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UNDERSTANDING MCDONALD'S NUTRITION FACTS USING DISCRIMINANT ANALYSIS AND NEURAL NETWORK

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ABSTRACT

Using data extracted from MacDonald's nutrition facts for targeted popular menu items, this study tried to classify groups exhibiting common patterns of nutrition facts from the targeted popular menu items. The one-way ANOVA results showed that significant differences in saturated fat, trans fat, cholesterol and protein were found with the three types of the targeted popular menu items. In this study, group means were significantly different using the Wilk's Lambda scores for both discriminant functions, respectively. The canonical correlation results also supported that there were strong relationships between the discriminant score and the group membership. The multilayer perceptron neural network model was utilized as a predictive model in deciding the classification of MacDonald's nutrition facts for targeted popular menu items. The predictive model developed had excellent classification accuracy. From an architectural perspective, it showed a 10-2-2-3 neural network construction. Results of this study may provide insight into the understanding of the importance of MacDonald's nutrition facts for targeted popular menu for consumer references.

Contribution/Originality: This study is one of very few studies which have classified groups of nutrition facts from McDonald's popular menu items. This study also addresses that discriminant analysis and multilayer perceptron neural network model can be utilized to detect the classification of MacDonald's nutrition facts for targeted popular menu items.

1. INTRODUCTION

More than 69 million customers from over 100 different countries arrive daily at McDonald's, one of the largest fast food chain restaurants of hamburger joints in the world (Wikipedia -- McDonald's, https://en.wikipedia.org/wiki/McDonald%27s). This fast food chain restaurant originated in 1940 and maintains headquarters in Oak Brook, IL. Primarily selling hamburgers, chicken, French fries, desserts, soft drinks, and breakfast items, the Golden Arches expanded to also offer fish, wraps, salads, and milkshakes (https://www.mcdonalds.com/us/en-us.html).

Using Data from the National Health and Nutrition Examination Survey, Fryar, Hughes, Herrick, and Ahluwalia (2018) found that about 37 percent of adults (ages above 20) consumed fast food on a given day during 2013-2016. Among adults who consumed fast food, the most commonly reported eating occasions were lunch (43.7%) and dinner (42.0%), followed by breakfast (22.7%) and snacks (22.6%). They also highlighted that fast food consumption has been associated with increased intake of calories, fat, and sodium. McCrory, Harbaugh, Appeadu, and Roberts (2019) showed that the number of entrees, sides, and desserts for all restaurants combined increased by 26% from 1986 to 2016. They also demonstrated that fast food entrées, sides, and desserts increased significantly in calories and sodium, and entrees and desserts in portion size over time.

Compared adolescents purchasing behavior at McDonald's and Subway, Lesser et al. (2013) found that adolescents purchased an average of 1,038 calories at McDonald's and 955 calories at Subway. At McDonald's, adolescents purchased significantly more calories from drinks and from side dishes, but fewer cups of vegetables at McDonald's. On recent research (Petimar et al., 2019) revealed that calorie labeling at McDonald's was not associated with changes in calories purchased in adults, adolescents, or children. Although participants were more likely to notice calories on menus post-labeling, there was no improvement in ability to accurately estimate calories purchased.

Consumers can find nutritional information on calories on the menu in most fast food establishments and restaurants (http://www.heart.org/en/news/2018/07/20/major-restaurants-now-requiredto-show-calories-on-the-menu). However, McDonald's provided in-store nutrition information pamphlets, on food wrappers, on tray placemats as well as official restaurant website in order to let the customers be aware of it. Samsudin et al. (2011) showed that customers perceived McDonald's icon-based nutrition labels positively as a good effort and were more conscious and aware of their health and nutritious food intake.

In recent years, there has been a growing interest in applying neural networks to analyze consumer behavior and to model the consumer decision-making process. Neural networks are mathematical models that are commonly used to model relationships between variables. Technically, neural networks seek to classify an observation as belonging to some discrete class as a function of the inputs (Haykin, 2009). Recently, Yunus et al. (2019) used different deep learning models to automatically estimate food attributes such as ingredients and nutritional value by classifying the input image of food for accurate food identification. Thus, the aim of this study was to explore the usefulness of the neural network methodology to correctly classify and recognize the importance of MacDonald's nutrition facts for targeted popular menu items.

2. MATERIALS AND METHODS

The data used for this study was extracted from MacDonald's nutrition facts for targeted popular menu items (http://nutrition.mcdonalds.com/nutrition1/nutritionfacts.pdf). The descriptive statistics of MacDonald's nutrition facts for targeted popular menu items were shown in Table 1 (total sample, n = 56), Table 2 (Breakfast group, n = 23), Table 3 (Burger group, n = 14), and Table 4 (Chicken group, n = 19).

Average calories was 438.39 for the total sample, the *Breakfast* group was 436.96, the *Burger* group was 511.43, and the *Chicken* group was 386.32. Average cholesterol was 114.73 for the total sample, 183.26 for the *Breakfast* group, 88.21 for the *Burger* group, and 51.32 for the *Chicken* group. In the total sample, average protein was 20.50, while the *Breakfast* group was 15.30, the *Burger* group was 28.21, and the *Chicken* group was 21.11.

Table-1. Descriptive Statistics of MacDonald's Nutrition Facts for Targeted Popular Menu Items (Total Sample, n = 56).

Nutrition Facts	Mean	Median	Std. Deviation	Std. Error of Mean
Calories	438.39	415.00	176.85	23.63
Total Fat	21.66	20.50	11.35	1.52
Saturated Fat	7.57	7.00	4.89	0.65
Trans Fat	0.38	0.00	0.68	0.09
Cholesterol	114.73	65.00	135.49	18.11
Sodium	926.70	910.00	411.06	54.93
Carbohydrates	40.29	39.00	16.82	2.25
Dietary Fiber	2.29	2.00	1.16	0.15
Sugars	7.25	5.50	6.83	0.91
Protein	20.50	18.00	10.42	1.39

For average total fat, the total sample was 21.66, the *Breakfast* group was 21.87, the *Burger* group was 26.36, and the *Chicken* group was 17.95. Average saturated fat was 7.57 for the total sample, 8.28 for the *Breakfast* group, 11.18 for the *Burger* group, and 4.05 for the *Chicken* group. In the total sample, average trans fat was 0.38, while the *Breakfas*t group was 0.043, the *Burger* group was 1.43, and the *Chicke*n group was 0.00.

Table-2. Descriptive Statistics of MacDonald's nutrition facts for targeted popular menu items (Breakfast group, n = 23).

Nutrition Facts	Mean	Median	Std. Deviation	Std. Error of Mean
Calories	436.96	420.00	200.06	41.71
Total Fat	21.87	22.00	13.36	2.79
Saturated Fat	8.28	8.00	5.08	1.06
Trans Fat	0.043	0.00	0.14	0.03
Cholesterol	183.26	115.00	189.29	39.47
Sodium	916.74	930.00	499.20	104.09
Carbohydrates	44.43	44.00	21.11	4.40
Dietary Fiber	2.57	2.00	1.31	0.27
Sugars	9.17	4.00	9.41	1.96
Protein	15.30	15.00	8.28	1.73

Table-3. Descriptive Statistics of MacDonald's nutrition facts for targeted popular menu items (Burger Group, n = 14).

Nutrition Facts	Mean	Median	Std. Deviation	Std. Error of Mean
Calories	511.43	435.00	182.47	48.76
Total Fat	26.36	25.50	10.43	2.79
Saturated Fat	11.18	10.00	4.69	1.25
Trans Fat	1.43	1.50	0.58	0.16
Cholesterol	88.21	75.00	39.45	10.54
Sodium	1086.43	1040.00	416.00	111.18
Carbohydrates	40.36	36.50	12.62	3.37
Dietary Fiber	2.50	2.00	1.02	0.27
Sugars	7.57	7.50	3.11	0.83
Protein	28.21	25.00	11.50	3.07

Table-4. Descriptive Statistics of MacDonald's nutrition facts for targeted popular menu items (Chicken Group, n = 19).

Nutrition Facts	Mean	Median	Std. Deviation	Std. Error of Mean
Calories	386.32	360.00	124.87	28.65
Total Fat	17.95	16.00	8.08	1.85
Saturated Fat	4.05	3.50	1.33	0.31
Trans Fat	0.00	0.00	0.00	0.00
Cholesterol	51.32	45.00	19.64	4.51
Sodium	821.05	750.00	234.47	53.79
Carbohydrates	35.21	34.00	12.49	2.87
Dietary Fiber	1.79	1.00	0.92	0.21
Sugars	4.68	4.00	0.96	0.91
Protein	21.11	16.00	8.46	1.94

Methodologically, the types of the targeted popular menu items were assigned from the names on the menu. First, a one-way ANOVA and post hos (LSD) test to check the differences between the types of the targeted popular menu items associated with the nutrition facts. Second, a discriminant analysis was conducted to classify the targeted popular menu items into the specific groups based on their nutrition facts. Third, a multilayer perceptron neural network model was employed as a predictive model in deciding the classification and importance of MacDonald's nutrition facts for targeted popular menu items.

3. RESULTS

3.1. One-Way ANOVA

The one-way ANOVA results showed that significant differences in saturated fat ($F(2, 53) = 12.845$, $p = 0.000$), trans fat ($F(2, 53) = 112.507$, $p = 0.000$), cholesterol ($F(2, 53) = 6.313$, $p = 0.003$), and protein ($F(2, 53) = 8.575$, $p = 0.001$), were found with the three types of the targeted popular menu items Table 5.

Table-5. One-Way ANOVA among the three types of the targeted popular menu items.

Nutrition Facts		*df*	*F*	*P*
Calories	Between Groups	2	2.099	0.133
	Within Groups	53		
Total Fat	Between Groups	2	2.325	0.108
	Within Groups	53		
Saturated Fat	Between Groups	2	12.845	0.000
	Within Groups	53		
Trans Fat	Between Groups	2	112.507	0.000
	Within Groups	53		
Cholesterol	Between Groups	2	6.313	0.003
	Within Groups	53		
Sodium	Between Groups	2	1.737	0.186
	Within Groups	53		
Carbohydrates	Between Groups	2	1.598	0.212
	Within Groups	53		
Dietary Fiber	Between Groups	2	2.845	0.067
	Within Groups	53		
Sugars	Between Groups	2	2.380	0.102
	Within Groups	53		
Protein	Between Groups	2	8.575	0.001
	Within Groups	53		

Table-6. Post hoc (LSD) comparisons among the three types of the targeted popular menu items.

Nutrition Facts	Group (I)	Group (J)	Mean Difference (I-J)	Std. Error	Sig.
Calories	Breakfast	Burger	-74.472	58.785	0.211
	Breakfast	Chicken	50.641	53.762	0.350
	Burger	Chicken	125.113*	61.081	0.045
Total Fat	Breakfast	Burger	-4.4876	3.7587	0.238
	Breakfast	Chicken	3.9222	3.4375	0.259
	Burger	Chicken	8.4098*	3.9055	0.036
Saturated Fat	Breakfast	Burger	-2.8960*	1.3853	0.041
	Breakfast	Chicken	4.2300*	1.2669	0.002
	Burger	Chicken	7.1259*	1.4394	0.000
Trans Fat	Breakfast	Burger	-1.3851*	0.1029	0.000
	Breakfast	Chicken	0.0435	0.0941	0.646
	Burger	Chicken	1.4286*	0.1069	0.000
Cholesterol	Breakfast	Burger	95.047*	42.047	0.028
	Breakfast	Chicken	131.945*	38.454	0.001
	Burger	Chicken	36.898	43.690	0.402
Sodium	Breakfast	Burger	-169.689	137.511	0.223
	Breakfast	Chicken	95.686	125.762	0.450
	Burger	Chicken	265.376	142.883	0.069
Carbohydrates	Breakfast	Burger	4.078	5.642	0.473
	Breakfast	Chicken	9.224	5.160	0.080
	Burger	Chicken	5.160	5.862	0.384
Dietary Fiber	Breakfast	Burger	0.065	0.379	0.864
	Breakfast	Chicken	0.776*	0.347	0.030
	Burger	Chicken	0.711	0.394	0.077
Sugars	Breakfast	Burger	1.602	2.260	0.481
	Breakfast	Chicken	4.490*	2.067	0.034
	Burger	Chicken	2.887	2.349	0.224
Protein	Breakfast	Burger	-12.910*	3.129	0.000
	Breakfast	Chicken	-5.801*	2.861	0.048
	Burger	Chicken	7.109*	3.251	0.033

According to the post-hoc comparisons with the LSD test, the results revealed that there was a statistically significant difference in calories between the *Burger* group and the *Chicken* group, with a mean difference of 125.113 and a *p-value* of 0.045. Also, the *Burger* group was significantly different from the *Chicken* group in total fat, with a mean difference of 8.4098 and a *p-value* of 0.036. Similarly, there was a statistically significant difference in trans fat between the *Burger* group and the *Chicken* group, with a mean difference of 1.4286 and a *p-value* of 0.000.

In trans fat, there was a statistically significant difference between the *Breakfast* group and the *Burger* group, with a mean difference of -1.3851 and a *p-value* of 0.000. Similarly, the *Breakfast* group was significantly different from the *Burger* group in cholesterol, with a mean difference of 95.047 and a *p-value* of 0.028. In cholesterol, dietary fiber, and sugars, there was a statistically significant difference between the *Breakfast* group and the *Chicken* group, with a mean difference of 131.945, 0.776, 4.490 and a *p-value* of 0.001, 0.030, and 0.034, respectively.

3.2. Discriminant Analysis

Discriminant analysis is useful in developing discriminating functions of the combination of input variables by running an algorithm that tries to discriminate the groups based on these independent functions. It is a powerful technique of classification when the dependent variable is categorical and independent variables are numeric (Tabachnick & Fidell, 2013). In this study, the Wilk's Lambda scores were 0.048 (χ^2 = 149.173; df = 18; $p < 0.001$) and 0.322 (χ^2 = 55.464; df = 8; $p < 0.001$) for both discriminant functions, respectively, indicating that group means were significantly different. The canonical correlation results were both above 0.7, supporting that there were strong relationships between the discriminant score and the group membership.

The classification results based on discriminant analysis Table 7, 23 cases fell into the *Breakfast* group, 14 fell into the *Burger* cluster, and 19 fell into the *Chicken* group in the original row total, which is the frequencies of groups found in the data. Across each row, how many of the cases in the group can be classified by this analysis into each of the different groups. For example, of the 23 cases that were in the *Breakfast* group, 22 were predicted correctly and 1 were predicted incorrectly (0 were predicted to be in the *Burger* group and 1 were predicted to be in the *Chicken* group).

Predicted group membership indicates the predicted frequencies of groups from discriminant analysis. The numbers going down each column indicate how many were correctly and incorrectly classified. For example, of the 23 cases that were predicted to be in the *Breakfast* group, 22 were correctly predicted, and 1 were incorrectly predicted (1 cases were in the *Burger* group and 0 cases were in the *Chicken* group) Table 7.

Table-7. Classification results[a] based on discriminant analysis.

Items		Type	Predicted Group Membership			
			Breakfast	Burger	Chicken	Total
Original	Count	Breakfast	22	0	1	23
		Burger	1	13	0	14
		Chicken	0	0	19	19
	%	Breakfast	95.7	0	4.3	100.0
		Burger	7.1	92.9	0	100.0
		Chicken	0	0	100.0	100.0

Note: **a.** 96.4% of original grouped cases correctly classified.

3.3. Multilayer Perceptron (MLP) Neural Network

After the formation of the three different types of MacDonald's nutrition facts for targeted popular menu items, a MLP neural network model was employed as a predictive model in deciding the classification of MacDonald's nutrition facts for targeted popular menu items. The MLP Module of IBM SPSS Statistics 26 was used to build the neural network model and to test its accuracy. The MLP neural network model trained with a back-propagation learning algorithm which uses the gradient descent to update the weights towards minimizing the error function.

The aim of this study was to explore the usefulness of the neural network methodology to correctly classify and recognize the importance of MacDonald's nutrition facts for targeted popular menu items. The data were randomly assigned to training (67.9%, n=38) and testing (32.1%, n=18) subsets. The training dataset is used to find the weights and build the model, while the testing data is used to find errors and prevent overtraining during the training mode.

The MLP Module of IBM SPSS Statistics 26 was used as the tool to choose the best architecture model automatically and it built the network with two hidden layers. From the ten independent variables, automatic architecture selection chose 2 nodes for the first hidden layer and 2 nodes for the second hidden layer, while the output layer had 3 nodes to code the depended variable *Type*. For the hidden layers the activation function was the hyperbolic tangent, while for the output layer used the softmax function. Cross entropy was used as error function because of the use of softmax function.

The network diagram showed the 10 input nodes, the 2 hidden nodes for the first layer, the 2 hidden nodes for the second layer, and the three output nodes representing the three different types of MacDonald's nutrition facts for selected popular menu items. In the architectural point of view, it was a 10-2-2-3 neural network, means that there were total 10 independent (input) variables, 2 neurons in the first hidden layer, 2 neurons in the second hidden layer, and 3 dependent (output) variables Figure 1.

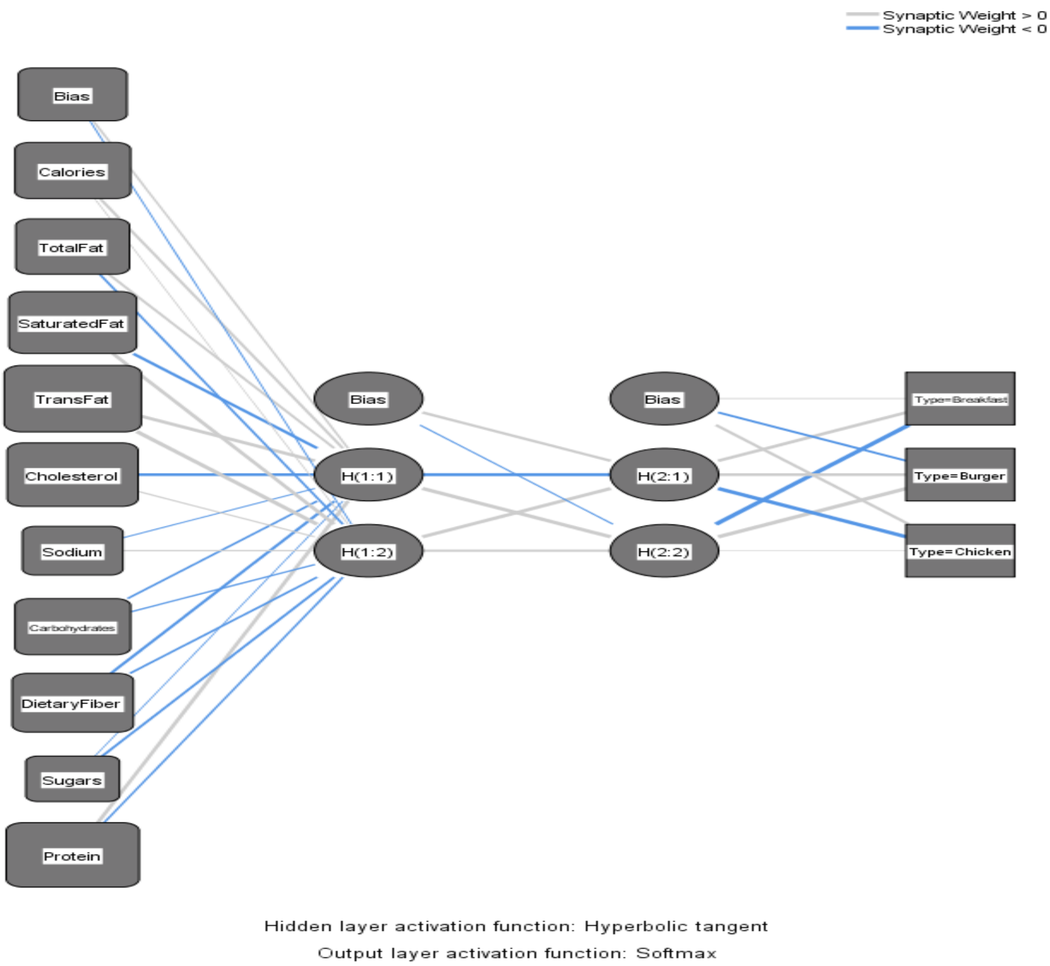

Figure-1. Network diagram.

The model summary provided information related to the results of training and testing sample Table 8. Cross entropy error is displayed because the analysis is based on softmax activation function, and is given for both training and testing sample since is the error function that neural network minimizes during the training phase. The value of cross entropy error (= 1.113) indicated the power of the model to predict the three different types of MacDonald's nutrition facts for targeted popular menu items.

Sheela and Deepa (2013) pointed out that as the number of neurons or the number of layers of a neural network increase, the training error also increases due to the overfitting. The cross entropy error was less for the testing sample compared with the training data set, meaning that the neural network model had not been overfitted to the training data and has learned to generalize from trend. The result justified the role of testing sample which was to prevent overtraining.

In this study the percentage of incorrect prediction was equal to 0.0% in the training sample. So the percentage of correct prediction was 100% which is an excellent prediction in a qualitative study for determining management results of recognizing the importance of MacDonald's nutrition facts for targeted popular menu items. The learning procedure was performed until 1 consecutive step with no decrease in error function was attained from the training sample.

Table-8. Model summary.

Target	Type of neural network trained	Stopping rule that stopped training
Training	Cross Entropy Error	1.113
	Percent Incorrect Predictions	0.0%
	Stopping Rule Used	1 consecutive step(s) with no decrease in error[a]
	Training Time	0:00:00.02
Testing	Cross Entropy Error	1.045
	Percent Incorrect Predictions	0.0%

Note: Dependent Variable: Cluster
a. Error computations are based on the testing sample.

Using the training sample only, MLP neural network utilized synaptic weights to display the parameter estimates that showed the relationship between the units in a given layer to the units in the following layer Table 9. Note that the number of synaptic weights can become rather large and that these weights are generally not used for interpreting network results (IBM, 2019).

Table-9. Parameter estimates.

Predictor		Predicted						
		Hidden Layer 1		Hidden Layer 2		Output Layer		
		H(1:1)	H(1:2)	H(2:1)	H(2:2)	Breakfast	Burger	Chicken
Input Layer	(Bias)	0.302	-0.152					
	Calories	0.547	0.080					
	Total Fat	0.515	-0.362					
	Saturated Fat	-0.795	1.187					
	Trans Fat	1.681	1.805					
	Cholesterol	-1.209	0.257					
	Sodium	-0.205	0.289					
	Carbohydrates	-0.414	-0.289					
	Dietary Fiber	-0.666	-0.484					
	Sugars	-0.090	-0.497					
	Protein	0.996	-0.360					
Hidden Layer 1	(Bias)			0.990	-0.207			
	H(1:1)			-1.368	2.067			
	H(1:2)			1.802	0.707			
Hidden Layer 2	(Bias)					0.114	-0.577	0.764
	H(2:1)					1.294	1.021	-2.600
	H(2:2)					-3.477	3.133	0.020

Based on the MLP neural network, a predictive model was developed and displayed a classification table (i.e. confusion matrix) for categorical dependent variable, the three different types of MacDonald's nutrition facts for targeted popular menu items, by partition and overall Table 10. As can be seen, the MLP neural network correctly classified 38 popular menu items out of 38 in the training sample and 18 out of 18 in the testing sample. Overall 100% of the training cases were correctly classified. The predictive model developed had excellent classification accuracy.

Using the training sample only, it was able to classify 17 *Breakfast* popular menu items into the *Breakfast* group, out of 17. It held 100% classification accuracy for the *Breakfast* group. Similarly, the same model was able to classify 10 *Burger* popular menu items into the *Burger* group out of 10, and 11 *Chicken* popular menu items into the *Chicken* group out of 11. It was able to generate 100% classification accuracy for both the *Burger* and the *Chicken* groups, respectively Table 10.

Table-10. Predictive ability and classification results.

Classification					
Sample	**Observed**	**Predicted**			
		Breakfast	**Berger**	**Chicken**	**Percent Correct**
Training	Breakfast	17	0	0	100.0%
	Burger	0	10	0	100.0%
	Chicken	0	0	11	100.0%
	Overall Percent	44.7%	26.3%	28.9%	100.0%
Testing	Breakfast	6	0	0	100.0%
	Burger	0	4	0	100.0%
	Chicken	0	0	8	100.0%
	Overall Percent	33.3%	22.2%	44.4%	100.0%

Note: **Dependent Variable:** Type.

The Cumulative Gains chart is the presentence of correct classifications obtained by the MLP neural network model against the correct classifications that could result by chance (i.e. without using the model) (IBM, 2019). The farther above the baseline a curve lies, the greater the gain. A higher overall gain indicates better performance. For example, the second point on the curve for the *Burger* group was at (20%, 85%), meaning that if the network score a dataset and sort all of the cases by predicted pseudo-probability of *Burger*, it would be expected the top 20% to contain approximately 85% of all of the cases that actually take the group *Burger*. The selection of 100% of the scored dataset, obtained all of the observed *Burger* cases in the dataset Figure 2.

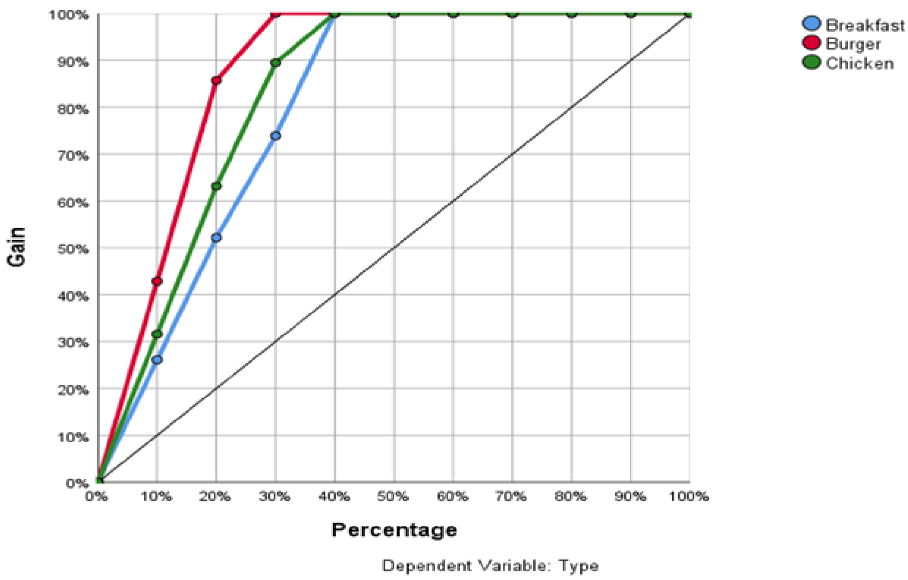

Figure-2. Cumulative gains chart.

The importance of the individual independent variables (factor influencing MacDonald's nutrition facts for targeted popular menu items) is a measure of how much the neural network model predicted value changes for different independent variables. The input parameters - MacDonald's nutrition facts for targeted popular menu items which influenced the three different types of targeted popular menu items have been ranked by the neural network model were given in the following Table 11.

The first three significant dominant factors that have been found were "Trans Fat" (100%), contributed the most in the neural network model construction, followed by "Protein" (92.7%), and "Cholesterol" (89.3%), had the greater effect on the importance of MacDonald's nutrition facts for popular menu items. The next two important factors were "Saturated Fat" (83.5%) and "Dietary Fiber" (72.3%). The other factors were relatively not important such as "Calories" (62.6%), "Carbohydrates" (62.5%), "Total Fat" (59.4%), "Sodium" (36.0%), and the least important factor which has been identified was "Sugars" (23.8%).

Table-11. Independent variable importance analysis.

Nutrition Facts	Importance	Normalized Importance	Rank
Calories	0.092	62.6%	6
Total Fat	0.087	59.4%	8
Saturated Fat	0.122	83.5%	4
Trans Fat	0.147	100.0%	1
Cholesterol	0.131	89.3%	3
Sodium	0.053	36.0%	9
Carbohydrates	0.092	62.5%	7
Dietary Fiber	0.106	72.3%	5
Sugars	0.035	23.8%	10
Protein	0.136	92.7%	2

Independent variable importance chart showed the impact of each independent variable in the MLP neural network model in terms of relative and normalized importance (IBM, 2019). Independent variable importance chart also depicted the importance of the independent variables, i.e. how sensitive is the model is the change of each input variable Figure 3.

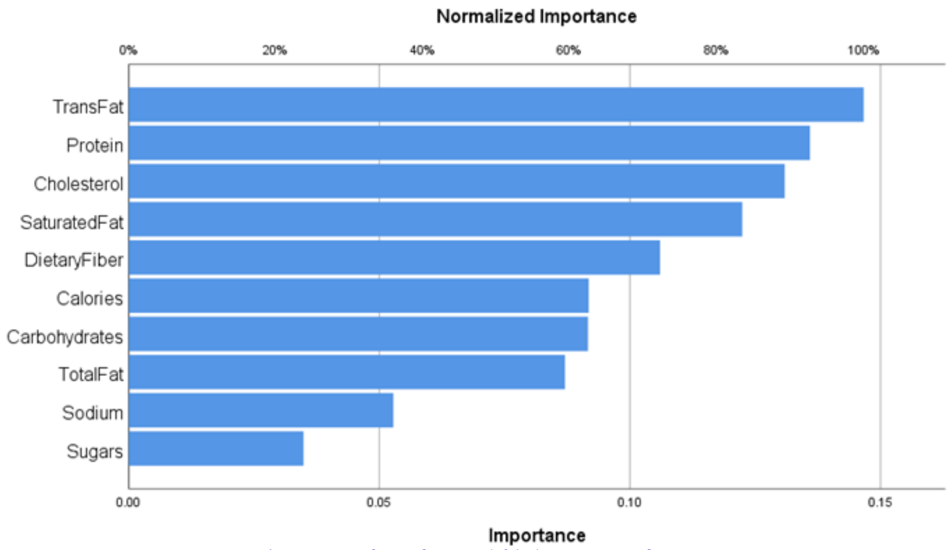

Figure-3. Independent variable importance chart.

4. CONCLUSIONS

From one-way ANOVA, there was a statistically significant differences in saturated fat, trans fat, cholesterol, and protein among *Breakfast*, *Burger*, and *Chicken* groups of the targeted popular menu items from McDonald's. Furthermore, there was a significant differences in trans fat and cholesterol between *Breakfast* and *Burger* groups; a significant differences in cholesterol, dietary fiber, and sugars between *Breakfast* and *Chicken* groups; and a significant differences in cholesterol, total fat, and trans fat between *Burger* and *Chicken* groups.

The aim of this study was to explore the usefulness of the neural network methodology to correctly classify and recognize the importance of MacDonald's nutrition facts for targeted popular menu items. Using discriminant analysis, classification results showed 96.4% of original grouped cases correctly classified. From multilayer perceptron neural network analysis, the predictive model developed had excellent classification accuracy (100%). The top five factors influencing MacDonald's nutrition facts for targeted popular menu items were trans fat, protein, cholesterol, saturated fat, and dietary fiber among three different types of the targeted popular menu items. Results of this study may provide insight into the understanding of the importance of MacDonald's nutrition facts for targeted popular menu for consumer references.

More and more chain restaurants and cafeterias are labeling menus to provide consumers with calories and other information about standard menu items. However, having higher nutritional knowledge may only be a piece of the equation to healthier eating. In order for nutritional knowledge to be meaningful, individuals need to utilize the information and incorporate it into their everyday lives. It is worth to mention that McDonald's encourages the customers to make informed food choices before purchase. It is not about the nutrition labels itself, but it is more towards educating the customers to form healthy and balanced lifestyle.

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REFERENCES

Fryar, C. D., Hughes, J. P., Herrick, K. A., & Ahluwalia, N. (2018). Fast food consumption among adults in the United States, 2013–2016. NCHS Data Brief, No. 322. 8. Retrieved from: https://www.cdc.gov/nchs/data/databriefs/db322-h.pdf.

Haykin, S. S. (2009). *Neural networks and learning machines* (3rd ed.). Upper Saddle River, New Jersey: Pearson Education, Inc.

IBM. (2019). *IBM SPSS neural networks 26*. Armonk, NY: IBM Corporation.

Lesser, L. I., Kayekjian, K. C., Velasquez, P., Tseng, C.-H., Brook, R. H., & Cohen, D. A. (2013). Adolescent purchasing behavior at McDonald's and Subway. *Journal of Adolescent Health, 53*(4), 441-445.Available at: https://doi.org/10.1016/j.jadohealth.2013.02.014.

McCrory, M. A., Harbaugh, A. G., Appeadu, S., & Roberts, S. B. (2019). Fast-food offerings in the United States in 1986, 1991, and 2016 show large increases in food variety, portion size, dietary energy, and selected micronutrients. *Journal of the Academy of Nutrition and Dietetics, 119*(6), 923-933.Available at: https://doi.org/10.1016/j.jand.2018.12.004.

Petimar, J., Ramirez, M., Rifas-Shiman, S. L., Linakis, S., Mullen, J., Roberto, C. A., & Block, J. P. (2019). Evaluation of the impact of calorie labeling on McDonald's restaurant menus: a natural experiment. *International Journal of Behavioral Nutrition and Physical Activity, 16*(1), 1-11.Available at: https://doi.org/10.1186/s12966-019-0865-7.

Samsudin, A., Jusoff, K., Zaini, Z., Musa, M., Khalid, K., Ngali, N., & Hamid, M. (2011). Customer's perception towards McDonald's icon-based nutritional labels. *World Applied Sciences Journal, 12*, 1-07.

Sheela, K. G., & Deepa, S. N. (2013). Review on methods to fix number of hidden neurons in neural networks. *Mathematical Problems in Engineering, 425740*, 1-11.Available at: https://doi.org/10.1155/2013/425740.

Tabachnick, B. G., & Fidell, L. S. (2013). *Using multivariate statistics* (6th ed.). Upper Saddle River, New Jersey: Pearson Education, Inc.

Yunus, R., Arif, O., Afzal, H., Amjad, M., Abbas, H., Bokhari, H., & Nawaz, R. (2019). A framework to estimate the nutritional value of food in real time using deep learning techniques. *IEEE Access, 7*, 2643-2652.Available at: https://doi.org/10.1109/access.2018.2879117.