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Bachelor of Computer Science and Artificial Intelligence

Probability for Computing Science

A novel, complex system approach to modelling psychological distress in young adolescents - A prototype of the Bayesian Network

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I. Introduction

It is widely recognized that psychological distress in adolescents often stems from various environmental, social, and contextual influences. Gaining insight into these factors is essential for effectively providing support for teen patients' mental well-being and for proactively addressing issues in this area. In this report, we present the design and rationale behind our prototype of a Bayesian network modelling psychological distress in teenagers. We will introduce the model, we will discuss our choice of variables, their states, and the values attributed to their probabilities. As the basis of our work we will take the study *A novel, complex system's approach to modelling risk of psychological distress in adolescents as reference for baseline design choices*.

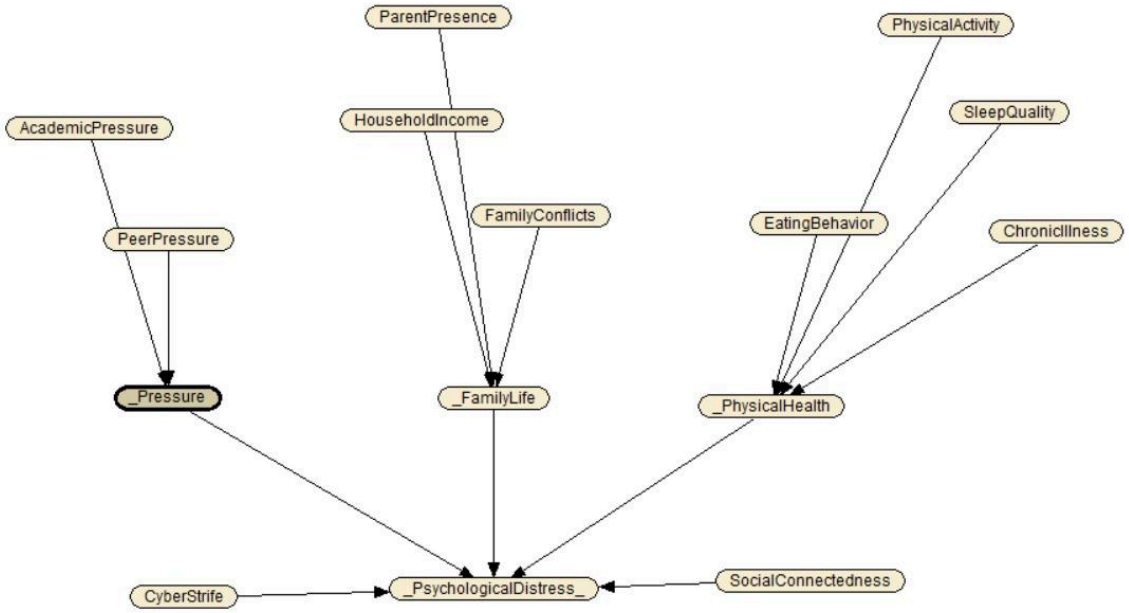


Figure 1. The resultant prototype's Bayesian Network

II. Prototype

In this section you can find a link to the prototype along with a figure of the final Bayesian Network and CPTs.

[Link to the prototype]

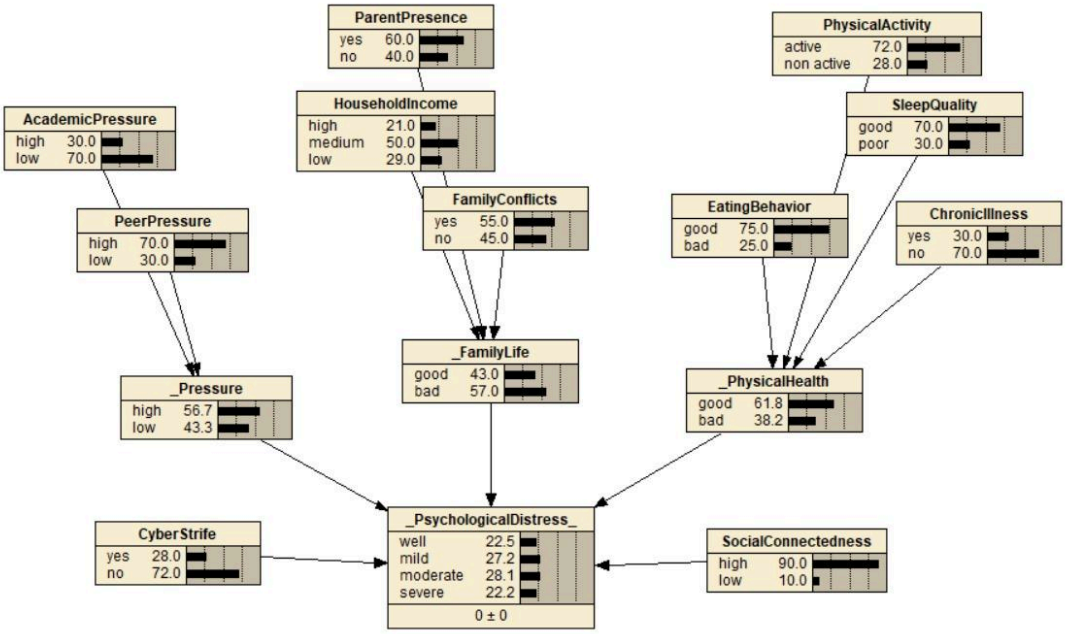


Figure 2. The final Bayesian Network + CPTs

III. The choice of the variables

The selection of variables was partly inspired by the Bayesian network presented in *A novel, complex system's approach to modelling risk of psychological distress in adolescents as reference for baseline design choices*. The variables which were taken exclusively from the paper are "cyber strife", which encompasses various forms of online conflicts including cyberbullying, online harassment, trolling etc…, "Cyber victimization was found to be related to depression, low self-esteem, anxiety, low academic achievement, loneliness, poor life satisfaction, substance use, somatic symptoms, stress, and suicidal ideation"[1], "Physical health" from which we also kept parent variables "Sleep", "Physical activity" and "Eating behaviours". We decided that Physical health should have another affecting factor, chronic illnesses as a parent node.

Other factors found relevant include feeling pressured, stemming from academic pressure to excel and succeed (enforced by parents or academic teams like professors) and social pressure to conform to peers' standards and societal expectations. This can be seen through the following quote which was taken from a study done to research psychological distress in children and adolescents; "Pressure to perform well in the examination or test and time allocated makes academic environment very stressful. One of the major impacts of stress is that it affects drastically the psychological functions in turn mental health of people"[3]

These previously mentioned pressures can be measured through qualitative assessments of adolescents' perceptions and experiences, as well as quantitative evaluations of stress levels like for example through measurements of cortisol.

Another main factor is family life, "A better appreciation of the web of social and psychosocial processes that surround the association between family structure and health outcomes needs to be studied"[1] its subsets are family conflicts, lack of parenting and household income. As mentioned before, physical health also has other contributing factors other than physical activity and sleep, namely chronic illnesses and Eating behaviours. Lastly, we consider social connectedness as a key factor which was also demonstrated in the research paper that we started with.

In conclusion each variable was selected based on its significance and contribution towards distress and psychological wellness whether based on our selected research paper or extra research we have done to draw such conclusions..

IV. The choice of the states of the variables

First we would like to start with a definition of a state. A state refers to the different conditions or levels of each variable being measured. They represent the various scenarios or situations that adolescents may encounter in relation to the specific factors being assessed. Each state reflects a distinct aspect of the adolescent's environment or experiences, providing insights into their circumstances and potential challenges.

We can explain the choice of the states of the variables as follows:

1. Peer Pressure: this variable usually comes in a spectrum. We decided to quantify it in two levels: High and Low.
2. Academic Pressure: Similarly to peer pressure, we will quantify it in two levels : High and Low.
3. Pressure: This variable's states are indicated as High or Low. And is the direct result of all the previous variables.
4. Family Conflicts: This is also a straightforward variable where its state would be Yes or No.
5. Parents' presence: Also a straightforward variable which means whether parents of the adolescent are active and present parents, with Yes or No as states.
6. Household Income: Income is generally divided into three tiers, High - Medium - Low.
7. Family Life: The parents of this variable are the variables 4-6. The states chosen were Good or Bad.
8. Chronic Illnesses: Its states as Yes or No, since adolescents either have a chronic illness or don't.
9. Eating Behaviours: This variable is uncomplicated, offering only the choices of Good or Bad.
10. Sleep Quality: Sleep is either Good or Poor, therefore those were the states.
11. Physical Activity: This refers to whether adolescents practise sports so the states were set to Active or Inactive.

12. Physical Health: Again this variable is the child node of nodes 8 through 11, and its selected states are Good or Bad.
13. Cyber Strife: It's a direct variable with binary states: Yes or No.
14. Social Connectedness: This variable was stressed upon in the research paper. Its possible outcomes are Yes or No.

V. The choice of the edges of the Bayesian network

The determination of edges in the Bayesian network was informed by known relationships and dependencies between the selected variables. For example:

1. Peer Pressure and Academic Pressure were chosen as parents of Feeling Pressured due to their established influence on a student's psychological state[5].
2. Family Conflicts, Parents' presence, and Household Income were selected as parents of Family Life, reflecting their impact on the family environment and its subsequent influence on psychological well-being.
3. Sleep, Chronic illnesses, Eating behaviours and Physical Activity were chosen to be parents of physical health as they are all direct indicators and effectors of its quality. As was mentioned earlier this relationship is well established in studies like LABs.
4. Inspired by the research paper, which had found cyber strife and social connectedness as important factors that contribute heavily towards the psychological well-being of young adolescents, hence the choice of the edge between these variables.

VI. The choice of the entries of the CPTs

The entries of the Conditional Probability Tables (CPTs) were populated based on available data (the research paper) and domain knowledge (Extra scholarly articles and research). Probabilities were assigned to each state combination of parent and child variables.

The probability of Academic Pressure being high was set to 0.70 and 0.30 for low. This was extracted from a study where they explained “It is estimated that 10–30% of students

experience some degree of academic stress during their academic career." Same goes for Peer Pressure where we had found an article that cited 85%[9] of highschoolers experiencing high peer pressure, however, this was stated to be a slight overestimate so we decided to adjust it to 70%.

Moving to the second main factor - Family Life - and its parents. We start with family conflicts; we found that a study done by Whitefield explained that more than 50% of families are dysfunctional therefore we chose the probability of this variable to be 55% defaulting the functional families (No state) to 45%. Household income was shown in a study to be split into three tiers of high (21%), medium (50%) and low (29%)[10]. Last parent is parent's presence where a study found almost 40% of kids and adolescents grew up in single parent households[11]

Third direct factor is physical health, some of the values and variables were directly inspired by the research paper so the probabilities were the following, Sleep Quality being good is 0.70 and bad 0.30, physical activity was set as 72% for active adolescents and 28% non-active, then eating behaviours being good is 75% and bad 25%. And lastly chronic illnesses, where the values were set at 30% with chronic diseases while 70% healthy.

And finally the last two factors are cyber strife and social connectedness which were set to 66%(No), 34% (Yes) and 90% (high connectedness) and 10% (low connectedness).

Resultant CPTs can be viewed through Figures 3 - 8.

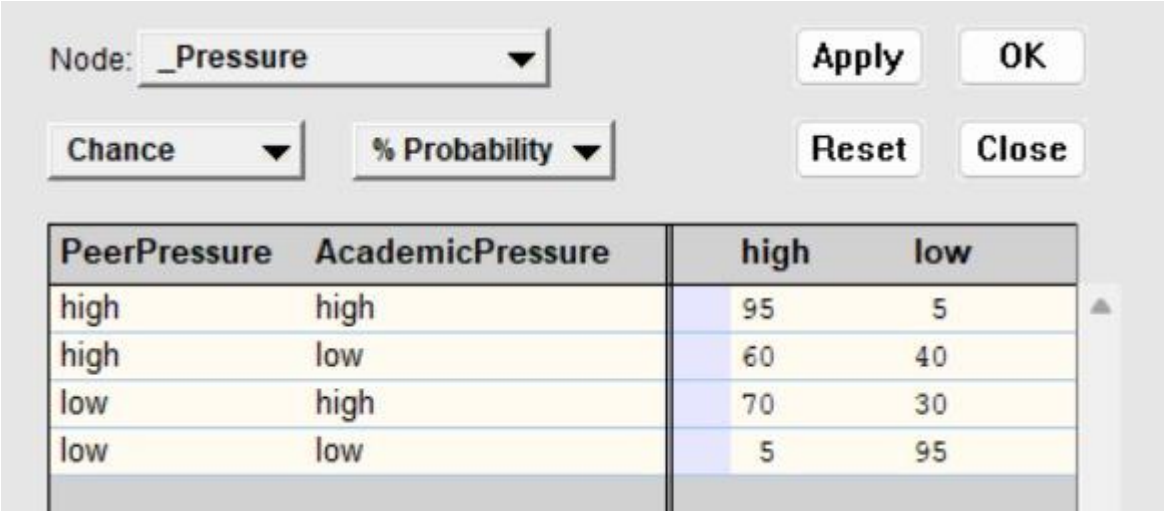


Figure 3. The CPT of Pressure.

Node: _FamilyLife

Apply OK

Chance % Probability

Reset Close

FamilyConflicts	HouseholdIncome	ParentPresence	good	bad
yes	high	yes	40	60
yes	high	no	20	80
yes	medium	yes	35	65
yes	medium	no	45	55
yes	low	yes	30	70
yes	low	no	5	95
no	high	yes	95	5
no	high	no	60	40
no	medium	yes	75	25
no	medium	no	40	60
no	low	yes	45	55
no	low	no	10	90

Figure 4. The CPT of Family Life

Node: _PhysicalHealth

Apply OK

Chance % Probability

Reset Close

ChronicIllness	EatingBehavior	SleepQuality	PhysicalActivity	good	bad
yes	good	good	active	90	10
yes	good	good	non active	20	80
yes	good	poor	active	25	75
yes	good	poor	non active	20	80
yes	bad	good	active	10	90
yes	bad	good	non active	15	85
yes	bad	poor	active	20	80
yes	bad	poor	non active	5	95
no	good	good	active	90	10
no	good	good	non active	75	25
no	good	poor	active	80	20
no	good	poor	non active	70	30
no	bad	good	active	30	70
no	bad	good	non active	30	70
no	bad	poor	active	20	80
no	bad	poor	non active	5	95

Figure 5. The CPT of Family Life

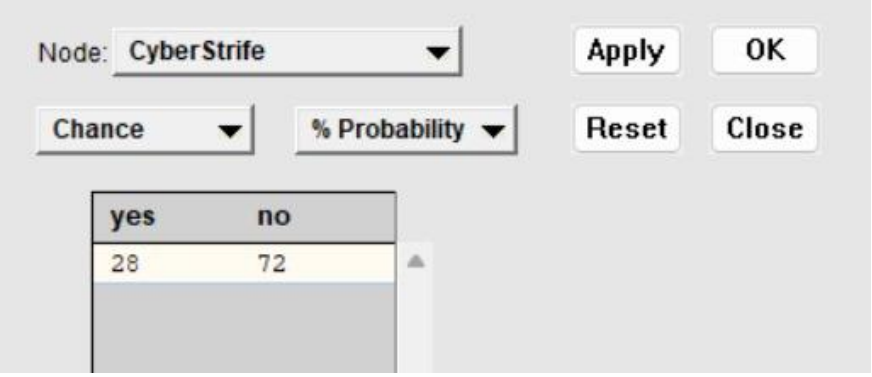


Figure 6. The CPT of Cyber Strife

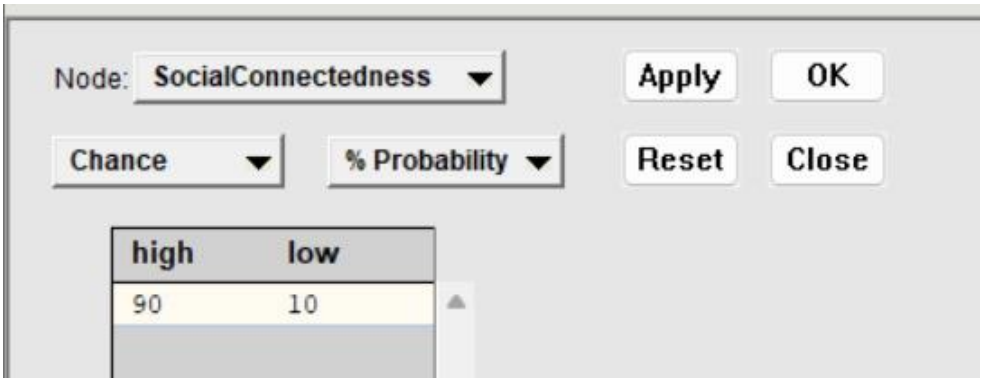
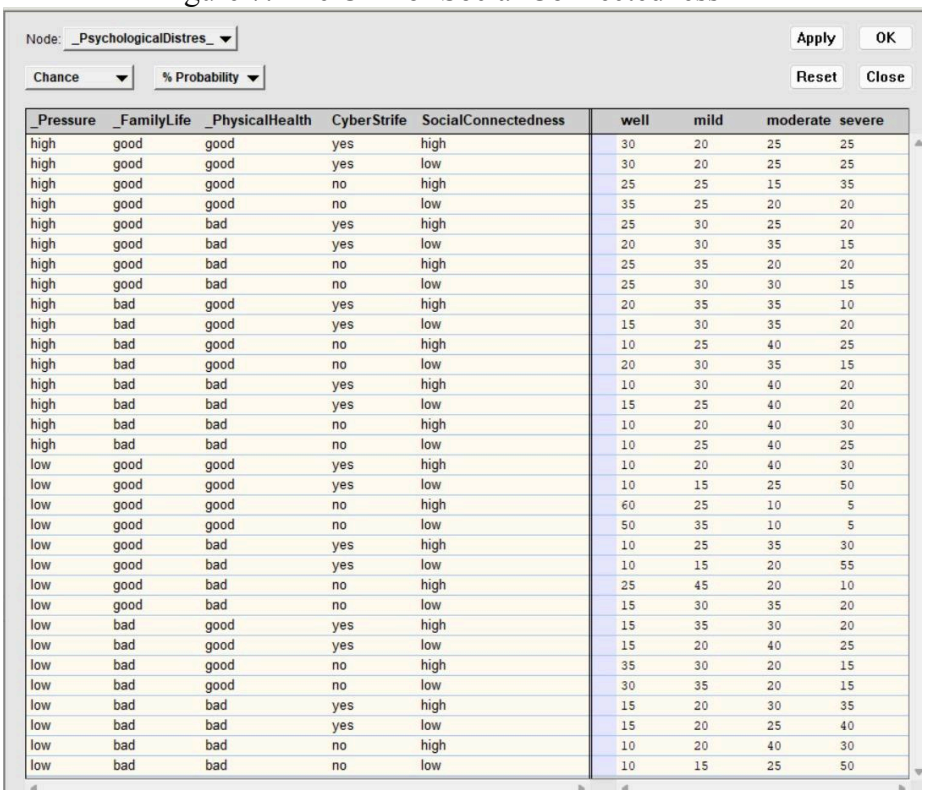


Figure 7. The CPT of Social Connectedness



_Pressure	_FamilyLife	_PhysicalHealth	CyberStrife	SocialConnectedness	well	mild	moderate	severe
high	good	good	yes	high	30	20	25	25
high	good	good	yes	low	30	20	25	25
high	good	good	no	high	25	25	15	35
high	good	good	no	low	35	25	20	20
high	good	bad	yes	high	25	30	25	20
high	good	bad	yes	low	20	30	35	15
high	good	bad	no	high	25	35	20	20
high	good	bad	no	low	25	30	30	15
high	bad	good	yes	high	20	35	35	10
high	bad	good	yes	low	15	30	35	20
high	bad	good	no	high	10	25	40	25
high	bad	good	no	low	20	30	35	15
high	bad	bad	yes	high	10	30	40	20
high	bad	bad	yes	low	15	25	40	20
high	bad	bad	no	high	10	20	40	30
high	bad	bad	no	low	10	25	40	25
low	good	good	yes	high	10	20	40	30
low	good	good	yes	low	10	15	25	50
low	good	good	no	high	60	25	10	5
low	good	good	no	low	50	35	10	5
low	good	bad	yes	high	10	25	35	30
low	good	bad	yes	low	10	15	20	55
low	good	bad	no	high	25	45	20	10
low	good	bad	no	low	15	30	35	20
low	bad	good	yes	high	15	35	30	20
low	bad	good	yes	low	15	20	40	25
low	bad	good	no	high	35	30	20	15
low	bad	good	no	low	30	35	20	15
low	bad	bad	yes	high	15	20	30	35
low	bad	bad	yes	low	15	20	25	40
low	bad	bad	no	high	10	20	40	30
low	bad	bad	no	low	10	15	25	50

Figure 8. The CPT of Psychological Distress

VII. The use of the prototype to answer the research question

A potent tool for tackling a range of research topics relevant to adolescents' psychological distress is the constructed Bayesian network prototype. Researchers can receive pertinent conditional probabilities to gain insights into the elements impacting psychological discomfort by querying the network with particular variable configurations. For example:

1. What is the probability of experiencing psychological distress given high levels of academic pressure and family conflicts?
2. How does the probability of feeling pressured vary based on the presence of peer pressure and Parents' presence?

These questions can be answered using the Bayesian network prototype, providing valuable insights into the complex interplay of factors affecting psychological well-being. As we can see in Figure 2. The probability of pressure being high is 56.7%, and the probability of family life being bad outweighs the probability of it being good by 57% compared to 43%. But even though these two variables are indicating a high probability for a severe psychological distress we find that cyber strife and social connectedness - relatively low (28% for cyberbullying, and 72% for non-bullying) and social connectedness (90% high and 10% low) - are balancing the probabilities, therefore they are considered the most contributing factors to the probabilities of distress. This results in the close probabilities of distress; well is 22.5%, mild 27.2%, moderate 28.1% and severe 22.2%. This supports the claim that Cyberstarife and Social Connectedness have a greater impact on psychological distress hence the choice of these variables.

VIII. Bibliography

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