

Supporting the Asperger syndrome diagnostic process by selected AI methods

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Abstract. Asperger Syndrome or (Asperger's Disorder) is a neurobiological disorder named for a Viennese physician, Hans Asperger, who in 1944 published a paper which described a pattern of behaviors in several young boys who had normal intelligence and language development, but who also exhibited autistic-like behaviors and marked deficiencies in social and communication skills. In this paper we propose AI techniques to improve the diagnostic process for Asperger Syndrome based on consistency-driven pairwise comparisons (CDPC) and automatic understanding (AU).

Keywords. Asperger syndrome, pairwise comparisons, automatic understanding

- ❑ Medicine is not an exact science.
- ❑ It is also applicable even in a greater extent, to the medical diagnostic process.
- ❑ For example, it took two years and 126 medical appointments for a woman of letter to have her illness diagnosed as MS (multiple sclerosis).
- ❑ The women's education has been stressed as well as her high level of organization (how many of us keep track of the number of medical appointment?) since these two factors are probably at the top of helpfulness for making any diagnosis.

- ❑ A brain, or data processing capabilities of a mentally disabled patient can be compared to a runaway car with no brakes, broken steering mechanism, and all four wheels attached to axis by one loose screw only.
- ❑ No wonder that it is reflected by the four editions of the Diagnostic and Statistical Manual of Mental Disorders (DSM, a Roman numeral is often used for the edition) published by the American Psychiatric Association.
- ❑ DSM is a handbook for mental health professionals that list different categories of mental disorder and the criteria for diagnosing them.
- ❑ It is used worldwide by clinicians and researchers as well as insurance companies, pharmaceutical companies and policy makers. It has attracted controversy and criticism as well as praise.
- ❑ The first edition of 1952 was 134 pages long and listed 182 disorders. The most current IV edition of 1994 is 886 pages long and lists 297 disorders.

- ❑ The DSM-IV is a categorical classification system.
- ❑ The categories are prototypes, and a patient with a close approximation to the prototype is said have that disorder.
- ❑ DSM-IV states that “there is no assumption that each category of mental disorder is a completely discrete entity with absolute boundaries...” but isolated, low-grade and non-criterion (unlisted for a given disorder) symptoms are not given importance.
- ❑ Any improvement to psychiatric assessment process is of great help.
- ❑ In some case, the accuracy in recognizing a mental disorder is as low as 5%

- ❑ This is a work in progress and a part of one projects in the eHealth program at McMaster University with an anticipated budget of 10 billion dollars.
- ❑ McMaster U is known as the originator of EBM (Evidence-based Medicine)
- ❑ Our conjecture is that the combination of the consistency-driven pairwise comparisons (CDPC) and automatic understanding (AU) approaches may be helpful.
- ❑ A Monte Carlo statistical study demonstrated that the error of assessing lengths of randomly generated bars has decreased from 15% to 5% when bars were compared in pairs.
- ❑ Considering unreliability of the psychiatric assessments, much can be achieved if a better technology is applied. It needs to be stressed that it is a supplementary method fully respecting DSM-IV classifications and its procedures.

- ❑ This paper will only focus on the Asperger syndrome which is associated with the learning disability and is easier to comprehend for most academic researchers.
- ❑ In 1994 that Asperger Syndrome was added to the DSM IV and only in the past few years has AS been recognized by professionals and parents.

Characteristics of Asperger syndrome are reduced to bare minimum and include:

A. Limited social relationships – social isolation

Few/no sustained relationships; relationships that vary from too distant to too intense

Awkward interaction with peers

1. Unusual egocentricity, with little concern for others or awareness of their viewpoint; little empathy or sensitivity
2. Lack of awareness of social rules; social blunders

B. Problems in communication

1. An odd voice, monotonous, perhaps at an unusual volume
2. Talking 'at' (rather than 'to') others, with little concern about their response
3. Superficially good language but too formal/stilted/pedantic; difficulty in catching any meaning other than the literal
4. Lack of non-verbal communicative behavior: a wooden, impassive appearance with few gestures; a poorly coordinated gaze that may avoid the other's eyes or look through them
5. An awkward or odd posture and body language

C. Absorbing and narrow interests

1. Obsessively pursued interests
2. Very circumscribed interests that contribute little to a wider life, e.g. collecting facts and figures of little practical or social value
3. Unusual routines or rituals; change is often upsetting

(After Gillberg et al, 2001)

From the mathematical point of view, the pairwise comparisons method creates a matrix (say A) of values (a_{ij}) of the i -th candidate (or alternative) compared head-to-head (one-on-one) with the j -th candidate. A scale $[1/c, c]$ is used for i to j comparisons where $c > 1$ is a not-too-large real number (5 to 9 in most practical applications).

It is usually assumed that all the values (a_{ij}) on the main diagonal are 1 (the case of i compared with i and that A is reciprocal: $(a_{ij}) = 1/(a_{ji})$ since i to j is (or at least, is expected to be) the reciprocal of j to i . (As explained below, the reciprocity condition is not automatic in certain scenarios of comparisons.) It is fair to assume that we are powerless, or almost powerless, as far as inconsistency is concerned. All we can do is to locate it and reconsider our own comparisons to reduce the inconsistency in the next round.

Using scale 1:5, we have three group and we compare them against each other receiving:

| | | |
|-----|-------|-----|
| 1 | 2 | 3 |
| 1/2 | 1 | 2.5 |
| 1/3 | 1/2.5 | 1 |

Clearly, the above matrix is not consistent since $a_{13}=3$ but it is not equal to $a_{12} \cdot a_{23}$. After the additional data gathering, we may reconsider the above table changing, for example 3 to 4 and receiving the inconsistency index $ii=0.2$, where $ii=\min(|1-a_{ij}/(a_{ik} \cdot a_{kj})|, |1-a_{ik} \cdot a_{kj}/a_{ij}|)$ for $i=1$, $j=2$, and $k=3$ (as explained in

For the improved matrix, the relative weights are computed as:

| | |
|---|---------|
| A | 0.56475 |
| B | 0.30418 |
| C | 0.13106 |

The above values are computed as normalized geometric means of the matrix row. The above method is applied to subgroups receiving overall results for all criteria as:

| | |
|----|--------|
| A1 | 0.2524 |
| A2 | 0.1510 |
| A3 | 0.1096 |
| B1 | 0.1032 |
| B2 | 0.0919 |
| C1 | 0.0603 |
| A4 | 0.0518 |
| B3 | 0.0455 |
| B4 | 0.0420 |
| C2 | 0.0418 |
| C3 | 0.0290 |
| B5 | 0.0216 |

About the automatic understanding support

The “automatic understanding of the images” is well established (for example, [4, 5, and 6]). It helps with the recognition of such type images as:

- ❑ morphology of health organ is different for every human being, so we have not any kind of template of “*proper view*” of the analyzed object.
- ❑ deformations of the organs shape and size (caused by the illness) can be very different in the form, number and in localization also if the diseases are in fact identical!

The understanding process is always based on the medical knowledge and this is the main difference between every method of the interview processing, analysis and also recognition, which is ever data-driven procedure, and the task performed by the doctors mind, which is all the time knowledge-based reasoning.

Proposed method is based on the linguistic description of the interviews, which must be prepared for every kind of situation under consideration (e.g., uncontrolled outburst of anger or a total lack of response) on the base of specially designed artificial interview content describing language.