Assessing Characteristics Of Representative Signal Methods

Desmond Brent-Hurst[1,2], Michael Robles[1,3], Amy Coyle[1], Sydney Garrah[1], Richard Moulton[1]
[1]HAS-Motion, Kingston, ON
[2]Department of Mechanical and Materials Engineering, Queen's University, Kingston, ON
[3]Department of Electrical and Computer Engineering, Queen's University, Kingston, ON

Introduction: Biomechanical data is typically summarized using representative signals (RS) like the mean for group analysis. Here we compare eight methods of finding RS, evaluating their sensitivity and robustness by varying input.

Methods: We extracted hip, knee and ankle angles, and ankle flex./ext. angular velocity and acceleration for 34 (24 M) healthy participants from a public data set [1] using Visual3D and Sift (HAS-Motion, Canada). We computed RS with real signal methods (Euclidean medoid [2], PCA medoid [3], vector correlation [4], DTW medoid [5]) and synthetic signal methods (mean, median, shapeDBA [5], softDBA [5]). We evaluated robustness via bootstrapping, randomly removing 10% of traces for 25 iterations, and calculating the dispersion of the resulting RS. We evaluated sensitivity by excluding the top or bottom 1/3 of signals based on the sum of y-values and comparing RS.

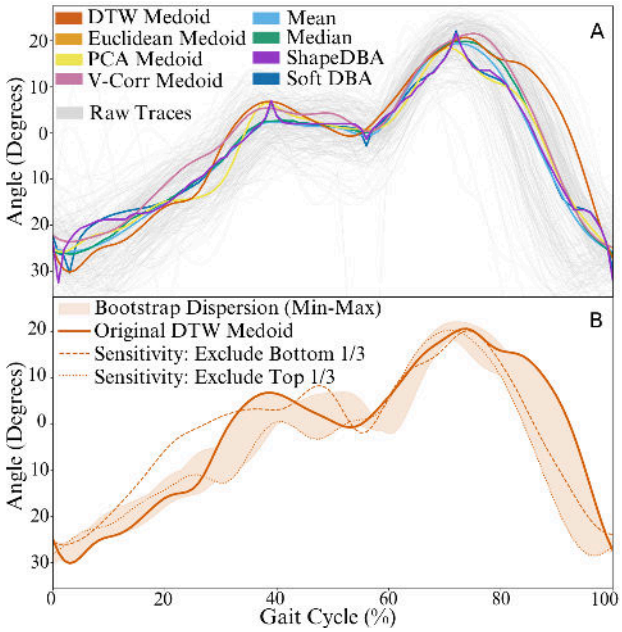

Figure 1: A) Ankle flex./ext. RS for 8 methods. B) Sensitivity and robustness of DTW medoid.

Results: Each method found different RS (Figure 1A). Methods producing real signals were more sensitive and less robust than methods producing synthetic signals. Figure 1B shows that DTW Medoid has a large bootstrapping dispersion and a clear distinction between exclusion scenarios.

Discussion and Conclusions: While measures of sensitivity/robustness clearly demonstrate advantages of synthetic methods, the resulting RS are not a real signal whose properties can be explored and are sometimes radically different (shapeDBA and softDBA). Given this, method selection should consider whether a real signal is needed when finding RS.

References:

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