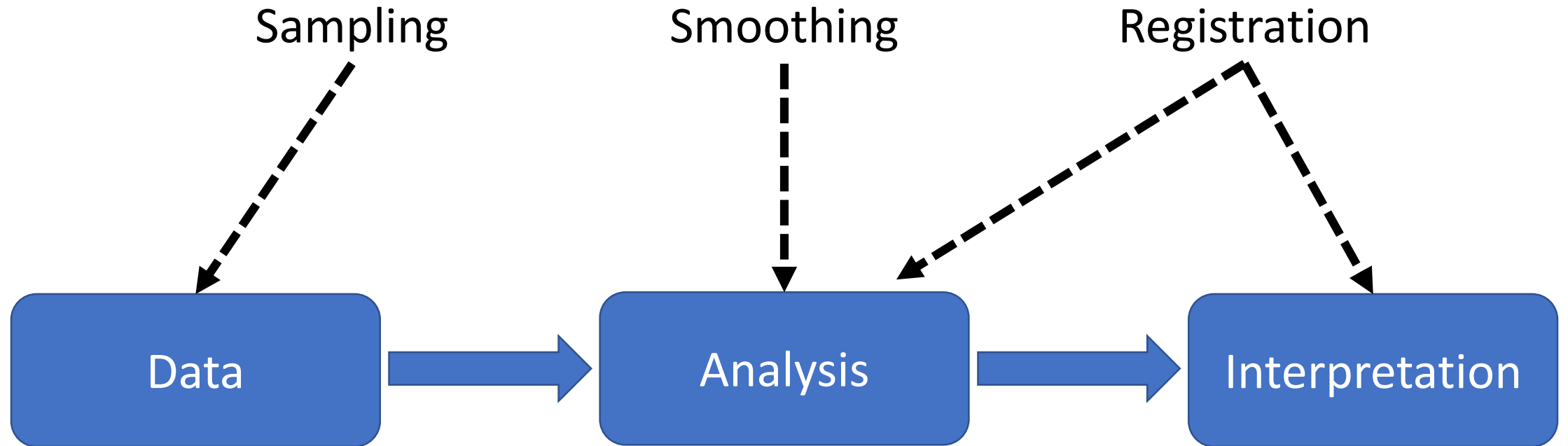


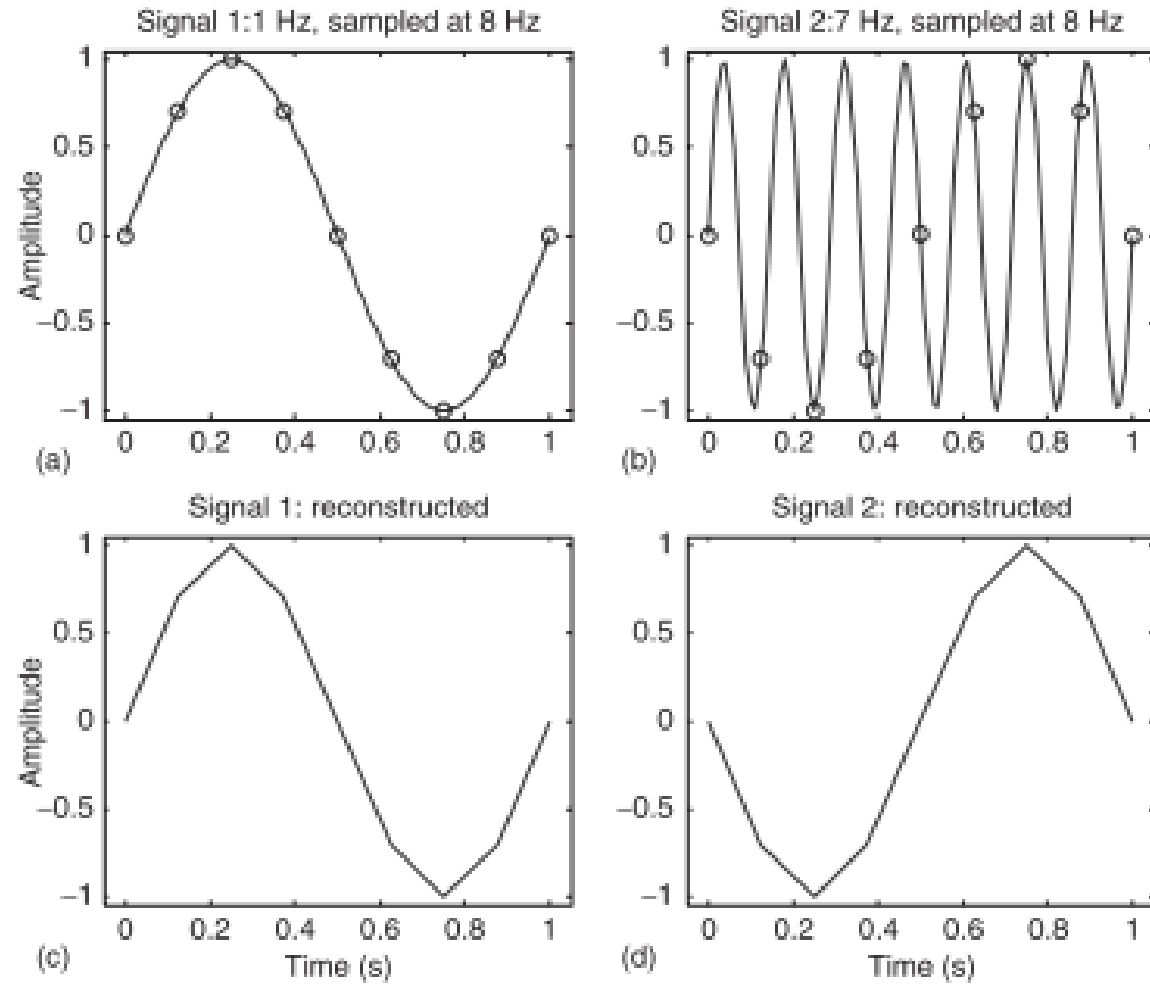
# Part 1

## Time Series Analysis Basics

# Overview

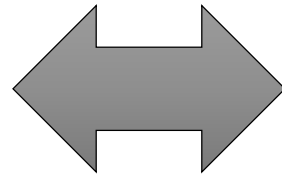


# Sampling biomechanical data



# Smoothing biomechanical data

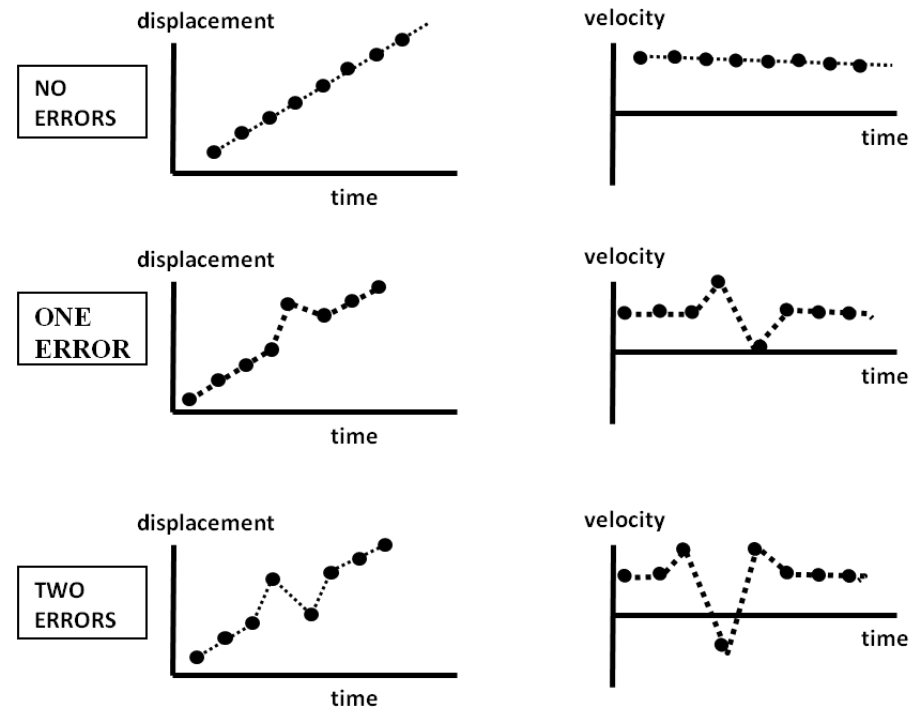
Remove  
artefact



Retain  
signal

# Smoothing

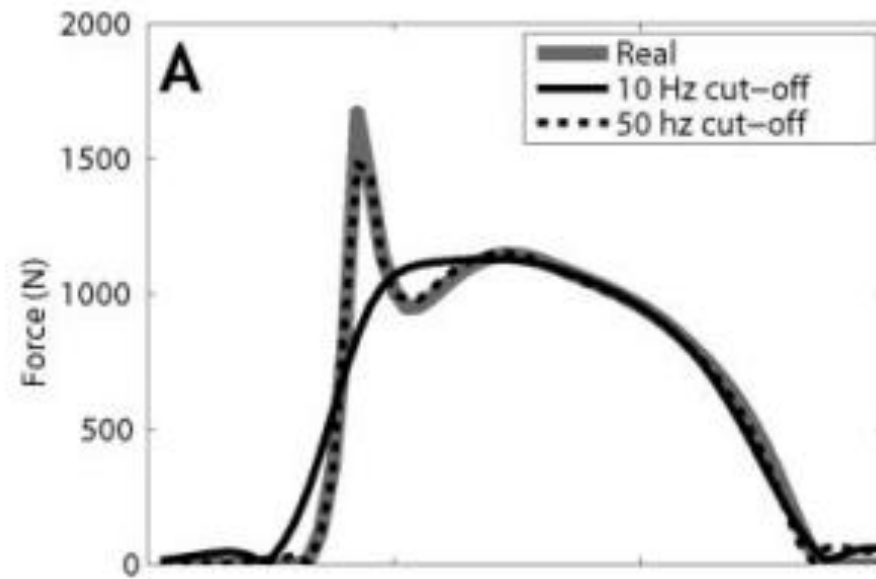
## Kinematic data



Displacement:  $x(t) = \sin t$ ;    Noise  $(t) = 0.001 \sin 50t$ ;    Signal to noise ratio: 1:0.001.  
Velocity:  $v(t) = \cos t$ ;    Noise  $(t) = 0.05 \cos 50t$ ;    Signal to noise ratio: 1:0.05.  
Acceleration:  $a(t) = -\sin t$ ;    Noise  $(t) = -2.5 \sin 50t$ ;    Signal to noise ratio: 1:2.5.

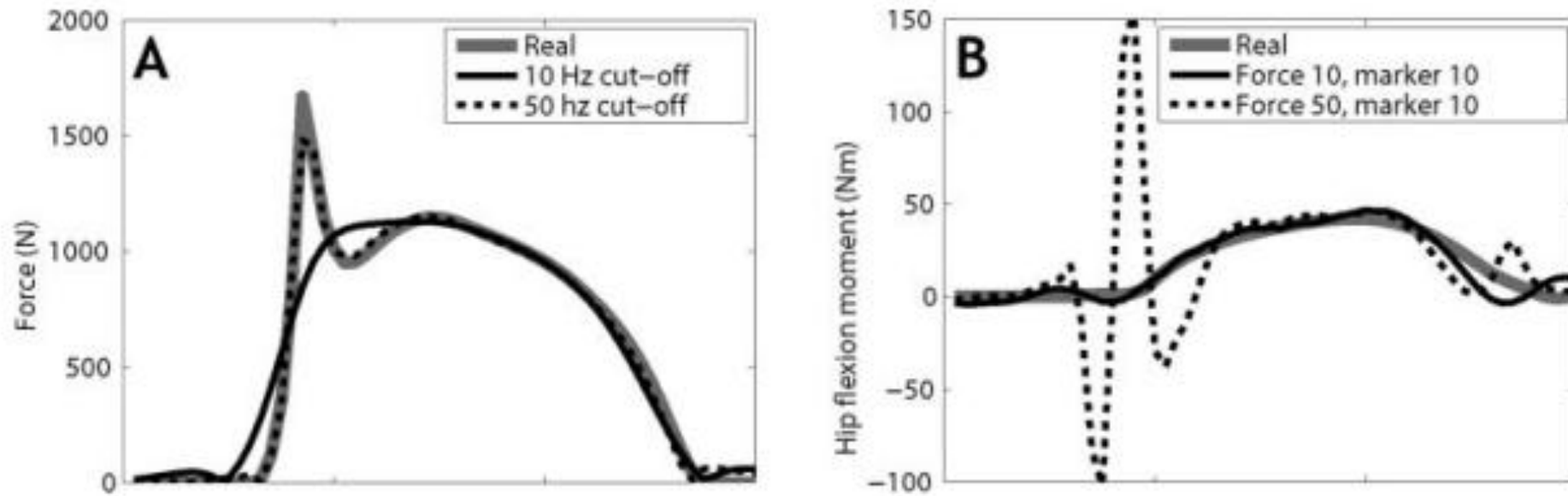
# Smoothing

Force data



# Smoothing

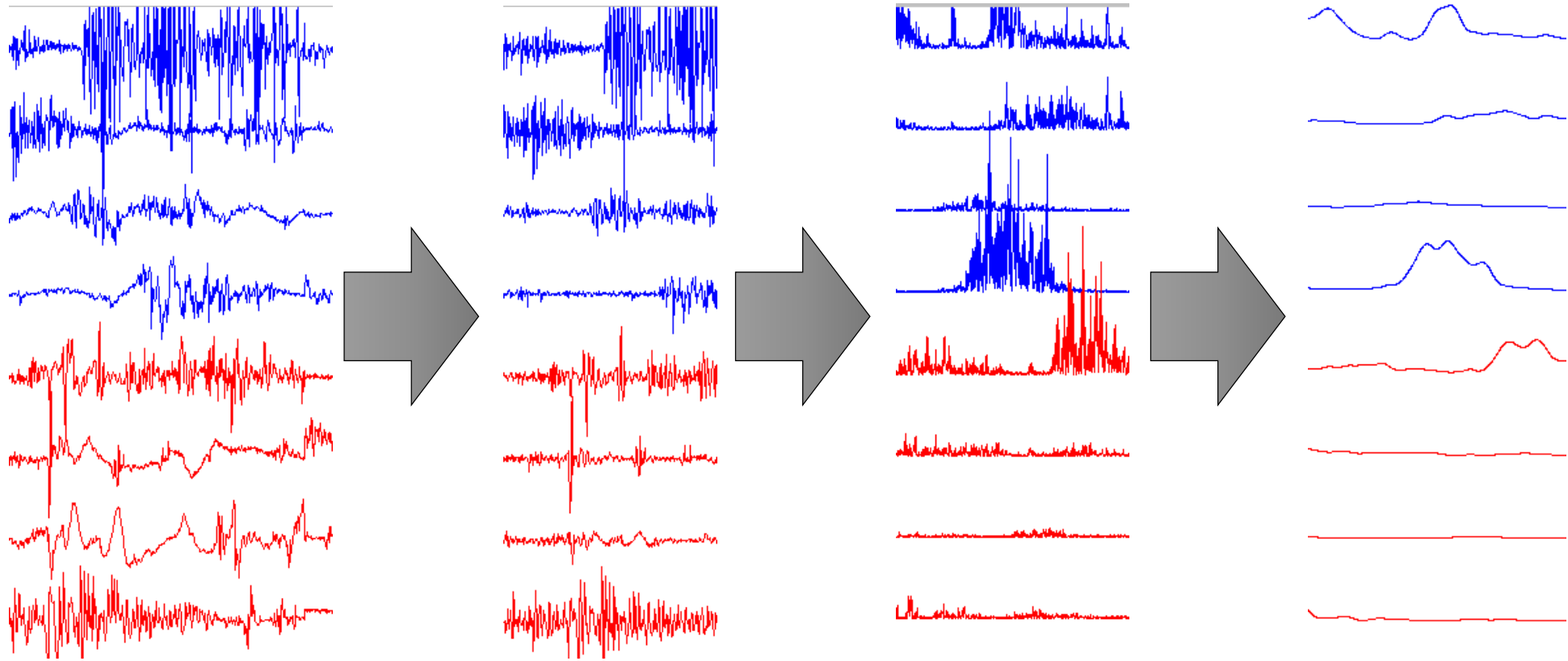
## Kinetic data



Kristianslund et al. (2012) Effect of low-pass filtering on joint moments from inverse dynamics: implications for injury prevention. J Biomech, 45, 666-671.

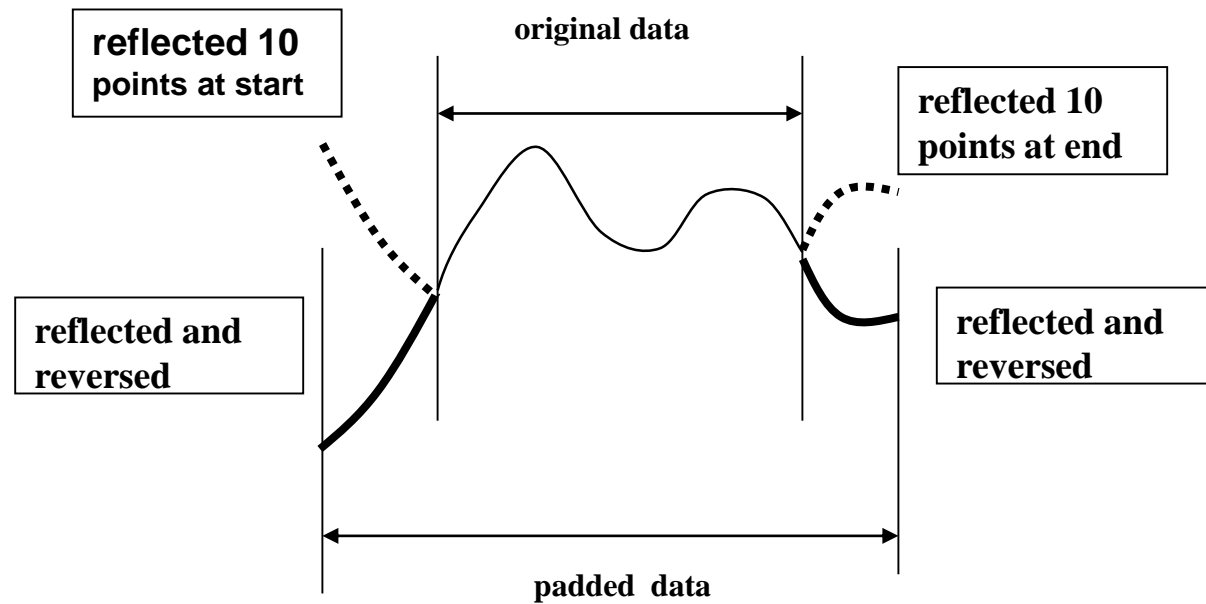
# Smoothing

EMG data

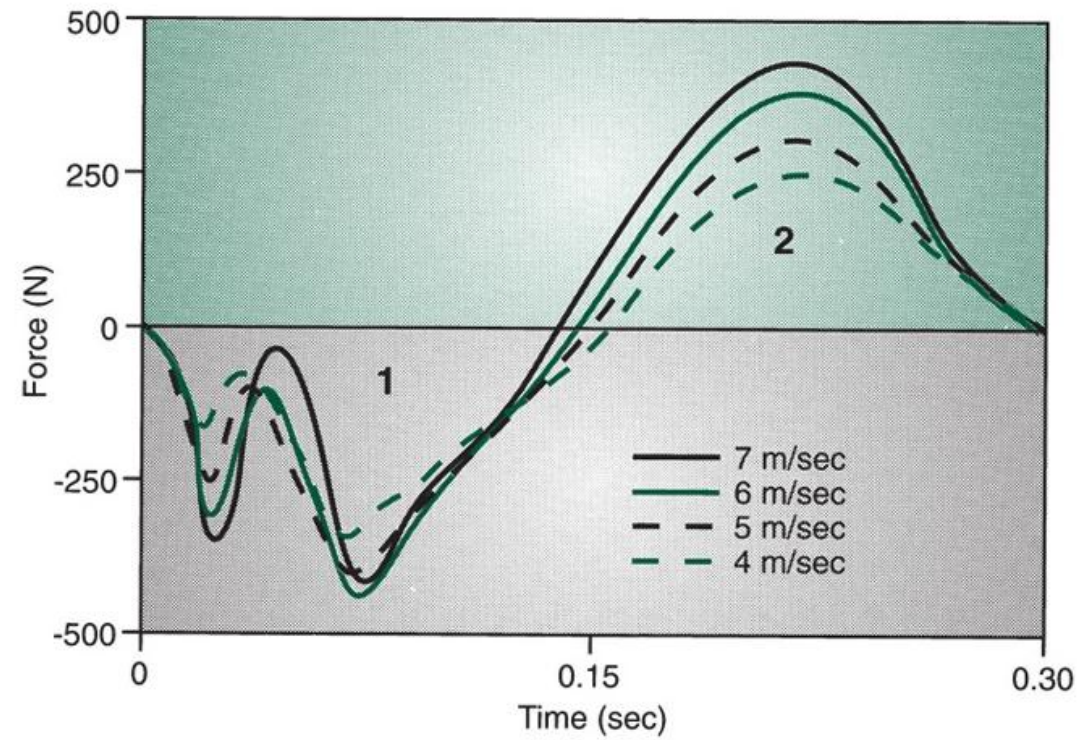




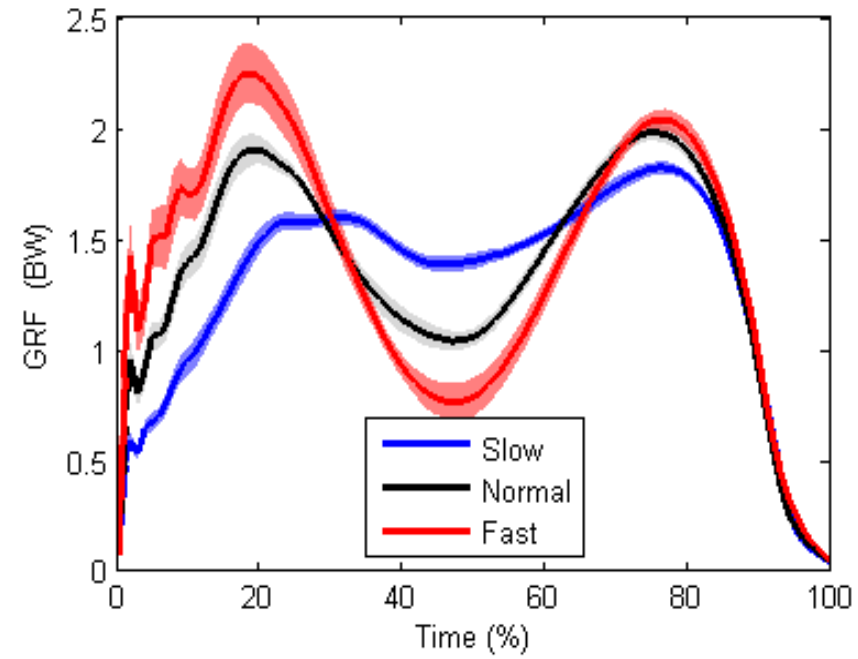
# End point effects



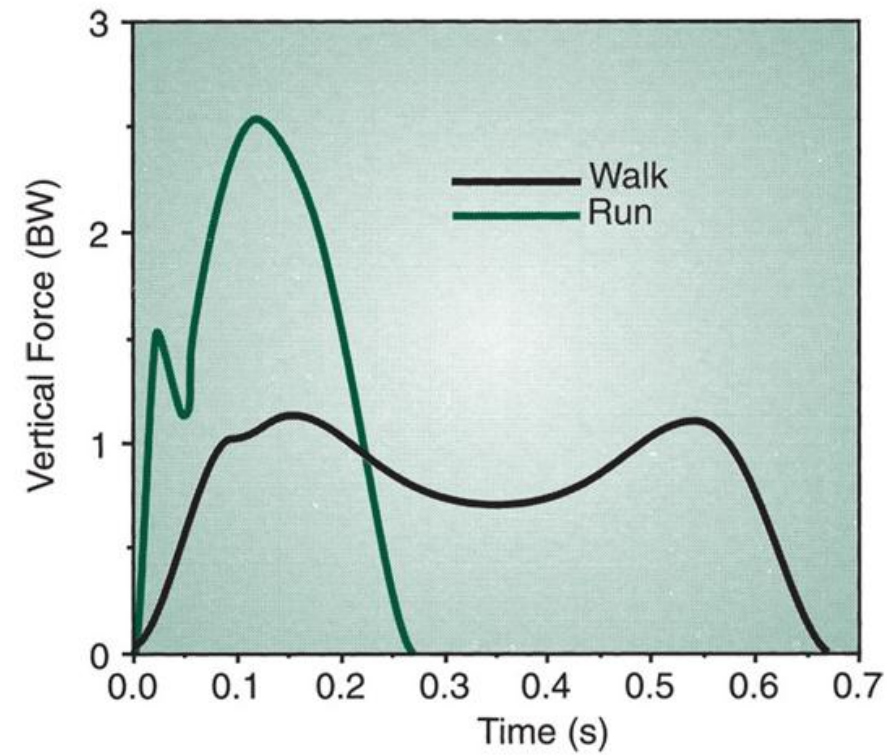
# Registration



# Registration



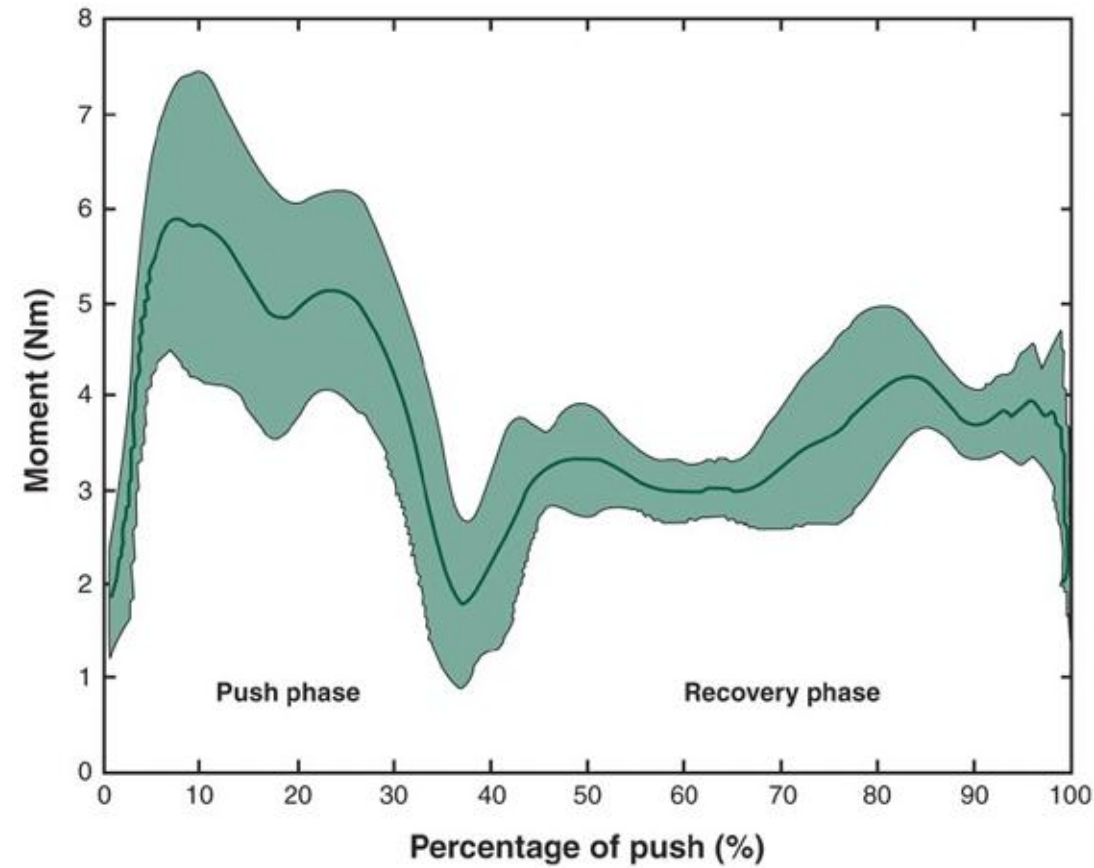
# Registration



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# Registration

linear



# Registration

non-linear

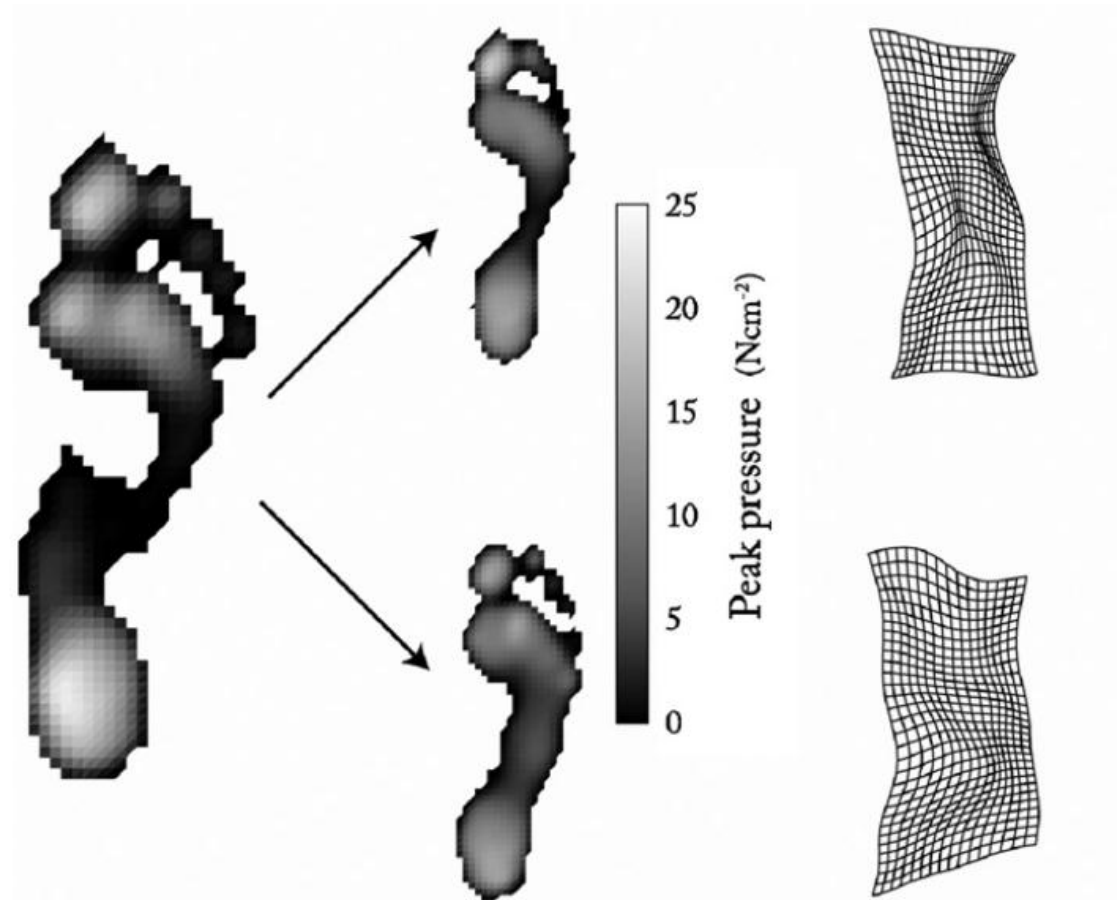


Image taken from Pataky et al., Gait Posture, Vol. 29, pp. 477-482, 2009

# Recap

