Elanco BCS Project: Methods

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Elanco BCS Project Abstract

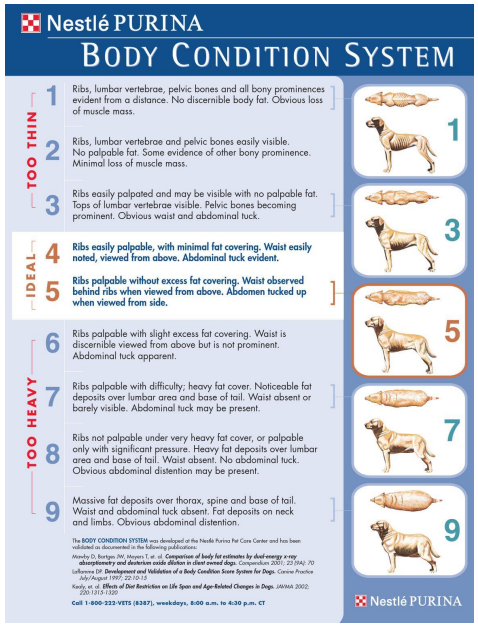
This team coordinated with Purdue University's Data Mine and Elanco Animal Health in order to solve an issue regarding pet's health centered around an animal's body condition score.

Body condition score, or BCS is defined as a scale usually used by veterinarians to rate the overall condition of a pet (https://raleighncvet.com). Not many pet owners are aware of their animal's BCS score and during this past year, it may be difficult or unsafe to travel to a vet's office.

The project's goal is to analyze the different body composition scores of dogs through methods in computer vision.

Currently, the team is developing a calculator to determine the body condition score a veterinarian would use for basic health monitoring, through a simple to use, Android app.

Below is the nine-level Nestle-Purina BCS system. This is the system that the team used for this project.



Data: Storage and Use

Use:

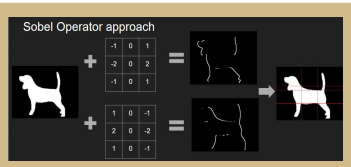
- **A:T Ratio:** The abdominal to thoracic ratio, taken by dividing the abdominal region by the thoracic region.
- Abdominal & thoracic regions marked up using vertical lines across a silhouette image.
- Lines created through Sobel Operator, Statistical, and DeepLabCut methods.

Dog image with a labelled A:T ratio

Storage:

- At first, we marked up images on the slack channel.
- We are now using a student's laptop to store images from the app.
- We plan to eventually store all data on scholar.

Sobel Operator Method



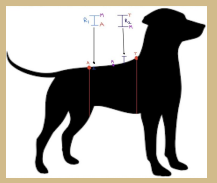
Sobel Operator demonstration diagram

- The team used Sobel-Feldman Operator to draw the horizontal and vertical lines that defines the estimated AT score of the dog within the picture.
- The Sobel Operator was implemented by using a 3 by 3 kernel that extracts "edge" features.
- By applying the kernel twice on the image with opposite directions, the team managed to get the intersection of the body with front leg and hind leg, respectively.

Statistical Method

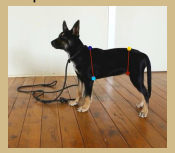
- Calculate the top middle of the dog (label M).
- Calculate the standard deviation (σ) of black pixel column sums for each black pixel column left and right from M.
- If the σ exceeds some range R1 (left) or R2 (right) draw a red line downwards until we encounter a white pixel. The ratio of the red lines will be our AT ratio

Labeled diagram with points of interest, using the stats-based approach.

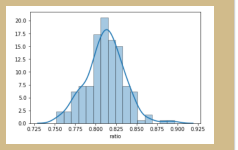


DeepLabCut Method

- **DeepLabCut** is a neural network-based software package for animal pose estimation.
- Methods behind the toolbox: transfer learning with deep convolutional neural networks.



Screenshot from labelled video



Distribution of calculated A:T ratio from each frame

- Label the top and bottom side of a dog's chest and waist in frames extracted as training data.
- After the neural network is trained, a new video can be analyzed and the output (x, y) coordinates of labelled body parts can be used to calculate the chest length, waist length and then the A:T ratio.
- By calculating the A:T ratio of each frame of the video analyzed, a distribution of A:T ratio can be generated.

Problems/Future Goals

Problems:

- Estimating BCS for all types of dog breeds require large data set for training.
- The stats-based approach uses the highest standard deviation from the center point M, to determine R1 and R2, which may not always be accurate.
- The center of the image is not always the center of the dog with the stats-based approach.

Future Goals:

- Improve the current approaches to generating an A:T ratio, to generate a more accurate BCS score. (Accurate)
- Make sure the model performs well across various breeds of dog with different features. (Robust)
- Upload all data onto a scholar directory as it has more space than a student's laptop. (Scalable)

Conclusion/Acknowledgements

Conclusion:

The team tried many methods to determine an AT ratio, to determine A BCS score. These three were the most successful:

- **DeepLabCut:** Using deep neural network to track body parts.
- **Stats-based:** Using standard deviation of column sums.
- **Sobel operator:** Using kernels to extract features.

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References:

https://raleighncvet.com (formal BCS definition)
Can you Estimate Body Composition in Dogs from Photographs? (paper on BCS in dogs)
Mathis, A. et al. (2018) (paper on DeepLabCut)

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