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APPLICATION OF BAYESIAN NETWORKS: WHY STUDENT PREFER FAST-FOOD, KAMPAR DISTRICT

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ABSTRACT

It is common in nowadays where people eat at restaurant rather than cook or prepare meal by themselves. Comparing to home cook meal, eating at restaurant may have been ignoring the hygiene and balance nutrition issue by human for the sake of convenient and time saving. Thus, fast-food has naturally become one of the choices of their preference. We used Bayesian network to identify the factors that influence UTAR Kampar students to have fast-food as their proper meal. Bayesian Networks is one of the probabilistic graphical models and the network must be a directed acyclic graph. The network structure is formed by nodes (random variables) and they are linked by a directed arc corresponding to the causal relationship between them. In this paper, we discovered that the main reason for McD fast-food to be treated as a proper meal mostly in not because of "fast", i.e., the time saving factor, though it is the inspiration of emerging fast-food restaurants. Besides the unexpected result, the food preference of university students is not easily influenced by friends' suggestions.

Keywords: Bayesian Network, Fast-Food, Structural Network, Directed Acyclic Graph.

INTRODUCTION

Most of the fast-food are having a perception of taking unhealthy foods because food that contains synthetic ingredient that can prompt memory loss, get diabetes, damage kidney. Moreover, indirectly it has other unpleasant effect on blood pressure, enemies of teeth, trigger headaches and acne. It may be considered as junk food and makes people over-eat. For instance, sugary drinks where added sugar is one of the worst ingredients in the modern diet. To stay longer and enjoy our life happily, health is one of the important issues for it. Health is a relationship between us and our body. Therefore, food that we consume should brings benefit for our body. We eat to live, not live to eat. Nutrient should not be a restriction but a healing for human body. Moreover, taking medicine is not for health care instead it is sick care. However, due to the busy life in the society, people have no choice but to eat out.

"What to eat later?" It is always a common question to be asked every day. There are many types of restaurants in our nearby. It brings convenience to us whenever we can hunt for food for anytime anywhere. With the advantages such as fast serving, affordable price, air-conditioned and 24 hours service available, we, especially students tend to opt for having fast-food as their normal meal. The main purpose of this paper is to determine the reasons that UTAR Kampar students prefer to have fast-foods as their lunch or dinner by means of Bayesian networks.

Fast-food this term commences with the first fish and chip shops in Britain in 1860s while drive through restaurant were first popularize in the 1950s in the US. Fast-food such as pizza or fried food are high in calories and have most no essential nutrients. Fast-food is addictive even though it is mass-produced and low in nutrients. Of course, the advantage of fast-food is that they are quick, easy to get, and the taste match majority.

A university built in Kampar has subsequently led to many cafés, restaurants, including fast-food restaurants have started their business in this small district in Perak state. Despite other type of business developing in Kampar, catering business is always the most decision to startup a business since food is a necessity. Therefore, the catering business is in a very intensive competition. As an owner of a restaurant, it is crucial to identify the factors that students will take into consideration before they take their meal. Those restaurant owners can be based on the few important factors to outstanding their restaurant among other competitors. It would be a great help on the business if the factors are identified. The fast-food restaurants in this study are referring to McDonald in Kampar.

In this study, proportional quota sampling method is applied. Proportional quota sampling method is used because it represents the major characteristic of the population by sampling a proportional amount of each. Bayesian networks theory is used in this study to identify the relationship between these factors. With the constructed network structure, we may know the casual factors relationship of the variables.

LITERATURE REVIEW

Factors

There are numerous restaurants in Kampar selling various types of food such as Western food, Malay food, Chinese food, Indian food, Korean food, Japanese Cuisine and Thai style food etc. Of course, we can't have all the restaurants to be fully occupied during lunch hour or dinner time, but there are always some restaurants that having full house during certain hours. Out of all the choices available, what would be the first choice a customer would pick? From the

previous researches done. There are some researches on the important factors that affect the consumers' selection of restaurants. The most general factors like food taste, price, service time, location, food quality and other factors (Medeiros & Salay, 2011). Among all the fast-food restaurants, McDonalds is chosen as the target restaurant since most of the UTAR Kampar students are familiar with it. We cannot deny that food taste is the crucial factors that affect our decision on food selection. There are several researches done and conclude that food taste is the top three in the list of important factors that affecting consumers' food choice (Markovina, 2016). Human eating behavior is exclusively affected by the taste or flavor of food since early age (Ulijaszek, 2007). There is a study found that most of the people especially children are sensitive in the bitterness or do not like to eat bitter food. The observation shown that most of the children try to avoid eating bitter food because they do not like the taste. This indicated that people tend to avoid the food that they do not like the taste since early ages (Negri et al., 2012). Normally, people will choose to eat the food that match their palate. For example, some of consumers might not choose to go to a restaurant if they knew that the food taste of the restaurant is not good although the price is cheaper compared to other restaurants. However, consumers are willing to revisit the restaurant if the food is delicious although the price of food is slightly expensive. Thus, taste of the food is one of the important factors that can attract new customers or stay the existing customers (French, .

Hippocrates of Kos, the father of modern medicine was the first person who found the healin power of food (Flinders, 2017). A satisfying delicious meal can make people having good mood. Some people will consume food to improve their mood or for relaxation purpose. This is because consuming food can maintain the blood-sugar level in a steady range which help mood to be stabilized. Researchers found that there is a strongly relationship between food choice and poor mood. People who have a poor mood tend to prefer sugary, salty, or fatty food. These kinds of foods may boost energy, make people feel comfort and improve mood in short time. However, this positive effect is just for short term because overly consume these kinds of foods is not good for health (Flinders, 2017). Savvy Psychologist, Dr. Hendriksen (2014) said that there is a type of hormones which called cortisol will be produced when people feel under-appreciated or feeling something happened out of their control. Appetite will be increased when cortisol is being produced, especially for the foods that are high in sugar and fat (Hendriksen, 2014). Normally, when people are in bad mood or feeling stress, they tend to crave for desserts or beer. There is research found that people tend to choose healthier or indulgent foods based on their mood at that moment. This result shows that whoever in good mood will choose healthier food compared to those who are in bad mood (Meryl, 2014).

Price is one of the important factors that influence consumers on food selection, especially for those who are from lower socioeconomic status. Therefore, they prefer to hunt for food that are tastier and cheaper but not limited to nutrient. They have a higher tendency in having unbalanced diets due to affordable low cost on meal. This is because usually the healthier food will have a higher price compared to lesser one (French, 2003). Certainly, buyers will tend to buy healthier food if it costs lesser. The connection between price of food and consumer selection were examined and research been carried out. When there is a lowering price in healthy foods or fruit and vegetables, the demand of healthy foods had risen more than 40 percent. However, the raising prices on unhealthy foods or products, the demand of unhealthy

foods did not drop dramatically. For example, the demand of soda drinks and fast-food drop around 7 percent and 3 percent respectively (Ducharme & Wellness, 2017).

What kind of meal is considered as a proper nutrition's meal? A meal which consists of carbohydrate, protein, fat, fiber and other nutrient? Nowadays, many people like to eat meat compare with vegetables. Therefore, a meal without vegetables usually will be considered as a not balanced diet. People who are more concern about health and nutrition might consider the nutritional quality of foods before they decide what food to consume as most of them are veggie lover. Based on a health and lifestyle survey from Health Education Authority in 1993, people who consume less fruits and vegetables were more agree to the statement 'I don't really care what I eat' and disagree to 'healthy foods are enjoyable' statement (Pollard, et al., 2002). The result based on research and its observation shows that women spent more time on comparing the price of food while men spent more time on choosing the food which good for their general healthiness (Missagia, et al., 2012).

Bayesian Network

Bayesian networks is also known as Bayes nets or belief networks which belongs to the family of probabilistic graphical models. The graphical structures are used to represent relationship between the variables. A graphical structure is a network that connected by the nodes. In particular, each node in the network represents a random variable, while the edges between the nodes represent probabilistic dependencies among the corresponding random variables. These conditional dependencies in the graph are often estimated by using known statistical and computational methods. Hence, Bayesian networks combine principles from graph theory, probability theory, computer science, and statistics. Bayesian networks can represent the data in graphical view and compute the joint probability distribution effectively based on the conditional probabilities (Murphy, 2001).

Bayesian Network Learning

There are two types of Bayesian networks learning which are parameter learning and structure learning. Parameter learning is being obtained after the structure learning been studied.

Score-and-search Based Algorithm

Score-and-search approach is a method that used to determine the structure of a network through a metric. Search algorithm is employed to identify the network structure with the metric which has the best score (Wong & Leung, 2004). There are several score-and-search based algorithms available in structural learning such as hill-climbing (HC), Tabu search (TABU) and greedy algorithm.

Constraint-based Algorithm

Constraint-based algorithms use conditional independence tests to obtain the Directed Acyclic Graph (DAG) of a Bayesian network where under the assumption that graphical separation and probabilistic independency indicating each other. Mutual information test and exact Student's test for correlation are the tests to be used generally for discrete Bayesian networks and General Bayesian Networks respectively (Scutari, 2014). Constraint-based algorithm included Grow-Shrink (GS), Incremental Association (IAMB), Fast Incremental Association (Fast-IAMB), Interleaved Incremental Association(Inter-IAMB), Max-Min Parents and Children (MMPC) and Semi-Interleaved HITON-PC constraint-based algorithms.

Scoring Functions

The scoring functions for the Bayesian network learning are generally classified into two main

classes which are Bayesian scoring functions and information-theoretic scoring functions. Bayesian scoring functions consist of few types of scoring functions such as BD (Bayesian Dirichlet), BDe ("e" for likelihood-equivalence), DBeu ("u" for uniform joint distribution) and K2. LL (Log-likelihood), MDL (Minimum Description Length) or BIC (Bayesian Information Criterion), AIC (Akaike Information Criterion), NML (Normalized Minimum Likelihood) and MIT (Mutual Information Tests) are belongs to Information-theoretic scoring functions (Carvalho, 2009).

Bayesian scoring functions compute the posterior probability by starting from prior probability distribution on a possible network, G with conditioned to the data D, $P(G|D)$. A way to obtain the best network is choosing the network that maximizes the posterior probability. The value $\log(P(D, G))$ is used commonly instead of $P(D, G)$ since it is computed easily in the logarithmic space.

METHODOLOGY AND DATASET

The purpose of this study is to determine the factors that influence UTAR Kampar students to choose fast-food as their meal. A questionnaire was developed as the research instrument to collect data from respondents. The questions design based on the factors that will be considered by students before they take their meal. The questionnaire consists of four parts since the factors have been classified into demographic factor, personal factor, restaurant factor and food quality. The data were collected from the target population, students who study in UTAR Kampar Campus.

Demographics

The first session of the questionnaire is regarding the demographic of the respondents. It consists of basic information such as gender, age, year of study, faculty of study, average expenses on a meal etc. A total of 210 sets of questionnaires have been collected from the students who are currently studying in UTAR Kampar campus, Perak. The summary of the description of demographics is shown in Table 1.

Table 1

Description of Respondents

	Category	Total	Percentage (%)
Gender	Male	79	37.6
	Female	131	62.4
Faculty	Centre of Foundation Studies	8	3.8
	Institute of Chinese Studies	9	4.3
	Faculty of Information and Communication Technology	7	3.3
	Faculty of Engineering and GreenTechnology	19	9
	Faculty of Arts and Social Science	36	17.1
	Faculty of Science	47	22.4
	Faculty of Business and Finance	84	40
Current year of study	Foundation	8	3.8
	First Year	50	23.8
	Second Year	57	27.1
	Third Year	84	40
	Fourth Year	10	4.8
	Fifth Year	0	0

	Sixth Year	1	0.5
Average spent on a meal	RM 1.00 – RM 5.00	46	21.9
	RM 5.10 – RM 10.00	128	61
	RM 10.10 – RM 15.00	29	13.8
	RM 15.10 – RM 20.00	5	2.4
	RM 20.10 – RM 25.00	0	0
	RM 25.10 – RM 30.00	0	0
	RM 30.10 and above	2	1

Variable Construction

There are a series of questions were inquire in questionnaire to determine the potential variables that might influence UTAR Kampar students to choose fast-food as their meal. For the Likert scale question, there is a scale with 1 to 5 and represented strongly disagree, disagree, neutral, agree and strongly agree respectively.

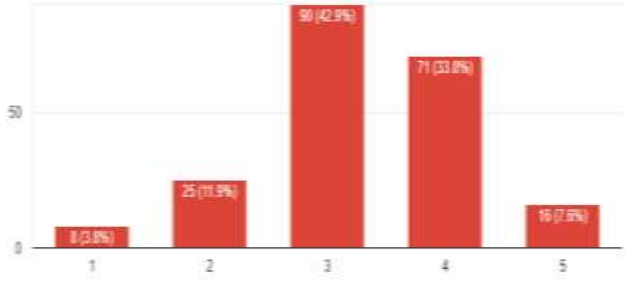

Figure 1 Percentage of student favoured on fast-food

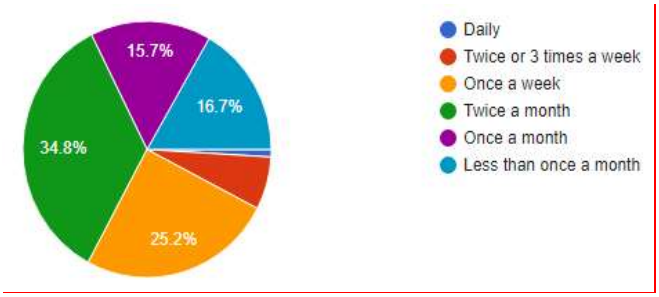

Figure 2 Percentage of fast-food consumption regularity

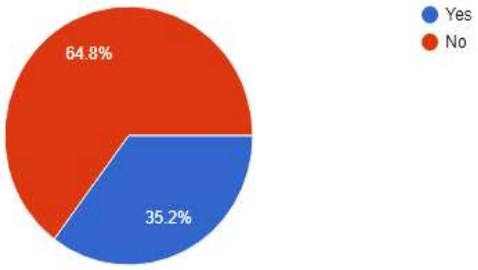

Figure 3 Percentage of students consuming vegetable

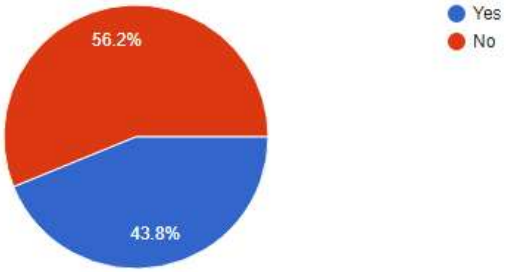

Figure 4 Percentage of student will cook by their own

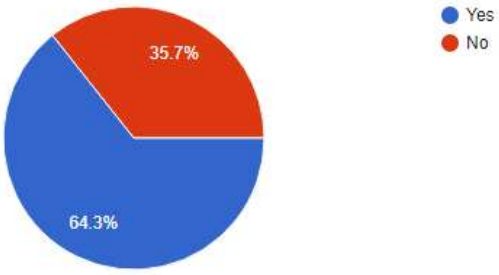

Figure 5 Percentage of willingness to eat fast-food

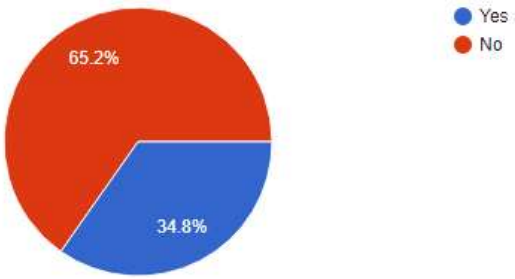

Figure 6 Percentage of introducing fast-food to friends and family

RESULTS

The Bayesian network structure that shows in Figure 7 is being obtained by using hill-climbing algorithm. The default scoring function used is Bayesian information criterion score (BIC). Since only one algorithm is being used in this study, there is no point to compare the scoring functions for one network. The relationship between all the 36 variables is shown as the Figure 7. Figure 8 shows the direct causal relationship on desire of fast-food. Table 2 to Table 6 are the conditional probability tables of one variable given another variable has occurred. The levels from one to four represent "Strongly Disagree", "Disagree", "Agree", and "Strongly Agree", respectively.

Based on the network structure in Figure 8, the node "taste" is directed to the node "Suggestion" and "like?". The node "taste", "suggestion" and "like?" are referring the taste of the restaurant's food, invitation or suggestion on restaurant given by friends and the levels that UTAR Kampar

students like to eat McDonald respectively. We can conclude that taste of a restaurant's food can influence whether UTAR Kampar students like to go to McDonald for having their meal. Also, the taste of the food directly decides whether to accept or reject the invitation of their friends to have meal in McDonald.

Taste of food is a very important factor to increase the frequency of preference of visiting a restaurant. Based on the Table 2, we found that the relationship between customers like to eat the food is directly proportional to the taste of food. Therefore, we can conclude that improving the taste of the restaurant's food can attract more customers to eat the food of the restaurant.

Moreover, Table 3 shows UTAR Kampar students who strongly dislike the taste of McDonald's food will not go to eat although there is a suggestion or invitation of their friends. The number of students who dislike the taste of McDonald's food will reject the invitation from their friends is almost the same as the number of students who dislike the taste of McDonald's food but will accept the invitation of their friends to eat fast-food. However, there are quite large number of students who will not refuse the invitation of their friends to eat in McDonald given that they are also like the taste of McDonald's food. As a conclusion, most of the students who dislike the taste of McDonald's food will reject the invitation of their friends but for those who like the taste of McDonald's food will not reject the invitation of their friends.

Node "frequency" implies the frequency of the respondents will take their meal at McDonald while node "recommend" represents whether they will recommend their family and friends to eat McDonald's food. From the DAG obtained, the node "like?" is the parent of the node "frequency" and "recommend". The frequency of going to McDonald to have their meal will be affected by their levels of liking fast-food.

One of the techniques to improve the awareness of a restaurant owner is through peer to peer. Students are mostly having their lunch or dinner in a group. There is rarely to find a student taking his or her meal alone in a restaurant because he or she would rather opt to take away. When a group of students want to take their meal, but they do not have any idea about which restaurant should they go, everyone tends to agree with the only suggestion or recommendation of a person. However, by referring to the Table 4, we found that most of the UTAR Kampar students would not recommend their family or friends to eat at McDonald if they themselves do not like the foods. There are still around 50-50 chances that students who like to eat at McDonald's will recommend their family or friends to eat fast-food.

On the flipside, why some of respondents who like to eat McDonald's food would not recommend to others? The study proves that most of the students believe that having fast-foods may not be able to provide complete and proper nutrition (see Table 5) . Thus, we assume the reason of students do not recommend McDonald to their family and friends is because they concern on their health. As we know that consume fast-food frequently is not good for our health although some of us might like its taste.

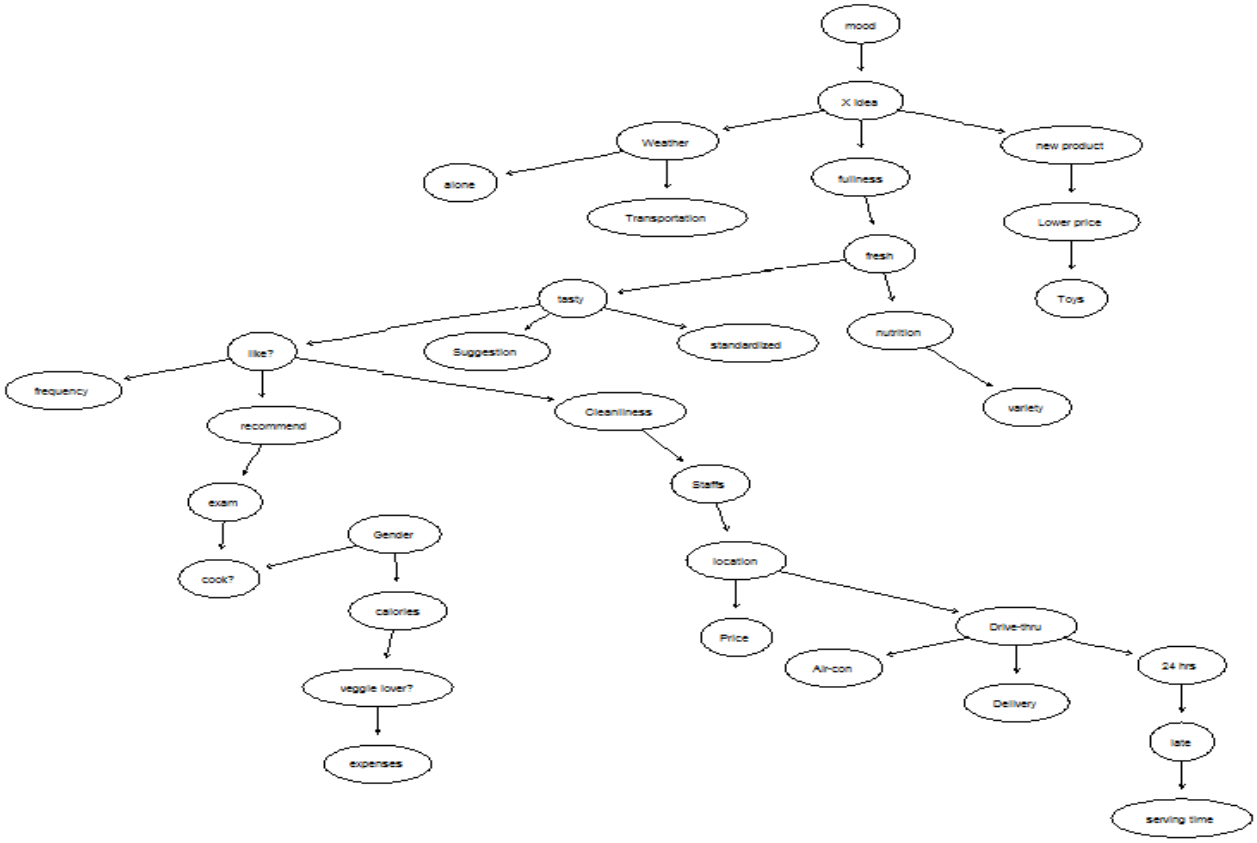

Figure 7 Hill-climbing algorithm

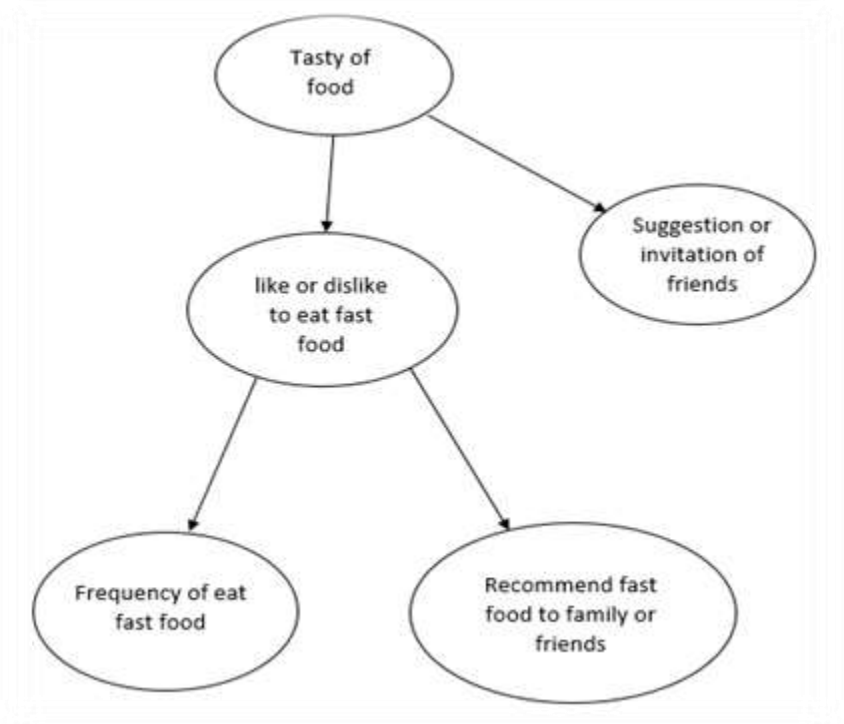

Figure 8 Summary of the Direct Related Factors of Like or Dislike to Eat Fast-food

Table 2
Conditional Probability Table of "like?" given "tasty"

Parameters of node like? (multinomial distribution)

Conditional probability table:

like? \ tasty	1	2	3	4
1	0.375000000	0.020833333	0.008695652	0.076923077
2	0.375000000	0.229166667	0.086956522	0.025641026
3	0.125000000	0.583333333	0.486956522	0.128205128
4	0.000000000	0.145833333	0.373913043	0.538461538
5	0.125000000	0.020833333	0.043478261	0.230769231

Table 3
Conditional Probability Table of "Suggestion" given "tasty"

Parameters of node Suggestion (multinomial distribution)

Conditional probability table:

Suggestion \ tasty	1	2	3	4
1	0.750000000	0.083333333	0.008695652	0.153846154
2	0.125000000	0.395833333	0.191304348	0.102564103
3	0.125000000	0.437500000	0.643478261	0.410256410
4	0.000000000	0.083333333	0.156521739	0.333333333

Table 4
Conditional Probability Table of "recommend" given "like?"

Parameters of node recommend (multinomial distribution)

Conditional probability table:

recommend \ like?	1	2	3	4	5
1	0.2500000	0.0800000	0.2444444	0.5633803	0.4375000
2	0.7500000	0.9200000	0.7555556	0.4366197	0.5625000

Table 5
Conditional Probability Table of "nutrition" given "fresh"

Parameters of node nutrition (multinomial distribution)

Conditional probability table:

nutrition \ fresh	1	2	3	4
1	0.76470588	0.16666667	0.14285714	0.33333333
2	0.17647059	0.76923077	0.59340659	0.29166667
3	0.05882353	0.06410256	0.25274725	0.16666667
4	0.00000000	0.00000000	0.01098901	0.20833333

Table 6

Conditional Probability Table of "frequency" given "like?"

Parameters of node frequency (multinomial distribution)

Conditional probability table:

	like?				
frequency	1	2	3	4	5
1	0.00000000	0.00000000	0.00000000	0.00000000	0.06250000
2	0.00000000	0.04000000	0.05555556	0.08450704	0.12500000
3	0.25000000	0.08000000	0.24444444	0.30985915	0.37500000
4	0.00000000	0.12000000	0.40000000	0.42253521	0.25000000
5	0.00000000	0.36000000	0.21111111	0.07042254	0.00000000
6	0.75000000	0.40000000	0.08888889	0.11267606	0.18750000

The level of like (from one to five) is defined as "Strongly Dislike", "Dislike", "Neutral", "Like" and "Strongly Like", respectively. The level of frequency (from one to six) is defined as daily, twice or three time in a week, once a week, twice a month, once a month, more than once a month. There is a direct proportional relationship between variables "like" and "frequency". As the level of like to eat McDonald's food increases, the frequency of go to McDonald to have a meal also increases.

Refer to Table 6, we found that the probability of customers who will go to a restaurant daily is only happened on the customers who are incredibly like to eat the food of the restaurant. There is a high probability for those who are strongly dislike eating the restaurant's food will not revisit the restaurant. Result shows that 75% of UTAR Kampar students who do not like to eat McDonald's food will have a lower frequency of going there to have their meal. The last visit of McDonald has been more than one month ago. Perhaps, it may not be a comfortable place merely for chit chat and small talk activities.

In short, the main reason students look for McDonald for their meal as they prefer the taste of it neither because of the price nor the speed of serving. If some restaurants would prepare some healthy while same taste as fried food in fast-food restaurant, it would encourage more students to have their meal in a common restaurant instead of fast-food restaurant.

CONCLUSIONS

There is a total of 36 possible factors leading student to have fast-food as their proper meal. Based on the network structure obtained, we know the reasons of UTAR Kampar students like to eat fast-food is because of the taste of the food. Since taste is the major reason where student chosen fast-food, it seems that unhealthy food (fried food) is still the favourite taste bud of teenagers. However, the data collected were just students from UTAR Kampar campus. Include and increase the number of respondents from other state may increase the accuracy of the result. Last but not least, fast-food can cause cancer, acne, diabetes, weight gain, obesity, and many other health problems. Therefore, consume a healthy food is our concern. Exercise is king. Nutrient is queen. Put them together and you have a kingdom. Fitness should not be a punishment but a blessing for human body. Since movement is also a medicine for our body, we should exercise for our lives and take healthy food.

References

Carvalho, A.M. (2009). *Scoring functions for learning Bayesian networks*. Retrieved from http://www.lx.it.pt/~asmc/pub/talks/09-TA/ta_pres.pdf

Ducharme, J., & Wellness, B. (2017). Study: How Food Prices Affect What You Eat. *Boston Magazine*. Retrieved from http://www.bostonmagazine.com/health/blog/2017/03/01/food-prices-shopping-decisions/

Flinders, K. (2017). Health check: how food affects mood and mood affects food. *The Conversation*. Retrieved from http://theconversation.com/health-check-how-food-affects-mood-and-mood-affects-food

French, S.A. (2003). Pricing effects on food choices. *Journal of Nutrition*, 133(3), 841S-843S. doi: 10.1093/jn/133.3.841S

Hendriksen, E. (2014). How Mood Affects Food. *Health and Fitness.*Retrived from http://www.quickanddirtytips.com/health-fitness/mental-health/how-mood-affects-food

Meryl, G., Wansink, B., Kim, J.Y., & Park, S.B. (2014). Feeding Your Feelings How Mood Influences Food Choice. *Journal of Consumer Psychology*, *24*(3), 320-335.

Medeiros, C.O., & Salay, E. (2013). A review of food service selection factors important to the consumer. *Food and Public Health*, *3*(4), 176-190.

Missagia, S.V., de Oliveira, S.R., & de Rezende, D.C. (2012). Food Choice Motives and Healthy Eating: Assessing Gender differences. *Journal of ENANPAD, 36*(2), 1-10.

Murphy, K.P. (2001). A Brief Introduction to Graphical Models and Bayesian Networks. *Graphical Model*, Retrieved from http://www.cs.ubc.ca/~murphyk/Bayes/bayes_tutorial.pdf

Negri, R., Di Feola, M., Di Domenico, S., Scala, M.G., Artesi, G., Valente S., Smarrazzo, A., Turco, F., Morini, G., & Greco, L. (2012). Taste perception and food choices. *Journal of Pediatric Gastroenterology and Nutrition*, 54(5), 24-629, doi: 10.1097/MPG.0b013e3182473308

Pollard, J., Kirk, S.F.L., & Cade, J.E. (2002). Factors affecting food choice in relation to fruit and vegetable intake: a review. *Nutrition Research Reviews*, *15*(2), 373-387. doi: 10.1079/NRR200244

Scutari, M. (2014). Bayesian network constraint-based structure learning algorithms: parallel and optimised implementations in the bnlearn R Package. *Journal of Statistical Software*, *10(*2), 2-5.

Ulijaszek, S.J. (2007). Human eating behaviour in an evolutionary ecological context. *Proceedings of the Nutrition Society*, *61*(4), 517-526. doi: https://doi.org/10.1079/PNS2002180

Wong, M.L., & Leung, K.S. (2004). An efficient data mining method for learning Bayesian networks using an evolutionary algorithm-based hybrid approach. *IEEE transactions on evolutionary computation*, *8*(4), 378-404.