

Application of Soft-Set Relations and Soft Matrices in Medical Diagnosis using Sanchez's Approach

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ABSTRACT

This article presents the concepts of soft set theory and its relations. It the common observation that more symptoms give more accuracy to calculate the disease, so we enhanced the work (Jafar *et al.*, 2019) from trapezoidal to octagonal symptoms symbolically. So, we have used Sanchez's Approach in terms of Octagonal fuzzy number. In the end for the better understanding the theory an elaborative example using hypothetical data has also been presented.

Keywords

Fuzzy Number (FN), Octagonal Number, Soft Set (SS), Soft Matrix (SM) Sanchez's Method

1. INTRODUCTION

Provisional record is involved in most of the fields like engineering, economic and social disciplines etc. All such issues that a person encounters in his life cannot be solved by using ancient mathematical skills. In ancient arithmetic, digital model of a substance is formed and idea of specific classification of this traditional pattern is sought out. That's why, the digital data is much stunning, and the specific results can't come out.

There is various popular supposition to show errors in measurements. For example, (Zadeh, 1965) started Fuzzy set theory (FST), (Pawlak, 1999) Started rough set of theory. For very comprehensive concept regarding decision making Moldstove (1999) gave the concept of Soft set theory. Now a day's work on soft set theory make progress very quickly. In order to get over these difficulties, (Maji, Biswas and Roy, 2001) introduced the idea of Fuzzy soft set (FSS) like other computational procedures for illustration of obscurities which excluded all the strategies affecting the recent challenges. The theory of SS has powerful ability for adequate functions in various fields some of them were explain by many investigators. Recently, struggles on SS theory are getting famous really. Soft sets and Fuzzy soft sets are being used in decision making concepts of every field of life. (Saeed, M. 2018) has used TOPSIS in medical for diabetes investigations and (Saqlain *et al.*, 2019) introduced the TOPSIS by using accuracy function in his work and an application of MCDM is proposed. Application of fuzzy numbers in mobile selection in metros like Lahore is proposed by (Saqlain. M. *et al.*, 2019). TOPSIS technique of MCDM can also be used for the prediction of games, and it's applied in FIFA 2018 by (Saqlain. M. *et al.* 2019). Prediction of games is a very complex topic and this game is also predicted by (Saqlain. M. *et al.* 2019) Decision making is a very big problems for such a complex world. (Sanchez, 1976) gave an approach for

decision making regarding medical diagnosis. (Jafar *et.al*, 2019) used Soft set theory and Sanchez approach in medical diagnosis using Trapezoidal numbers. In this study we are going to use the similar concept of diagnosis using Octagonal numbers.

2. PRELIMINARIE

2.1 Soft Set [9]

Let U be a discourse set and S be the set of parameters. The collection of power set of U is denoted by $P(U)$, Then the soft set is denoted by a pair (F, \hat{A}) and defined by function $F: \hat{A} \rightarrow P(U)$ where \hat{A} is the sub collection of the set of parameters.

Example: Let $U = \{m_1, m_2, m_3, m_4, m_5\}$ be a set of five mobile phones and $S = \{e_1, e_2, e_3, e_4\}$ be the set of four parameters which are 'expensive, beautiful, compatible, brand'. Let A be the sub collection of S which $\hat{A} = \{e_2, e_3, e_4\}$, so the soft set is $(F, \hat{A}) = \{(e_2, F(e_2)), (e_3, F(e_3)), (e_4, F(e_4))\}$ where

$F(e_2)$ $= \{m_1, m_2, m_3\}$	$F(e_3)$ $= \{m_4, m_5\}$	$F(e_4)$ $= \{m_1, m_2, m_3, m_5\}$
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2.2 Soft Relation [7-9]

Consider two soft sets (F, A) and (G, B) over the same discourse set U , then the soft relation relation (R, C) or simply R in between soft sets (F, A) and (G, B) is the soft subset of $(F, A) \times (G, B)$ where $C \subseteq A \times B$ and for all $(a, b) \in C$, $R(a, b) = H(a, b)$ where $(H, A \times B) = (F, A) \times (G, B)$

3. ALGORITHM

- Construct the soft sets of in patient's and symptoms.
- Construct the soft set in symptoms and disease.
- Write the matrix form of both 1 and 2.
- Compute the product matrix using given in methodology.
- Using Mean all the values.
- Make decision against highest value involved in the row.

4. METHODOLOGY

Sanchez's approach to disease identification using octagonal fuzzy number

Let the set of patients $P = \{p_1, p_2, p_3 \dots p_n\}$ with a set of symptoms $S = \{\tilde{s}_1, \tilde{s}_2, \tilde{s}_3, \dots \tilde{s}_n\}$ and suppose the set of associated diseases $D = \{d_1, d_2, d_3 \dots d_m\}$

We employ FS notion to create strategy through Sanchez to analyse which patient is suffering from what disease. For this we build a Soft S (F, S) over M where G is a function $F: P \rightarrow F(s)$. This FSS offers the patient disease the patient disease sign matrix which is ground that delineate relation between patient and symptoms and is symbolised as T, where the entry items are FNs \tilde{s} constrict restrained by a octuplet $[(n-4), (n-3), (n-2), (n-1), (n+1), (n+2), (n+3), (n+4)]$.

At that point develop alternative FSS (H, M) upon A where H is a mapping $H: S \rightarrow F(d)$. This FSS provide a relation matrix every component indicates the significance of the symptoms for a particular sickness. These components are considered identical to triangular FNs.

Hence the conventional form of T is

$$T = \begin{matrix} & \tilde{s}_1 & \tilde{s}_2 & \tilde{s}_3 & \tilde{s}_4 & \tilde{s}_5 & \tilde{s}_6 & \tilde{s}_7 & \tilde{s}_8 \\ \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix} & \begin{bmatrix} \tilde{a}_{11} & \tilde{a}_{12} & \tilde{a}_{13} & \tilde{a}_{14} & \tilde{a}_{15} & \tilde{a}_{16} & \tilde{a}_{17} & \tilde{a}_{18} \\ \tilde{a}_{21} & \tilde{a}_{22} & \tilde{a}_{23} & \tilde{a}_{24} & \tilde{a}_{25} & \tilde{a}_{26} & \tilde{a}_{27} & \tilde{a}_{28} \\ \tilde{a}_{31} & \tilde{a}_{32} & \tilde{a}_{33} & \tilde{a}_{34} & \tilde{a}_{35} & \tilde{a}_{36} & \tilde{a}_{37} & \tilde{a}_{38} \end{bmatrix} \end{matrix}$$

As well as the conventional form of U is

$$U = \begin{matrix} & d_1 & d_2 & d_3 \\ \begin{matrix} \tilde{s}_1 \\ \tilde{s}_2 \\ \tilde{s}_3 \\ \tilde{s}_4 \\ \vdots \\ \tilde{s}_8 \end{matrix} & \begin{bmatrix} \tilde{b}_{11} & \tilde{b}_{12} & \tilde{b}_{13} \\ \tilde{b}_{21} & \tilde{b}_{22} & \tilde{b}_{23} \\ \tilde{b}_{31} & \tilde{b}_{32} & \tilde{b}_{33} \\ \tilde{b}_{41} & \tilde{b}_{42} & \tilde{b}_{43} \\ \tilde{b}_{51} & \tilde{b}_{52} & \tilde{b}_{53} \\ \tilde{b}_{61} & \tilde{b}_{62} & \tilde{b}_{63} \\ \tilde{b}_{71} & \tilde{b}_{72} & \tilde{b}_{73} \\ \tilde{b}_{81} & \tilde{b}_{82} & \tilde{b}_{83} \end{bmatrix} \end{matrix}$$

Presently executing the transformation operation $T \otimes U$, we procure the disease identification matrix of patient D^* like so,

$$D^* = \begin{matrix} & d_1 & d_2 & d_3 \\ \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix} & \begin{bmatrix} \tilde{c}_{11} & \tilde{c}_{12} & \tilde{c}_{13} \\ \tilde{c}_{21} & \tilde{c}_{22} & \tilde{c}_{23} \\ \tilde{c}_{31} & \tilde{c}_{32} & \tilde{c}_{33} \end{bmatrix} \end{matrix}$$

Where C_{ij} is

$$C_{ij} = \begin{pmatrix} \sum_{i,j=1}^8 (a_{ij} - 4)(b_{ij} - 4) \\ \sum_{i,j=1}^8 (a_{ij} - 3)(b_{ij} - 3) \\ \sum_{i,j=1}^8 (a_{ij} - 2)(b_{ij} - 2) \\ \sum_{i,j=1}^8 (a_{ij} - 1)(b_{ij} - 1) \\ \sum_{i,j=1}^8 (a_{ij} + 1)(b_{ij} + 1) \\ \sum_{i,j=1}^8 (a_{ij} + 2)(b_{ij} + 2) \\ \sum_{i,j=1}^8 (a_{ij} + 3)(b_{ij} + 3) \\ \sum_{i,j=1}^8 (a_{ij} + 4)(b_{ij} + 4) \end{pmatrix}$$

All that point, averaging every component we get a brief disease identification matrix D^{**}

$$D^{**} = \begin{matrix} p_1 & p_2 & p_3 \\ \begin{bmatrix} v_{11} & v_{12} & v_{13} \\ v_{21} & v_{22} & v_{23} \\ v_{31} & v_{32} & v_{33} \end{bmatrix} \end{matrix}$$

5. CASE STUDY

Sanchez's approach to disease identification using octagonal fuzzy number

Here we have 3 patients Bilal, Khurram and Salman in a hospital having disease signs fever, cerebral problem, and cough, loss of appetite, abdominal disorder, weight loss, headache and malaise. We consider a set $P = \{p_1, p_2, p_3\}$ as a ground set which symbolise the set of patients. $S = \{\tilde{s}_1, \tilde{s}_2, \tilde{s}_3, \dots \tilde{s}_8\}$ as a universal set for symptoms. And $D = \{d_1, d_2, d_3\}$ denotes the set for diseases as pyrexia, liver inflammation and pleurisy according to the disease signs.

We have

$$\begin{matrix} F(p_1) & \{\tilde{s}_1|7, \tilde{s}_2|3, \tilde{s}_3|4, \tilde{s}_4|9, \tilde{s}_5|5, \tilde{s}_6|4, \tilde{s}_7|5, \tilde{s}_8|6\} \\ F(p_2) & \{\tilde{s}_1|2, \tilde{s}_2|8, \tilde{s}_3|5, \tilde{s}_4|7, \tilde{s}_5|1, \tilde{s}_6|9, \tilde{s}_7|8, \tilde{s}_8|7\} \\ F(p_3) & \{\tilde{s}_1|6, \tilde{s}_2|5, \tilde{s}_3|1, \tilde{s}_4|3, \tilde{s}_5|8, \tilde{s}_6|7, \tilde{s}_7|6, \tilde{s}_8|5\} \end{matrix}$$

7 have 3 patients Bilal, khuram medical diagnosis.pezoidal numbers. In this study we are going to use the similar concept of dThe FSS (G, S) is a parameterized group of all FS over M and offers an assemblage of a rough depiction of patients-disease identification in the hospital. The FSS (G, S) describe the patient-disease sign matrix T (relation matrix)

$$T = \begin{matrix} p_1 & \tilde{7} & \tilde{3} & \tilde{4} & \tilde{9} & \tilde{5} & \tilde{4} & \tilde{5} & \tilde{6} \\ p_2 & \tilde{2} & \tilde{8} & \tilde{5} & \tilde{7} & \tilde{1} & \tilde{9} & \tilde{8} & \tilde{7} \\ p_3 & \tilde{6} & \tilde{5} & \tilde{1} & \tilde{3} & \tilde{8} & \tilde{7} & \tilde{6} & \tilde{5} \end{matrix}$$

$H(\tilde{s}_1)$	$H(\tilde{s}_2)$
$\{\tilde{d}_1 9, \tilde{d}_2 5, \tilde{d}_3 1\}$	$\{\tilde{d}_1 3, \tilde{d}_2 5, \tilde{d}_3 5\}$
$H(\tilde{s}_5)$	$H(\tilde{s}_6)$
$\{\tilde{d}_1 1, \tilde{d}_2 7, \tilde{d}_3 3\}$	$\{\tilde{d}_1 1, \tilde{d}_2 7, \tilde{d}_3 6\}$
$H(\tilde{s}_3)$	$H(\tilde{s}_4)$
$\{\tilde{d}_1 5, \tilde{d}_2 2, \tilde{d}_3 5\}$	$\{\tilde{d}_1 1, \tilde{d}_2 8, \tilde{d}_3 7\}$
$H(\tilde{s}_7)$	$H(\tilde{s}_8)$
$\{\tilde{d}_1 8, \tilde{d}_2 9, \tilde{d}_3 5\}$	$\{\tilde{d}_1 5, \tilde{d}_2 6, \tilde{d}_3 9\}$

The FSS (H, M) is a parameterised group of all FS upon the set M where $H: M \rightarrow G(D)$ and is established after special health credentials. Hence the FSS (H, M) offers an estimated delineation of the 3 disease and their symptoms. This SS is denoted by a relative matrix (symptom-disease matrix) U and is presented via

$$d_1 \quad d_2 \quad d_3$$

$$U = \begin{bmatrix} \tilde{9} & \tilde{2} & \tilde{1} \\ \tilde{3} & \tilde{5} & \tilde{4} \\ \tilde{5} & \tilde{2} & \tilde{5} \\ \tilde{1} & \tilde{8} & \tilde{7} \\ \tilde{7} & \tilde{6} & \tilde{3} \\ \tilde{6} & \tilde{7} & \tilde{6} \\ \tilde{8} & \tilde{9} & \tilde{5} \\ \tilde{5} & \tilde{6} & \tilde{9} \end{bmatrix} \quad C_{ij} = \begin{pmatrix} \sum_{i,j=1}^8 (a_{ij} - 4)(b_{ij} - 4) \\ \sum_{i,j=1}^8 (a_{ij} - 3)(b_{ij} - 3) \\ \sum_{i,j=1}^8 (a_{ij} - 2)(b_{ij} - 2) \\ \sum_{i,j=1}^8 (a_{ij} - 1)(b_{ij} - 1) \\ \sum_{i,j=1}^8 (a_{ij} + 1)(b_{ij} + 1) \\ \sum_{i,j=1}^8 (a_{ij} + 2)(b_{ij} + 2) \\ \sum_{i,j=1}^8 (a_{ij} + 3)(b_{ij} + 3) \\ \sum_{i,j=1}^8 (a_{ij} + 4)(b_{ij} + 4) \end{pmatrix}$$

Presently executing the transformation operation $T \otimes U$, we acquire the disease identification matrix of patient D^* like so,

$$D^* = \begin{matrix} & d_1 & d_2 & d_3 \\ \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix} & \begin{bmatrix} \widetilde{230} & \widetilde{269} & \widetilde{223} \\ \widetilde{186} & \widetilde{299} & \widetilde{276} \\ \widetilde{228} & \widetilde{246} & \widetilde{184} \end{bmatrix} \end{matrix}$$

Where C_{ij} is

For $i = 1 \ \& \ j = 1$
$C_{11} = \{(a_{11} - 4)(b_{11} - 4) + (a_{12} - 4)(b_{21} - 4) + (a_{13} - 4)(b_{31} - 4) + (a_{14} - 4)(b_{41} - 4) + (a_{15} - 4)(b_{51} - 4) + (a_{16} - 4)(b_{61} - 4) + (a_{17} - 4)(b_{71} - 4) + (a_{18} - 4)(b_{81} - 4)\},$ $\{(a_{11} - 3)(b_{11} - 3) + (a_{12} - 3)(b_{21} - 3) + (a_{13} - 3)(b_{31} - 3) + (a_{14} - 3)(b_{41} - 3) + (a_{15} - 3)(b_{51} - 3) + (a_{16} - 3)(b_{61} - 3) + (a_{17} - 3)(b_{71} - 3) + (a_{18} - 3)(b_{81} - 3)\},$ $\{(a_{11} - 2)(b_{11} - 2) + (a_{12} - 2)(b_{21} - 2) + (a_{13} - 2)(b_{31} - 2) + (a_{14} - 2)(b_{41} - 2) + (a_{15} - 2)(b_{51} - 2) + (a_{16} - 2)(b_{61} - 2) + (a_{17} - 2)(b_{71} - 2) + (a_{18} - 2)(b_{81} - 2)\},$ $\{(a_{11} - 1)(b_{11} - 1) + (a_{12} - 1)(b_{21} - 1) + (a_{13} - 1)(b_{31} - 1) + (a_{14} - 1)(b_{41} - 1) + (a_{15} - 1)(b_{51} - 1) + (a_{16} - 1)(b_{61} - 1) + (a_{17} - 1)(b_{71} - 1) + (a_{18} - 1)(b_{81} - 1)\},$ $\{(a_{11} + 1)(b_{11} + 1) + (a_{12} + 1)(b_{21} + 1) + (a_{13} + 1)(b_{31} + 1) + (a_{14} + 1)(b_{41} + 1) + (a_{15} + 1)(b_{51} + 1) + (a_{16} + 1)(b_{61} + 1) + (a_{17} + 1)(b_{71} + 1) + (a_{18} + 1)(b_{81} + 1)\},$ $\{(a_{11} + 2)(b_{11} + 2) + (a_{12} + 2)(b_{21} + 2) + (a_{13} + 2)(b_{31} + 2) + (a_{14} + 2)(b_{41} + 2) + (a_{15} + 2)(b_{51} + 2) + (a_{16} + 2)(b_{61} + 2) + (a_{17} + 2)(b_{71} + 2) + (a_{18} + 2)(b_{81} + 2)\},$ $\{(a_{11} + 3)(b_{11} + 3) + (a_{12} + 3)(b_{21} + 3) + (a_{13} + 3)(b_{31} + 3) + (a_{14} + 3)(b_{41} + 3) + (a_{15} + 3)(b_{51} + 3) + (a_{16} + 3)(b_{61} + 3) + (a_{17} + 3)(b_{71} + 3) + (a_{18} + 3)(b_{81} + 3)\},$ $\{(a_{11} + 4)(b_{11} + 4) + (a_{12} + 4)(b_{21} + 4) + (a_{13} + 4)(b_{31} + 4) + (a_{14} + 4)(b_{41} - 4) + (a_{15} + 4)(b_{51} + 4) + (a_{16} + 4)(b_{61} + 4) + (a_{17} + 4)(b_{71} + 4) + (a_{18} + 4)(b_{81} + 4)\}$ $= \{(7-4)(9-4)+(3-4)(3-4)+(4-4)(5-4)+(9-4)(1-4)+(5-4)(7-4)+(4-4)(6-4)+(5-4)(8-4)+(6-4)(5-4)\},$ $\{(7-3)(9-3)+(3-3)(3-3)+(4-3)(5-3)+(9-3)(1-3)+(5-3)(7-3)+(4-3)(6-3)+(5-3)(8-3)+(6-3)(5-3)\},$ $\{(7-2)(9-2)+(3-2)(3-2)+(4-2)(5-2)+(9-2)(1-2)+(5-2)(7-2)+(4-2)(6-2)+(5-2)(8-2)+(6-2)(5-2)\},$ $\{(7-1)(9-1)+(3-1)(3-1)+(4-1)(5-1)+(9-1)(1-1)+(5-1)(7-1)+(4-1)(6-1)+(5-1)(8-1)+(6-1)(5-1)\},$ $\{(7+1)(9+1)+(3+1)(3+1)+(4+1)(5+1)+(9+1)(1+1)+(5+1)(7+1)+(4+1)(6+1)+(5+1)(8+1)+(6+1)(5+1)\},$ $\{(7+2)(9+2)+(3+2)(3+2)+(4+2)(5+2)+(9+2)(1+2)+(5+2)(7+2)+(4+2)(6+2)+(5+2)(8+2)+(6+2)(5+2)\},$ $\{(7+3)(9+3)+(3+3)(3+3)+(4+3)(5+3)+(9+3)(1+3)+(5+3)(7+3)+(4+3)(6+3)+(5+3)(8+3)+(6+3)(5+3)\},$ $\{(7+4)(9+4)+(3+4)(3+4)+(4+4)(5+4)+(9+4)(1+4)+(5+4)(7+4)+(4+4)(6+4)+(5+4)(8+4)+(6+4)(5+4)\}$ $= \{(3)(5)+(-1)(-1)+0+(5)(-3)+(1)(3)+0+(1)(4)+(2)(1)\},$ $\{(4)(6)+0+(1)(2)+(6)(-2)+(2)(4)+(1)(3)+(2)(5)+(3)(2)\},$ $\{(5)(7)+(1)(1)+(2)(3)+(7)(-1)+(3)(5)+(2)(4)+(3)(5)+(4)(3)\},$ $\{(6)(8)+(2)(2)+(3)(4)+0+(4)(6)+(3)(5)+(4)(6)+(5)(4)\},$ $\{(8)(10)+(4)(4)+(5)(6)+(10)(2)+(6)(8)+(5)(7)+(6)(9)+(7)(6)\},$ $\{(9)(11)+(5)(5)+(6)(7)+(11)(3)+(7)(9)+(6)(8)+(7)(10)+(8)(7)\},$ $\{(10)(12)+(6)(6)+(7)(8)+(12)(4)+(8)(10)+(7)(9)+(8)(11)+(9)(8)\},$ $\{(11)(13)+(7)(7)+(8)(9)+(13)(5)+(9)(11)+(8)(10)+(9)(12)+(10)(9)\}$ $= \{15+1-15+3+4+2\}, \{24+2-12+8+3+10+6\},$

$$\{5+1+6-7+15+8+15+12\}, \{48+4+12+24+15+24+20\}, \{80+16+30+20+48+35+54+42\}, \\ \{99+25+42+33+63+48+70+56\}, \{120+36+56+48+80+63+88+72\}, \{143+49+72+65+99+80+108+90\} \\ C_{11} = (10, 41, 88, 143, 325, 436, 563, 706)$$

C_{ij} $\forall i \& j$	Order Octuplet	Average	Values
C_{11}	(10, 41, 88, 143, 325, 436, 563, 706)	$\frac{(10 + 41 + 88 + 143 + 325 + 436 + 563 + 706)}{8}$	289
C_{12}	(33, 68, 119, 186, 368, 483, 614, 761)	$\frac{(33 + 68 + 119 + 186 + 368 + 483 + 614 + 761)}{8}$	329
C_{13}	(15, 43, 87, 147, 315, 423, 547, 687)	$\frac{(15 + 43 + 87 + 147 + 315 + 423 + 547 + 687)}{8}$	283
C_{21}	(3, 33, 108, 167, 333, 448, 579, 726)	$\frac{(3 + 33 + 108 + 167 + 333 + 448 + 579 + 726)}{8}$	299.6
C_{22}	(29, 86, 141, 212, 388, 493, 620, 741)	$\frac{(29 + 86 + 141 + 212 + 388 + 493 + 620 + 741)}{8}$	338.7
C_{23}	(52, 84, 132, 192, 372, 484, 612, 756)	$\frac{(52 + 84 + 132 + 192 + 372 + 484 + 612 + 756)}{8}$	335.5
C_{31}	(28, 69, 12, 171, 435, 591, 623, 706)	$\frac{(28 + 69 + 12 + 171 + 435 + 591 + 623 + 706)}{8}$	329.3
C_{32}	(26, 57, 104, 167, 341, 452, 592, 722)	$\frac{(26 + 57 + 104 + 167 + 341 + 452 + 592 + 722)}{8}$	307.6
C_{33}	(-8, 16, 56, 128, 272, 376, 496, 632)	$\frac{(-8 + 16 + 56 + 128 + 272 + 376 + 496 + 632)}{8}$	246

Hence after de averaging the exceeding matrix is

$$D^{**} = \begin{matrix} & d_1 & d_2 & d_3 \\ \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix} & \begin{bmatrix} 289 & 329 & 283 \\ 299.6 & 338.7 & 335.5 \\ 329.3 & 307.6 & 246 \end{bmatrix} \end{matrix}$$

It is observed by the above table the patient p_1 and p_2 are suffering from d_2 and p_3 is experiencing d_1

6. CONCLUSION

In this study we enhanced the concept that the applications of soft matrices along with Sanchez's approach. If we increase number of symptoms, then it gives us more accuracy in disease identification. Results are compared with the results of (Jafar.et al., 2019) and proposed technique gives us more accuracy in results. Thus, in future Sanchez's approach along with soft matrices can be implemented to identify the diseases and more accuracy can be gained by increasing the number of symptoms.

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