mentioned activities

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