Computer vision and 3D kinematics can monitor dairy cow comfort

Purpose

The aim of this research was to measure established criteria for cow comfort in free stalls using computer vision. Through digitalization of anatomical features, we obtain their coordinates in a 3D space and are able to track the movement at a sampling rate of 30Hz.

From these movements, measures of spatial use could be derived and compared with accepted standards for sufficient cow comfort.

Methods

Sample: n = 503 spontaneous rising bout sequences from 51 cows in free-stall housing. 900 points per sequence.

Digitalization: Convolutional Neural Networks detect animals and anatomical key-points. Triangulation of the key-points on synchronized frames from several cameras provide the 3D coordinates of the key-points.
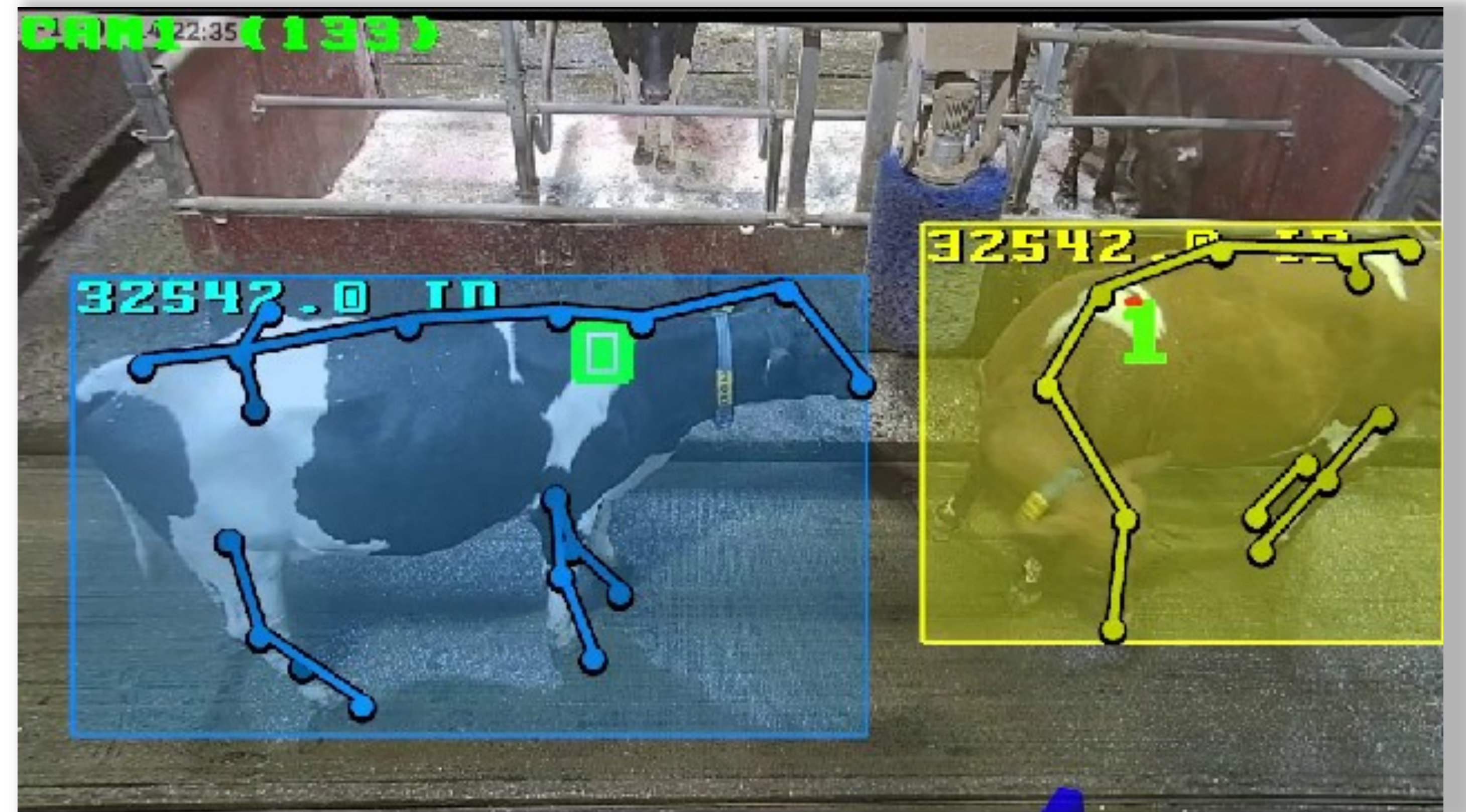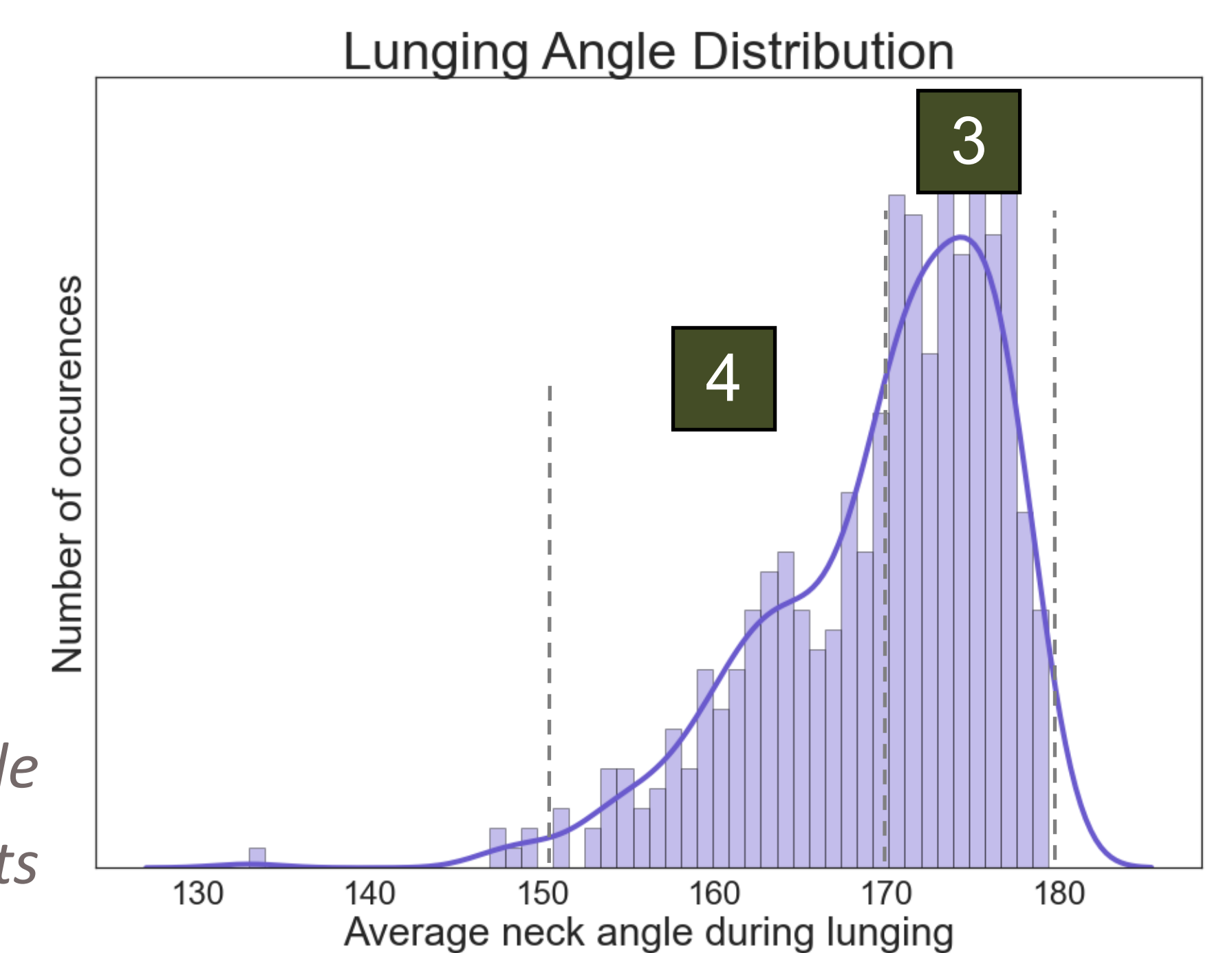
Results

Pause on front limbs

The following graphs show the height of the head, withers and sacrum key-points measured by the 3D vision system (reported in arbitrary units). In 1 the cow marks a short pause sitting on her front limbs, as is normal in a rising sequence. In sequence 2 which was scored as abnormal by expert assessors, there is an unusually long pause.
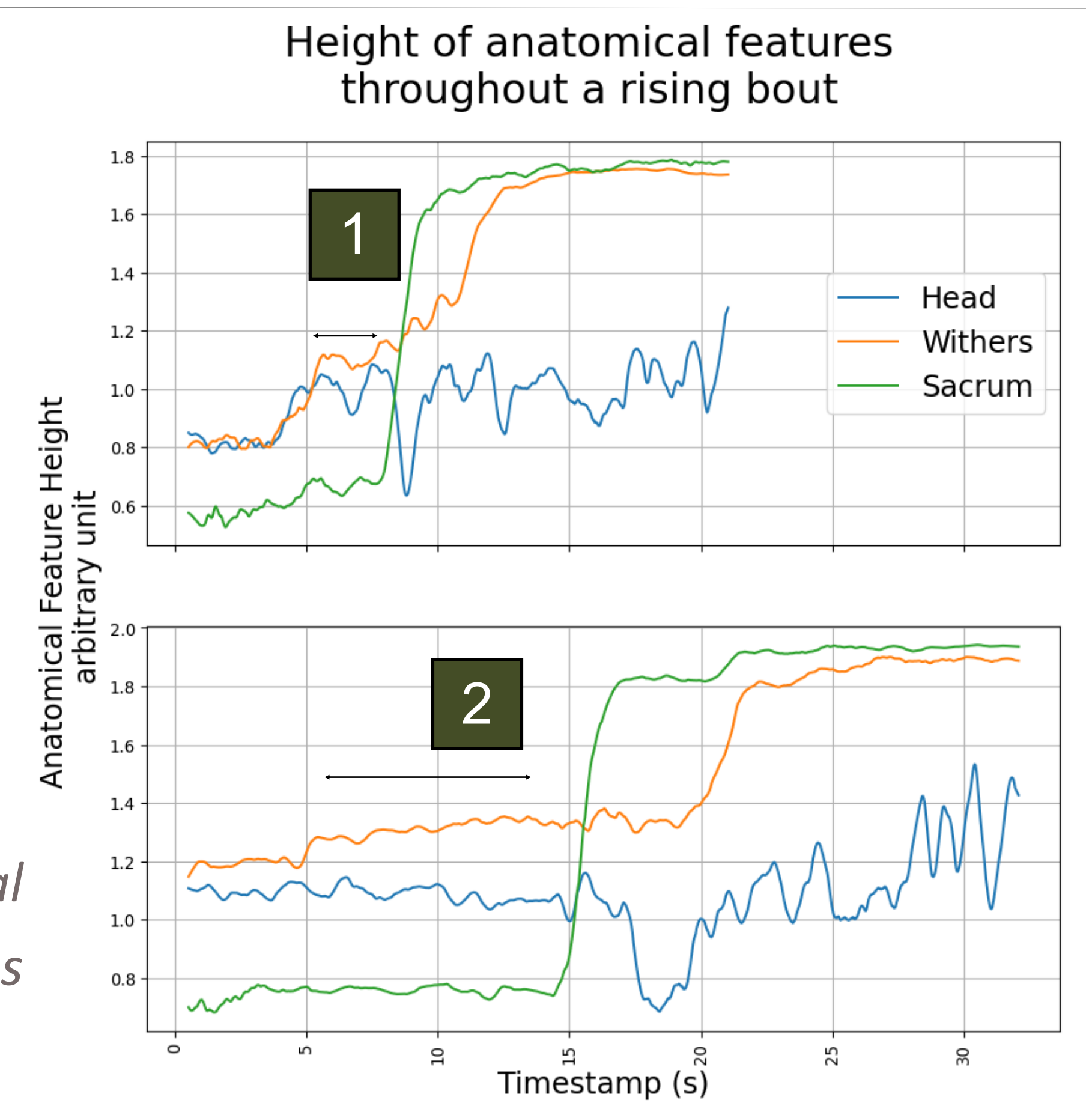
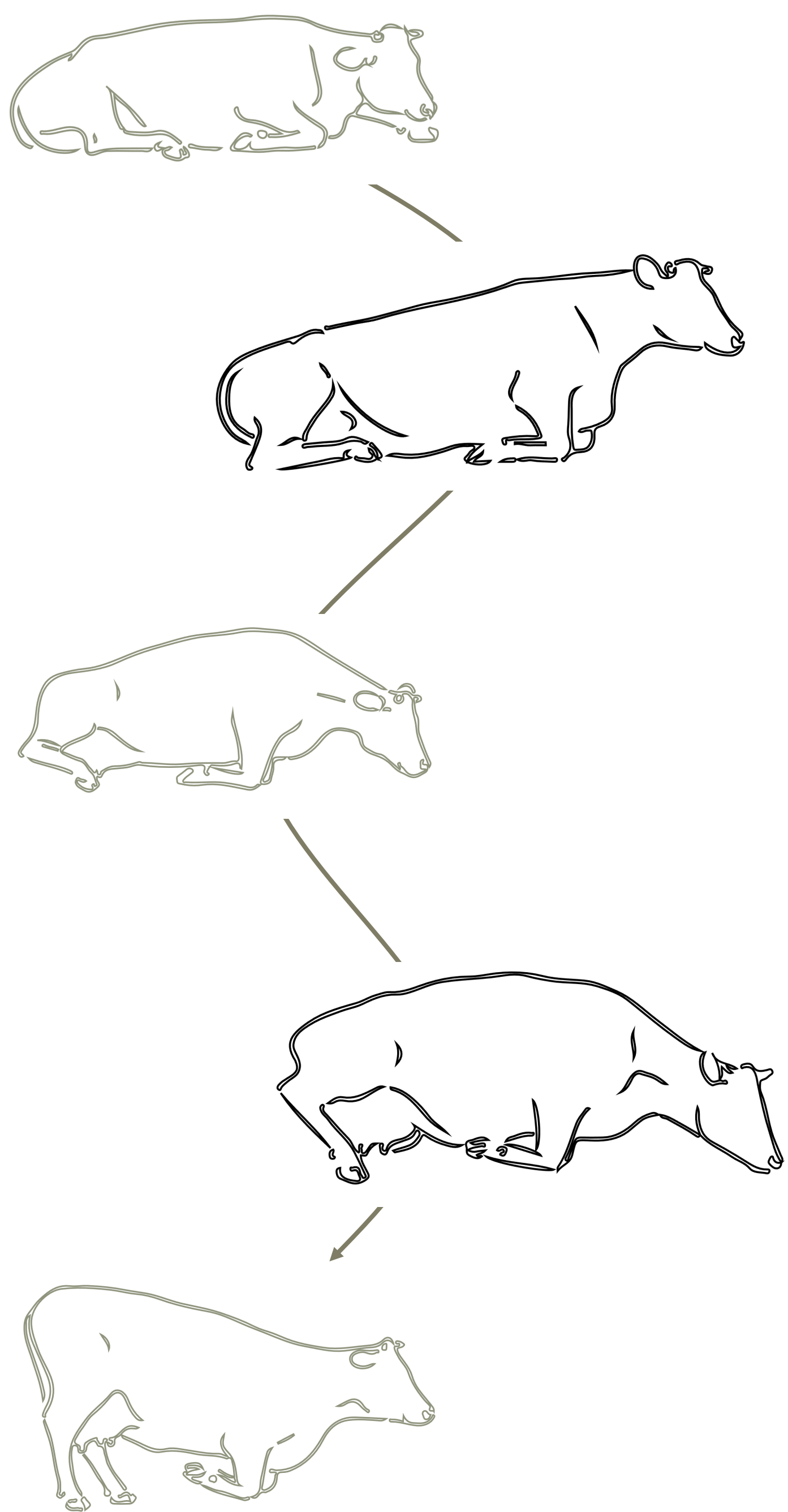*Height of anatomical features during normal and abnormal rising sequences*

Cow rising sequence from Schnitzer, 1971

Head lunge angle

3 In a majority of cases, the cows lunged in a straight motion. That is, at an angle ranging from 170° to 180° between the back and the neck.

4 In other cases, sideways lunging happened, the smaller the angle, the less frequent the motion however.

Distribution of lunging angle in all recorded bouts

Height of anatomical features throughout a rising bout

Head
Withers
Sacrum

Anatomical Feature Height arbitrary unit

Timestamp (s)

Lunging Angle Distribution

Number of occurences

Average neck angle during lunging

Real-time motion tracking can detect individual animals at risk of reduced health and welfare in commercial dairy herds, by measuring established comfort indicators with computer vision technology.

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