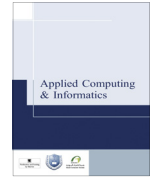




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ORIGINAL ARTICLE

A neuro-fuzzy approach for the diagnosis of depression

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Abstract Depression is considered to be a chronic mood disorder. This paper attempts to mathematically model how psychiatrists clinically perceive the symptoms and then diagnose depression states. According to Diagnostic and Statistical Manual (DSM)-IV-TR, fourteen symptoms of adult depression have been considered. The load of each symptom and the corresponding severity of depression are measured by the psychiatrists (i.e. the domain experts). Using the Principal Component Analysis (PCA) out of fourteen symptoms (as features) seven has been extracted as latent factors. Using these features as inputs, a hybrid system consisting of Mamdani's Fuzzy logic controller (FLC) on a Feed Forward Multilayer Neural Net (FFMNN) has been developed. The output of the hybrid system was tuned by a back propagation (BPNN) algorithm. Finally, the model is validated using 302 real-world adult depression cases and 50 controls (i.e. normal population). The study concludes that the hybrid controller can diagnose and grade depression with an average accuracy of 95.50%. Finally, it is compared with the accuracies obtained by other techniques.

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22 1. Introduction

23 Medical decision making as a whole is a complex process due to handling of higher
24 dimensional, raw, and subjective clinical data. Correct decision requires an orches-
25 tration of clinician's high level perceptions and intuitions toward understanding a
26 disease process. Correctness of the diagnosis depends on the number of times
27 symptoms are matched with the representatives of the reference diseases (which
28 are called as 'classical' cases). Manual diagnosis is often individualized and so
29 as the presentation of an illness. Therefore, the appropriateness of the term clas-
30 sical becomes relative in clinical medicine. Applications of higher data mining
31 technique(s) and concepts of computational intelligence have tremendous research
32 scopes in modeling the process of clinical diagnosis due to its operational resem-
33 blance. It also invites an opportunity for the cross-disciplinary research.

34 1.1. The manual process of medical decision making (*Chattopadhyay, 2007*)

35 In medical decision making there are basically two major phases. The first phase is
36 known as the *differential diagnosis (DD)* and the second phase is termed as *provi-*
37 *sional or final diagnosis (PD)*. During *DD*, patients' history and sign-symptoms are
38 perceived by the clinicians as the inputs. This information, in turn, is processed or
39 analyzed according to their medical knowledge-base and experience to arrive into
40 a diagnosis of overlapping look-alike diseases. According to the perception, med-
41 ical doctors possibly assign some arbitrary weights to symptoms to define its level
42 of representation on the overall disease load. Through multiple clinical assess-
43 ments (i.e., iterations in computer science term), such weights are repeatedly eval-
44 uated and if required, updated. In clinical medicine there might be chances where
45 different diseases present with similar patterns and vice versa. Hence, based on the
46 inputs, doctors try to match the symptom patterns with classical case of each of
47 the possible diseases (obtained during *DD*) by measuring the similarity. Based
48 on the degree of similarity, they then rank the possible diseases and management
49 strategies proposed aiming at the top most ranked disease. Results of the investi-
50 gations and the preliminary treatment are closely matched with all plausible dis-
51 eases (obtained during *DD*) and finally best matched disease is diagnosed. This
52 process is referred to as *PD*. However, in reality, the process is not so trivial
53 and straight forward. There are several iterations, needed to arrive from *DD* to
54 *PD*. Fig. 1 shows the schematic representation of clinical diagnosis process.

55 1.2. Complexities in depression diagnosis

56 Psychiatry is the most complex domain in Medical sciences. Psychiatric diseases
57 are not directly measurable due to vague symptomatic presentations. Results of
58 investigations and treatment are manually correlated with the course of morbidity
59 and such correlations could lead to biased decision-making.

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