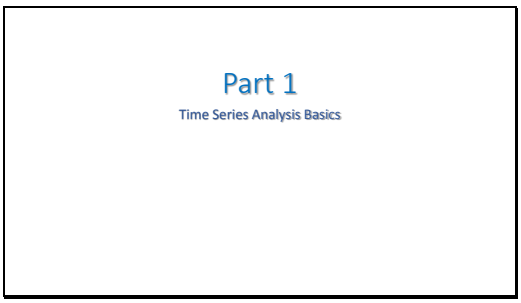
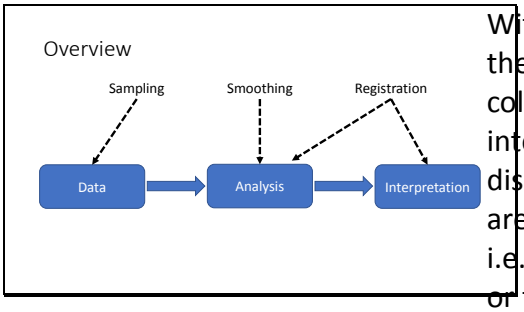
Slide 1



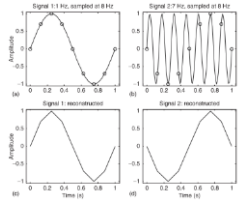
Slide 2



Within context of experimentation there are typically 3 phases, data collection, analysis and interpretation. Within the discipline of biomechanics there are a number of basic processes, i.e. data sampling, data smoothing or filtering, and data registration (normalisation), which come with some limitations. To minimize the impact of those limitations we need to adhere to some core principles which will be briefly addressed here. Whilst this workshop will focus heavily on data analysis and interpretation, we will still first start from a core principle on data sampling…

Slide 3

Sampling biomechanical data



A/D conversion – Nyquist theorem

Slide 4

Smoothing biomechanical data

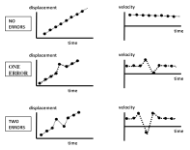
Remove artefact ⟺ Retain signal

Question to audience: why do you smooth data?

Slide 5

Smoothing

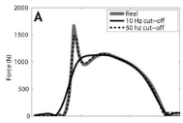
Kinematic data



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

Slide 6

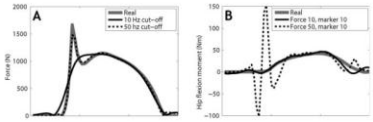
Smoothing
Force data



Difficulty dealing with transients…

Slide 7

Smoothing
Kinetic data

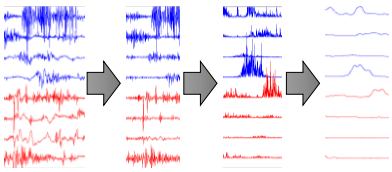


Kristianslund et al. (2012) Effect of low-pass filtering on joint moments from inverse dynamics: implications for injury prevention. J Biomech, 45, 666-671.

Conflict force/acceleration signals with high frequency contents and displacement signals with low frequency contents. Calculation of inverse dynamics is exposed to introduction of artefacts when different smoothing frequencies are applied.

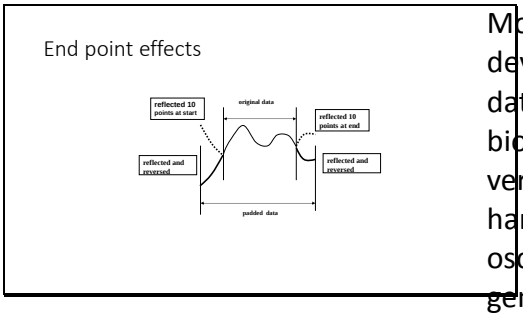
Slide 8

Smoothing
EMG data



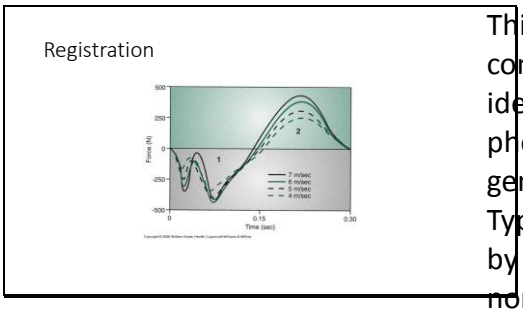
Danger of over-smoothing when considering individual data as a representation of averaged population data

Slide 9



Most smoothing algorithms were developed for quasi continuous data smoothing, whilst in biomechanics we tend to have very short sections of data with hardly one or two periods of oscillations within them. Besides generating variable impact of your filtering algorithm on data with differerent signal shapes, it also comes with the limitations of end point artefact…

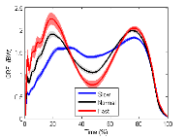
Slide 10



Third but definitely not least: considering that we wish to identify population wide phenomena, there is a need to generate an average profile. Typically, such as here, we do that by first of all temporally normalising the data, more generically termed, data registration. The bottomline is that we try to fit all the data in one template which then allows us to quantify effects within that template. Sticking to the analogy of a shoe, we're not looking at whether someone has a bigger or smaller foot that would need different shoe sizes, but we're trying to find out whether the structure of the foot within the shoe is comparable, for example whether individual bone sizes are the same or not. Take this example, is it suitable to compare these force profiles despite the small temporal variations?

Slide 11

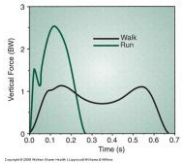
Registration



What about this example?

Slide 12

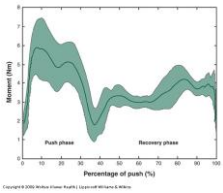
Registration



And what about this example?

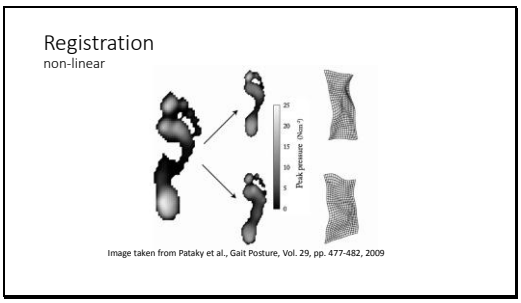
Slide 13

Registration
linear

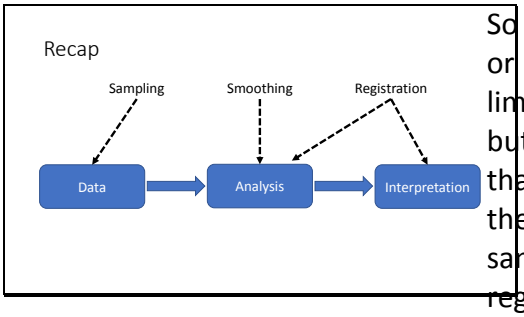


So principally, if we undertake registration we (1) assume that we are comparing apples with apples and (2) decide that topically we have a good reason to evaluate any effects we believe our experimentation may bring about. Interestingly, in biomechanics from a temporal perspective we tend to be very lenient on this, but if one considers the next example, then it is clear that one should be a little apprehensive…

Slide 14



Slide 15



So overall, whether utilizing SPM or FDA, we will today discuss some limitations about both techniques, but it is important to keep in mind that these limitations depend on the limitations inherent to data sampling, smoothing and registration…