Early detection of ketosis in dairy cows using computer vision and machine learning

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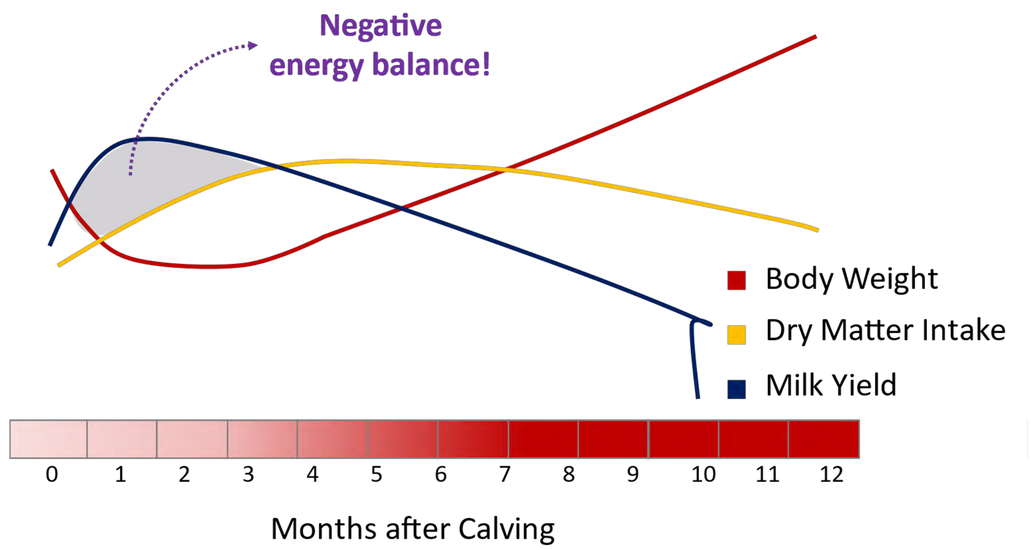
DAIRY INNOVATION HUB

Background

- ***67% of all disease*** cases in dairy cows occur during the transition period (Carvalho et al., 2019)



- Ketosis is one of the main peripartum disorders associated with acute NEB
  - Subclinical ketosis can cost from **$169 to $359** per case (Mostert et al., 2018; Raboissan et al., 2015)
  - Clinical ketosis can cost up to **$1,673** per case (Steeneveld et al., 2020)

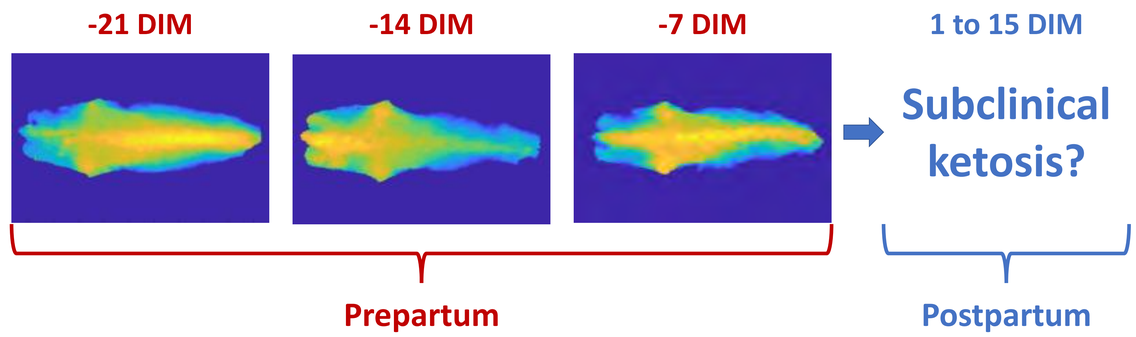
Objective

- Develop a computer vision system that processes 3D images collected in the prepartum period to early-detect subclinical ketosis events

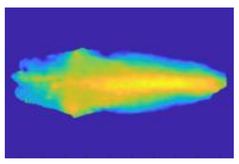
Material and Methods

- 22,800 top-down 3D images from 76 Holstein cows collected 21, 14 and 7 days prior to calving (100 images per cow and day)
- Background pixels were removed, and three biological features were extracted from each 3D image: number of pixels containing a cow, estimated surface area, and projected volume of the cow's body
- 1,024 computational features were extracted from each 3D image using a convolutional neural network previously trained to predict body condition score
- For each feature, a mean value was calculated per cow and day
- For each cow, all features from the three days were grouped, generating a dataset containing 76 data points and 3,081 features
- Gradient Boosting Decision Tree (GBDT) and Partial Least-Squares Discriminant Analysis (PLS-DA) algorithms were used to predict subclinical ketosis (SCK) events during the first 15 days after calving
- The dataset was randomly split into training (85%) and testing set (15%), grouping together images of the same animal, and this procedure was repeated 10 times
- Hyperparameters were selected to maximize F1-score using 5-fold cross-validation (using exclusively the training set)

Feature Extraction and Data Analysis

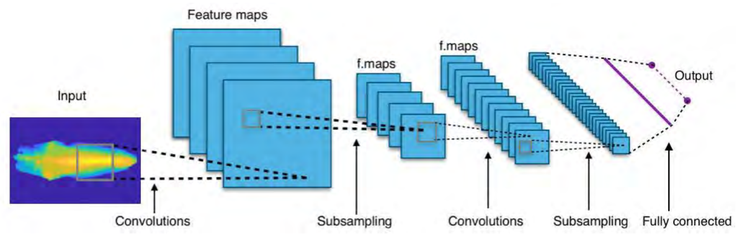


Biological Features



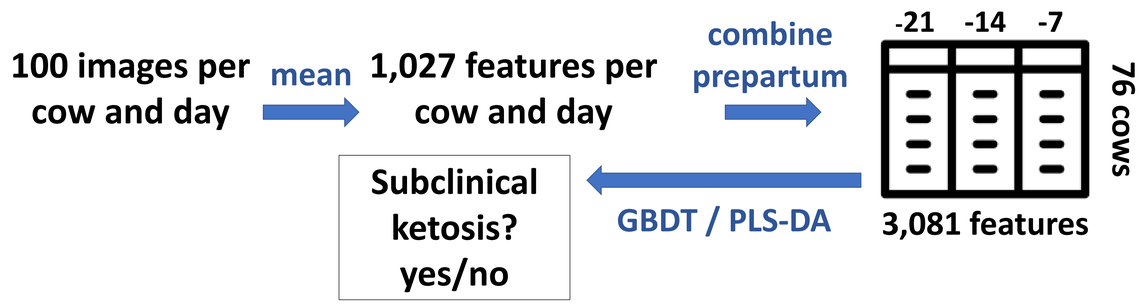
Nº pixels
Area
Volume

Computational Features



1,024 features

Biological + Computational Features = 1,027 features/image



Results

Algorithm	Precision (mean ± stdev)	Recall (mean ± stdev)	F1-Score (mean ± stdev)
GBDT	0.630 ± 0.094	0.908 ± 0.106	0.739 ± 0.086
PLS-DA	0.650 ± 0.090	0.912 ± 0.102	0.754 ± 0.081

Conclusions

- 91.2% of SCK cows were classified as SCK using prepartum images
- These promising results suggest the potential use of computer vision systems for real-time individual animal monitoring in livestock operations, and for the development of preventive practices to improve animal health