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SOME REAL LIFE APPLICATIONS OF SOFT SET THEORY USING COMPUTER PROGRAMMING APPROACH

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Abstract: In this paper, a computer programming is used to determine how the theory of soft set is usable in determining patients with high-level risk of hypertension by setting the causes of hypertension as the set of parameters and the set of interviewed persons as the universe set. It is shown that, 21 patients out of the one hundred and sixty patients have the highest-level risk of hypertension, 7 patients have high risk of being hypertensive, 41 patients have moderate risk, 53 patients have low risk while 36 patients have very low risk and 12 patients does not have any risk since they are not expose to any of the causes. Patients with moderate, high and highest-level risk of being hypertensive could be advice on how to prevent themselves from hypertension. This helps in reducing the number of patients with hypertension.

Keywords: Soft Set, Hypertension Disease, Fuzzy Set, De Morgan’s Law

1. INTRODUCTION

Molodtsov (1999) introduced soft set theory and showed that the theory is free from the parameterization inadequacy syndrome of other theories developed for vagueness. A Soft set is a parameterized family of subsets defined over a universe associated with a set of parameters; it is soft because the boundary of the set depends on the parameters. Formally, a soft set over a universe set U and set of parameters E is a pair (F, A) where A is a subset of E, and F is a function from A to the power set of U. A soft set can be represented by Boolean-valued information system, and so it can be used to represent a dataset. Application of soft set is now catching momentum. Yuksel et al (2013) extended the work done by Enginoğlu and Memiş (2001), where limitations observed in the definition of intersection of two sets was addressed by defining new algebraic operations for soft sets such as restricted intersection, restricted union and extended intersections of fuzzy sets. Enginoğlu and Memiş (2001) introduced the concept of fuzzy soft set. By defining operations of soft set to make a detailed theoretical study on the soft set, Maji et al (2003) applied an algorithm which selects a set of optimum elements from alternatives. Sezgi and Atagün (2011) improved this study by defining equality of subsets, supersets, null sets, complement of soft sets and absolute soft sets. Operations such as AND, OR and De Morgan’s Laws are defined. Dauda et al (2015) also applied operations of intersection, restricted union and restricted difference on De Morgan’s law to show it holds in soft set theory. Isah et al (2019) worked on ‘’Application of soft sets to diagnose the prostate cancer risk’’. Which they devised a soft expert system (SES) as a prediction system for prostate cancer by using the prostate specific antigen (PSA), prostate volume (PV) and age factors of patients based on fuzzy sets and soft sets and have calculated the patient’s prostate cancer risk. Many researchers worked on the applications of soft sets real life practice, for more on recent applications of soft set refer to the work done by Nasef and El-Sayed (2017); Alshehri (2013); Sai (2020). In this paper, the concept of soft set will be applied to determine patients with high level risk of hypertension.

2. PRELIMINARIES

Definition 2.1 (Molodtsov (1999), Yuksel et al (2013))

If Let U be an initial universal set, E a set of parameters and A a subset of E. The power set of U is denoted by $P(U)$. A pair (F, A) is called soft set over U where F is a mapping given by $F: A \rightarrow P(U)$.
In other words, a soft set over U is a parameterized family of subsets of the universe U. For $e \epsilon A, F(e)$ may be considered as the set of e-approximation elements of the soft set (F, A). For illustration, Molodtsov considered several examples, which include.

Example 2.1
Suppose U is the set of houses under consideration and E the set of parameters (a word or sentence). E = {expensive; beautiful; wooden; cheap; in the green surroundings; modern; in good repair; in bad repair}.
In this case, to define a soft set means to point out expensive houses, beautiful houses, and so on. The soft set (F, E) describes the "attractiveness of the houses". This same example is considered below in more detail for our next discussion.
Mr. X and Miss Y are going to marry and they want to buy a house. The soft set (F, E) describes the 'capacity of the house'. Suppose that there are six houses in the universe U given by
$U = \{h_1, h_2, h_3, h_4, h_5, h_6\}$ and $E = \{e_1, e_2, e_3, e_4, e_5\}$, where
e_1 stands for the parameter 'expensive',
e_2 stands for the parameter 'beautiful',
e_3 stands for the parameter 'wooden',
e_4 stands for the parameter 'cheap',
e_5 stands for the parameter 'in the green surroundings'.
Such that

$$F(e_1) = \{h_2, h_4\},$$
$$F(e_2) = \{h_1, h_3\},$$
$$F(e_3) = \{h_3, h_4, h_5\},$$
$$F(e_4) = \{h_1, h_3, h_5\}.$$

The soft set (F, E) is a parameterized family $\{F(e_i), i = 1, 2, \cdots, 5\}$ of subsets of the set U and gives us a collection of approximate descriptions of an object. Consider the mapping F which is "houses (.)" where dot (.) is to be filled up by a parameter $e \epsilon E$. Therefore, $F(e_1)$ means "house (expensive)" whose functional value is the set $\{h_2, h_4\}$.

Thus, the soft set (F, E) can view as a collection of approximations as below: (F, E) = {expensive houses =$\{h_2, h_4\}$, beautiful houses =$\{h_1, h_3\}$, wooden houses =$\{h_3, h_4, h_5\}$, cheap houses =$\{h_1, h_3, h_5\}$}.These idea can be represented in tabular form as follows:

Table 1: Tabular representation of a soft set;

U	$\boldsymbol{e_1}$	$\boldsymbol{e_2}$	$\boldsymbol{e_3}$	$\boldsymbol{e_4}$
h_1	0	1	0	1
h_2	1	0	0	0
h_3	0	1	1	1
h_4	1	0	1	0
h_5	0	0	1	1
h_6	0	0	0	0

Definition 2.2

Let (F, A) and (G, B) be two soft set over U. Then
i. The union of (F, A) and (G, B) denoted by $(F, A) \cup (G, B)$ is define as the soft set (H, C), where $C = A \cup B$ and $\forall e \epsilon C$,

$$H(e) = F(e) \text{ } if \text{ } e \epsilon A - B,$$
$$H(e) = G(e) \text{ } if \text{ } e \epsilon B - A$$
$$H(e) = F(e) \cup G(e) \text{ } if \text{ } e \epsilon A \cap B.$$

ii. The extended intersection of (F, A) and (G,B) denoted by $(F, A) \sqcap_{\wp} (G, B)$ is defined as the soft set (H, C), where $C = A \cup B$ and for all e ϵ c,

$$H(e) = F(e) \text{ } if \text{ } e \epsilon A - B$$
$$H(e) = G(e) \text{ } if \text{ } e \epsilon B - A$$
$$H(e) = F(e) \cap G(e) \text{ } if \text{ } e \epsilon A \cap B.$$

iii. The restricted intersection of (F,A) and (G,B) denoted by (F,A) ∩ (G,B) is defined as the soft set (H,C), where C = A ∩ B, and for every c ϵ C, H(c) = F(c) ∩ G(c).

Definition 2.3

Let (*F*, *A*) and (*G*, *B*) be two soft sets over a common universe *U*, we say that
(*F*,*A*) is a soft subset of (*G*,*B*), denoted $(F, A) \tilde{\subseteq} (G, B)$, if
$A \subseteq B$ and $\forall e \in A, F(e) \subseteq G(e)$.
(F, A) said to be soft equal to (G, B) if (F, A) is a soft subset of (G, B) and (G, B) is a soft subset of (F, A).

Example 2.2

Let $A = \{e_1, e_3, e_5\} \subset E$, and $B = \{e_1, e_2, e_3, e_5\} \subset E$. Clearly, $A \subset B$.
Let (F, A) and (G, B) be two soft sets over the same universe $U = \{h_1, h_2, h_3, h_4, h_5, h_6\}$ such that G(e_1) = $\{h_2, h_4\}$, G(e_2) = $\{h_1, h_3\}$, G(e_3) = $\{h_3, h_4, h_5\}$, G(e_5) = $\{h_1\}$ and F (e_1) = $\{h_2, h_4\}$, F(e_3) = $\{h_3, h_4\}$, F (e_5) = $\{h_1\}$.
We have $(F, A) \tilde{\subseteq} (G, B)$.

Definition 2.4

A soft set (F, A) over U is said to be a NULL soft set donated by Φ, if $\forall \epsilon \in A, \ F(\epsilon) = \Phi$ (null-set)

Example 2.3

Suppose that, U is the set of wooden houses under consideration; A is the set of parameters. Let there be five houses in the universe U given by $U = \{h_1, h_2, h_3, h_4, h_5\}$and A={brick; muddy; steel; stone}.
The soft set (F, A) describes the “construction of the houses”. The soft sets (F, A) is defined as
F(brick) means the brick built houses,
F(muddy) means the muddy houses,
F(steel) means the steel built houses,
F (stone) means the stone built houses.
The soft set (F, A) is the collection of approximations as below:
(F, A) = {brick built houses=ϕ, muddy houses = ϕ, steel built houses =ϕ, stone built houses =ϕ}. Hence (F, A) is a null soft set.

3. APPLICATION OF SOFT SET IN DETERMINING PATIENTS WITH HIGH LEVEL RISK OF HYPERTENSION

Soft set theory is applicable in so many real-life situations and can as well be apply in computer especially if population is so large. To illustrate this, we consider a situation where a community is interested in determining the level of risk of its citizen to hypertension. The causes of hypertension could be considered as the set of parameters and the number of its citizens as the universal set. If the causes were certain health conditions like diabetes, lack of regular exercise, weight, family history and smoking/drinking alcohol, a questionnaire can be formulated as:

Question 1: Are you diabetic patient?
Question 2: Are you involved in regular physical activity?
Question 3: Are you over weight?
Question 4: Do you have any family history of hypertension?
Question 5: Are you smoking/ drinking alcohol?

Suppose after distributing the questionnaire, responses of one hundred and sixty respondent were collected and are represent in a soft set with $U = \{p_1, p_2, p_3, p_4, p_5, p_6, \cdots, p_{160}\}$ as the set of respondents. The risk factors of being hypertensive could be the set of parameters as {e_1 = diabetic patients, e_2 = those having regular physical activities, e_3 = those that are overweight, e_4 = those with family history of hypertension, e_5 = those that are smoking or drinking alcohol}. The responses can be presented in the following soft set (F, A) which represents the chances of a patient having exposed to hypertension based on the risk factors above.

$$F(e_1) = \{p_1, p_2, p_3, p_7, p_{10}, p_{12}, p_{18}, p_{20}, p_{25}, p_{28}, p_{29}, p_{30}, p_{33}, p_{35}, p_{37}, p_{38}, p_{39}, p_{40}, p_{41}, p_{44}, p_{45}, p_{47}, p_{152}, p_{54}, p_{58}, p_{60}, p_{65}, p_{68}, p_{70}, p_{73}, p_{75}, p_{77}, p_{81}, p_{83}, p_{87}, p_{89}, p_{92}, p_{98}, p_{100}, p_{102}, p_{105}, p_{106}, p_{109}, p_{110}, p_{115}, p_{117}, p_{118}, p_{120}, p_{121}, p_{123}, p_{125}, p_{128}, p_{131}, p_{132}, p_{138}, p_{139}, p_{140}, p_{142}, p_{146}, p_{149}, p_{150}, p_{155}, p_{157}, p_{158}, p_{160}\}$$

$$F(e_2) = \{p_1, p_2, p_3, p_4, p_5, p_7, p_8, p_{10}, p_{11}, p_{12}, p_{14}, p_{15}, p_{17}, p_{18}, p_{19}, p_{21}, p_{22}, p_{24}, p_{26}, p_{27}, p_{29}, p_{31}, p_{32}, p_{36}, p_{37}, p_{39}, p_{40}, p_{45}, p_{46}, p_{47}, p_{48}, p_{51}, p_{52}, p_{54}, p_{58}, p_{59}, p_{61}, p_{62}, p_{64}, p_{67}, p_{69}, p_{72}, p_{76}, p_{77}, p_{80}, p_{83}, p_{84}, p_{85}, p_{86}, p_{93}, p_{94}, p_{95}, p_{96}, p_{97}, p_{98}, p_{102}, p_{104}, p_{105}, p_{106}, p_{107}, p_{109}, p_{110}, p_{112}, p_{116}, p_{117}, p_{121}, p_{122}, p_{123}, p_{124}, p_{125}, p_{126}, p_{133}, p_{134}, p_{135}, p_{136}, p_{137}, p_{138}, p_{139}, p_{140}, p_{142}, p_{144}, p_{146}, p_{147}, p_{149}, p_{150}, p_{151}, p_{156}, p_{157}, p_{159}\}$$

$$F(e_3) = \{p_1, p_2, p_3, p_4, p_9, p_{10}, p_{12}, p_{22}, p_{25}, p_{29}, p_{31}, p_{32}, p_{35}, p_{37}, p_{38}, p_{39}, p_{42}, p_{43}, p_{44}, p_{49}, p_{50}, p_{52}, p_{58}, p_{62}, p_{65}, p_{66}, p_{69}, p_{70}, p_{71}, p_{77}, p_{78}, p_{82}, p_{83}, p_{87}, p_{90}, p_{92}, p_{98}, p_{102}, p_{105}, p_{106}, p_{109}, p_{111}, p_{113}, p_{115}, p_{117}, p_{122}, p_{123}, p_{126}, p_{127}, p_{132}, p_{135}, p_{136}, p_{137}, p_{138}, p_{140}, p_{142}, p_{145}, p_{146}, p_{149}, p_{151}, p_{153}, p_{155}, p_{157}, p_{158}\}$$

$$F(e_4) = \{p_1, p_2, p_3, p_4, p_6, p_8, p_{13}, p_{14}, p_{15}, p_{16}, p_{17}, p_{19}, p_{20}, p_{22}, p_{24}, p_{25}, p_{26}, p_{27}, p_{29}, p_{35}, p_{36}, p_{37}, p_{39}, p_{40}, p_{41}, p_{46}, p_{47}, p_{48}, p_{52}, p_{53}, p_{56}, p_{58}, p_{59}, p_{65}, p_{66}, p_{69}, p_{71}, p_{75}, p_{77}, p_{83}, p_{84}, p_{88}, p_{91}, p_{94}, p_{97}, p_{102}, p_{104}, p_{105}, p_{106}, p_{107}, p_{109}, p_{117}, p_{119}, p_{120}, p_{123}, p_{124}, p_{131}, p_{133}, p_{135}, p_{136}, p_{137}, p_{138}, p_{139}, p_{142}, p_{146}, p_{149}, p_{155}, p_{157}, p_{159}\}$$

$$F(e_5) = \{p_1, p_2, p_3, p_4, p_6, p_{13}, p_{15}, p_{17}, p_{19}, p_{20}, p_{22}, p_{24}, p_{25}, p_{27}, p_{29}, p_{30}, p_{32}, p_{36}, p_{37}, p_{38}, p_{39}, p_{40}, p_{43}, p_{44}, p_{48}, p_{52}, p_{58}, p_{60}, p_{65}, p_{67}, p_{72}, p_{77}, p_{78}, p_{81}, p_{83}, p_{84}, p_{86}, p_{88}, p_{90}, p_{92}, p_{93}, p_{94}, p_{95}, p_{100}, p_{101}, p_{102}, p_{104}, p_{105}, p_{106}, p_{107}, p_{108}, p_{109}, p_{111}, p_{112}, p_{117}, p_{118}, p_{120}, p_{121}, p_{123}, p_{126}, p_{128}, p_{130}, p_{133}, p_{134}, p_{135}, p_{138}, p_{140}, p_{141}, p_{142}, p_{144}, p_{145}, p_{146}, p_{147}, p_{148}, p_{149}, p_{152}, p_{157}, p_{158}, p_{160}\}$$

For easy analysis of the above results, the soft set is represented in a tabular form as shown below. This style of representation will be useful for storing a soft set in a computer memory. If $h_i \epsilon F(e)$ then $h_{ij} = 1$, otherwise $h_{ij} = 0$, whereh_{ij} are the entries in the table below.

Table 2: Tabular Representation of this Soft Set

U	e_1	e_2	e_3	e_4	e_5
h_1	1	1	1	1	1
h_2	1	1	1	1	1
h_3	1	1	1	1	1
h_4	0	1	1	1	1
h_5	0	1	0	0	0
h_6	0	0	0	1	1
h_7	1	1	0	0	0
h_8	0	1	0	1	0
h_9	0	0	1	0	0
h_{10}	1	1	1	0	0
h_{11}	0	1	0	0	0
h_{12}	1	1	1	0	0
h_{13}	0	0	0	1	1
h_{14}	0	1	0	1	0
h_{15}	0	1	0	1	1
h_{16}	0	0	0	1	0
h_{17}	0	1	0	1	1
h_{18}	1	1	0	0	0
h_{19}	0	1	0	1	1
h_{20}	1	0	0	1	1
h_{21}	0	1	0	0	0
h_{22}	0	1	1	1	1
h_{23}	0	0	0	0	0
h_{24}	0	1	0	1	1
h_{25}	1	0	1	1	1
h_{26}	0	1	0	1	0
h_{27}	0	1	0	1	1
h_{28}	1	0	0	0	0
h_{29}	1	1	1	1	1
h_{3o}	1	0	0	0	1
h_{31}	0	1	1	0	0
h_{32}	0	1	1	0	1
h_{33}	1	0	0	0	0
h_{34}	0	0	0	0	0
h_{35}	1	0	1	1	0
h_{36}	0	1	0	1	1
h_{37}	1	1	1	1	1
h_{38}	1	0	1	0	1
h_{39}	1	1	1	1	1
h_{4o}	1	1	0	1	1
h_{41}	1	0	0	1	0
h_{42}	0	0	1	0	0
h_{43}	0	0	1	0	1
h_{44}	1	0	1	0	1
h_{45}	1	1	0	0	0
h_{46}	0	1	0	1	0
h_{47}	1	1	0	1	0
h_{48}	0	1	0	1	1
h_{49}	0	0	1	0	0
h_{50}	1	0	1	0	0
h_{51}	0	1	0	0	0
h_{52}	1	1	1	1	1

h_{53}	0	0	0	1	0
h_{54}	1	1	0	0	0
h_{55}	0	0	0	0	0
h_{56}	0	0	0	1	0
h_{57}	0	0	0	0	0
h_{58}	1	1	1	1	1
h_{59}	0	1	0	1	0
h_{60}	1	0	0	0	1
h_{61}	0	1	0	0	0
h_{62}	0	1	1	0	0
h_{63}	0	0	0	0	0
h_{64}	0	1	0	0	0
h_{65}	1	0	1	1	1
h_{66}	0	0	1	1	0
h_{67}	0	1	0	0	1
h_{68}	1	0	0	0	0
h_{69}	0	1	1	1	0
h_{7o}	1	0	1	0	0
h_{71}	0	0	1	1	0
h_{72}	0	1	0	0	1
h_{73}	1	0	0	0	0
h_{74}	0	0	0	0	0
h_{75}	1	0	0	1	0
h_{76}	0	1	0	0	0
h_{77}	1	1	1	1	1
h_{78}	0	0	1	0	1
h_{79}	0	0	0	0	0
h_{8o}	0	1	0	0	0
h_{81}	1	0	0	0	1
h_{82}	0	0	1	0	0
h_{83}	1	1	1	1	1
h_{84}	0	1	0	1	1
h_{85}	0	1	0	0	0
h_{86}	0	1	0	0	1
h_{87}	1	0	1	0	0
h_{88}	0	0	0	1	1
h_{89}	1	0	0	0	0
h_{90}	0	0	1	0	1
h_{91}	0	0	0	1	0
h_{92}	1	0	1	0	1
h_{93}	0	1	0	0	1
h_{94}	0	1	0	1	1
h_{95}	0	1	0	0	1
h_{96}	0	1	0	0	0
h_{97}	0	1	0	1	0
h_{98}	1	1	1	0	0
h_{99}	0	1	0	0	0
h_{100}	1	0	0	0	1
h_{101}	0	0	0	0	1
h_{102}	1	1	1	1	1
h_{103}	0	0	0	0	0
h_{104}	0	1	0	1	1
h_{105}	1	1	1	1	1
h_{106}	1	1	1	1	1

h_{107}	0	1	0	1	1
h_{108}	0	0	0	0	1
h_{109}	1	1	1	1	1
h_{11o}	1	1	0	0	0
h_{111}	0	0	1	0	1
h_{112}	0	1	0	0	1
h_{113}	0	0	1	0	0
h_{114}	0	0	0	0	0
h_{115}	1	0	1	0	0
h_{116}	0	1	0	0	0
h_{117}	1	1	1	1	1
h_{118}	1	0	0	0	1
h_{119}	0	0	0	1	0
h_{12o}	1	0	0	1	1
h_{121}	1	1	0	0	1
h_{122}	0	1	1	0	0
h_{123}	1	1	1	1	1
h_{124}	0	1	0	1	0
h_{125}	1	1	0	0	0
h_{126}	0	1	1	0	1
h_{127}	0	0	1	0	0
h_{128}	1	0	0	0	1
h_{129}	0	0	0	0	0
h_{130}	0	0	0	0	1
h_{131}	1	0	0	1	0
h_{132}	1	0	1	0	0
h_{133}	0	1	0	1	1
h_{134}	0	1	0	0	1
h_{135}	0	1	1	1	1
h_{136}	0	1	1	1	0
h_{137}	0	1	1	1	0
h_{138}	1	1	1	1	1
h_{139}	1	1	0	1	0
h_{140}	1	1	1	0	1
h_{141}	0	0	0	0	1
H_{142}	1	1	1	1	1
h_{143}	0	0	0	0	0
h_{144}	0	1	0	0	1
h_{145}	0	0	1	0	1
h_{146}	1	1	1	1	1
h_{147}	0	1	0	0	1
h_{148}	0	0	0	0	1
h_{149}	1	1	1	1	1
h_{15o}	1	1	0	0	0
h_{151}	0	0	1	0	0
h_{152}	0	1	0	0	1
h_{153}	0	0	1	0	0
h_{154}	0	0	0	0	0
h_{155}	1	0	1	1	0
h_{156}	0	1	0	0	0
h_{157}	1	1	1	1	1
h_{158}	1	0	1	0	1
h_{159}	0	1	0	1	0
h_{16o}	1	0	0	0	1

The programme for this soft set is written as:

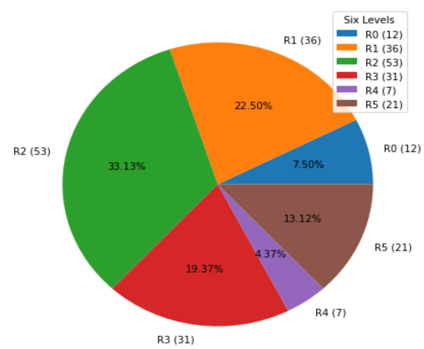
```
import csv
from matplotlib import pyplot as plt
%matplotlib inline

def resultMaker(filename): #Extracts the respondents answer from a file
   results = [0,0,0,0,0,0]
   with open(filename) as f:
      contents = csv.reader(f)
      for row in contents:
         level = sum(list(map(int,row[1:])))
         results[level]+=1
   graphMaker(results)

def graphMaker(result): # graphMaker plots the graph
   mylabels = ["R0 ("+str(result[0])+")","R1 ("+str(result[1])+")","R2 ("+str(result[2])+")","R3 ("+str(result[3])+")","R4 ("+str(result[4])+")","R5 ("+str(result[5])+")"]
   fig = plt.figure(figsize=(12,7))
   plt.pie(result,labels=mylabels, autopct='%1.2f%%')
   plt.legend(title="Six Levels")
   plt.show()

result = resultMaker("data.csv") #calling the resultMaker with the file name as argument
```

After running this program in python programming language, we obtain the following result.



From the above, we found out that:
We have six levels $R0, R1, R2, R3, R4$ and $R5$.
$R0$ Represent patients that did not appear in any of the parameters.
$R1$ Represent patients that appear in one of the parameters.
$R2$ Represent patients that appear in two of the parameters.
$R3$ Represent patients that appear in three of the parameters.
$R4$ Represent patients that appear in four of the parameters.
$R5$ Represent patients that appear in five of the parameters.

This shows that, 21 patients (equivalent to 13.12%) have very high risk of being hypertensive, 7 patients (equivalent to 4.37%) have high risk of being hypertensive, 41 patients (equivalent to 19.37%) have moderate risk, 53 patients (equivalent to 33.13%) have low risk while 36 patients (equivalent to 22.50%) have very low risk and 12 patients (equivalent to 7.50%) does not have any risk since they are not expose to any of the causes.

4. CONCLUSION

Soft set is used in determining the patients with risk of hypertension. Moreover, larger number of patients can be considered to thousands or millions of patients by establishing a programme that can be implemented using computer system. This can be extended to other diseases and similar problems. This indicates the applicability of soft set-in economics, health sector, entrepreneurship, marketing, computer science etc.

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