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Análisis de Nutrición y Clasificación de Alimentos Secos para Gatos Utilizando Técnicas de Reconocimiento de Patrones

Nutrition Analysis and Classification of Dry Cat Foods Using Pattern Recognition Techniques

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Abstract:

In this work, we present which dry cat foods are more recommended for pet consumption, considering only their cost and nutritional contributions. We used a database generated from the information published in the quality studies of dry cat foods conducted in 2022 by PROFECO; and by using pattern recognition techniques, we classified the cat foods into three groups: excellent, regular and not recommended for pet consumption.

Keywords:

Dry cat foot, Pattern recognition, PROFECO

Resumen:

En este trabajo, presentamos cuáles croquetas para gatos son más recomendadas para el consumo de las mascotas, considerando solo su costo y sus aportes nutricionales. Usamos una base de datos generada a partir de la información publicada en los estudios de calidad de croquetas para gatos realizados en 2022 por PROFECO; y mediante el uso de técnicas de reconocimiento de patrones, estos fueron clasificados en tres grupos: excelentes, regulares y no recomendados para el consumo de las mascotas.

Palabras Clave:

Croquetas para gato, Reconocimiento de patrones, PROFECO

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Introduction

Dry cat food is a type of food for cats that consists of kibble, which is made by combining and cooking meat, grains, vitamins, minerals and fats at high temperature and pressure. It is one of the most common and convenient choices for cat owners, as it does not require refrigeration and can be left out for longer periods of time. However, not all dry cat foods are equal in terms of quality, nutrition and cost. Some dry cat foods may contain ingredients that are harmful or unnecessary for cats, such as artificial colors, preservatives, fillers or by-products. Moreover, some dry cat foods may be overpriced or misleading in their labels, claiming to be natural, organic or premium when they are not.

Therefore, it is important for consumers to have reliable and objective information about the different brands and varieties of dry cat foods available in the market, so that they can make informed decisions about the best food for their cats. Unfortunately, this information may not be easy to find or understand, as there are many factors to consider when comparing dry cat foods, such as their ingredients, nutritional values, prices, ratings, reviews, and certifications.

In this work, we aim to address this problem by presenting a comprehensive and systematic analysis of dry cat foods based on their cost and nutritional contributions. We use a database generated from the information published in the quality studies of dry cat foods conducted in 2022 by PROFECO (Federal Consumer Attorney's Office), a Mexican government agency that protects and defends the rights of consumers. We apply pattern recognition techniques, such as k-means clustering and principal component analysis (PCA) to classify the dry cat foods into three groups: excellent, regular and not recommended for pet consumption. We also provide a graphical visualization of the results using a scatter plot.

Objectives

- To identify the best and worst dry cat foods in terms of cost and nutrition.
- To compare the ratings obtained by our model.
- To provide useful and actionable information for consumers who want to choose the best dry cat food.
- To complement the studies conducted by PROFECO.
- To help those who have a cat as a pet to make more informed decisions about their feeding.

Concepts and definitions

Dry cat food

Dry cat food is a type of food for cats that consists of kibble, which is made by combining and cooking meat, grains, vitamins, minerals, and fats at high temperature and pressure. Dry cat food has some advantages and disadvantages compared to wet cat food, which is canned and has a higher moisture content.

To choose the best dry cat food for your cat, you should look for the Association of American Feed Control Officials (AAFCO) label, which guarantees that the food meets the minimum nutritional standards for cats.

In Mexico exist some studies related with this subject, one of the most important are those carried out by PROFECO.

PROFECO

PROFECO is the acronym for the Federal Consumer Attorney's Office, a Mexican government agency that protects and defends the rights of consumers. Its mission is to empower consumers by promoting a rational, informed, sustainable, safe and healthy consumption, in order to correct market injustices, strengthen the internal market and the well-being of the population [1].

In this regard, it conducts and publishes quality studies of common consumption products and their impact on nutrition, safety and economy, through its National Consumer Protection Laboratory (LNPC).

Unsupervised learning

In artificial intelligence, there are algorithms that do not require training to classify a dataset, but they do it based on the intrinsic features of each element. This kind of technique is called unsupervised learning classification or clustering and it is very useful when there is no previous labeling, that is, when it is not known how a dataset can be grouped and it needs to be classified. On the other hand, they are often used for comparison purposes and to get feedback between the results (classification) obtained by a model and those determined by an expert.

K-Means

It is a technique that allows to group data points into clusters based on the similarity of their features. It is useful for finding patterns and structure in large and complex datasets. The pseudocode is:

1. Starts by randomly choosing *k* points as the initial cluster centers, where *k* is the number of clusters you want to form.
2. Then, it assigns each data point to the nearest cluster center, based on some distance measure, such as Euclidean distance.
3. It updates the cluster centers by computing the mean of all the data points in each cluster.
4. It repeats the steps 2 and 3 until the cluster centers stop changing or a maximum number of iterations is reached.

However, to be able to use it, is needed to specify the number of clusters *k* beforehand [2].

Elbow method

The *k*-means method has the drawback of having to determine beforehand the number *k* of groups into which the database will be split; to solve this task, the elbow method was used. The elbow method is a measure that calculates the sum of squared errors (SSE) between the mean distance and all other data points in the same group. It can be formally defined as:

$$SSE = \sum_{i=1}^{n} (x_i - \bar{x})^2 \qquad \text{I.}$$

To find the SSE values, we plot them from 2 to *n*; then, we look at the graph where the SSE or inertia values begin to drop in a straight line. That will be the *k* value recommended for classifying the database [3].

Principal Component Analysis: PCA

This technique helps to reduce the dimensions of a dataset, while keeping the most variation. It works by finding possible correlations using lines, planes and hyperplanes in the original space [4].

Pearson correlation coefficient

It is a measure that shows how two variables are related linearly. This coefficient is denoted by the letter r. The result will be between -1 and +1, and it can be interpreted as in Figure 1 - 2.

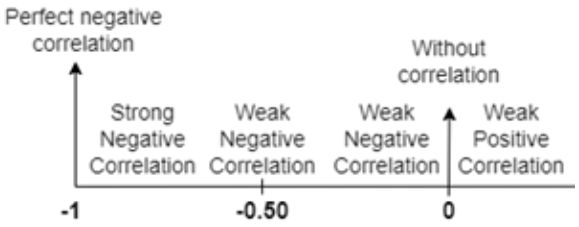

Figure 1. Interpreting a negative correlation

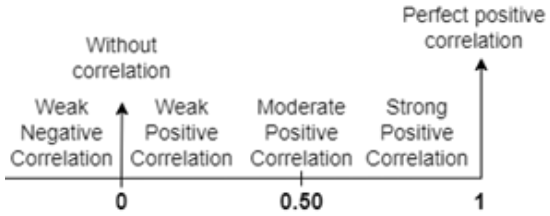

Figure 2. Interpreting a positive correlation

A positive correlation means that the variables are proportional, while a negative correlation means that they are inversely proportional [5].

Methodology

- Download the PROFECO studies about dry cat food, this can be consulted from [1].
- Create a database taking into account the studies.
- Normalize the database.
- Apply artificial intelligence techniques, such as: PCA and unsupervised classification methods on the normalized database.
- Analyse the results.
- Report the results in a clear way.

Results

A Pearson correlation analysis applied on the generated database (see Figure 3) and it demonstrates the following:

- There is a strong positive correlation between:
  - The energy content and the amount of fat
  - Cost and special features
  - Cost and veracity Special features and veracity
- There is a strong negative correlation between

- The presence of flour in their product with the veracity of what is reported, the cost and special features.

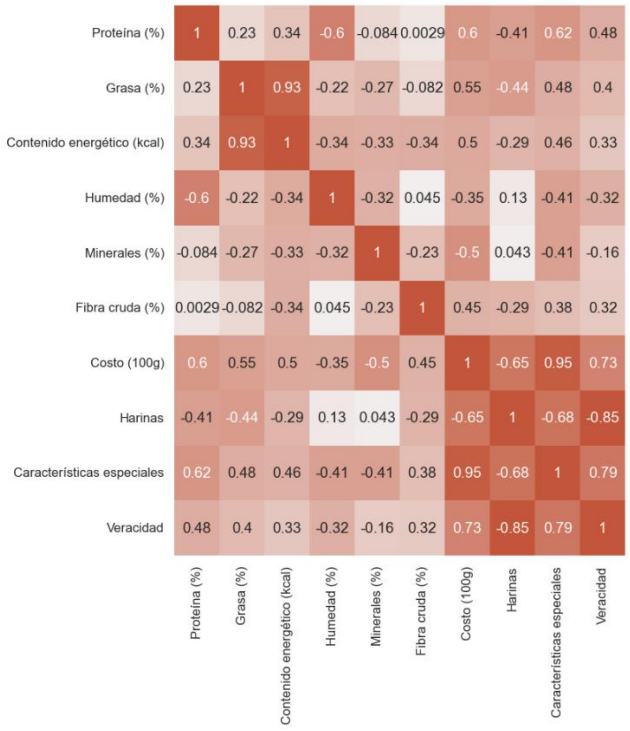

Figure 3. Correlation analysis

Afterwards, the elbow method was applied to the database (see Figure 4) to determine the number of classes recommended for the classification.

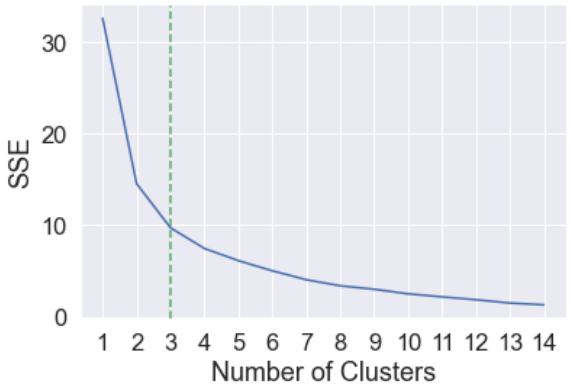

Figure 4. Elbow method results

Once the number of clusters was determined, the database was classified using k-means with its $k = 3$.

Thus, Table 1 shows a resume between the dry cat food and its classification obtained by our proposed model.

Table 1. Results from classification model

Name	Classification
Hill's Science Diet Adult 1-6	Excellent
Purina Pro Plan (Adult)	Excellent
Hills Science Hairball	Excellent
Purina Pro Plan Adult 7+	Excellent
Purina Pro Plan Sensitive	Excellent
Purina Pro Plan Sterilized	Excellent
Purina Pro Plan Urinary	Excellent
Royal Canin Persian	Excellent
Hill's Science Diet Light	Excellent
Purina Pro Plan Reduced	Excellent
Royal Canin Appetite	Excellent
Grancat	Regular
Kisha Grand Pet	Regular
Optimo Felino By Nupec	Regular
Pets club	Regular
Nupec Super Premium Adult Indoor	Regular
KiteKat	Not recommended
Minino	Not recommended
Minino Plus	Not recommended
Nucat by Nupec	Not recommended
Purina Cat Chow	Not recommended
Purina Cat Chow Delimix	Not recommended
Purina Gatina	Not recommended
Purina Felix	Not recommended
Purina One	Not recommended
Whiskas	Not recommended

Finally, for a better visualization of the classified articles, a scatter plot was made by reducing the database dimensions to 3 using PCA. In this plot, the points with the same color mean that they belong to the same class (see Figure 5).

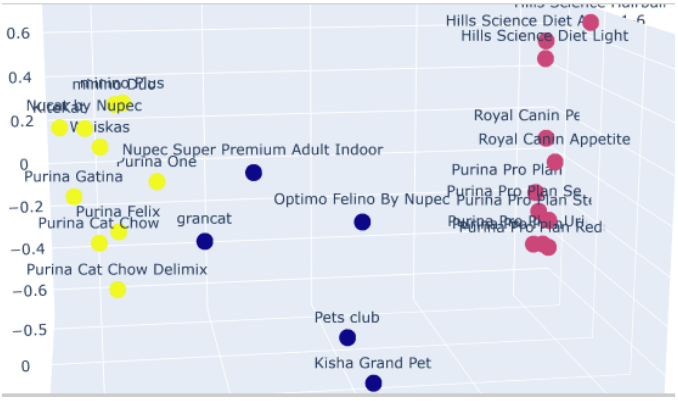

Figure 5. Scatter plot with PCA and k-means classification

In this graph, can be seen the groups that are formed, being yellow those not recommended, blue those regular, and red those excellent.

This way, we can observe that:

- The best dry cat foods in terms of cost and nutrition are: Hill's Science Diet Adult 1-6, Purina Pro Plan (Adult), Hills Science Hairball, Purina Pro Plan Adult 7+, Purina Pro Plan Sensitive, Purina Pro Plan Sterilized, Purina Pro Plan Urinary, Royal Canin Persian, Hill's Science Diet Light, Purina Pro Plan Reduced, and Royal Canin Appetite. These cat foods have high protein, low carbohydrates, low fat, low sugar, and reasonable prices. They also have special features that cater to the specific needs of cats, such as hairball control, urinary health, sensitive skin, or appetite stimulation. They are consistent with the veracity of what they report on their labels.

- The regular dry cat foods in terms of cost and nutrition are: Grancat, Kisha Grand Pet, Optimo Felino By Nupec, Pets club, and Nupec Super Premium Adult Indoor. These cat foods have moderate protein, moderate carbohydrates, moderate fat, moderate sugar, and moderate prices. They do not have any special features that distinguish them from other cat foods. They are mostly truthful about what they report on their labels.

- The worst dry cat foods in terms of cost and nutrition they offer are: KiteKat, minino, minino Plus, Nucat by Nupec, Purina Cat Chow, Purina Cat Chow Delimix, Purina Gatina, Purina Felix, Purina One, Whiskas. These cat foods have low protein, high carbohydrates, high fat, high sugar, and high prices. They do not have any special features that benefit cats. They are often misleading or false about what they report on their labels. They contain flour as a filler ingredient that is harmful or unnecessary for cats.

Conclusions

In this work, we have presented a comprehensive and systematic analysis of dry cat foods based on their cost and nutritional contributions. We have used a database generated from the information published in the quality studies of dry cat foods conducted in 2022 by PROFECO, a Mexican government agency that protects and defends the rights of consumers. We have applied pattern recognition techniques, such as *k*-means clustering and principal component analysis (PCA), to classify the dry cat foods into three groups: excellent, regular and not recommended for pet consumption. We have also provided a graphical visualization of the results using a scatter plot.

We have compared and classified the data generated by PROFECO. However, there are some discrepancies about our results and information available on Internet. For example, some sites review [6,7] rate Purina One as excellent while our model rated it as not recommended. This may be because they considered other factors besides cost and nutrition, such as customer satisfaction or brand reputation.

We hope that this work can provide useful and actionable information for consumers who want to choose the best dry cat food for their cats. We also hope that it can complement the studies conducted by PROFECO and help them improve their quality assessment methods. We suggest that future work can explore other factors that may affect the quality of dry cat foods, such as their environmental impact or ethical standards.

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