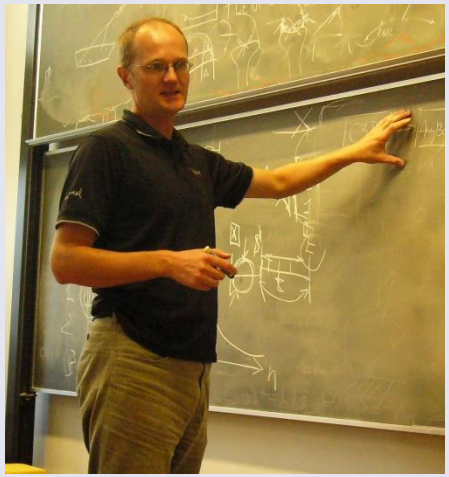
Modeling of population ergonomics with AnyBody

The webcast will start in a few minutes….



John Rasmussen and Kasper Pihl Rasmussen

Aalborg University

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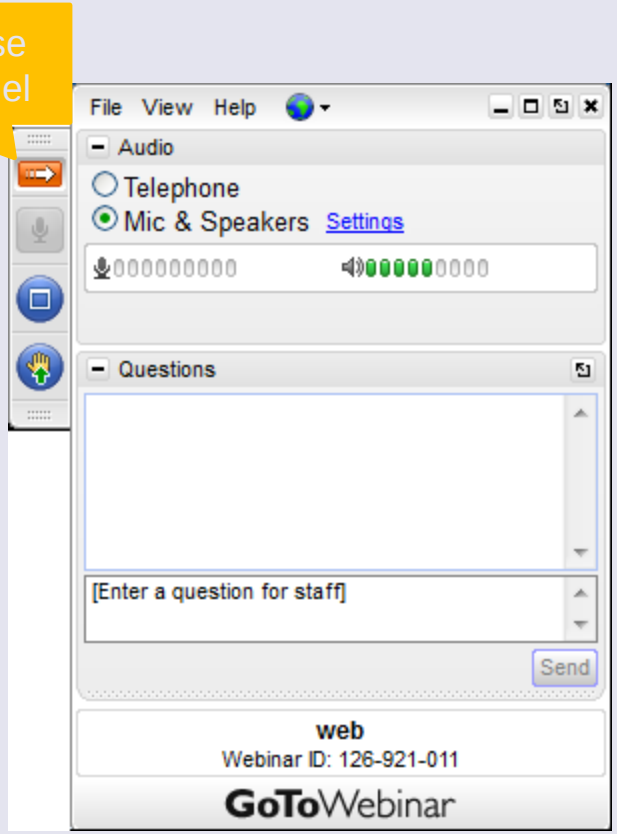
Control Panel

The Control Panel appears on the right side of your screen. Use the Control Panel to ask questions.

Questions will be addressed at the end of the presentation. If your question is not addressed, we will do so by email.



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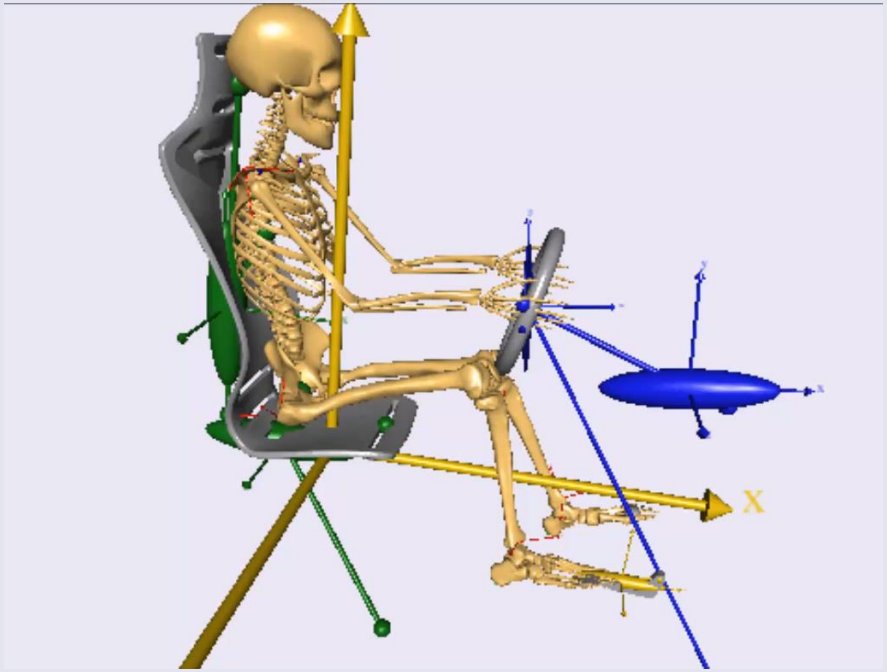
Modeling of population ergonomics with AnyBody

1. The prospective perspective
2. Population modeling
3. Car interior design



jr@m-tech.aau.dk

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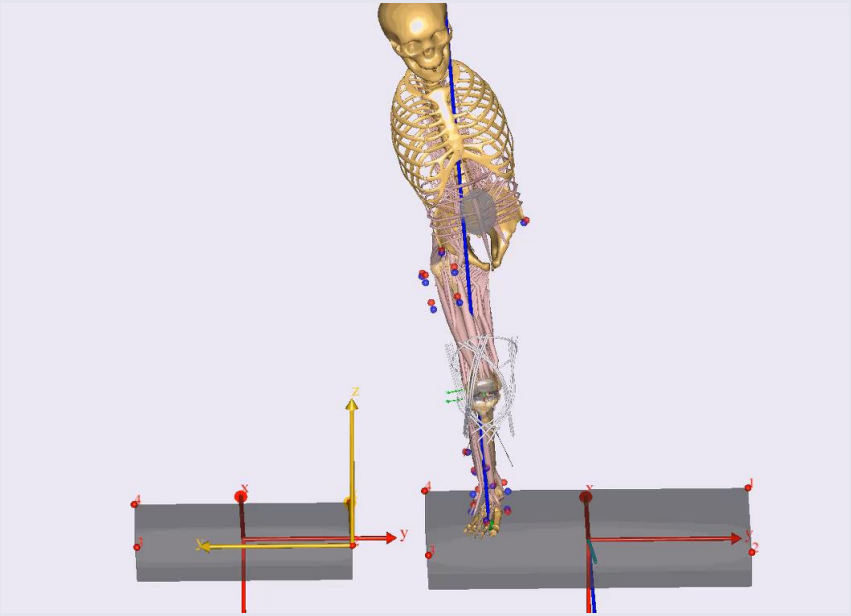
Inverse dynamics – a closer look

- Motion input from motion capture
- Force input from force platforms

Experimental input, i.e. we model something that has already happened.

Analysis is retrospective!



Taping simulation by Kuang-Wei Lin.

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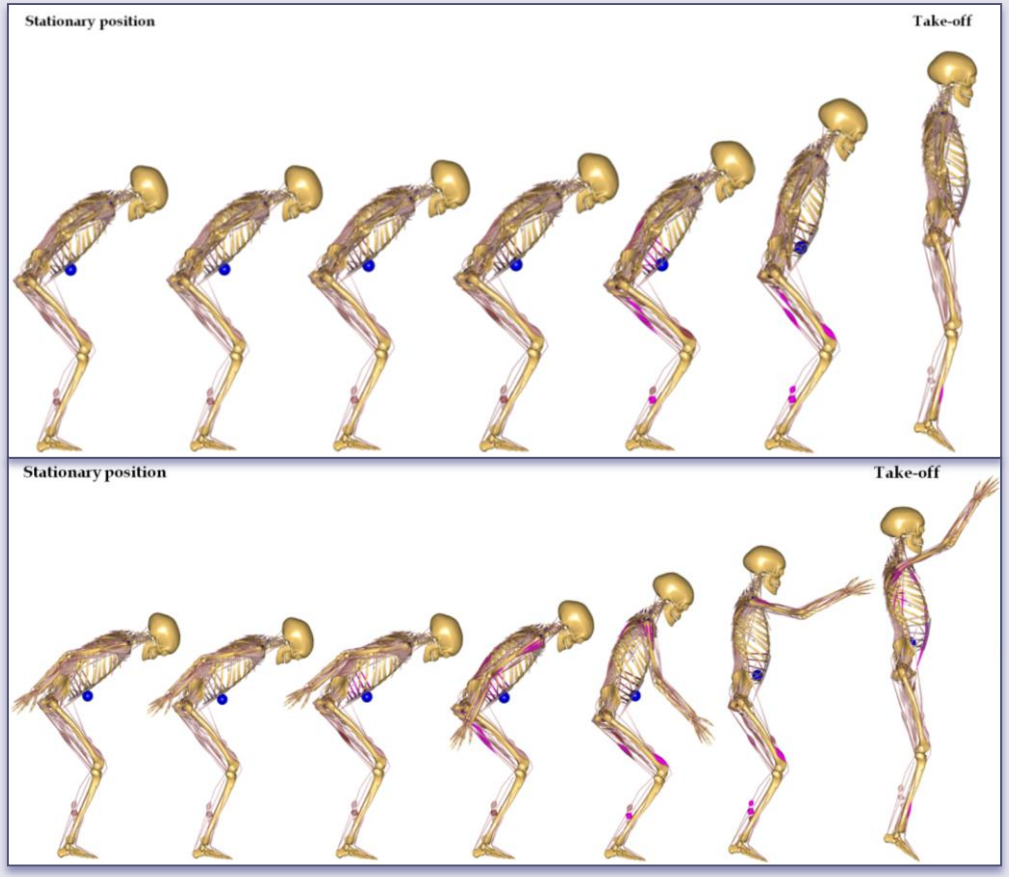
Prospective simulation based on optimization

- Idea: Movement is a function of physiognomy
- Can solve difficult problems
- Problem definition rather complex
- Long computation times



Farahani et al.: Optimization-based dynamic prediction of kinematic and kinetic patterns for a human vertical jump from a squatting position. Multibody System Dynamics (in press).

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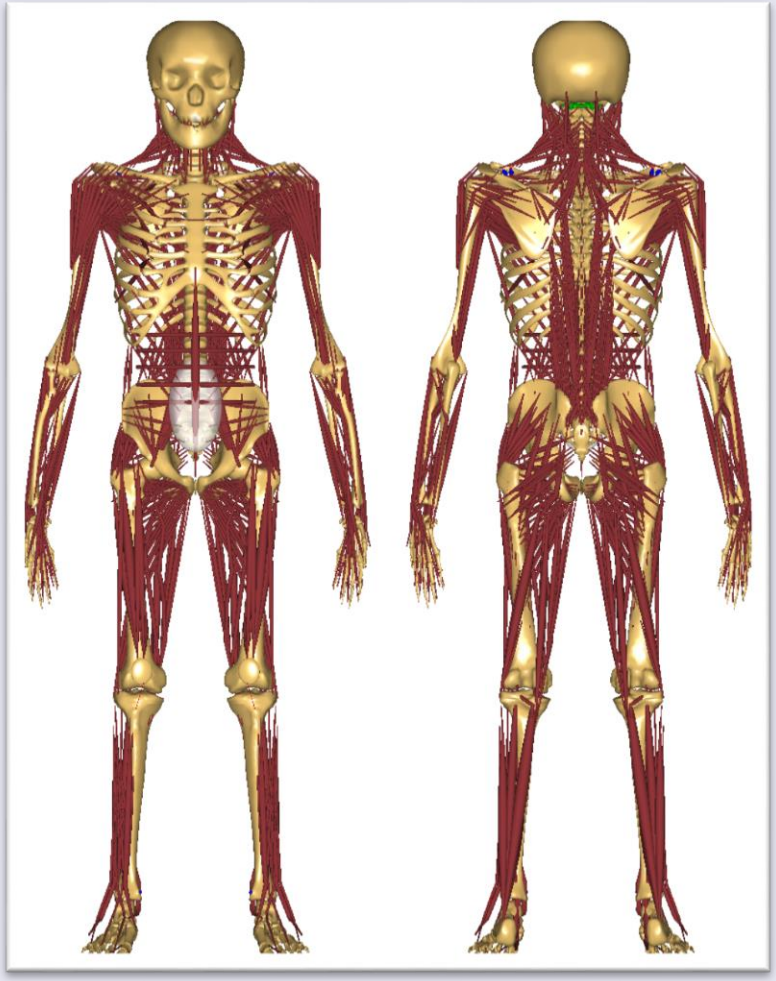
” Man is born free…



- Basic, unconstrained human model
- All degrees of freedom available
- All motions possible

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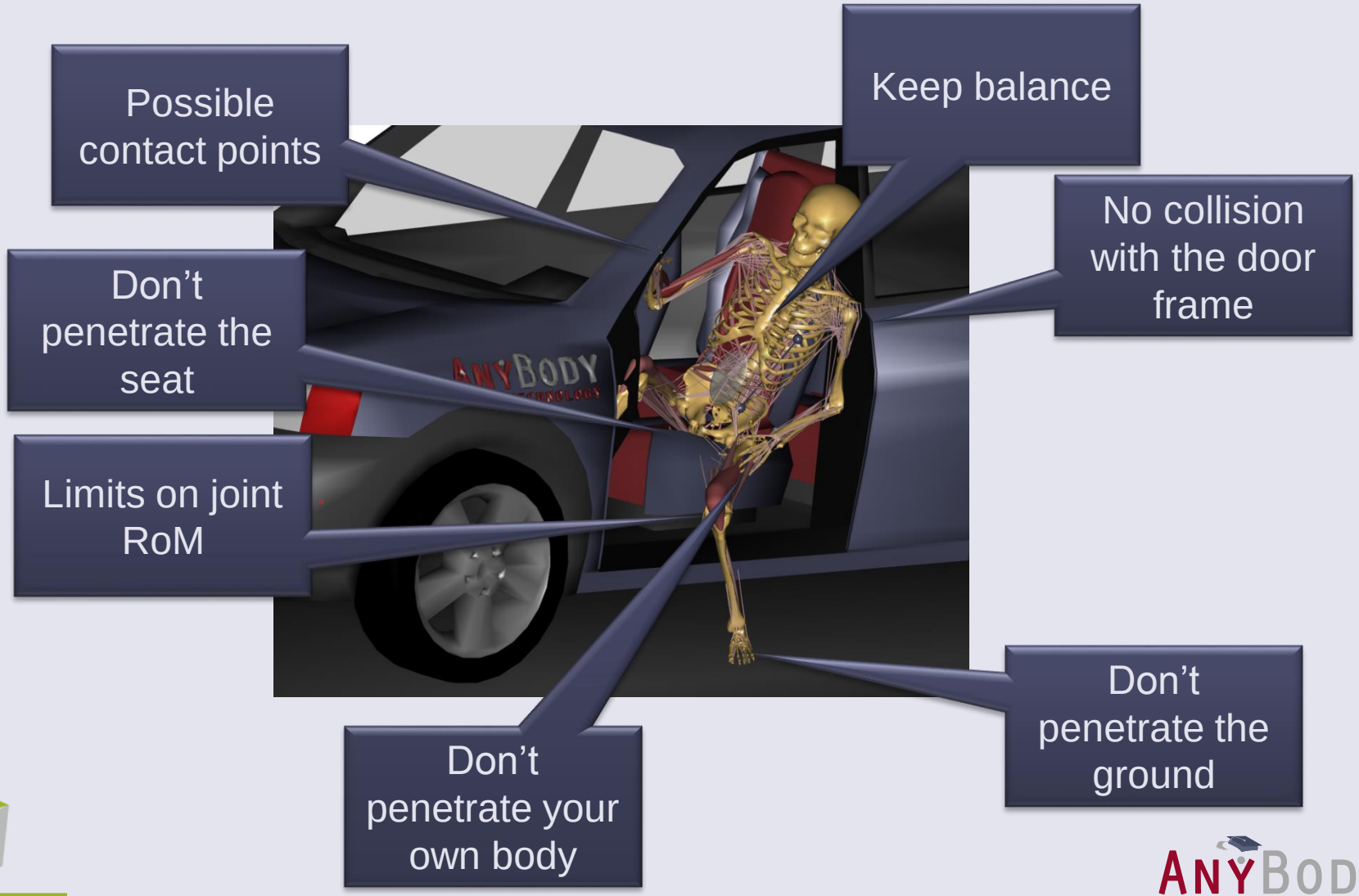
…and everywhere he is in chains”

”L'homme est né libre, et partout il est dans les fers.”
(Jean-Jacques Rousseau)



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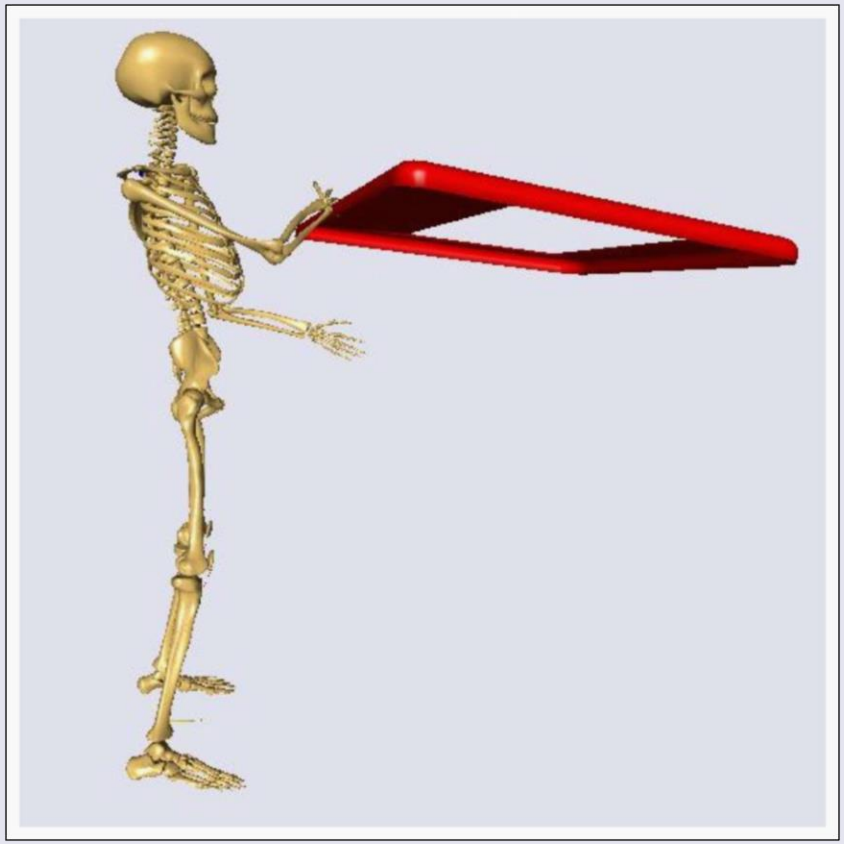
Over-determinate kinematics

- Developed by Michael Skipper Andersen for motion capture input.
- The solution is a compromise between kinematic constraints.
- We can have hard and soft constraints.
- We can add different weights (and weight functions) to the soft constraints.
  - Soft drivers specify basic posture
  - Hard driver ensures balance
  - Hard driver makes the hand reach forward
- Resulting motion is a compromise between these constraints.



ADL idea

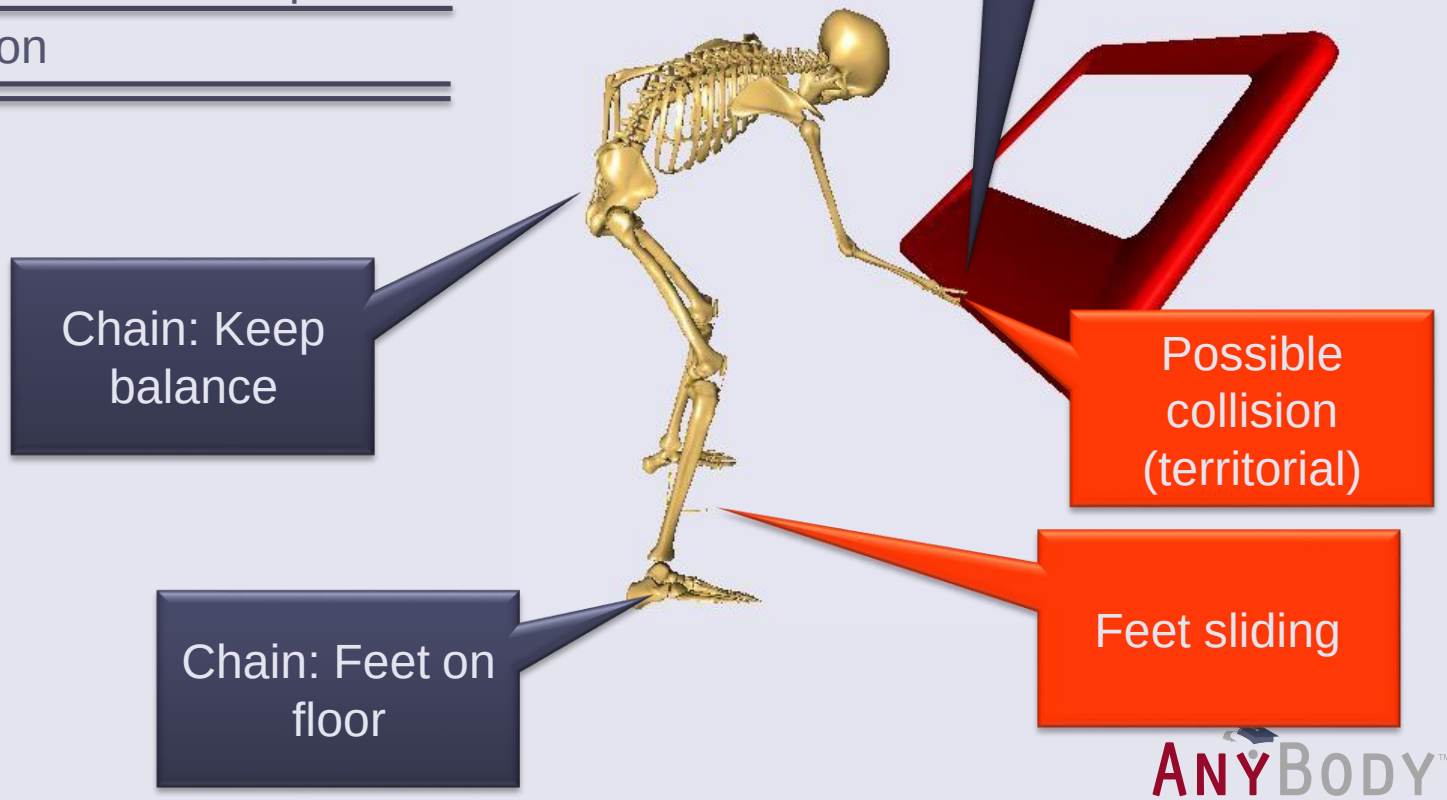
Man is born free

- all of the chains (constraints)

= A little freedom remaining

- reasonable kinematic assumptions

= predicted motion



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Redundant kinematics

Minimize

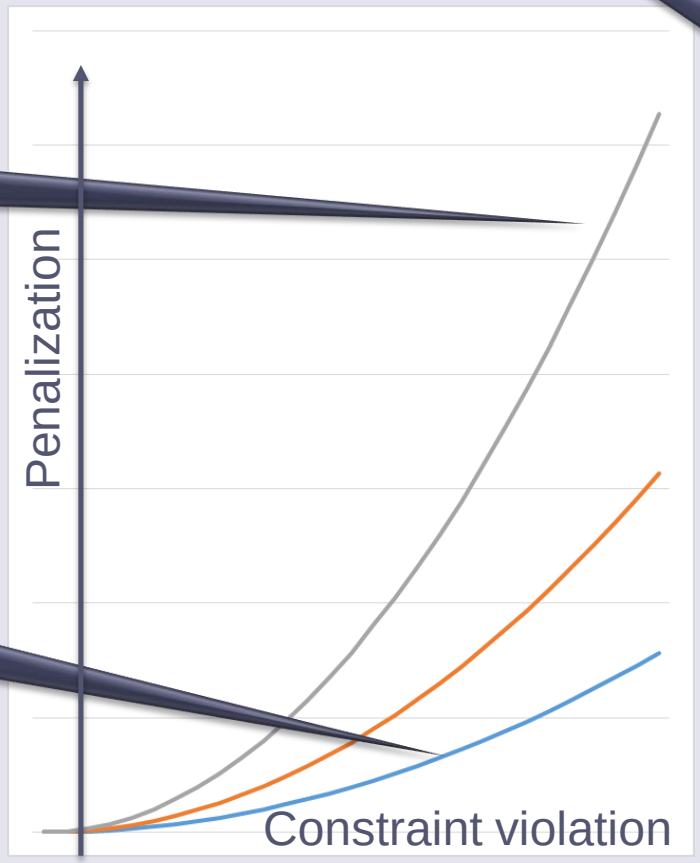
$$G(\Psi(q,t)) = \frac{1}{2}\Psi(q,t)^{\mathrm{T}} W(t)\Psi(q,t), \qquad (10)$$

M.S. Andersen et al.

Large, constant W

Small, constant W

Notice: W can be a function



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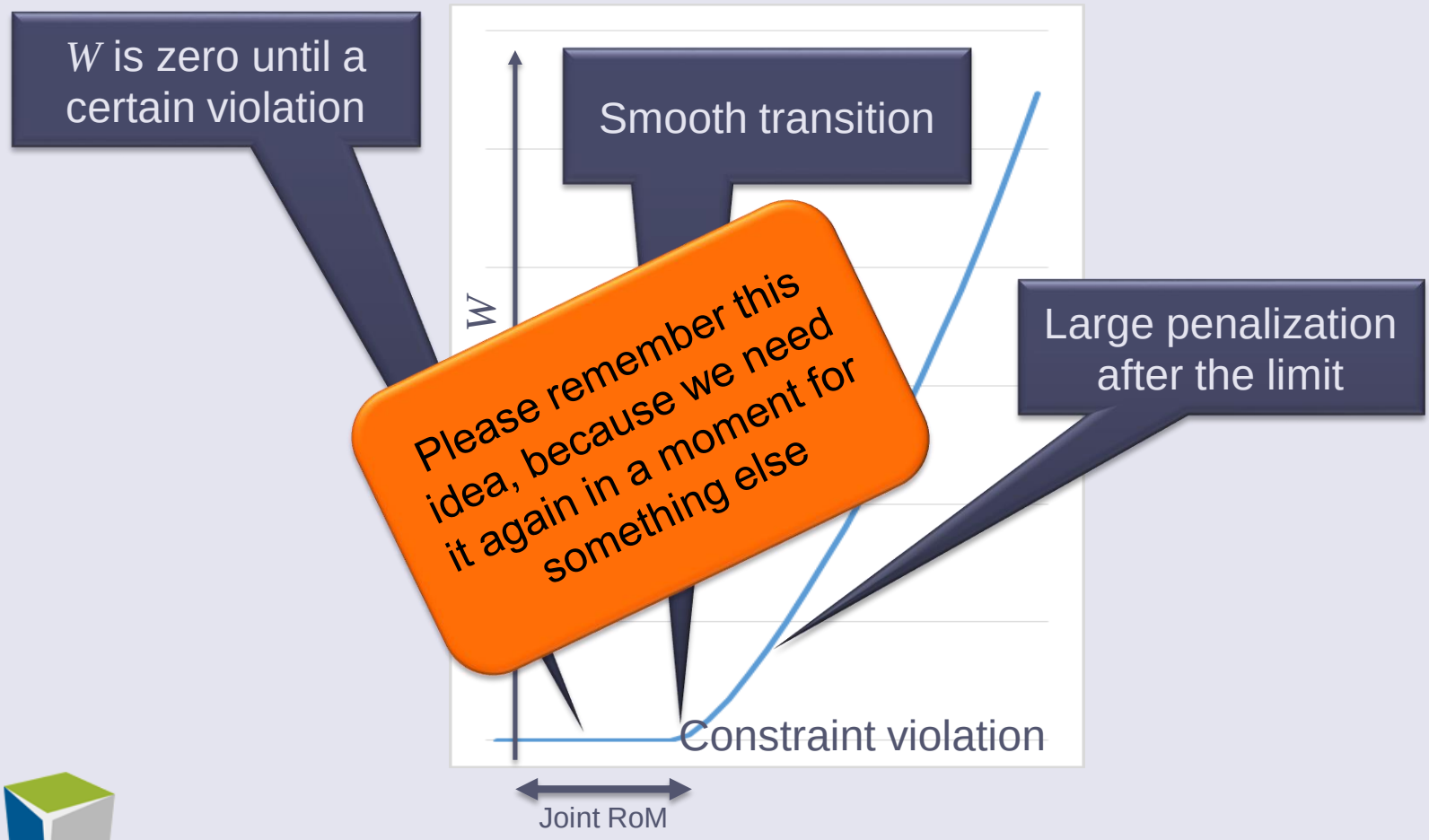
Weight function for territorial constraints



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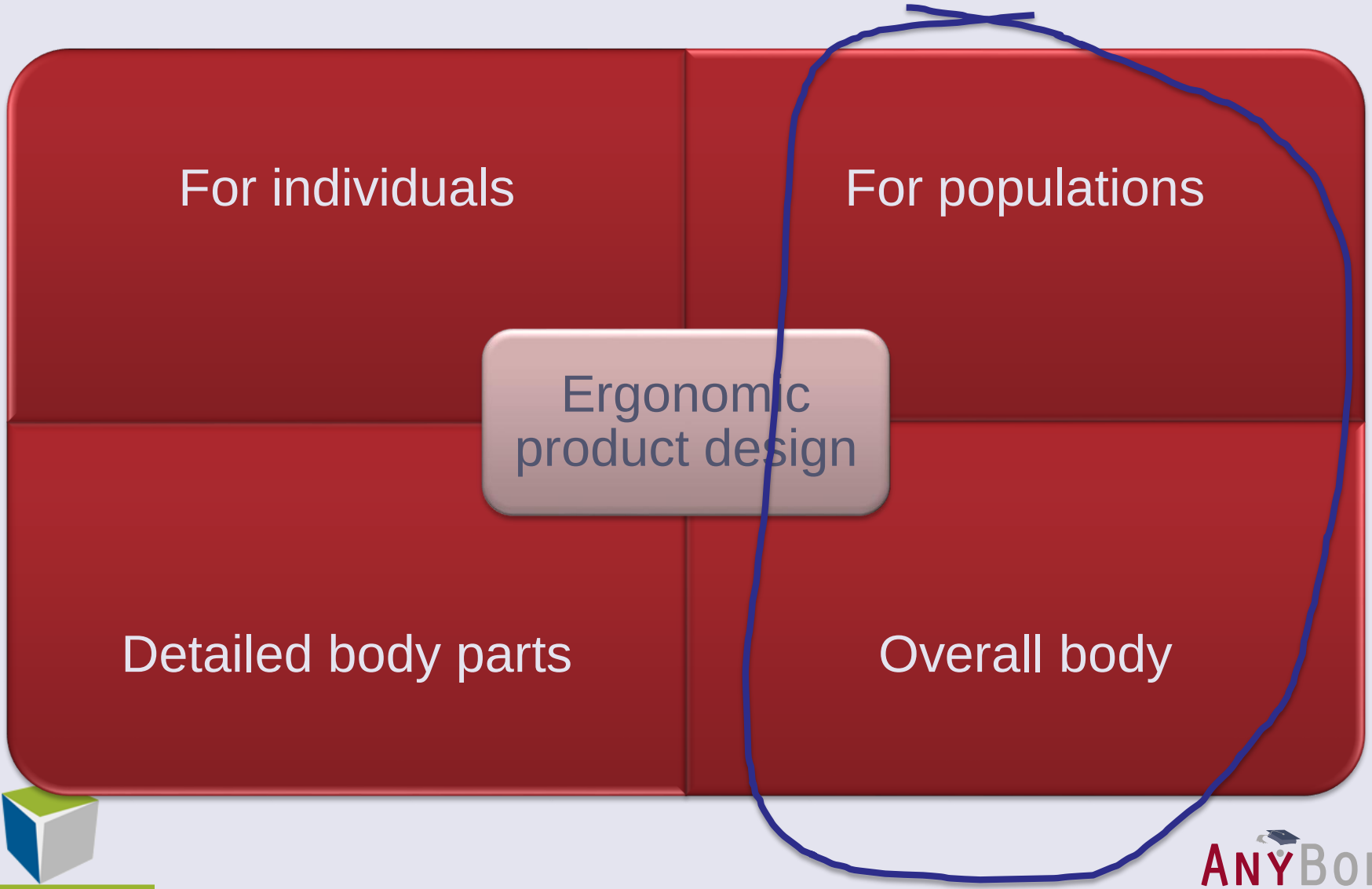
2. Population modeling



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Applications for population modeling

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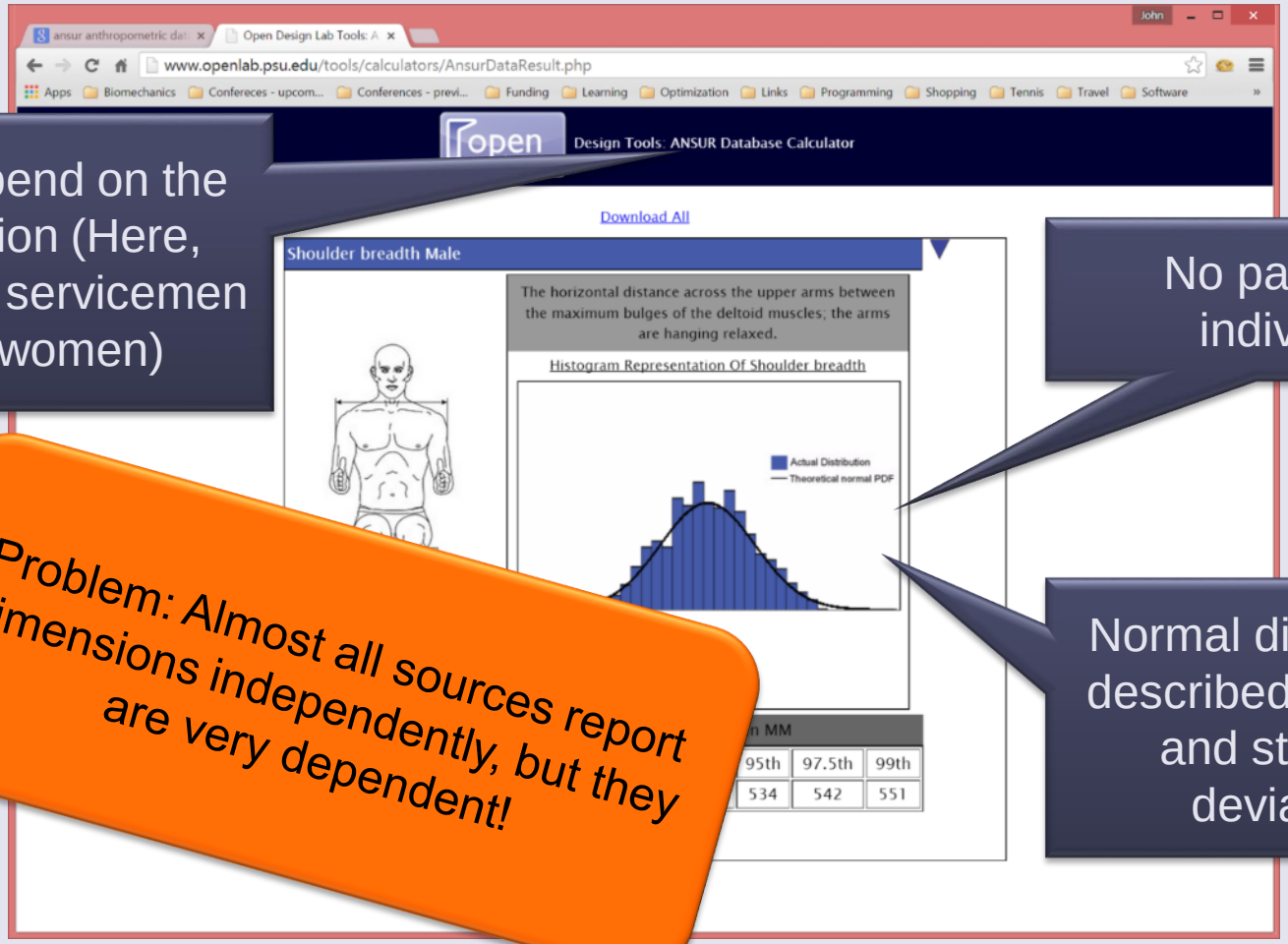
Anthropometric data sources

Many different sources, for instance:

- ANSUR – American servicemen and – women, 1988.
- NHANES – Large number of subjects but few variables.
- DINED – Dutch database
- AdultData – British, paper version only.
- NASA – American
- AIST – Japanese, 1998.
- DinBELG – Belgian, 2005

Data generally looks like this



Data depend on the population (Here, American servicemen and –women)

No particular individual

Problem: Almost all sources report dimensions independently, but they are very dependent!

Normal distributions described by means and standard deviations

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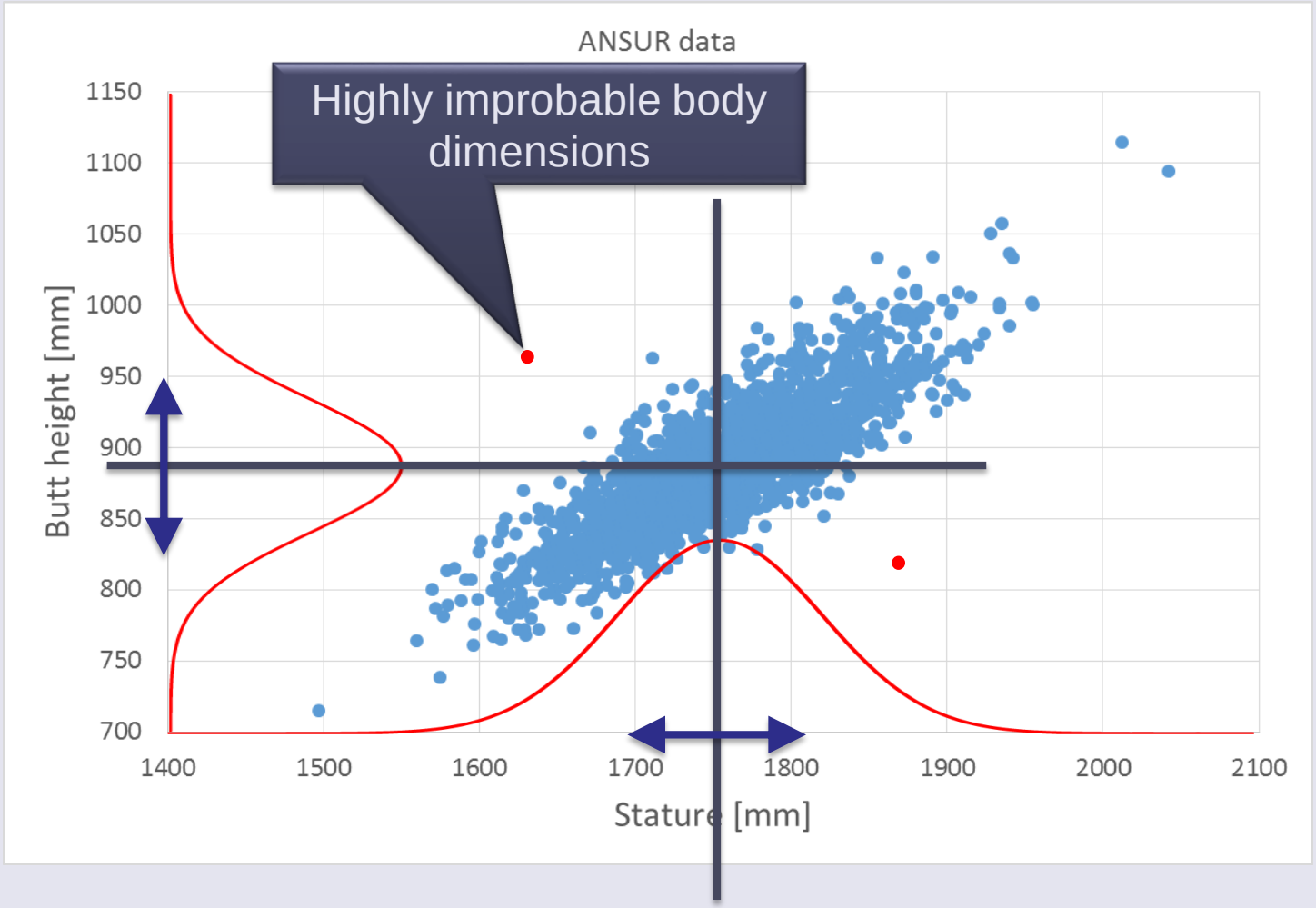
Dependent data



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Two selected solutions to this problem

Parkinson, M.B., Reed, M.P., 2010. Creating virtual user populations by analysis of anthropometric data. Int. J. Ind. Ergon. 40, 106–111.

- Principal Component Analysis (PCA)

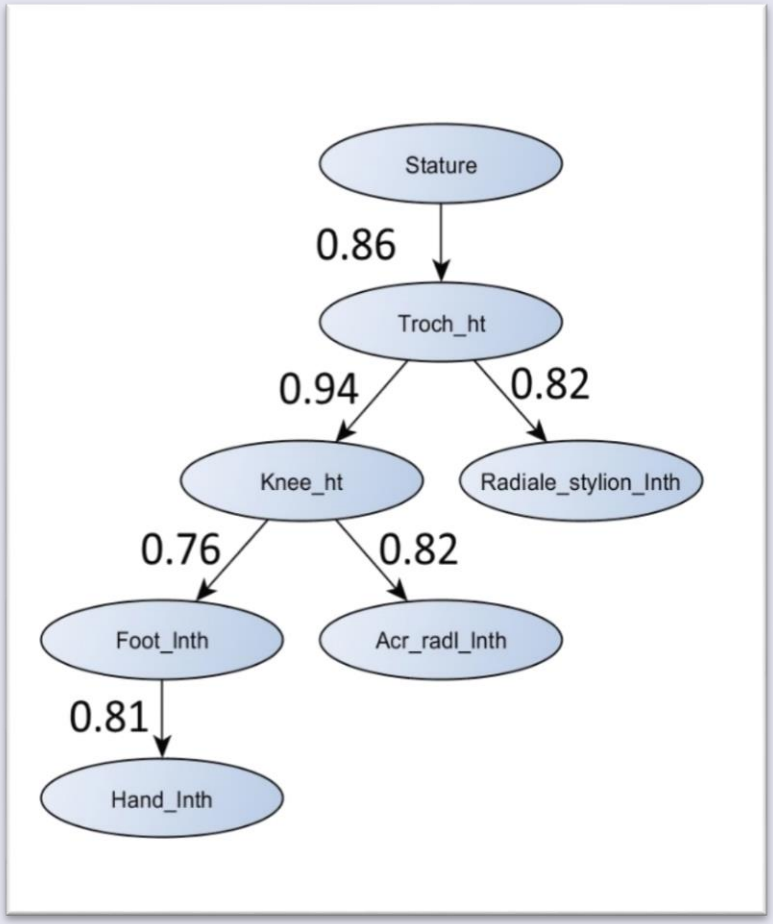
Jung, K., Kwon, O., You, H., 2009. Development of a digital human model generation method for ergonomic design in virtual environment. Int. J. Ind. Ergon. 39, 744–748.

- Hierarchical correlations

Based on raw data!

Allows correlations from raw data to be superimposed on other data sets.

Implementation of the method of Jung et al.



- Correlations mined out of the ANSUR database
- Stature is stochastic input
- Troch_th is stochatically generated from stature
- Knee_ht is stochastically generated from Troch_ht
- Etc.

This results in a stochastic population within the variation of the ANSUR set but scaled to the stature of another population.

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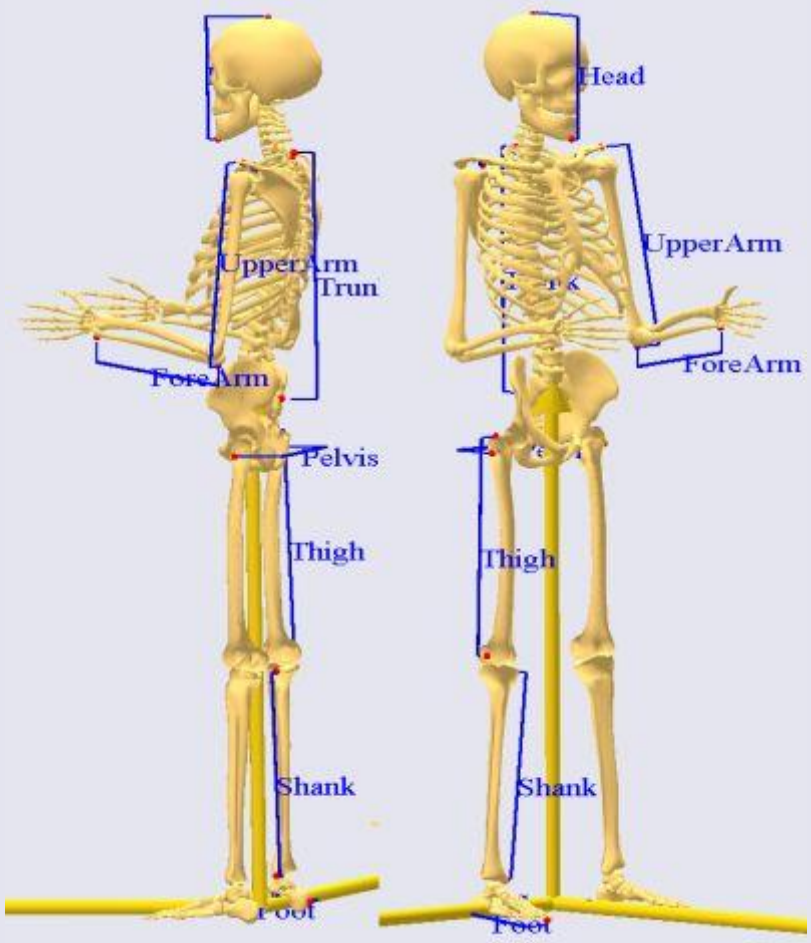
AnyBody Scaling

- Developed from the standard bony landmark scaling in AnyBody.
- Input parameters changed to the parameters of the data base in question.
- We can now randomly generate AnyBody models corresponding to a given population statistics.



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Please remember

1. Posture prediction with redundant kinematics.
2. Territorial kinematic constraints by tailor-made penalty functions.
3. The ability to make population statistics.

3. Car Interior Design

- Small Danish electrical car producer: http://ecomove.dk/
- Unconventional cabin layout.
- Unsuccessful use of traditional digital manikins.

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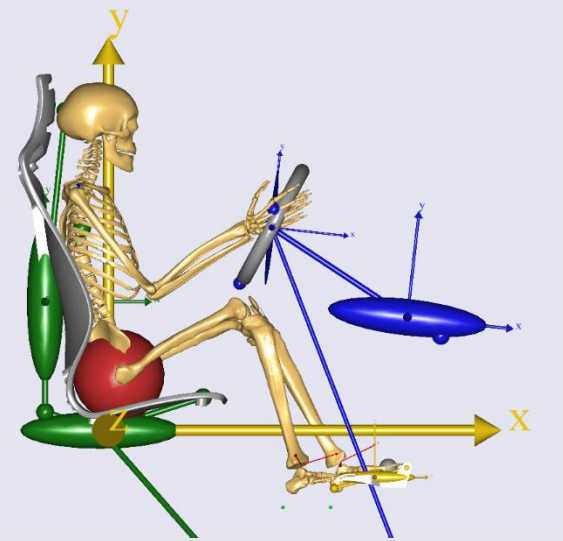
Ecomove package design
(Kasper Pihl Rasmussen)



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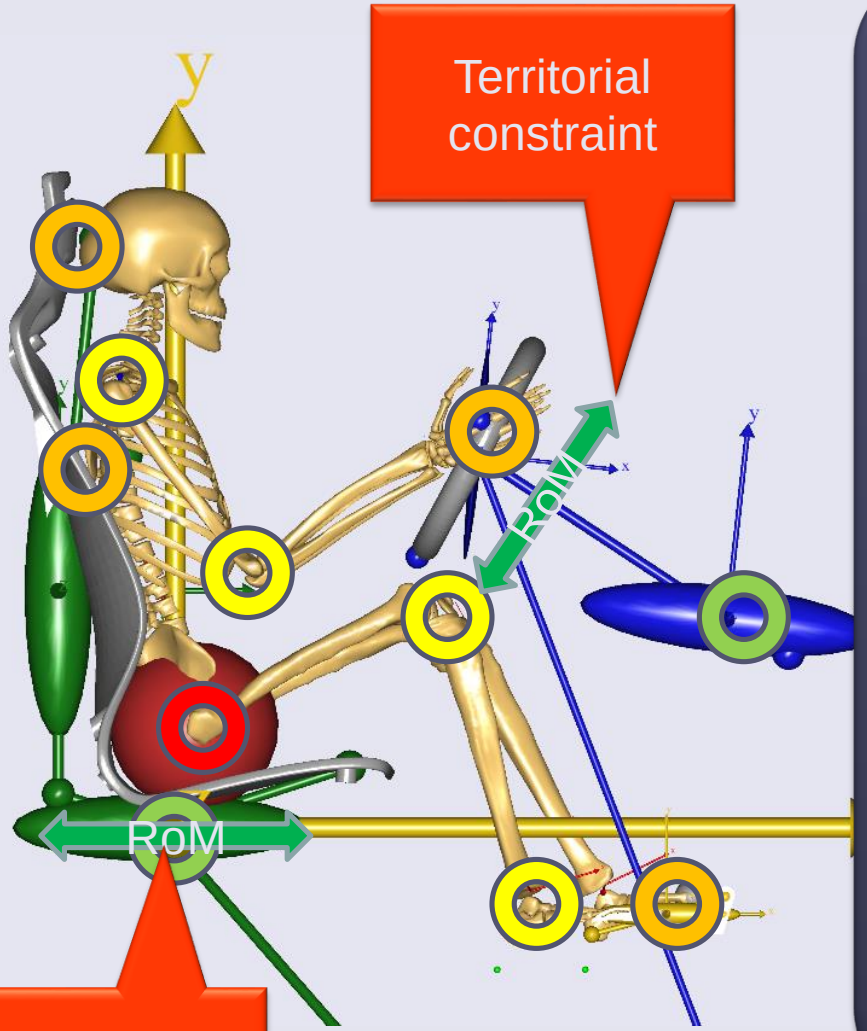
Hard constraint

Soft constraint



- Anthropometrical dimensions statistically varied to produce 16,000 different models.
- Each model placed according to soft and hard constraints.
- Territorial constraints (seat and steering wheel) attain preferred values within RoM
- Comfort = constraint violation

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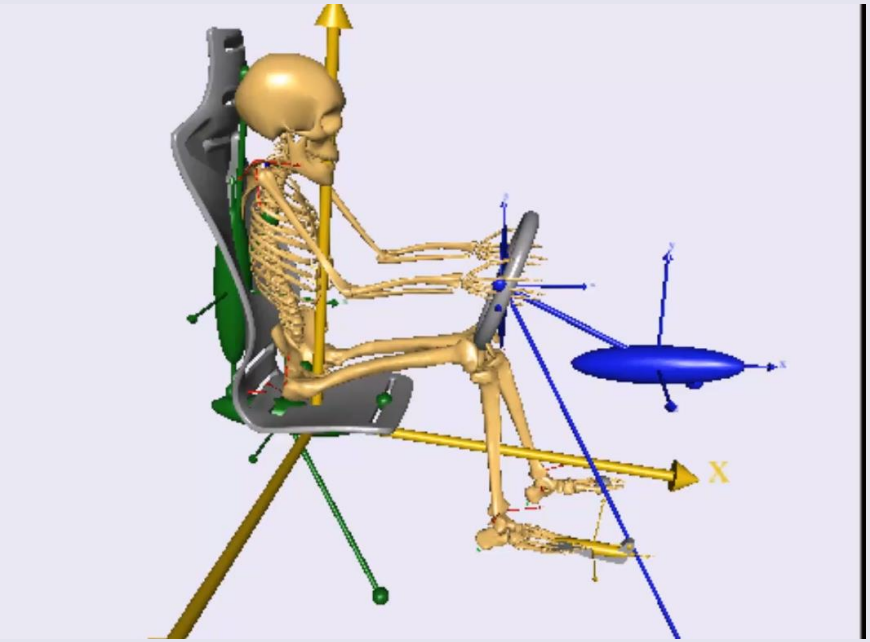
Result for suggested layout



- All subjects prefer the seat in the back-most position.
- All subjects prefer the steering wheel low.

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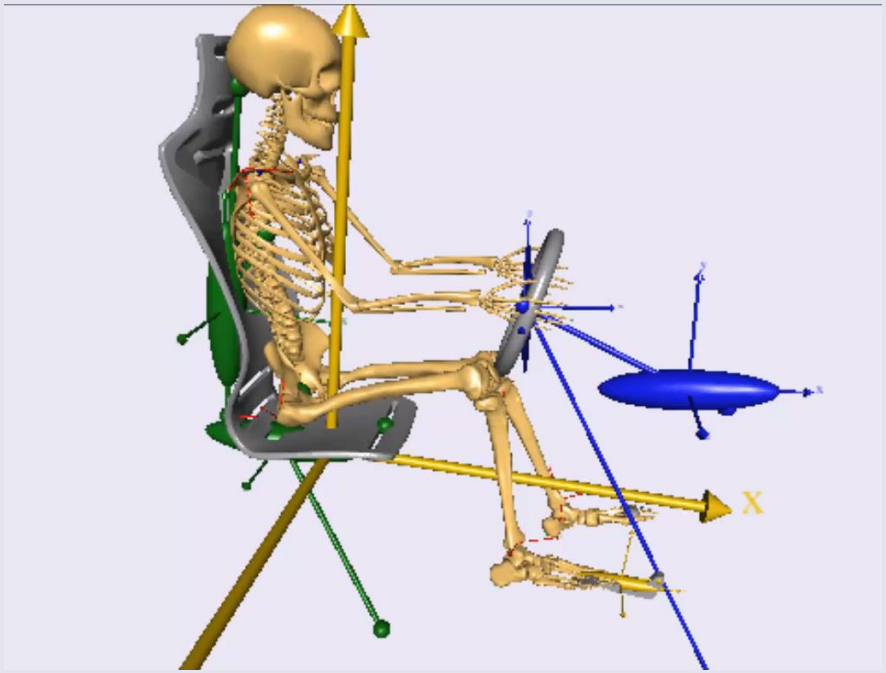
Result for with seat rail 7cm back



- Variation in seat position with anthropometry
- All subjects still prefer the steering wheel low.

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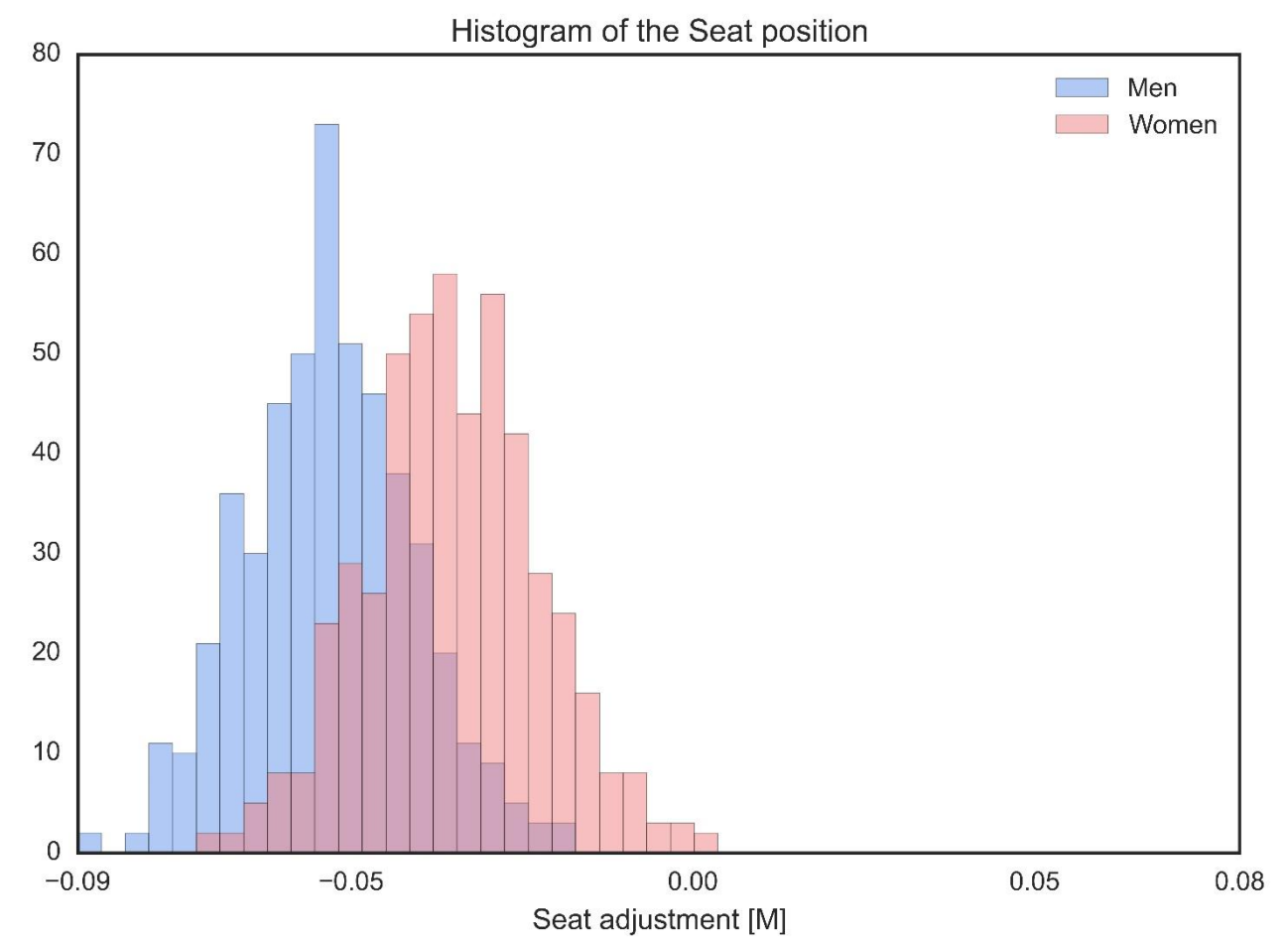
Resulting seat positions



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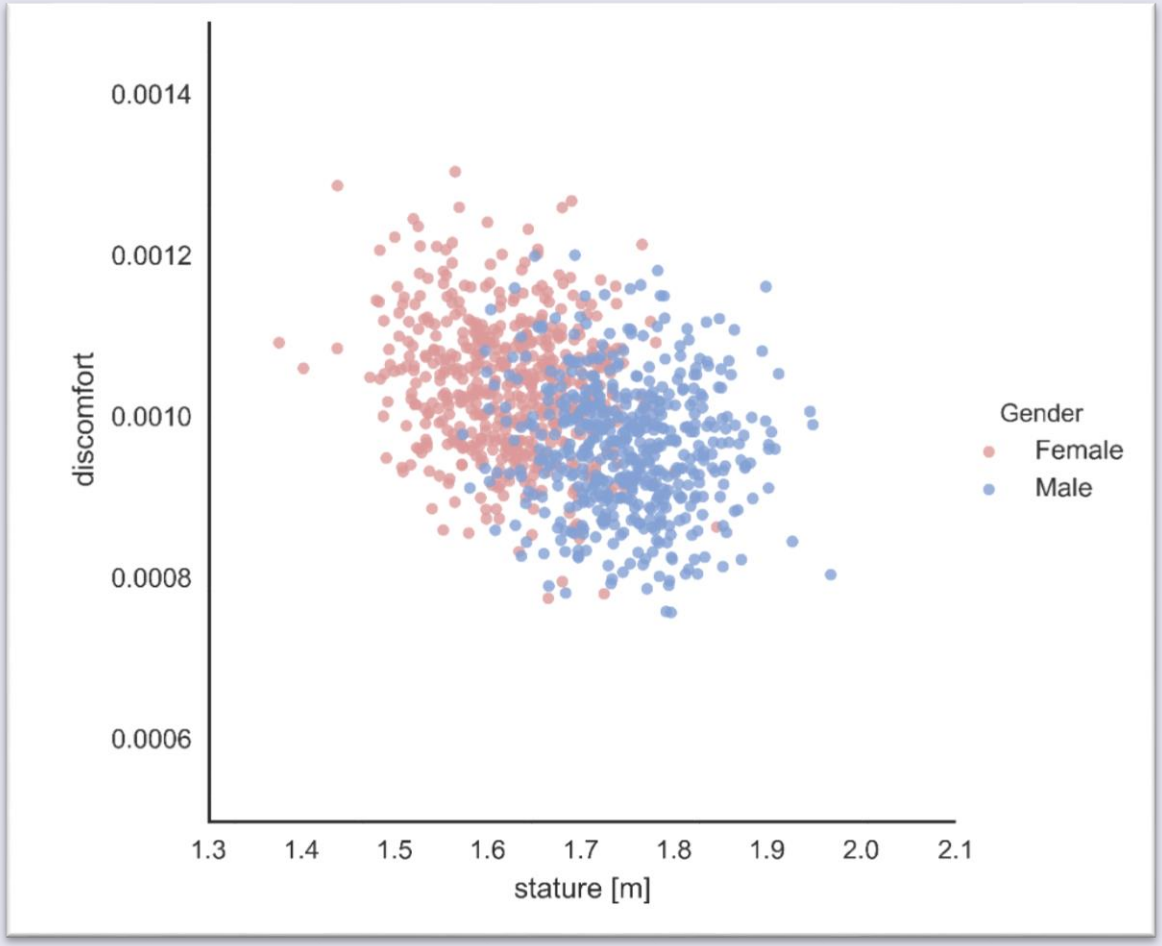
Discomfort in terms of stature



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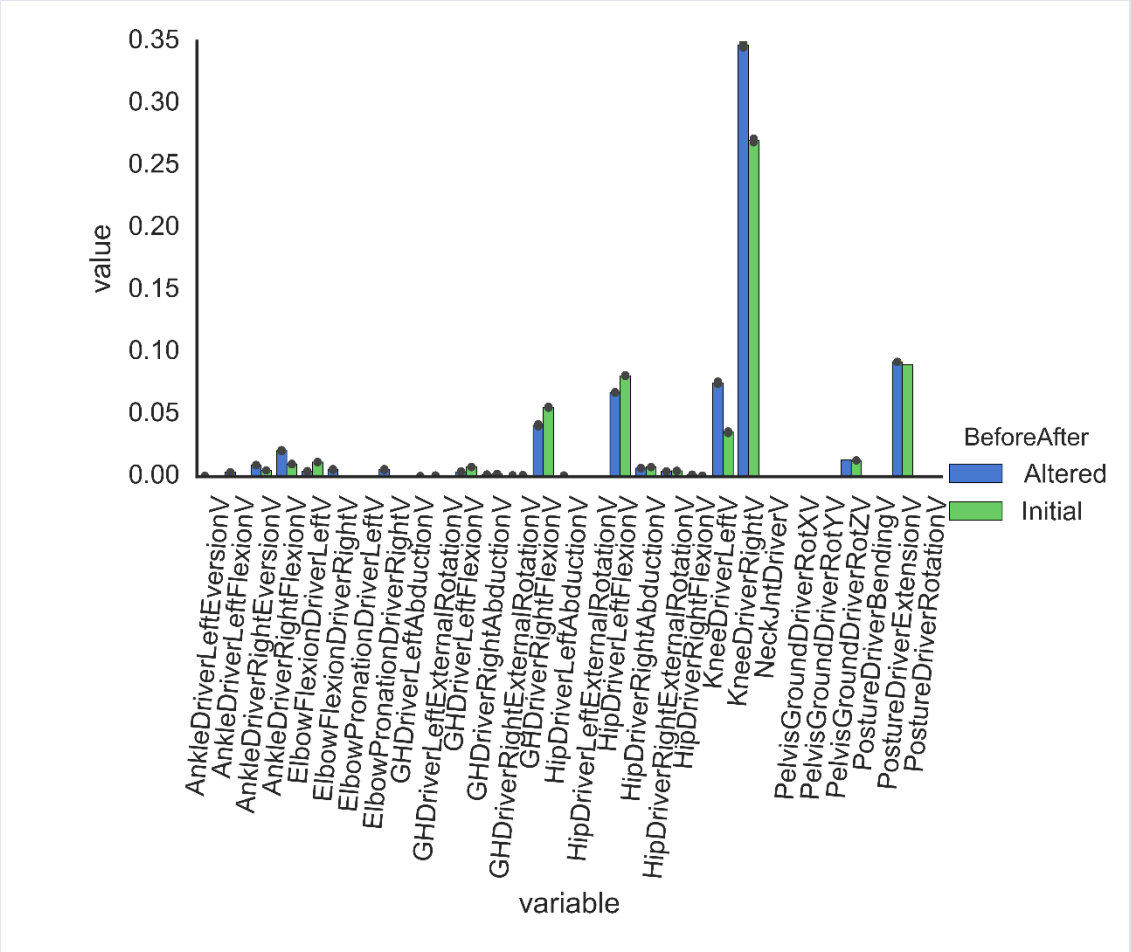
Sources of discomfort



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Methods

- Redundant kinematics to predict reasonable postures and motions.
- Special weight functions to model territorial constraints (range-of-motion and collisions).
- Population statistics to randomly generate *n* different models.

Methods (cont'd)

- We need anthropometric raw data, for instance from ANSUR.
- We need current data for our local population.
- Statistics implemented in Python and hooked up with AnyBody (Morten Lund's webcast on 30 June (signup open).

Results

- We can investigate ergonomic design problems like car interior design.
- Like building your own digital manikin in AnyBody.
- Using data of your choice.

Upcoming webcast

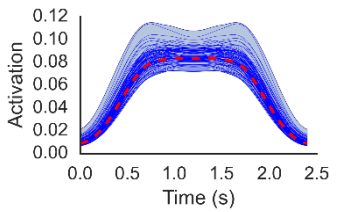
- Introduction to the macro commands
- Show how AnyBody can be used from Python
  - For existing Anybody users
  - No experience with the Python programming language is required.


```
from anypytools import AnyPyProcess
app = AnyPyProcess( )
macro = ['load "Knee.any"',
         'operation Main.MyStudy.Kinematics',
         'run',
         'exit']

app.start_macro(macro);
```

```
[**********100%**********]  1 of 1 complete

Total time: 0.6 seconds
```



30th of June 2015

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More prospective modeling

Michael Skipper Andersen has won the prestigious Sapere Aude grant.

Project on outcome prediction of TKA.

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Who can help you?

- Morten Lund's Webcast
- AnyBody Technology consultants
- Kasper Pihl Rasmussen is available on the job market ☺.

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