

A mathematical perspective on the DSM-iv and  
DSM-iv-TR

Stephen Lintott Bsc IT (RAU)

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# 1 Introduction

From 1994 to 2013, The DSM-iv set documents were used by Psychiatry to diagnose and treat mentally ill patients.

I have been subjected to these treatments in S.A. and because of that I started looking into why, my perception of science and that of Psychiatrists differ so much.

As a Bsc graduate I have been exposed to advanced ideas in mathematics and this document strives to show that these ideas would have bettered a lot people in the treatment they received from Psychiatrists.

The Mathematics in this document does not differ in any way from what was written in java in the open source project Medisis.

# 2 Background

## 2.1 Mental Illness

Mental illness has been around since the ancient Greeks and has been a troublesome issue for the whole of society, well for at least as long as I can remember. If you've ever dealt with someone who is considered to be mentally ill. The one thing you will definitely take away from that conversation is the fact that he or she feels Psychiatrists do not have the foggiest idea of what they are talking about.

Most people take this fact as a symptom of mental illness but after seeing Psychiatrists contradict themselves on a few occasions. I started wondering how true the idea of it being a symptom really is.

## 2.2 DSM-iv and DSM-iv-TR

The DSM-iv and DSM-iv-TR describes mental illness in terms of axis. Five to be exact. In the document the first four axis are factors and symptoms related to mental illness and then the fifth one the GAF or global assessment of functioning speaks to how functional a patient is. This according to the document is a number between 0 and a 100. 0 being not functional at all and 100 being totally functional.

These two documents do not state how to calculate a GAF or give any quantitative measure on what a GAF is, rather it allows for the Psychiatrist to assign this value to a patient on the basis of impression.

This in my opinion is not a very scientific way of doing anything and, once again in my opinion is the reason why so many Psychiatrists differ so much on so many patients.

## 2.3 Mathematics

With the help of mathematical ideas, some half implemented by the DSM-iv and DSM-iv-TR I aim to show that it would be possible to calculate this GAF value from identified symptoms and in so doing showing that no scientist should have to guess at a complex function such as GAF.

## 2.4 The axis

The axis in the DSM-iv and DSM-iv-TR is not a new idea or an idea that is unique to mental illness. Mathematicians throughout history have used this idea to describe all sorts of problems in nature.

These problems include but are not limited to Statics and Dynamics in Physics and various categorization problems.

Choosing axis for a problem however, is no simple task and it could be argued that the axis as chosen on the DSM-iv and DSM-iv-TR documents are incorrect. I say this because, If a closer look is taken at two of the axis in the DSM, namely Clinical Symptoms and Other medical conditions. It is quite easy to see that an entry on the one could influence the other. E.g. AIDS could cause Psychosis or so I'm told.

This fact shows that the basic rules of Linear Algebra were not applied in the formulation of the DSM-iv and DSM-iv-TR and once again in my opinion is one of the major contributing factors to why people with mental illness always say, "Psychiatrists don't know what they are talking about"

For this paper however I will work with the first four chosen axis and make adjustments in the calculations done to accommodate for axis influencing each other. In saying this, I want readers to realize that the calculation could be off in some cases as the vectors that describe the mental illness are not accurate and do not adhere to laws of Mathematics that have been around for at least 400 years.

The aim of this document is to show that the chosen 5th axis should have never been identified but rather calculated from the other axis in the DSM-iv and DSM-iv-TR

## 3 Linear algebra

Linear algebra sounds a lot more complicated than it really is. The reason for this is because Mathematicians speak of spaces, dimensions, vectors, norms of

vectors and all sorts of other big interesting words. However it is quite intuitive if you understand the basics.

### 3.1 space

A space is an abstract concept that describes all possible values a vector can take.

If you think in terms of movement a vector is described from point a to point b. The space that contains this vector and can contain all possible movement vectors would be the universe.

Space however does not need to be in 3 dimensions or a real physical space.

For most cases it is a definition of the problem at hand.

### 3.2 Dimension

A dimension or axis is a special type of vector that is not influenced by any other vector in that space.

### 3.3 Vector

A vector is nothing more than a directed number. The direction of the number is defined in the space the vector lives. Looking back to movement. A person walks from point A to point B. The direction is from A to B.

### 3.4 The norm of the vector

The norm of a vector is simply taking all of the components of a vector and adding them in such a way that the total is equal to the magnitude of this vector. This value can be calculated with the following formula

$$\vec{v} = \sqrt{v_i^2 + v_j^2 + v_k^2 + \dots + v_n^2} \quad (1)$$

With

$$v_i, v_j, v_k \dots v_n \quad (2)$$

the components of the vector

$$\vec{v} \quad (3)$$

## 4 The derivation

### 4.1 Observations

Before any mathematical work can be done a person has to first think what ones knows about the topic.

I'm no Psychiatrist and believe me I don't know all they do around symptoms and presentation of symptoms in patients. What I do know and the only thing I need to know to calculate a GAF is the fact that the worse symptoms are, the worse the GAF number would be.

Thus we know that if a symptom is rated 1 - 10. 1 being slightly present and 10 being totally present, the following holds true.

$$GAF \propto \left(1 - \frac{1}{f(s)}\right) \quad (4)$$

With

$$f(s) \quad (5)$$

a function describing how symptoms combine. and

$$f(s) \neq 0. \quad (6)$$

### 4.2 The Mathematics

With what we know from equation (4) all we have to do is look at symptoms in terms of the space defined in the DSM-iv document. Let the following hold for that space.

$$\vec{v} = [c, o, p, s] \quad (7)$$

With

c - Clinical symptom component

p - Psychological factor component

s - Social factor component

o - Other medical conditions component

and

v - The mental illness vector or combined symptoms talked about earlier.

Obviously there can be more than one vector

$$\vec{v} \tag{8}$$

Because of the interdependencies between the axis as defined by the DSM, the directionality of the vectors in this space will not be considered. Instead the average norm of the vector will be used to make the calculation. Substituting (1) into (4) we get.

$$GAF \propto \left( 1 - \frac{1}{\frac{\sum_{i=1}^n \sqrt{c_n^2 + o_n^2 + p_n^2 + s_n^2}}{n}} \right) \tag{9}$$

With n, the number of vectors present in the diagnosis. This simplifies to.

$$GAF \propto \left( 1 - \frac{n}{\sum_{i=1}^n \sqrt{c_n^2 + o_n^2 + p_n^2 + s_n^2}} \right) \tag{10}$$

All that is left now is to get rid of the proportional sign. That is pretty trivial. We know that the GAF is a value between 0 and 100 and we know that the sign turns into an equality if the equation is multiplied by a constant so.

$$GAF = 100 \left( 1 - \frac{n}{\sum_{i=1}^n \sqrt{c_n^2 + o_n^2 + p_n^2 + s_n^2}} \right) \tag{11}$$

## 5 Conclusion

The most important thing to take away from this exercise is the fact that the axis for the DSM-iv and DSM-iv-TR were chosen completely wrong. A lot of things can be said about the mathematics in this document including that there is room for error in the calculations due to the fact that the directional nature of the vectors are not taken into account but the fact that no attempt was made at this, 20 years ago shows lack of insight into the problem.

The relationship between the GAF and rated symptoms, I feel is accurate and may contribute to future work in the field of Psychiatry if the idea of the GAF is ever used again. This however does not seem likely as the APA after 19 years of backing the GAF states pretty much the same thing as me except for the Mathematics.

## 6 Bibliography

1. Salas and Hille's - Calculus one and several variables, seventh edition *Revised by Garret J. Etgen*1995.
2. Anton -Rorres - Elementary Linear Algebra *Applications version*2000.