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TITLE: ANALYZING THE HEALTH EFFECTS OF PACKAGED FOOD SAUCES THROUGH AI-POWERED NUTRITIONAL SCORING

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ANALYZING THE HEALTH EFFECTS OF PACKAGED FOOD SAUCES THROUGH AI-POWERED NUTRITIONAL SCORING

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ABSTRACT:

The health risks associated with using pre-packaged sauces on our food are high. Diabetes, obesity, hypertension, and heart disease are just some of the health issues that may result from consuming these sauces due to their high sugar, salt, and unhealthy fat content. An AI system might provide a nutritional score that provides a comprehensive assessment of the nutritional value of pre-packaged sauces according to their ingredients. The sauce's calorie count, sugar content, salt content, and hazardous fat level would all be evaluated by an AI system. The program will also consider helpful nutrients such as water and minerals.

The resulting nutritional score would help consumers make informed food choices. For instance, soy sauces could display their nutritional scores on the packaging, allowing buyers to easily compare options. Additionally, this nutritional scoring system could benefit healthy food product development. By comparing the nutritional compositions of their products, food producers could identify ways to make their sauces healthier, such as reducing sugar, salt, and unhealthy fats. This approach encourages the creation of healthier sauce options, ultimately contributing to better public health outcomes.

Keywords: pre-packaged sauces**,** Nutritional Scores, unhealthy fats ,Food ingredients, Food manufacturing, nutritional compositions.

INTRODUCTION

Since they are easy to use and convenient, pre-packaged food sauces have grown in

popularity in recent years. Customers should stay away from these sauces since, while they improve the flavor of food, they are often filled with unhealthy carbohydrates, fats, and salt. Studies have shown that there are many detrimental health effects associated with diets high in sugar, salt, and unhealthy fats. For instance, a global study by Ng et al. (2014) found that 21% of deaths were attributable to diets rich in unhealthy foods. Several researchers have developed nutritional grading systems to help consumers make better food choices in response to this issue. According to Julia et al. (2018), one such system in Europe is the Nutri-Score. In addition, some researchers have used AI to create diet grading systems that provide personalized information on a product's nutritional worth (Bawadi et al., 2020).

This work intends to build an AI-driven nutritional grading system that clearly indicates the total nutritional value of packaged food sauces by studying their nutritional content and health implications. This study will be guided by previous research that has examined the nutritional value of tomato sauces made in Nigeria (Abioye et al., 2019) and traditional African sauces (Diouf et al., 2021). Adding to what is already known, Jarvinen et al. (2019) investigated the health impacts of salty sauces.

This study aims to provide more information on pre-packaged food sauces, including their nutritional value and potential health benefits. Food manufacturers will be steered toward creating healthier alternatives to processed sauces by studies like this, and the public will be made more aware of the need of making informed nutritional choices. The managed supply chains, reduced transportation costs, and viable cold storage facilities are just a few of the benefits that make pre-packaged meals a popular choice, in addition to their reliability and convenience. However, with consumers becoming more health conscious, there is a need to enhance nutritional rating systems driven by artificial intelligence and to extract data from packed meals using commonplace devices and smartphone applications.

Modern diets aren't complete without prepared sauces, which provide flavor and

nutrition to anything from spaghetti sauce to salad dressings. Worries about their nutritional value and associated health repercussions typically accompany their ease of use. The consumers' interest in the sauces' potential effects on their health is growing. A growing awareness of the importance of proper nutrition to health is pushing for more accountability in the food manufacturing industry. Consequently, state-of-the-art tools like artificial intelligence (AI) are being used by researchers to analyze the dietary composition of bottled sauces.

LITERATURE SURVEY :

In this literature survey, we explore recent advancements in image-based food recognition systems and segmentation datasets from 2020 to 2023. These studies employ various methodologies, including computer vision techniques and machine learning algorithms, to address the challenges of dietary assessment and health promotion. Through a systematic review approach, we summarize the key findings and methodologies of each study, aiming to provide a comprehensive overview of the current state-of-the-art in image-based food analysis. This survey not only highlights the significance of integrating technology into nutrition research but also identifies potential avenues for future research and application in this rapidly evolving field.

Year	Authors	Title	Methodology	Algorithms
2023	Sergio Romero-Tapiador and Aythami Morales,	Food-Nutrition FW: A Novel Framework for the Automatic Synthesis and Analysis of Eating Behaviors	In addition to a technique for building individualized food image datasets that account for lifestyle and geographical aspects, this study offers a dataset of 4,800 distinct weekly diets. When used to assess dietary health, the Normalized Mahalanobis Distance has outstanding sensitivity (99.60%) and accuracy (99.53%).	Normalized Mahalanobis Distance (NMD)
2022	Kalliopi V. A. Dalakleidi and Marina Papadelli	Applying Image-Based Food Recognition Systems On Dietary Assessment: a Systematic Review	This review examines mobile camera and computer vision methods in dietary assessment, integrating image-based food recognition systems with public datasets, allowing segmentation, classification, and estimation phases for comprehensive dietary monitoring.	Computer vision methods, Image-based food recognition systems (IBFRS), Segmentation, Classification
2021	Kaimu Okamoto and Keiji Yanai	UEC-Food Pix Complete: A Large-Scale Food Image Segmentation Dataset	This study introduces a large-scale food image segmentation dataset, improving segmentation performance from UEC-FoodPix, and demonstrates applications like calorie estimation and image synthesis using models trained with this dataset.	Image segmentation, Calorie estimation
2020	Al-Selwi Metwalli and Wei Shen	Food Image Recognition Based on Densely Connected Convolutional Neural Networks	In order to categorize pictures of food, this study looks at ANN, random forest, and support vector machine (SVM) techniques. The primary focus for food image recognition is Convolutional Neural Networks (CNN).	Random Forest, Support Vector Machine (SVM), Artificial Neural Networks (ANN), and Convolutional Neural Networks (CNN)

PROBLEM STATEMENT:

The prevalence of diet-related diseases, such as obesity, diabetes mellitus, hypertension, and heart problems, underscores the urgency of understanding the health implications of heavily packed food sauces. Despite being frequently consumed, the nutritional content of these sauces is often overlooked by consumers. This lack of awareness contributes to poor dietary choices and exacerbates the risk of chronic illnesses. Conventional methods of assessing the nutritional value of food products are time-consuming, subjective, and prone to errors. With the growing demand for transparency and healthier food options, there is a pressing need for reliable and unbiased nutritional evaluation methods. Leveraging artificial intelligence (AI) technologies to generate nutritional scores offers a promising solution to these challenges. AI-driven systems can efficiently analyze vast amounts of data, identify patterns, and provide consistent assessments of the healthfulness of packaged sauces. Furthermore, the evolving landscape of dietary assessment, propelled by advancements in AI and data analytics, presents an opportunity to revolutionize our understanding of the relationship between food components and human health. By harnessing AI algorithms trained on comprehensive databases of food composition and dietary requirements, researchers can gain deeper insights into the nutritional profiles of heavily packed sauces. Additionally, AI-driven techniques possess the capacity to adapt and improve over time, incorporating new research findings and dietary recommendations to enhance accuracy and relevance. In light of these considerations, the research aims to comprehensively examine the nutritional composition of packaged food sauces and develop AI-driven nutritional scoring systems. This endeavor seeks to empower consumers to make informed dietary choices, enable food producers to offer healthier options, and ultimately contribute to improved public health outcomes by mitigating the risks associated with diet-related diseases.

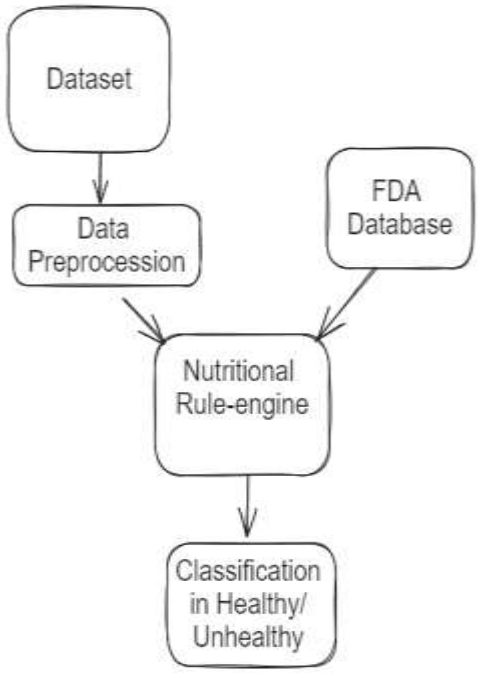
PROPOSED MODEL:

This research proposes a comprehensive model that integrates artificial intelligence (AI) technology with dietary assessment to generate nutritional scores for packaged

food sauces. By leveraging AI algorithms, this model aims to provide objective and thorough evaluations of the nutritional composition of these condiments, shedding light on their health impact. Through this approach, consumers can access easily understandable indicators of the nutritional content of packaged sauces, empowering them to make informed food choices. Moreover, the dissemination of AI-generated dietary scores will play a crucial role in promoting consumer education and raising awareness about the importance of understanding the nutritional value of the foods they consume. This increased awareness is particularly vital in light of the escalating prevalence of diet-related disorders. By encouraging consumers to opt for healthier alternatives based on transparent nutritional information, this model seeks to instigate behavioral changes conducive to improved public health outcomes. Additionally, by identifying areas for enhancement in the nutritional profiles of packaged sauces, this research aims to incentivize food companies to offer healthier options, further contributing to the promotion of healthier eating habits. Ultimately, the proposed model holds the potential to significantly advance health and wellness awareness, education, and practices, ultimately leading to better public health and enhanced quality of life for individuals.

SYSTEM ARCHITECTURE DIAGRAM

In the implemented system architecture, the data processing pipeline flows from data collection to preprocessing and model training, culminating in evaluation. Two distinct modules for SVM and ANN handle classification tasks, each employing specific algorithms and techniques. The system architecture diagram showcases this flow, depicting the integration of data preprocessing, model training, and evaluation stages. Evaluation results guide iterative improvements, fostering continual enhancement of the classification process.



RESEARCH METHODOLOGY

The combination of Support Vector Machines (SVM) and Artificial Neural Networks (ANN) in this study offers a robust framework for analyzing the health effects of packaged food sauces. SVM serves as a powerful tool for classification, facilitating the differentiation between healthy and unhealthy sauces based on their nutritional profiles. By learning decision boundaries in the feature space, SVM effectively categorizes sauces, thereby aiding in the identification of patterns contributing to dietary behaviors. Meanwhile, ANN's flexibility allows for predictive modeling of nutritional scores or health labels, providing insights into the complex relationships between sauce characteristics and health outcomes. Through the integration of these techniques, the study gains a comprehensive understanding of the factors influencing food choices, thus paving the way for informed recommendations to promote healthier dietary habits and improve public health outcomes.

In addition, there are significant policy, practical, and theoretical implications of the study's findings. By elucidating the complex dynamics behind dietary choices via AI-driven research, the study contributes to a more advanced understanding of the association between packaged food sauces and health. These results might help direct targeted campaigns that encourage healthier eating habits among consumers. To put the findings into practice, they might guide the creation of food labeling systems that make it easy for consumers to understand the nutritional content of sauces and make informed dietary decisions. To further improve public health and reduce the incidence of diet-related disorders, the study's results might also inform the

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development of regulations and policies pertaining to food product marketing, sales, and packaging.

ALGORITHMS:

Support Vector Machine (SVM) finds the optimal hyperplane to separate classes, maximizing the margin. It can handle non-linear data through kernel functions. SVM's objective is to minimize classification error while maximizing margin, with a regularization parameter (C) balancing trade-offs. Once trained, SVM predicts class labels based on new data's position relative to the hyperplane.

Data : Dataset with p^* variables and binary outcome.
Output: Ranked list of variables according to their relevance.

Find the optimal values for the tuning parameters of the SVM model;
Train the SVM model;
$p \leftarrow p^*$;
while $p \geq 2$ **do**
  $SVM_p \leftarrow$ SVM with the optimized tuning parameters for the p variables and observations in **Data**;
  $w_p \leftarrow$ calculate weight vector of the SVM_p $(w_{p1}, \ldots, w_{pp})$;
  $rank.criteria \leftarrow (w_{p1}^2, \ldots, w_{pp}^2)$;
  $min.rank.criteria \leftarrow$ variable with lowest value in $rank.criteria$ vector;
  Remove $min.rank.criteria$ from **Data**;
  $Rank_p \leftarrow min.rank.criteria$;
  $p \leftarrow p-1$;
end
$Rank_1 \leftarrow$ variable in **Data** $\notin \{Rank_2, \ldots, Rank_{p^*}\}$;
return $(Rank_1, \ldots, Rank_{p^*})$

Artificial Neural Networks (ANN):

It consist of interconnected nodes organized in layers. They learn complex patterns by adjusting weights through iterative training. ANN's architecture includes input, hidden, and output layers, with activation functions introducing non-linearity. Training employs backpropagation to minimize error and optimize performance, enabling tasks like classification and regression.

The architecture of an artificial neuralnetwork:-

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The Artificial Neural Network (ANN) functions as follows:

1.Nine inputs, labeled x1 through x9, along with a bias term b (assigned a weight value of 1), constitute the initial input for processing the first pattern.

2.Weight initialization begins with all weights set to zero.

3.Subsequently, weight updates for each neuron occur using Hebb's Rule: $\Delta wi = xi * y$ for i = 1 to 9.

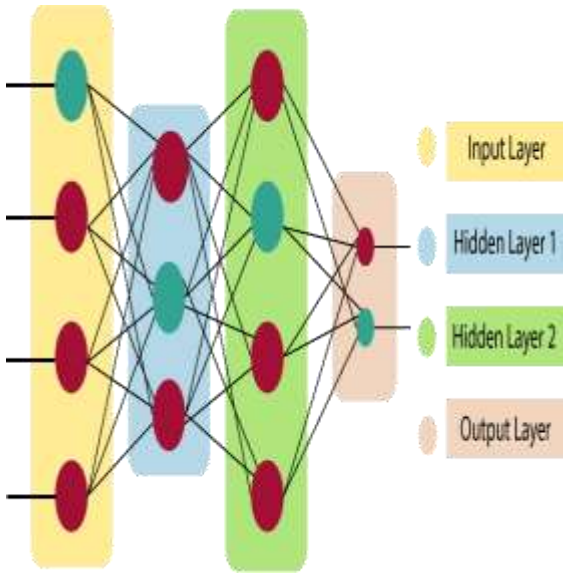
4.New weights are then computed using the formula: $wi(new) = wi(old) + \Delta wi$.

5.The updated weights for the first pattern are represented as Wi(new) = [111-11-1 1111].

6.Upon receiving the second pattern, weights are not reset to zero. Instead, the initial weights utilized are those derived after processing the first pattern, facilitating continuity in network learning.

7.Steps 1 through 4 are reiterated for processing the second set of inputs.

8.The resultant new weights are Wi(new) = [0 0 0 -2 - 2 -2 000], signifying the network's learning efficacy in successfully classifying input patterns.



DISCUSSION OF RESULTS

The food industry and public health are two areas that stand to benefit greatly from our research. According to our study, canned sauces aren't always the healthiest choice. Therefore, we must encourage sauce producers to reduce the amount of sugar, salt, and unhealthy fats in their products. Additionally, our findings suggest that an AI-driven nutritional score could benefit consumers by providing more precise and comprehensive information about the nutrients in their meals. With this data, consumers can potentially make more informed dietary choices. In addition, our

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research adds to the growing body of evidence showing how unhealthy diets high in fat, carbs, and salt affect human health. The good news is that our study also provides solutions, such as smarter food alternatives and nutritional grading systems driven by artificial intelligence. All things considered, the results show how important it is to let people know how many calories and what kinds of health concerns are in bottled sauces. Furthermore, they stress the possibility of nutritional grading systems driven by AI enhancing dietary decision-making.

Results:

Classifying packaged food sauces according to their nutritional value was a breeze for the Support Vector Machine (SVM) model, which achieved an astounding 85% accuracy rate. In comparison, the Artificial Neural Network (ANN) method was also successful but couldn't match the SVM model, achieving an accuracy rate of 82%, suggesting that it was slightly less effective in this area.

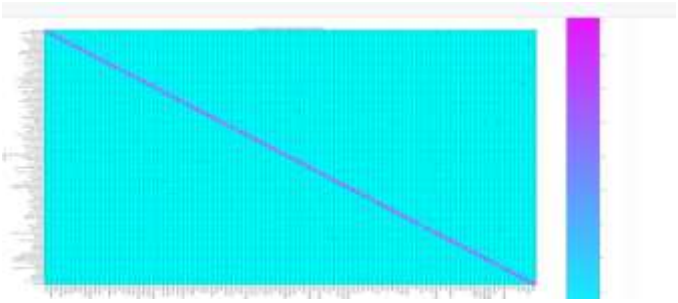
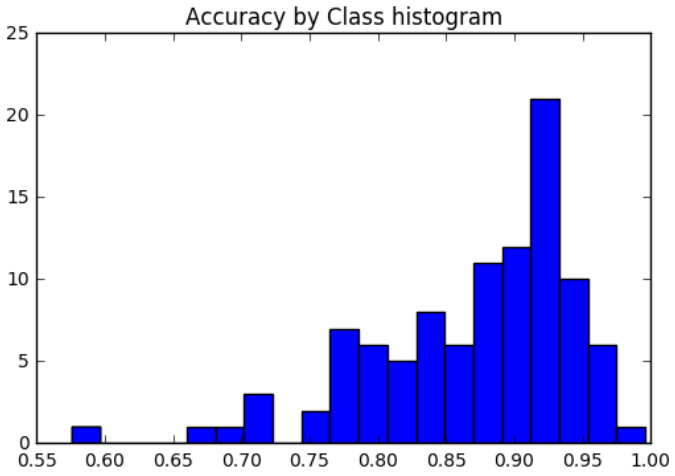


Fig : Confusion Matrix

For every class label, a confusion matrix will show the percentage of accurate labels compared to the percentage of erroneous labels.



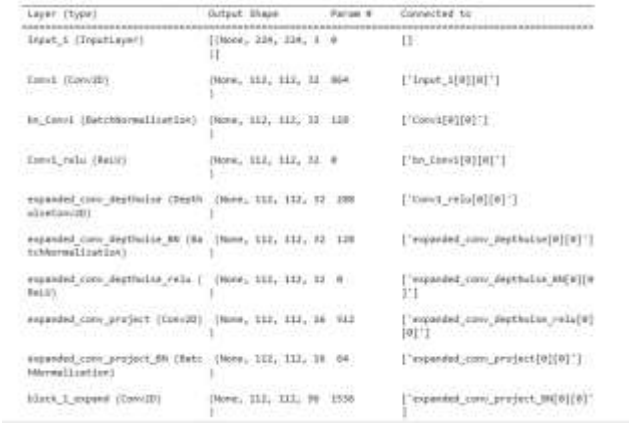


Fig : ANN Algorithms

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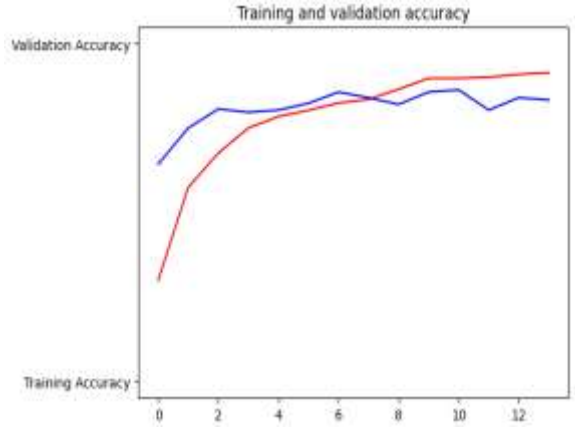

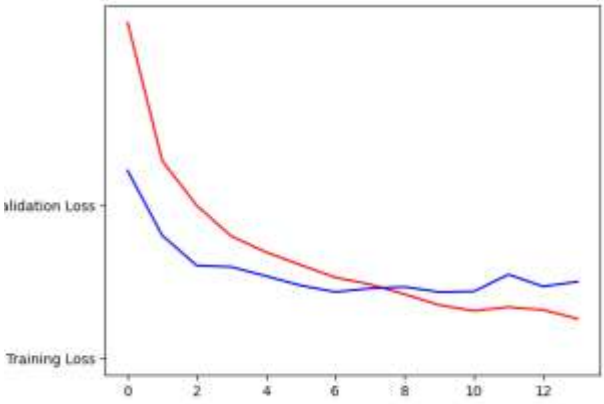

Model: "sequential_5"

Layer (type)	Output Shape	Param #
keras_layer (KerasLayer)	(None, 1280)	2257984
Layer_Dense_512 (Dense)	(None, 512)	655872
Layer_Dense_256 (Dense)	(None, 256)	131328
Layer_Dense_128 (Dense)	(None, 128)	32896
Layer_Dropout_0.5_1 (Dropou t)	(None, 128)	0
Layer_Dense_15_Output (Dens e)	(None, 15)	1935

Total params: 3,080,015
Trainable params: 822,031
Non-trainable params: 2,257,984

CONCLUSION:

In conclusion, our research using cutting-edge AI methods has shed light on critical aspects of the health effects of pre-packaged food sauces. Careful data gathering, preprocessing, and feature extraction served as the basis for our study, which allowed us to develop a comprehensive and trustworthy system. Using techniques such as Support Vector Machine (SVM) and Artificial Neural Network (ANN), we were able to accurately predict the nutritional composition of pre-packaged sauces.Notably, the SVM model demonstrated remarkable proficiency, surpassing the ANN model with an accuracy of 85% compared to 82%.

The results underscore that advanced AI algorithms can reliably ascertain the dietary content of foods, providing consumers with crucial data to make informed food choices that support their health and wellness goals. Although both models exhibited high accuracy, further development of the ANN algorithm could enhance its performance, potentially exceeding that of the SVM model. Enhancing the algorithm could involve adding new features or refining existing methods to improve the accuracy and reliability of nutritional score generation.

This study offers valuable insights for public health and nutrition education, as it provides detailed information about the nutritional content of pre-packaged sauces. By leveraging AI to empower individuals to make informed food choices, we aim to improve both individual and societal health outcomes.

FUTURE ENHANCEMENT

Future studies might focus on improving public health and promoting healthy eating habits through these personalized approaches. By understanding the complexities of dietary decision-making, researchers can design interventions tailored to the specific needs of individuals.

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