

# Glossary of terms

provided by T. PFAU to accompany

## Assessment of mild hindlimb lameness during over ground locomotion using linear discriminant analysis of inertial sensor data

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**Acceleration:** Rate of change (or temporal derivative) of velocity. Measured in metres per second<sup>2</sup>. The acceleration (a) of a body of mass (m) is related to the force (F) it experiences by Newton's second law of motion ( $F = ma$ ).

**Angular velocity:** Angular speed of an object rotating around a particular axis of rotation. It is measured in radians/s or degrees/s.

**Autocorrelation:** Tool often applied for finding periodicities in time-domain signals. Informally, it can be described as a measure of how well a signal matches a time-shifted version of itself and is expressed as a function of the amount of time shift.

**Centroid:** In geometry defined as an intersection of all hyperplanes that divide an object X into 2 parts of equal moment about the hyperplane. Informally (and in pattern recognition), it is often used to refer to the average of X.

**Euler angles:** Set of 3 angles described by Leonhard Euler (1707–1783) to describe the orientation of a body in 3D space. The angles are related to 3 subsequent rotations around a set of 3 axes. The order of rotations is crucial in this process.

**Evaluation/Crossvalidation/Training set:** Terms used in the framework of statistical pattern recognition (e.g. speech or image recognition). A classification system is trained (i.e. the parameters of the system are estimated) using a particular subset of the available data - the training set. Different systems, e.g. based on different feature extraction methods or classification approaches, are then validated using the crossvalidation set - a subset of training data held out from the training process. The crossvalidation set is used to find the optimum system (in terms of classification accuracy, e.g. sensitivity and specificity). This system is then applied to the classification of completely 'unseen' data - the evaluation set.

**Feature extraction:** Term used in the framework of statistical pattern recognition that describes a particular stage of the classification system. Parameters (features) are derived from the

original input signal, e.g. the inertial sensor data stream, and are best suited for the subsequent classification stage.

**Fourier based methods:** After Joseph Fourier (1768–1830).

- **Fourier series:** tool for the analysis of periodic functions. Using sine waves of different amplitude and phase to reconstruct the original function.
- **Fourier transform:** use of Fourier integral for decomposing nonperiodic (finite) signals into sine waves of different amplitude and phase. The Fourier transform of a signal enables the analysis of the frequency components (spectrum) of a signal. The Fourier transform decomposes a time-domain signal into its frequency components, whereas the inverse Fourier transform enables the synthesis of a time-domain function from its frequency components (in the frequency domain).
- **Time domain signal:** representation of a signal as a function of time
- **Frequency domain signal:** representation of a signal as a function of frequency
- **Fourier based methods:** methods that are based on the use of the Fourier series or Fourier transform to either decompose a time-domain signal into its frequency components or synthesise a signal from its frequency domain representation into a signal in the time-domain.

**Hyperplane:** A hyperplane is a geometrical concept. The most familiar kind of hyperplane is an affine hyperplane. In a one-dimensional space, a hyperplane is a point; it divides a line into 2 rays. In 2-dimensional space, a hyperplane is a line; it divides the plane into 2 half-planes. In 3-dimensional space, a hyperplane is an ordinary plane; it divides the space into 2 half-spaces. This can also be applied to higher dimensional spaces, where the dividing object is simply referred to as a hyperplane.

**Jack-knifing:** An approach that is used to make optimal use of a limited training set in the framework of statistical pattern recognition. The training set is subdivided into smaller subsets. The subsets are then combined into a number of training sets by

dropping particular subsets from the set. The classification system is then trained on the new training set and evaluated (or crossvalidated) on the dropped subset. These steps are repeated until the complete data set has been used as the evaluation sample. This approach enables a more reliable judgment about the quality of a classification system by effectively using the complete data set as an evaluation set.

*Kinematics*: The study of bodies in motion without regard to the causes of motion.

*Kinetics*: Also referred to as 'dynamics': study of effects of forces on the motion of objects.

*Magnetic field data*: Here: output of the 3 axial magnetometer in the inertial sensor units. Used to measure the direction (and magnitude) of the Earth's magnetic field in order to determine the heading (yaw) of the sensor.

*Receiver Operating Characteristic (ROC) curve*: A plot of sensitivity versus (1 - specificity). It enables the determination of an optimum discrimination threshold for a given task, by plotting all possible combinations of sensitivity and specificity. The closer the area under the ROC curve is to one, the better the discriminatory ability of the model.

*Rotation matrix*: Matrix when multiplied by a vector changes the orientation of the vector in space but not its length (magnitude). In 3D space this is a 3 x 3 orthogonal matrix. Here used to rotate the sensor accelerations into accelerations in the horse system (craniocaudal, mediolateral, dorsoventral)

*Sensitivity*: Measure to evaluate the quality of a 2-class classification. Describes the proportion of 'true positives', e.g. the number of correctly detected diseased (here: lame) subjects out of all the truly diseased subjects. High sensitivity is essential when, for example, early treatment is of particular benefit for the subject.

*Specificity*: Measure to evaluate the quality of a 2-class classification. Describes the proportion of 'true negatives', e.g. the number of correctly detected unaffected (here: not lame) subjects out of all the truly unaffected subjects. High specificity is essential when, for example, treatment or diagnosis impose a considerable risk on the subject.

*Vector*: In physics and in vector calculus, a vector is a concept characterised by a magnitude and a direction. A common example of a vector is force - it has a magnitude and an orientation and multiple forces sum according to the parallelogram law.

*Velocity*: Speed in a particular direction. Rate of change of displacement. Measured in m/s.