AnyBody 8

NEW FEATURES AND MODELS

NEW ANYBODY

Topics

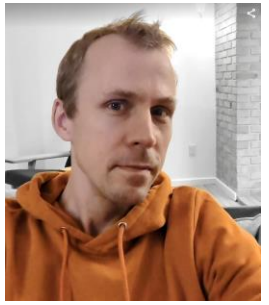
- New AnyBody 8
- New model repository (AMMR 3)
- Full thoracic models and public AMMR 4 on GitHub
- Questions…

Presenter

Morten Enemark Lund

Engineer

AnyBody Technology



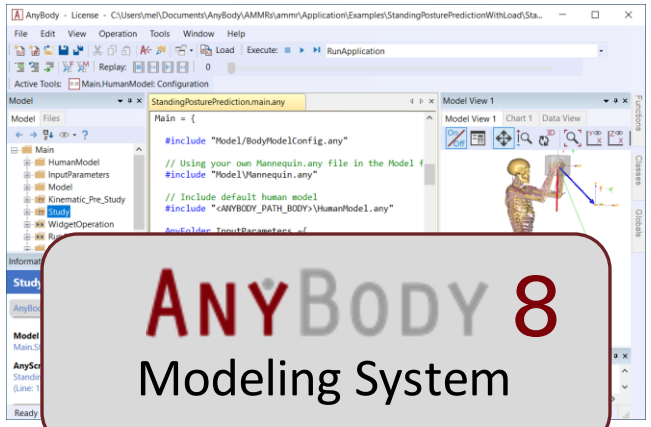
Panellist

Kristoffer Iversen

Head of Sales

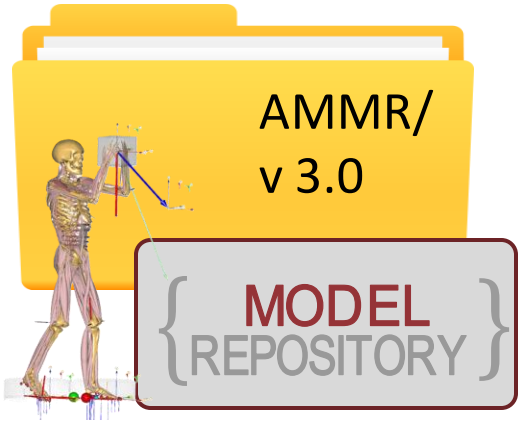
AnyBody Technology

New Release: AnyBody 8

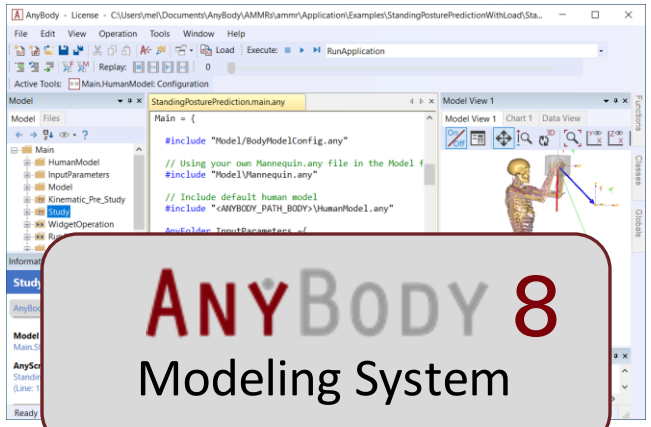


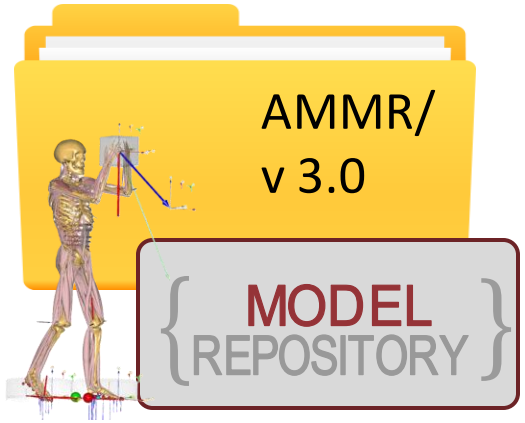
AnyBody 8
Modeling System

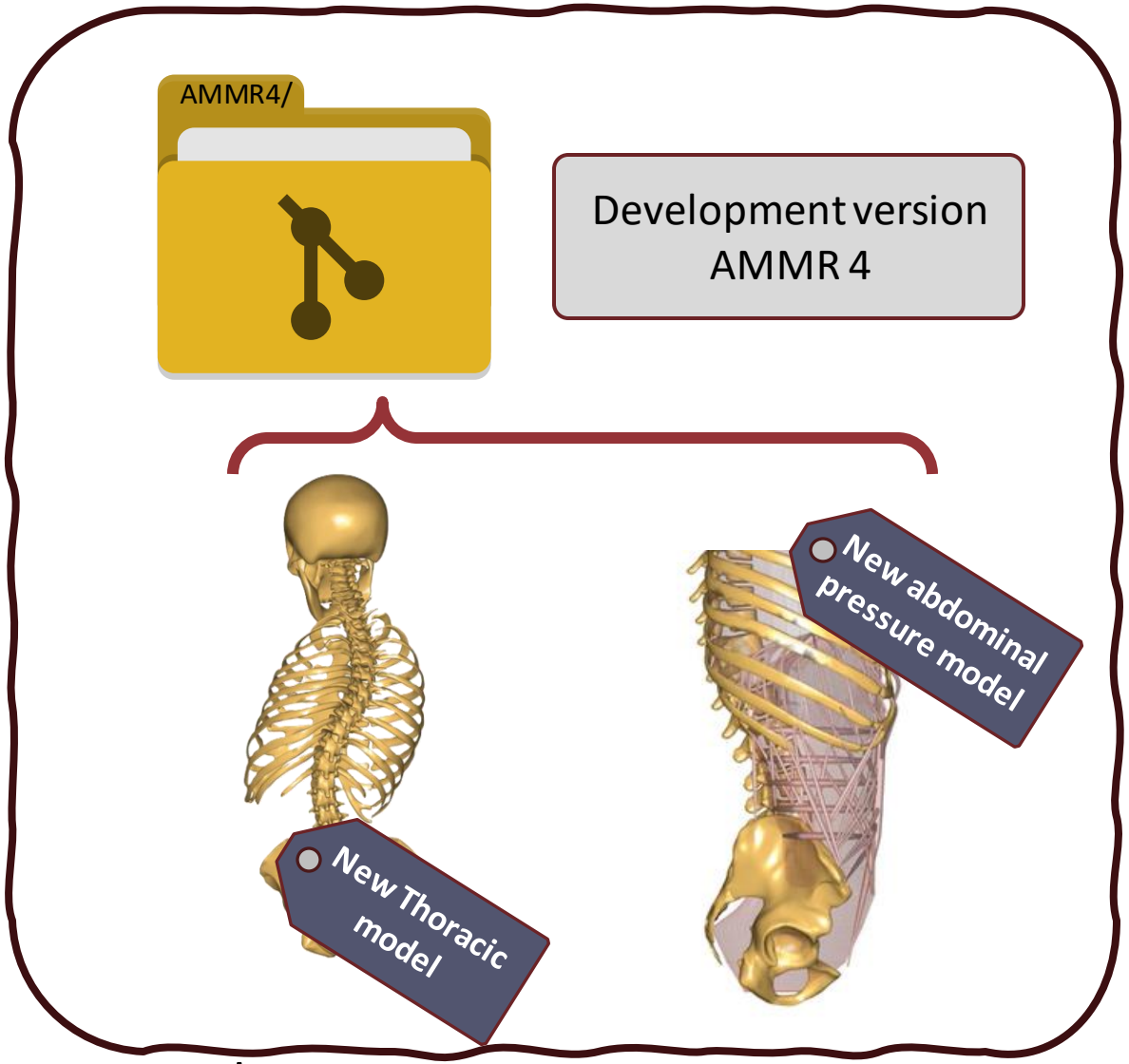
Version 8.0.1



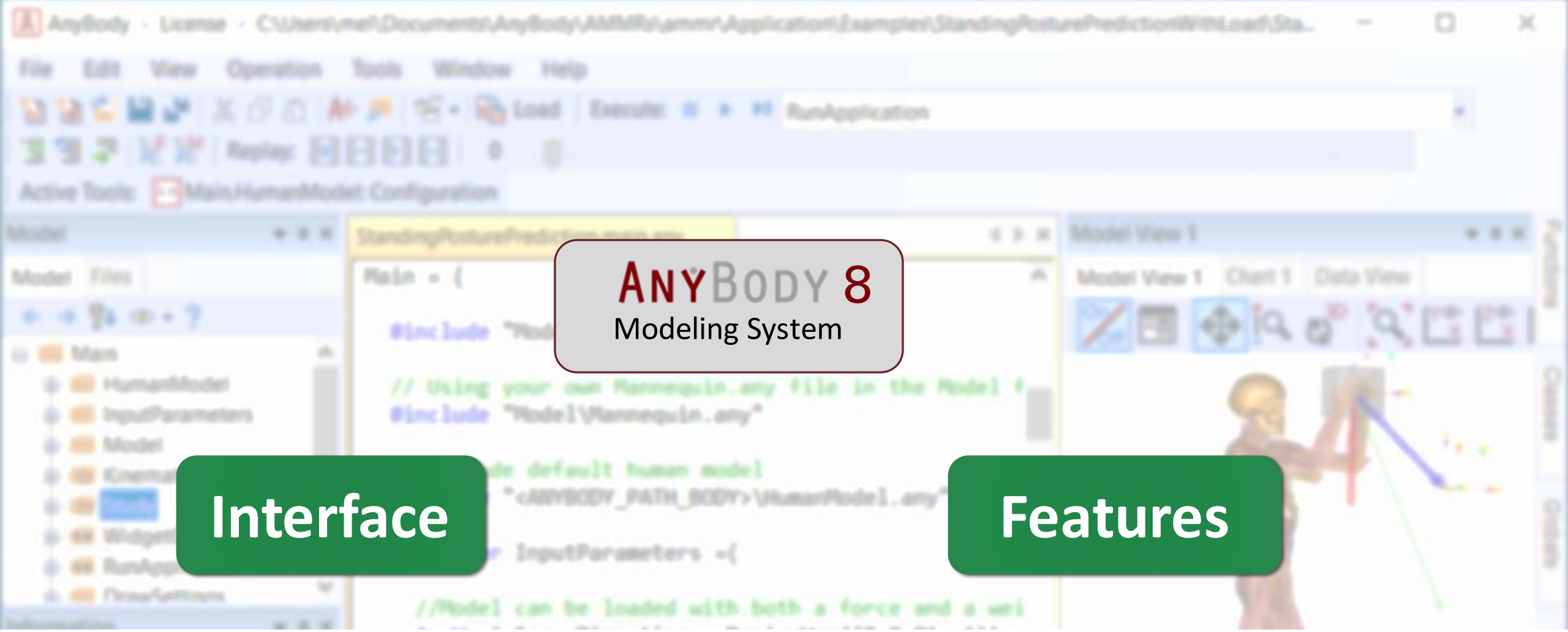
New Release:







Online resources: github.com/anybody

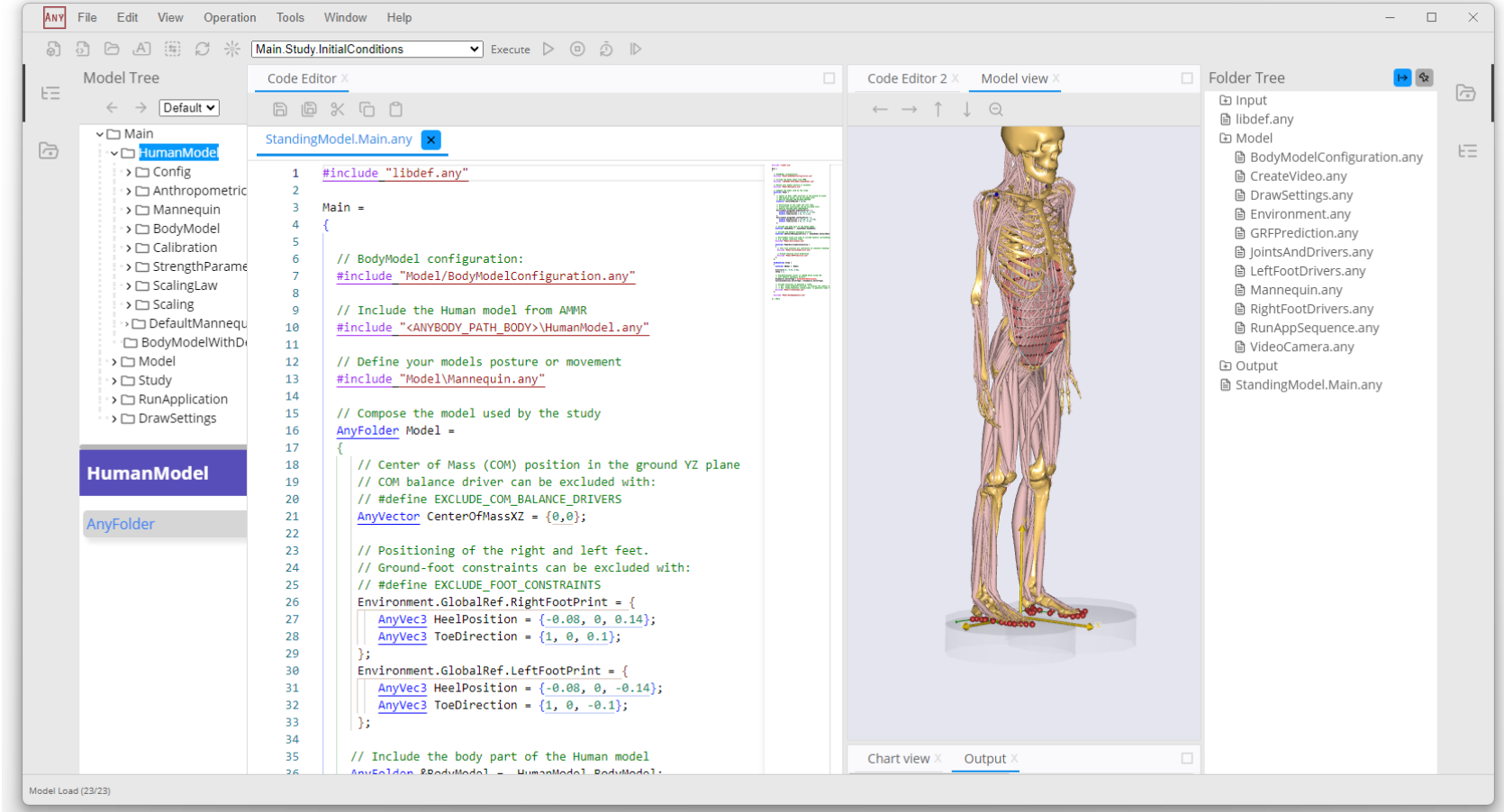


AnyBody Modeling System

✨ Highligts in Version 8

User Interface - Highlights

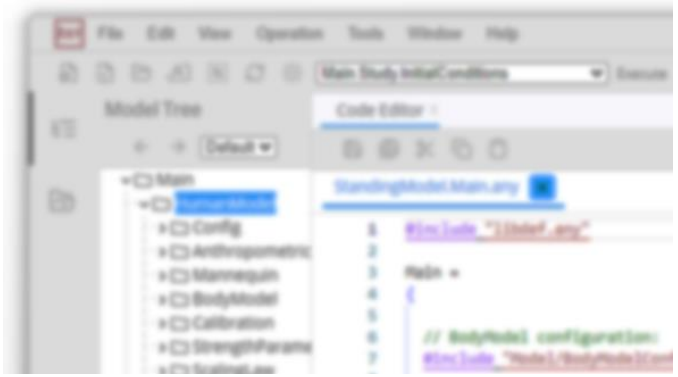
Only minor GUI changes



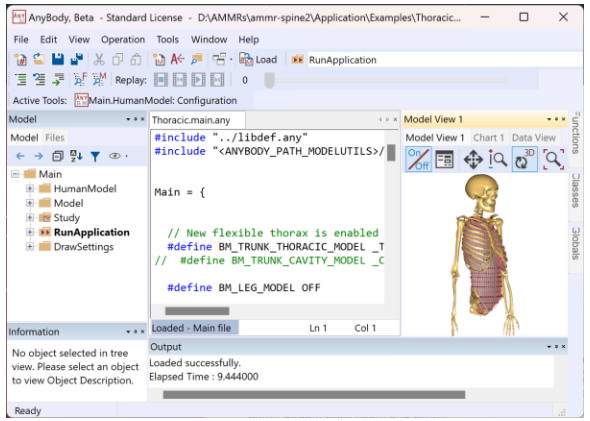
Teaser: New user interface in AnyBody 9

User Interface - Highlights

Only minor GUI changes

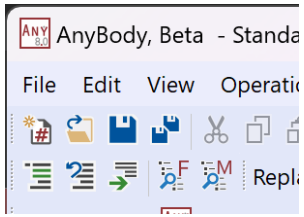


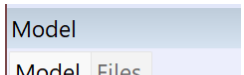
Teaser: New user interface in AnyBody 9

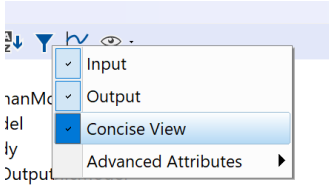


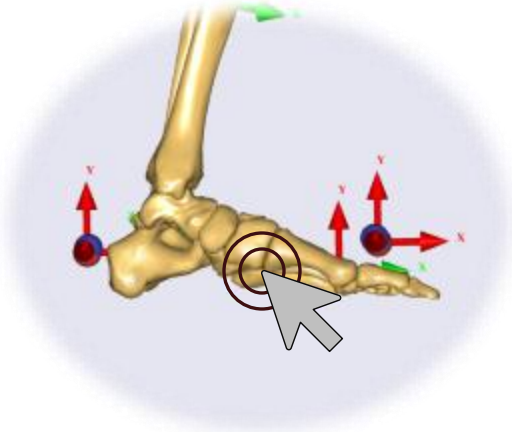
AnyBody 8 looks mostly the same

A few new buttons:









New Model view Interactions:

- CTRL+DoubleClick: Center view
- Shift+DoubleClick: Zoom and center

User Interface - Highlights

Only minor GUI changes

AnyScript

✨ Trailing commas in lists

✨ Class template imports

- Trailing commas now allowed in AnyScript

```
AnyString MyList = {
   "elem1",
   "elem2",
   "elem3",
};

AnyString Segments = arrcat(
   {"Humerus","Ulna", "Radius"},
   {"Scapula","Clavicula"},
);
```

In vectors, matrices and lists

In function arguments

- New features for Class templates
  - No longer restricted to outside `Main={` scope

```
#include "MyModelTemplates.any"

MyModelTemplate Model( ) = {
// ...
};
```

  - Much easier to reuse code with class templates

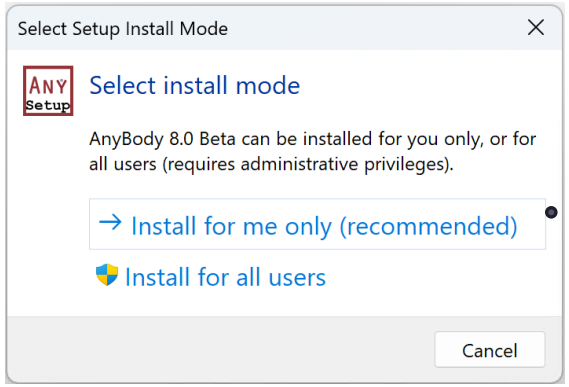
User Interface - Highlights

Only minor GUI changes

AnyScript

✨ **New Installer**

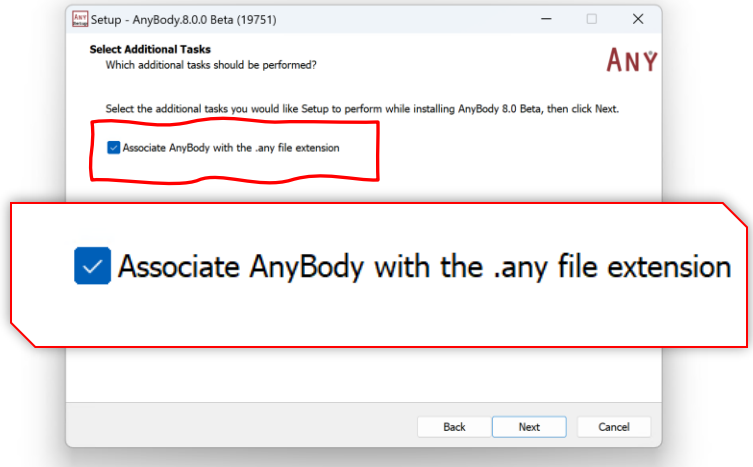
AnyBodySetup.8.0.1.exe

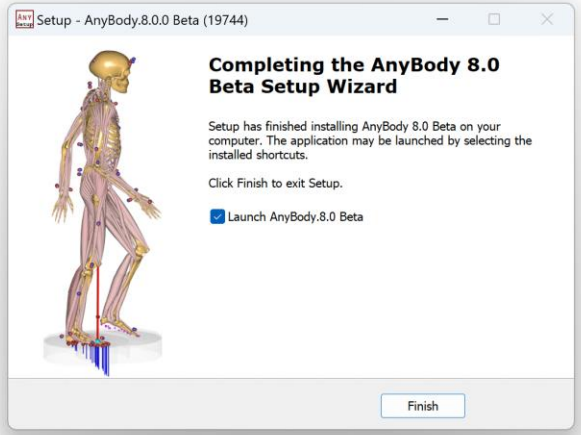


No need to call IT

✨ Much faster install/uninstall

✨ Silent installations



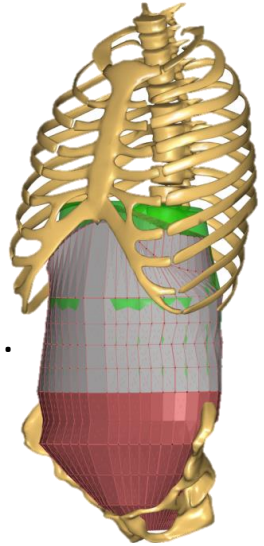


New features in AnyBody 8

- Better Performance:
  - Faster load times
  - Faster model simulation times
  - Much more robust FDK simulations

- New Advanced Features for Body Modeling
  1. Fatigue/metabolism modeling support
  2. New Inertia Objects based on Geometries
  3. New Volume kinematic measure

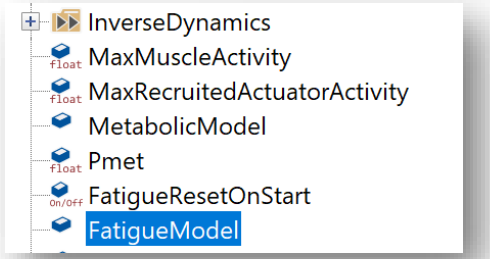
3.



2.

```
AnyInertiaSolid BoneInertiaObject = {
  AnySurfSTL surface = {
    FileName = ..BoneDraw.FileName;
    AnyFunTransform3D &scale = ..Scale;
  };
};
```

3.



Feature: Splitting Recruited forces

- Recruited forces are the foundation of AnyBody
- All Recruited forces were modelled as “muscles”

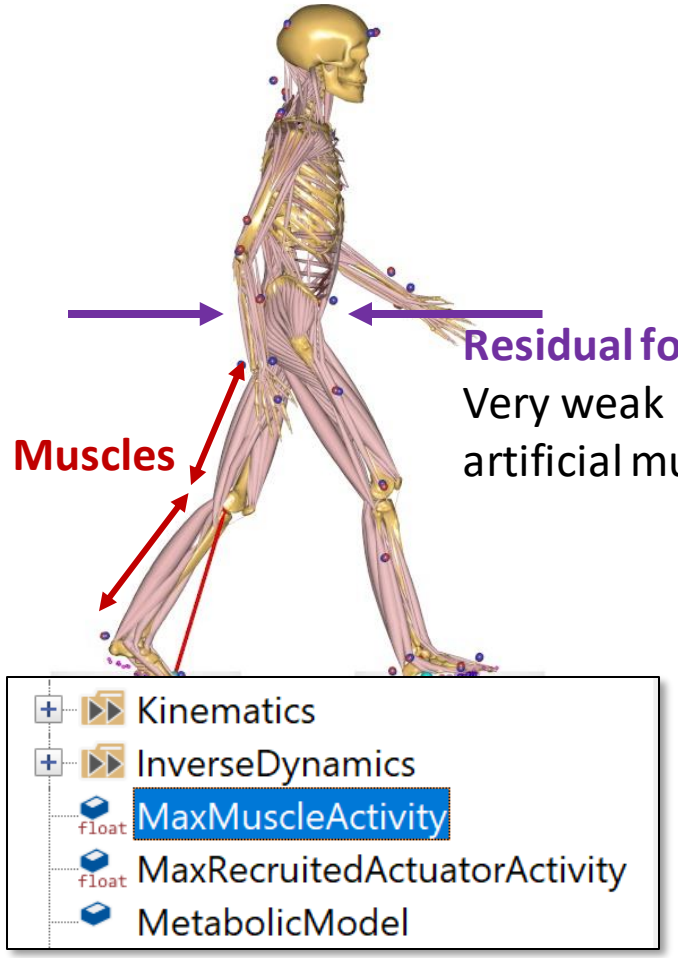
New in AMS 8:

- Distinction between real and artificial muscles

`AnyRecruitedActuator` ≠ `AnyMuscle`

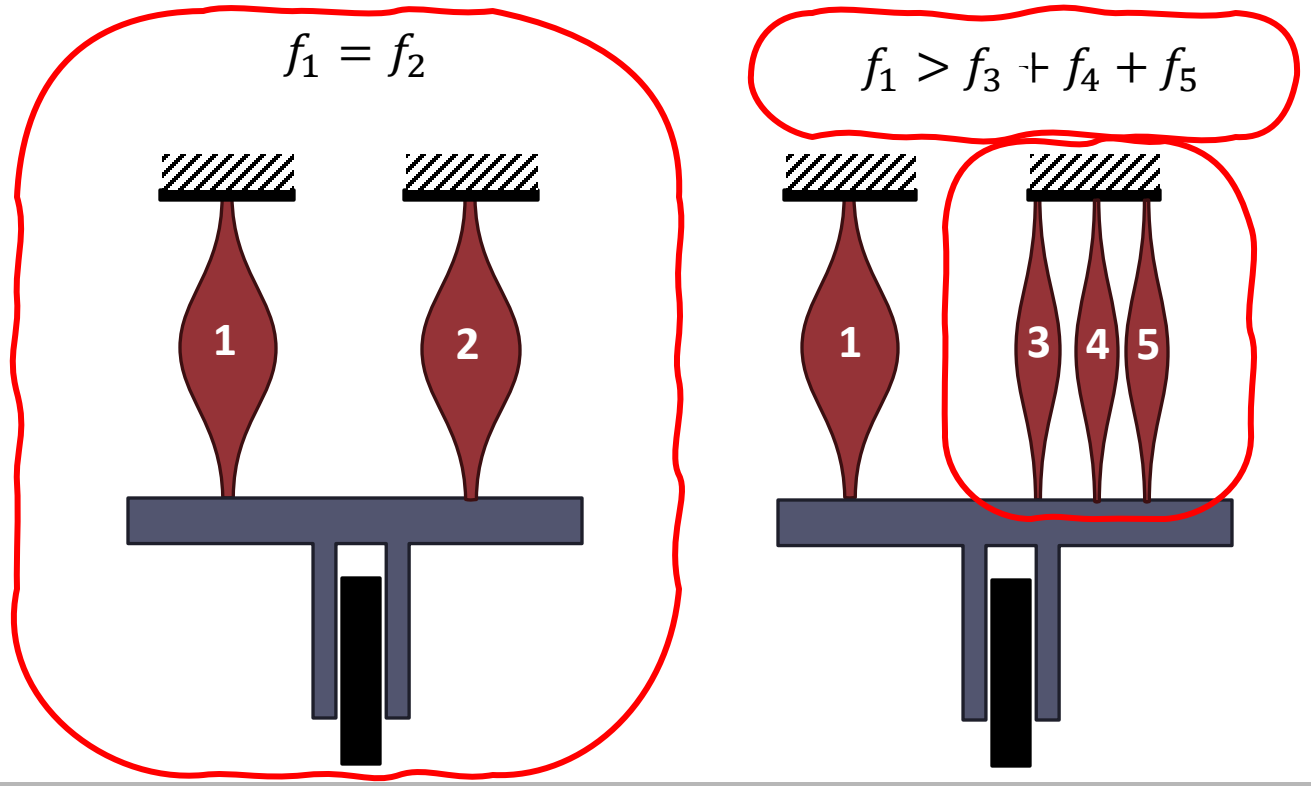
- **Ground reactions**
- **Residuals forces**
- **Other**

- **Muscles**
- **Physiological actuators**



Volume Weighted recruitment

- New recruitment criterion.
- Solves the "**muscle discretization**" problem.



Polynomial recruitment criterion:

$$J(\boldsymbol{f}^M) = \sum_{i=1}^{n} \left(\frac{f_i^M}{N_i}\right)^p$$

Minimize
muscle activation

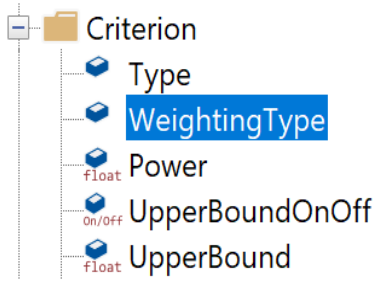
Volume Weighted recruitment

- Solution -> Volume weighted recruitment

Weighted by Muscle volume

$$J(\boldsymbol{f}^M) = \sum_{i=1}^{n} w_i \left(\frac{f_i^M}{N_i} \right)^p$$

- This is now natively supported by AnyBody




```
MR_Constant
MR_Volume
MR_UserDefined
```

- Still experimental:
  - Not all muscles have a volume in AMMR 3
  - How should Recruited-actuators be weighted

Feature: Object pointer improvements

- Many classes now accept object pointers instead of references.

```
AnyFolder& Foot_Reference = Leg.Seg.Foot;

AnyObjectPtr Foot_Pointer = &Leg.Seg.Foot;
```

Explicit references no longer necessary

Example: Center of Mass mesure AnyKinCoM

```
AnyKinCoM CenterOfMass = {

  #if  BM_ARM_RIGHT
   AnyFolder &RightArmSeg = ..Right.ShoulderArm.Seg;
  #endif

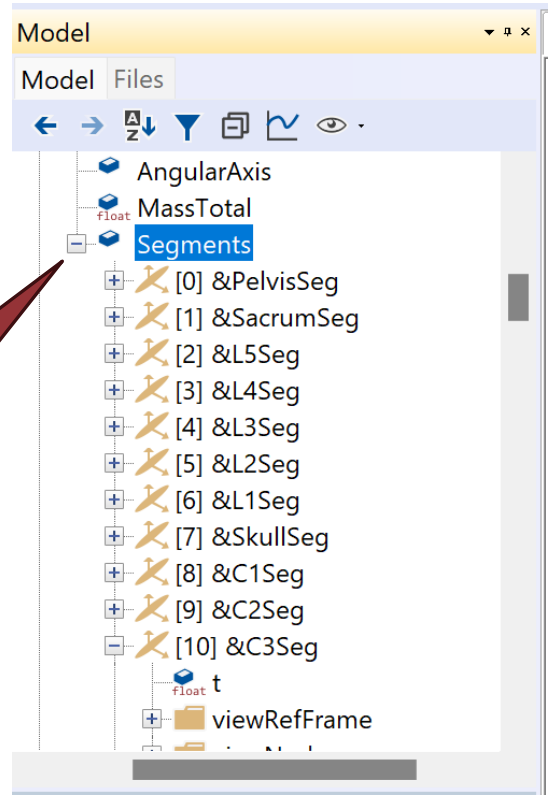
  #if  BM_ARM_LEFT
   AnyFolder &LeftArmSeg = ..Left.ShoulderArm.Seg;
  #endif
```

```
AnyKinCoM CenterOfMass = {
  RefFrames = ObjSearchRecursive( &...BodyModel, "*", "AnySeg");
};
```

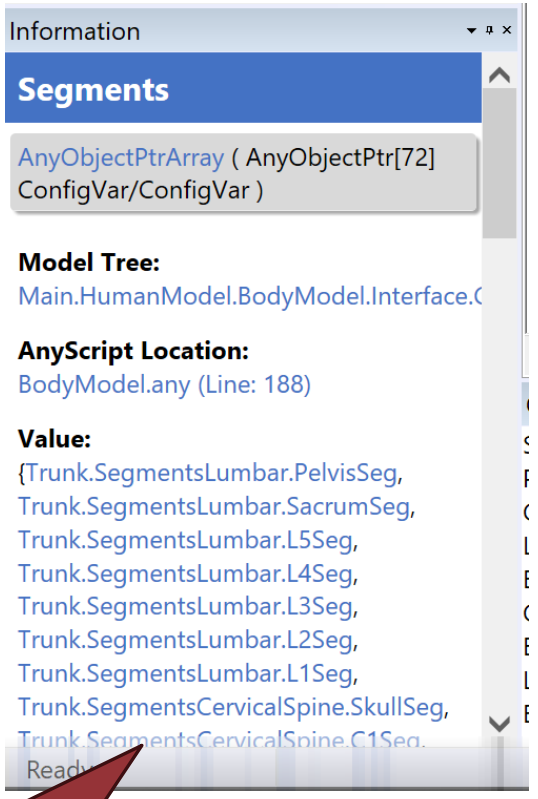
All objects are found with a search function

Feature: Object pointer improvements

- New functions for pointer arrays
  - `ObjGetMember(..)`
  - `ObjGetParent(..)`
  - `ObjRefResolve(..)`
  - `ObjFilterByClass(..)`
  - `ObjFilterByName(..)`
  - `ObjFilterByValue(..)`
  - `ObjSearch(..)`
  - `ObjSearchRecursive(..)`



Model three expands pointer arrays



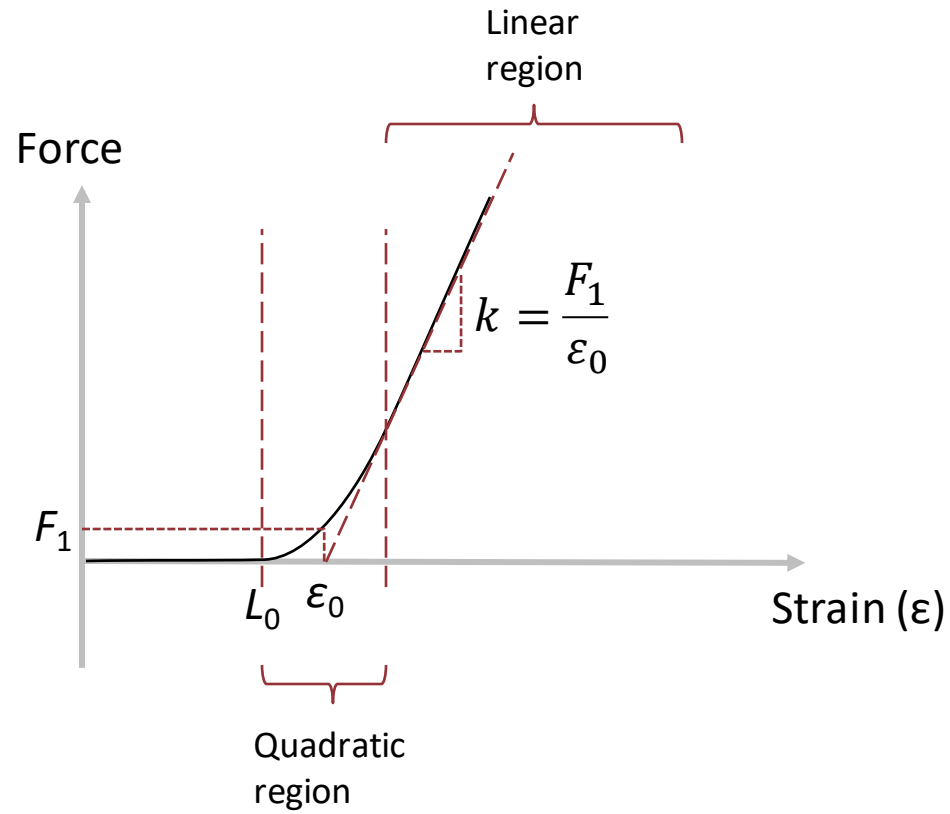
Pointer arrays are links in information window

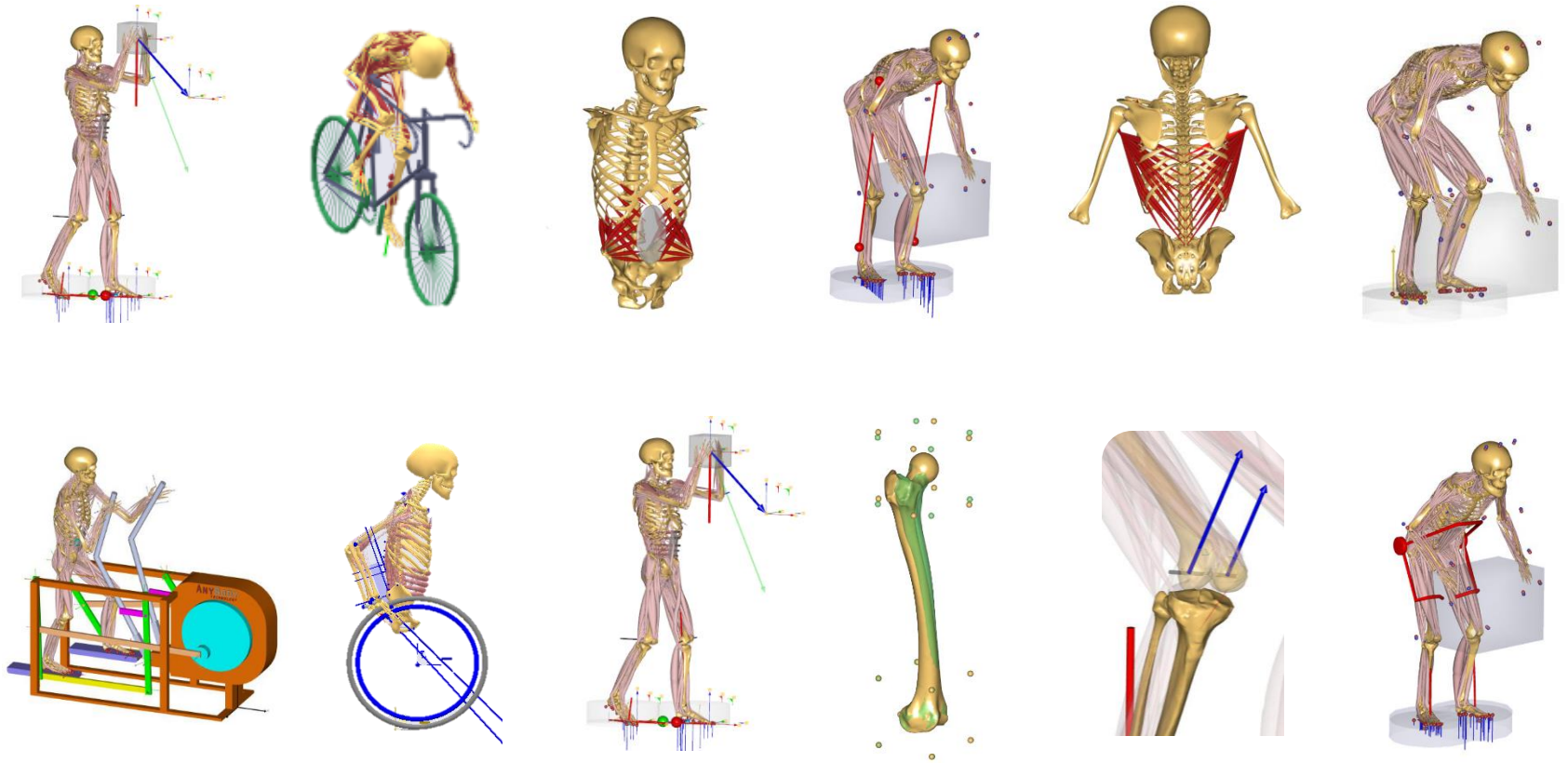
New Ligament Models

- New Ligament model often found in literature

```
AnyLigamentModelQuadLin MyLigament = {
    L0 = 1.30; // Slack length
    eps0 = 0.2; // Strain where F1 is valid
    epsr ?= eps0; // Calibration reference strain initiated to be eps0
    AnyVar F1 = 1000; // Force in the ligament at strain eps0
    k = F1 / eps0;
};
```

- New calibration option for ligaments
  - Allow for calibration at a reference strain ε_r (`epsr`), instead of slack length (L0).





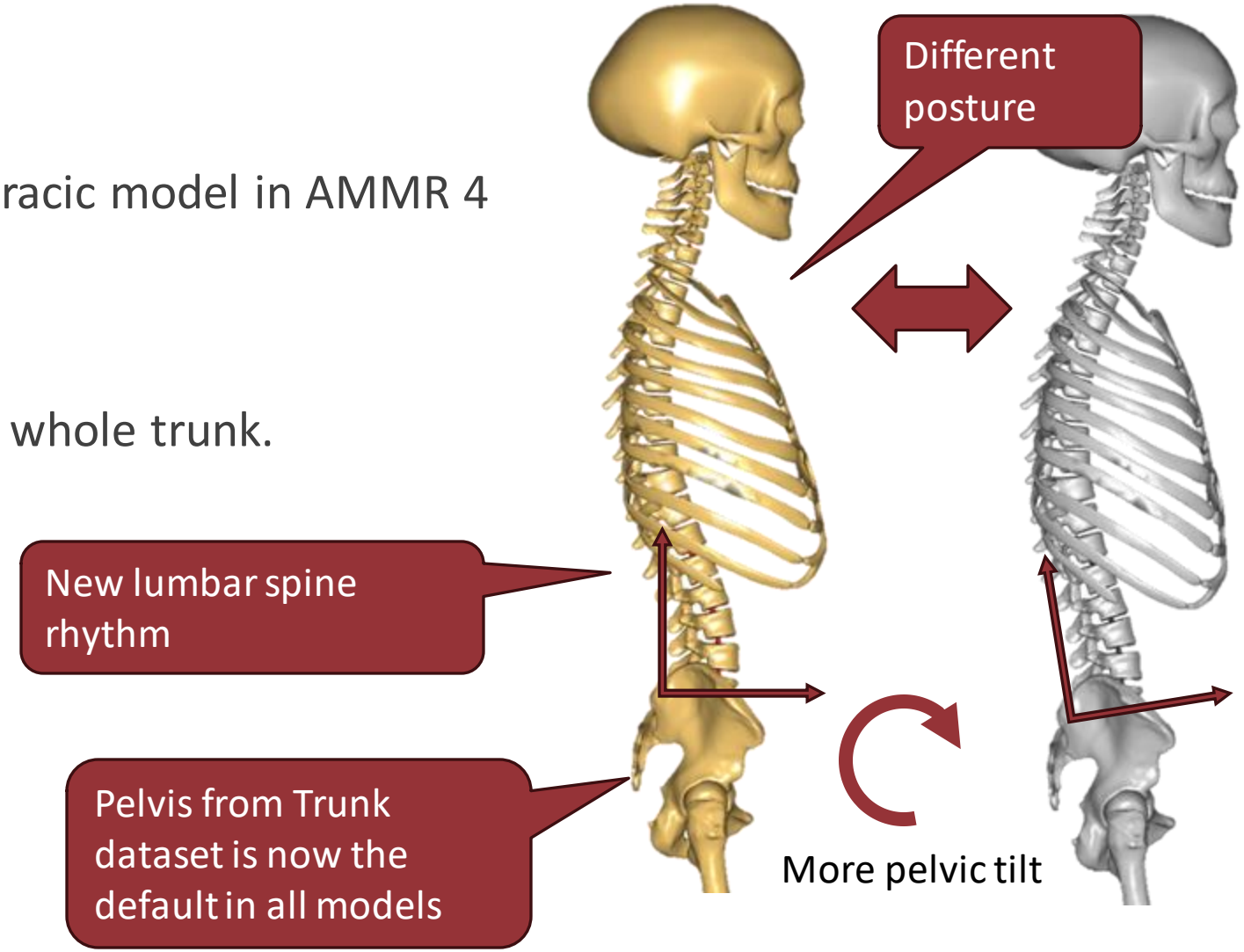
Model repository

- ✨ Highlights from AMMR 3

Unified trunk model

- Preparation for the detailed thoracic model in AMMR 4

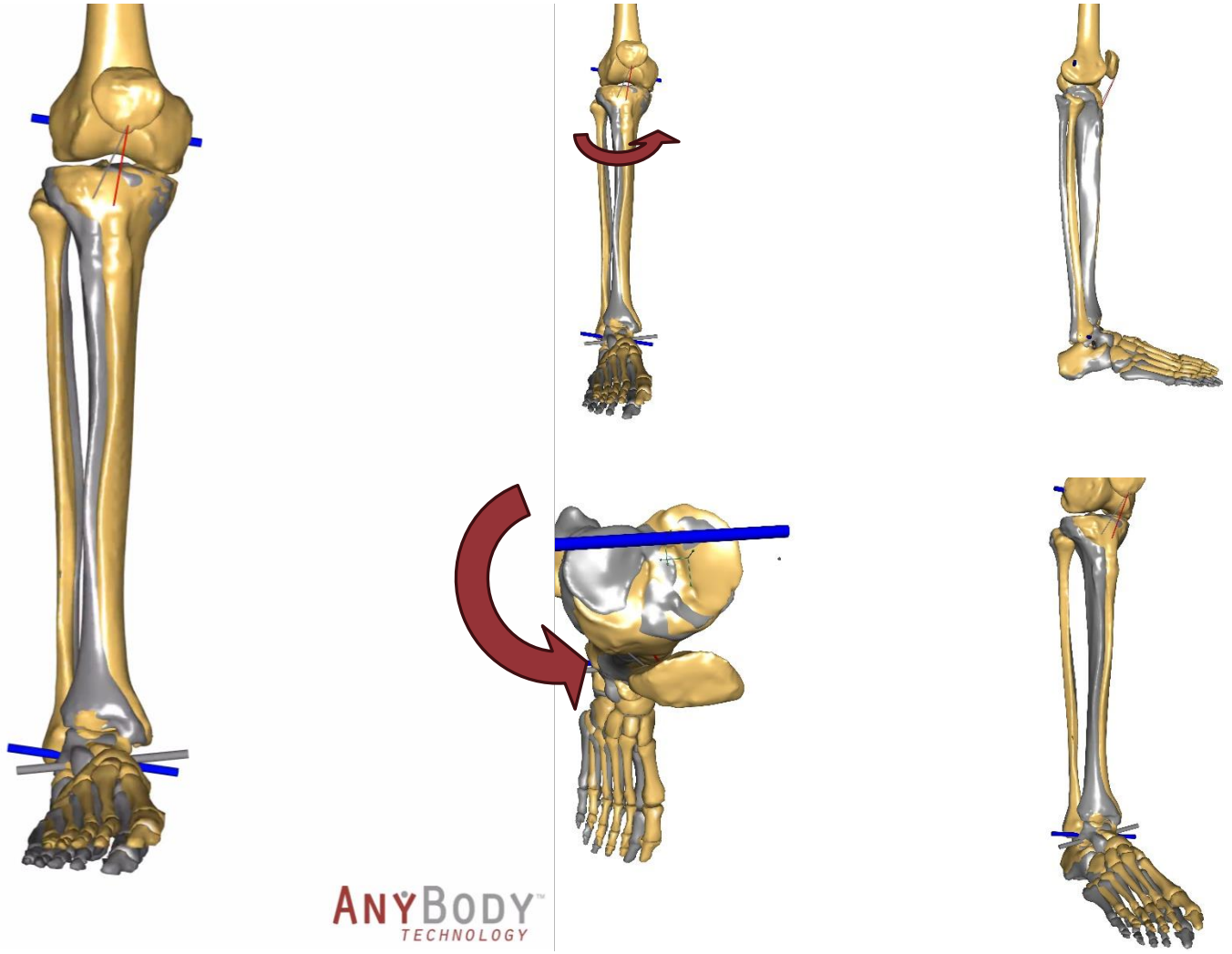
- Unified/common dataset of the whole trunk.



New updated Leg Model (TLEM 2.2)

- Compensation for non-neutral scan of original cadaver dataset

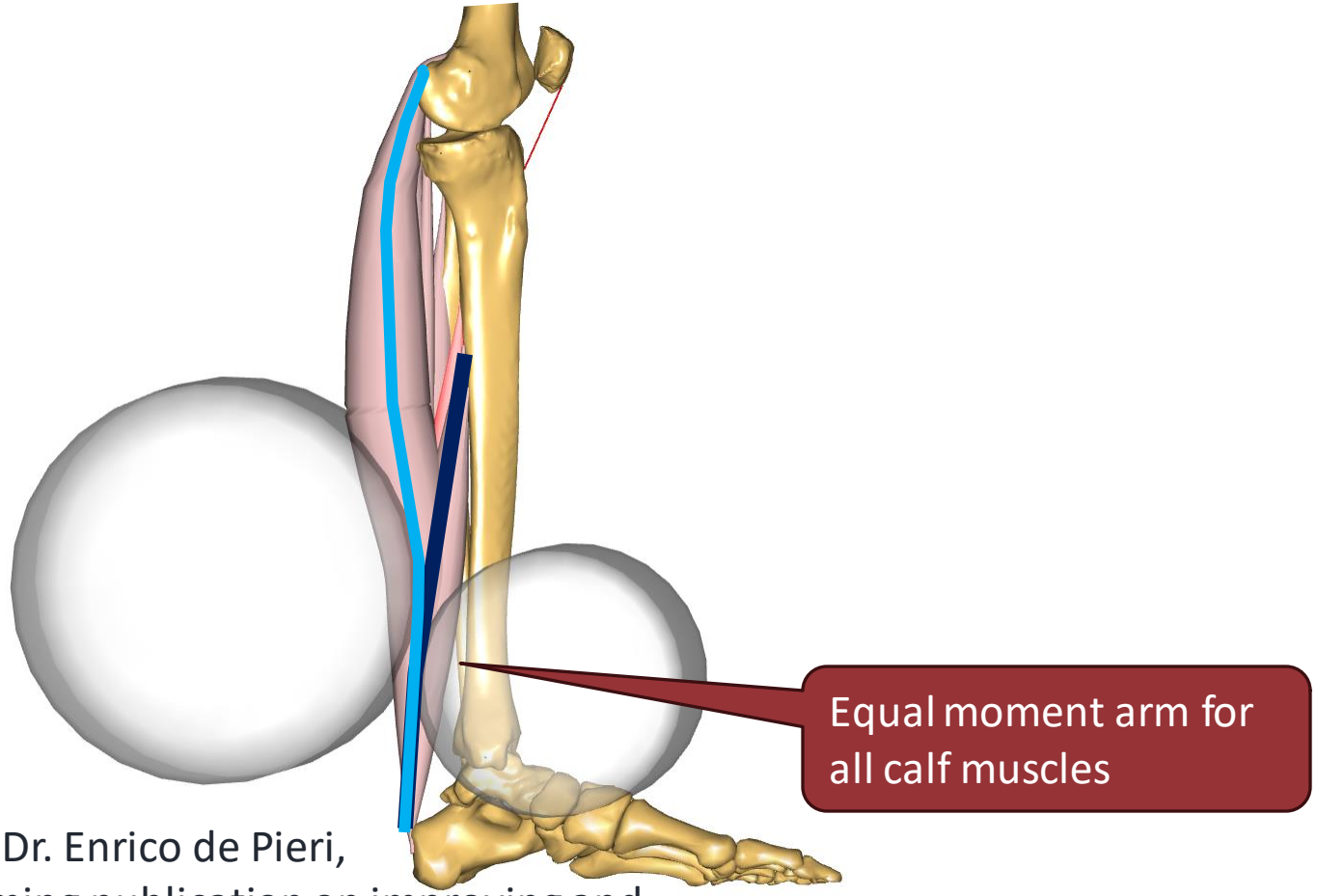
- New alignment of the shank
  - Rotation around the tibia long axis
  - New knee/ankle axis in the shank frame.



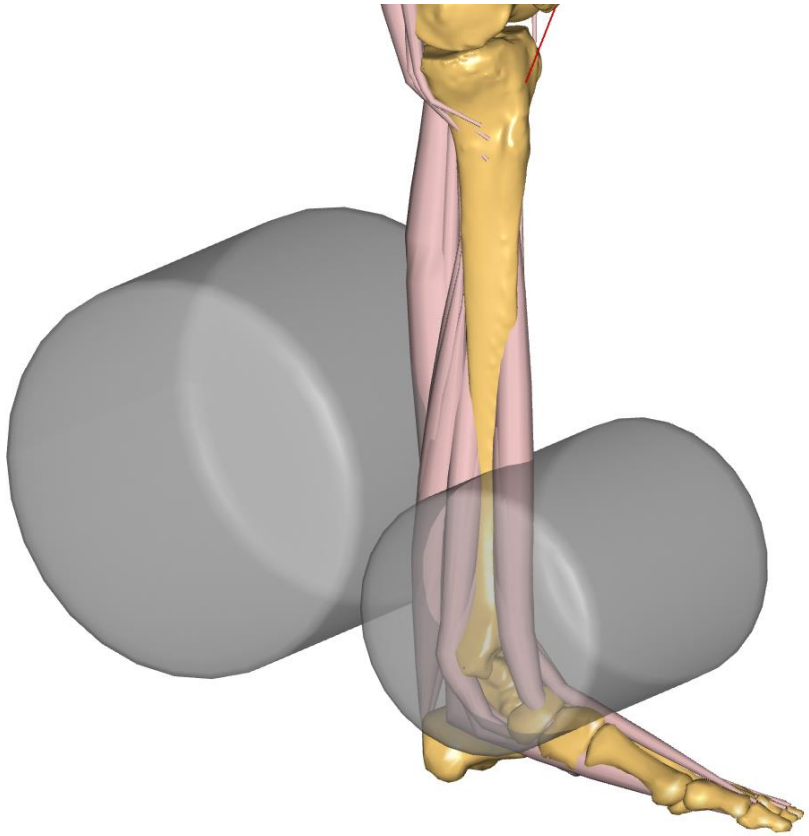
Credit: Dr. Enrico de Pieri,
- Upcoming publication on improving and validating the TLEM 2 leg model.

New updated Leg Model (TLEM 2.2)

New wrapping for calf muscles



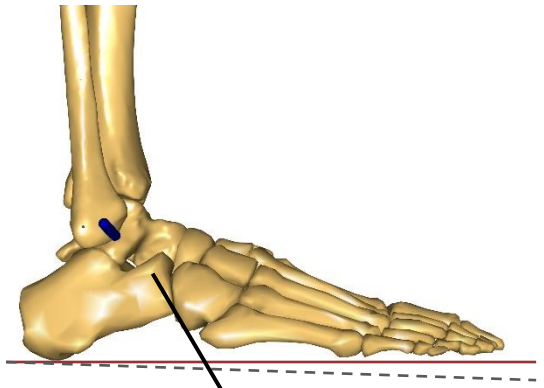
Equal moment arm for all calf muscles

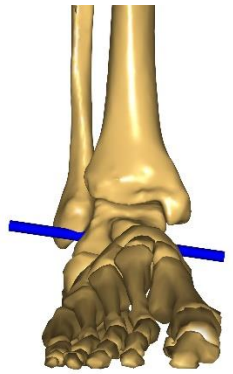


Credit: Dr. Enrico de Pieri,
- Upcoming publication on improving and validating the TLEM 2 leg model.

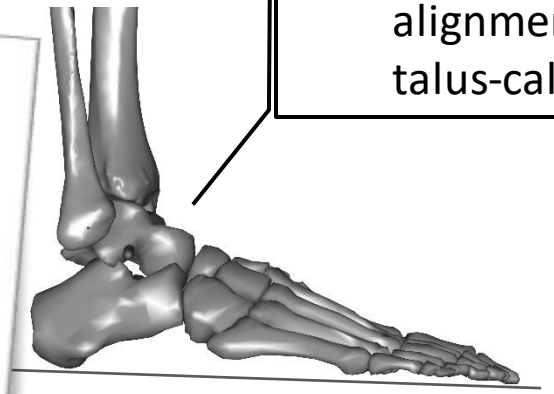
New updated Leg TLEM2.2

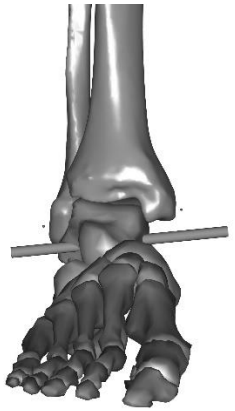
- Updates to the ankle complex:
  - Updated ankle joint axis based on talus geometry.
- Preparation for new three segment foot model.





Improved alignment of tibia-talus-calcaneus.





RESEARCH ARTICLE

Three-dimensional ankle, subtalar, and hindfoot alignment of the normal, weightbearing hindfoot, in bilateral posture

Jordan Stolle | Francois Lintz | Cesar de Cesar Netto | Alessio Bernasconi | Maria R. Rincon | Rena Mathew | Dhwanit Vispute | Sorin Siegler

e-based kinematic model of the tibiotalar and subtalar joints and

ion to gait analysis in children with Juvenile Idiopathic Arthritis

TTED TO JOURNAL OF BIOMECHANICS

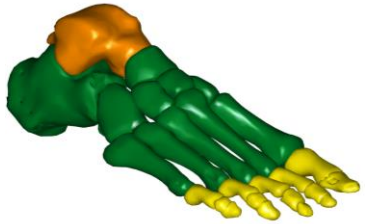
ON 13th February 2018

Planned updates for foot model

Rigid foot model (current):

Rigid foot with toe flexion:

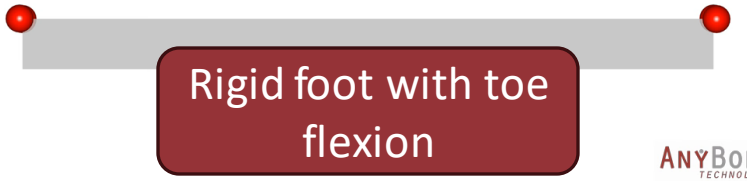
- Better fidelity for MoCap



Work in progress

Detailed foot model:

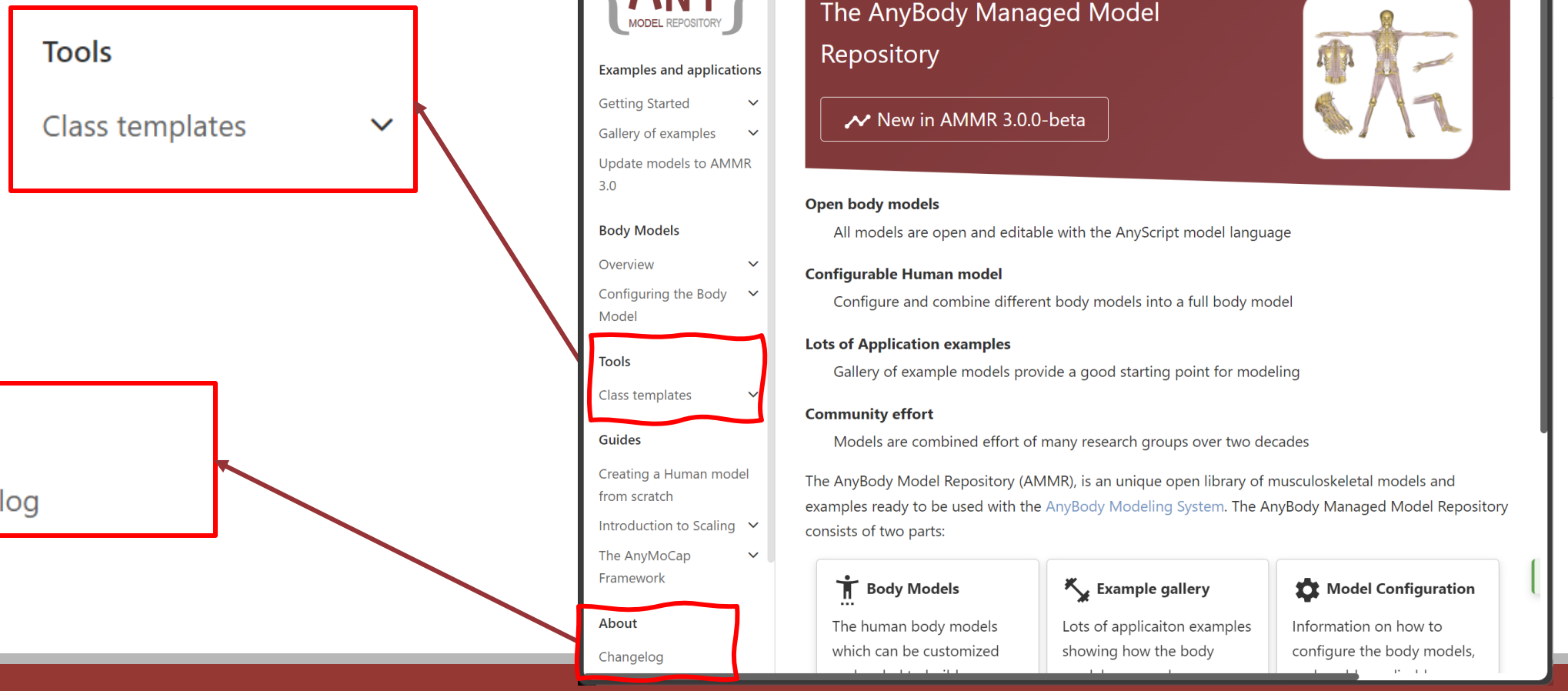
- 26 segments
- Based on Glasgow-Maastrict Foot Model
- For detailed foot research



New Model Documentation

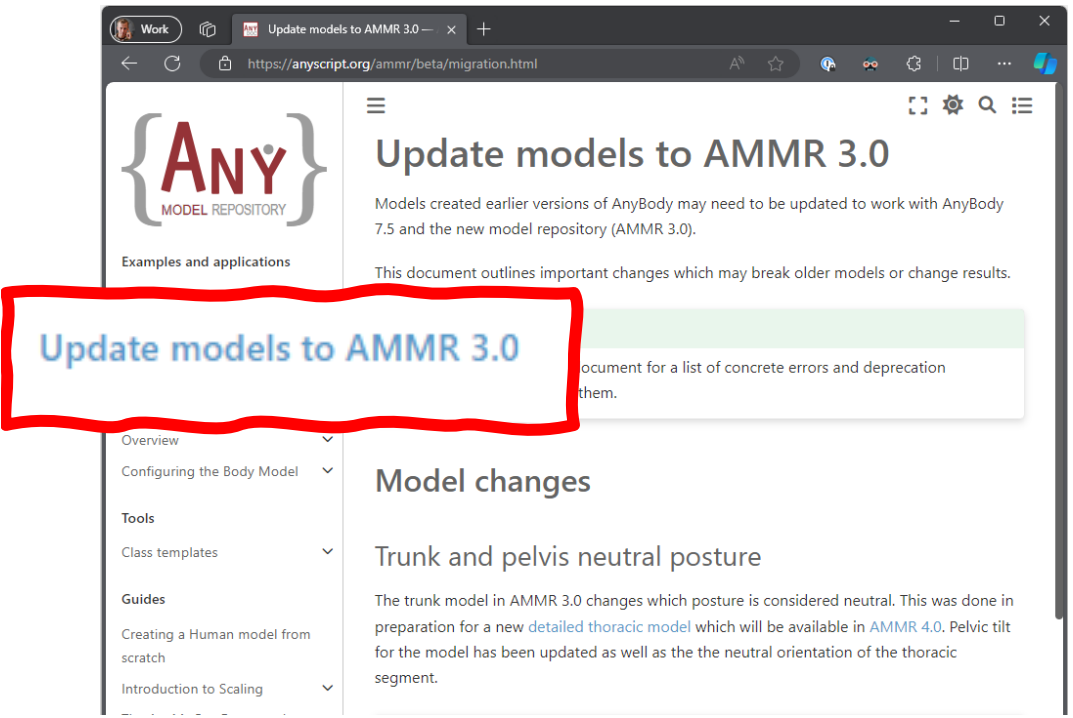
✨ New highlights

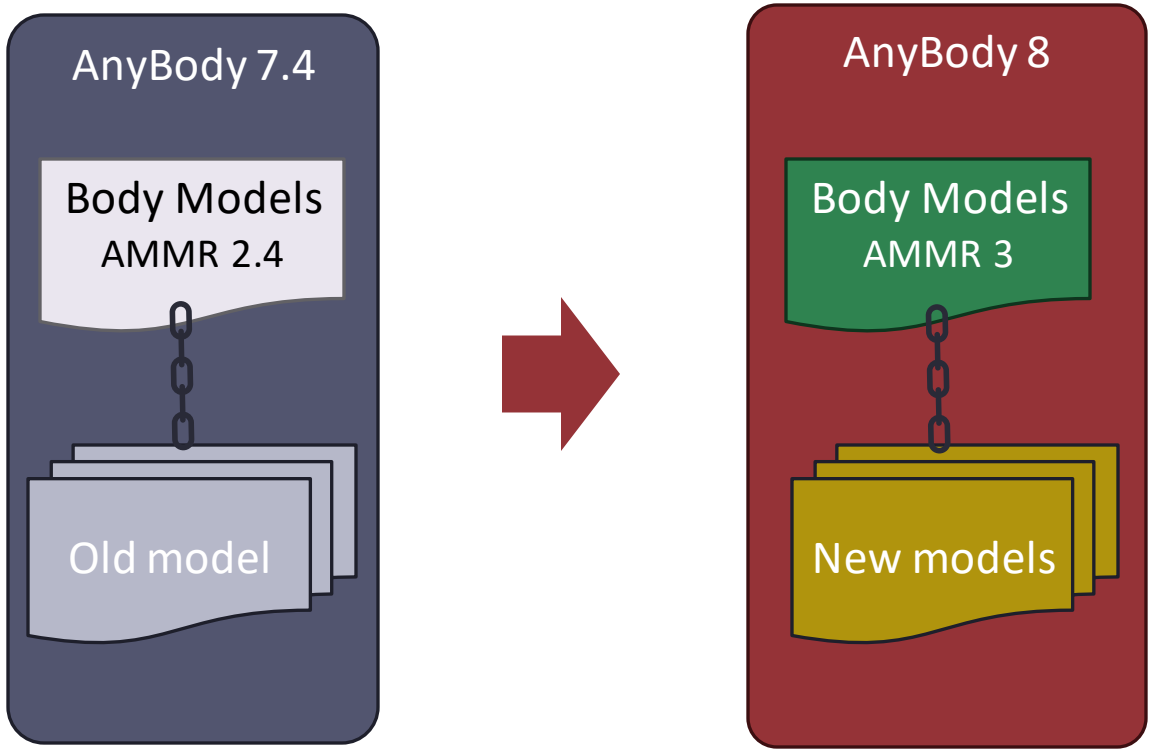
https://anyscript.org/ammr



Migrating models to AMMR 3

- Detailed guide on porting old models





Porting old models AnyBody 8…

Old Models, and old AMMR:

- Expect deprecation warning…

```
AMMR version detected :  2.4.4
'System.Compatibility.AnyBody75_AMMR24_CompatibilityOnOff' set to :On'
WARNING(SYS7) :    :  AnyBody75_AMMR24_CompatibilityOnOff  :  Compatibility mode auto-detected :
 - AnyMuscle::MuscleModel is renamed to '_MuscleModel' to avoid conflict with AMMR definitions.
It is recommended to update to a newer AMMR, or set this compatibility-mode to 'Off' and fix conflicts in
Parsing...
Constructing model tree...
```

```
NOTICE(SYS3) :  DiagnosticMuscle2.any(13)  :  PosMuscle  :  AnyGeneralMuscle  :  Deprecated class  :  The 'AnyGeneralMuscle'
NOTICE(SYS3) :  DiagnosticMuscle2.any(21)  :  NegMuscle  :  AnyGeneralMuscle  :  Deprecated class  :  The 'AnyGeneralMuscle
WARNING(SYS4) :  Jnt.any(226)  :  Measure1.NormedMeasureOnOff  :  Deprecated object/member
  'NormedMeasureOnOff', 'Base', and 'Exponent' are deprecated. It is recommended to use class 'AnyKinMeasureExpComb' to c
WARNING(SYS4) :  Jnt.any(389)  :  ScapulaTSThoraxMeasure.NormedMeasureOnOff  :  Deprecated object/member
  'NormedMeasureOnOff', 'Base', and 'Exponent' are deprecated. It is recommended to use class 'AnyKinMeasureExpComb' to c
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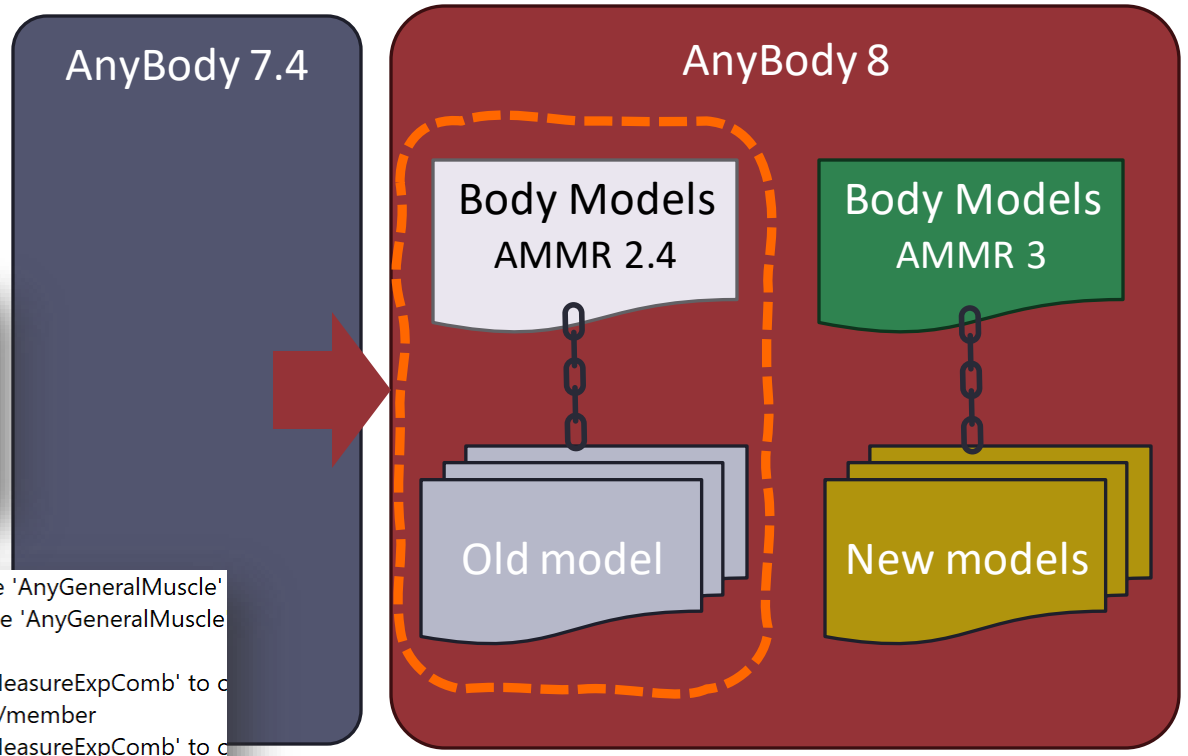
WARNING(SYS4) :  Jnt.any(389)  :  ScapulaTSThoraxMeasure.NormedMeasureOnOff  :  Deprecated object/member
  'NormedMeasureOnOff', 'Base', and 'Exponent' are deprecated. It is recommended to use class 'AnyKinMeasureExpComb' to c
Evaluating constants...
Configuring model...
```



Porting old models AnyBody 8…

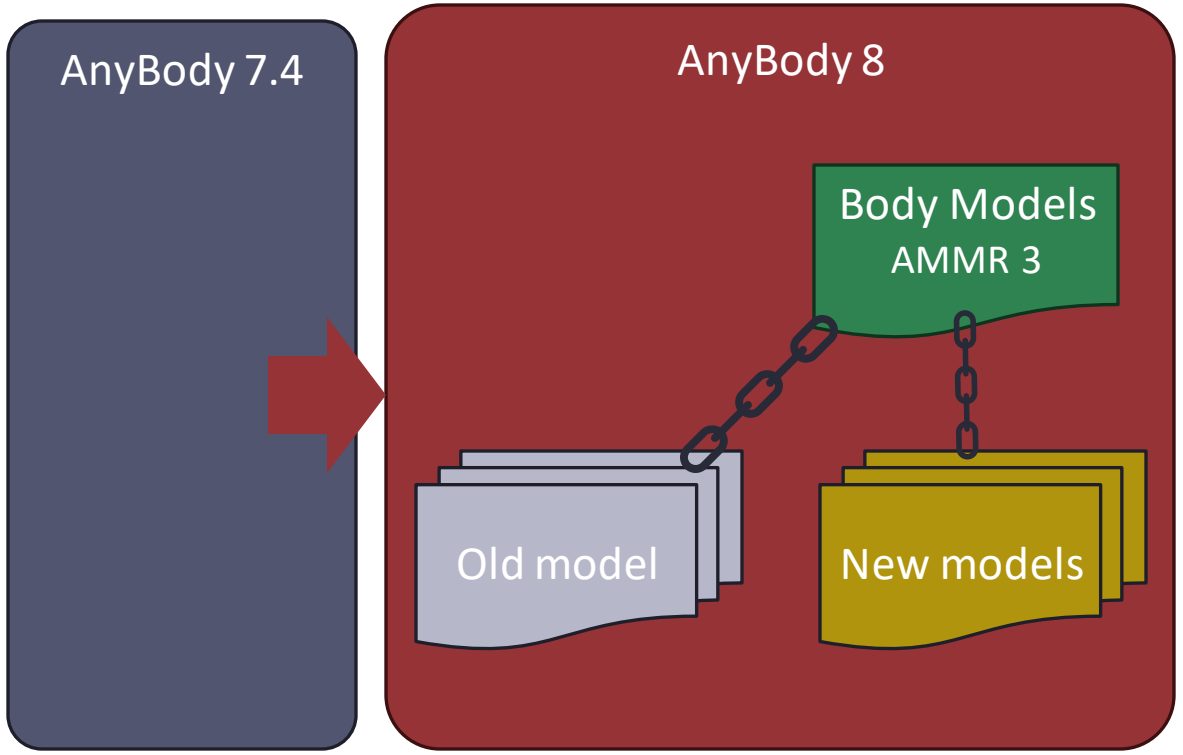
Old Models, and old AMMR:

Expect deprecation warning…

Old Models + new AMMR (3.0)

Simple models are OK

Complex models needs changes



Follow model development on GitHub

- Contribute any changes and fixes:

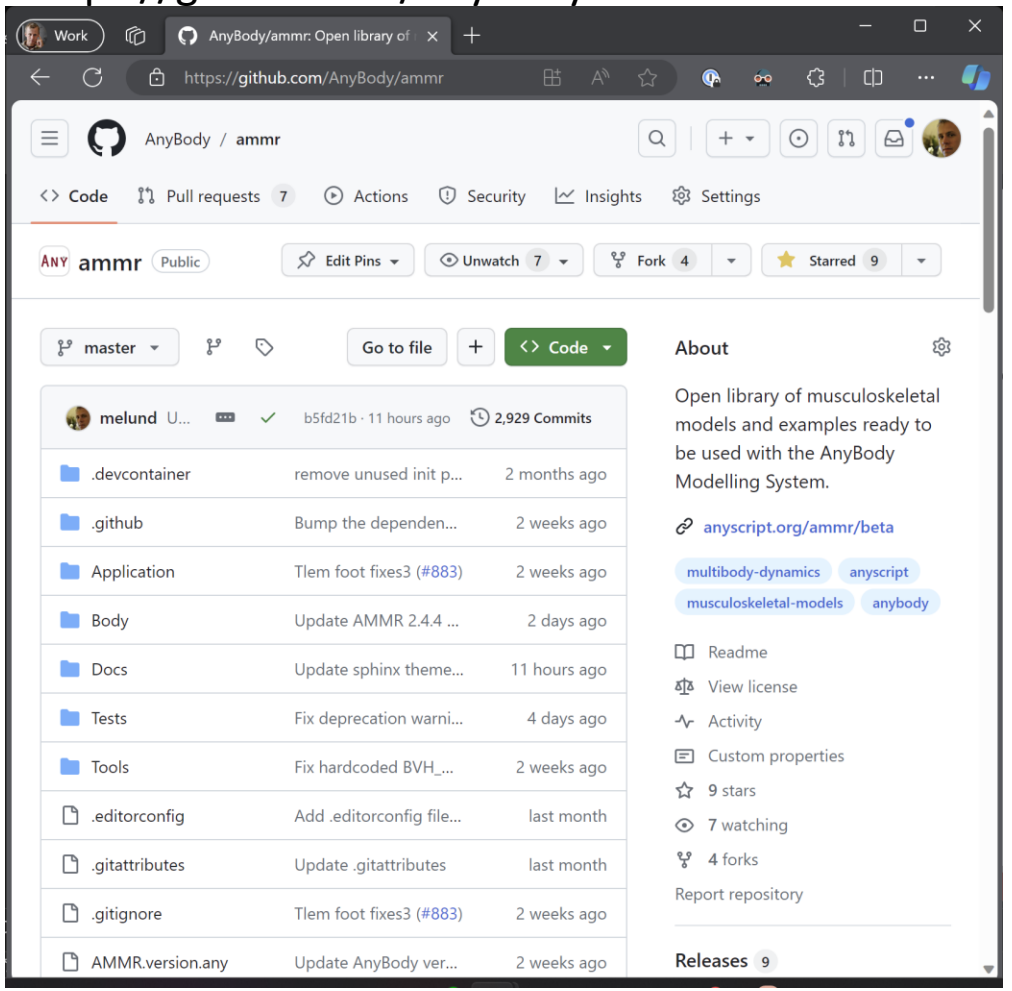
AnyBody / **ammr**

- Next version of AMMR (v.4) is available now:

AnyBody / **AMMR4-Beta**

- New Thoracic model
- New abdominal pressure model
- Foot models are coming

https://github.com/anybody

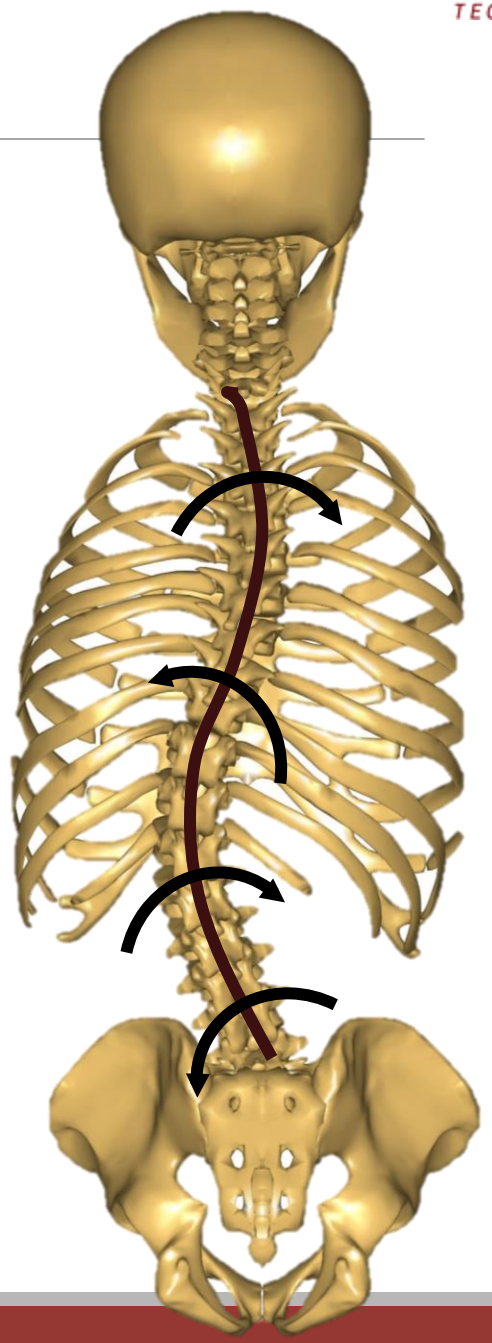


New Thoracic Model

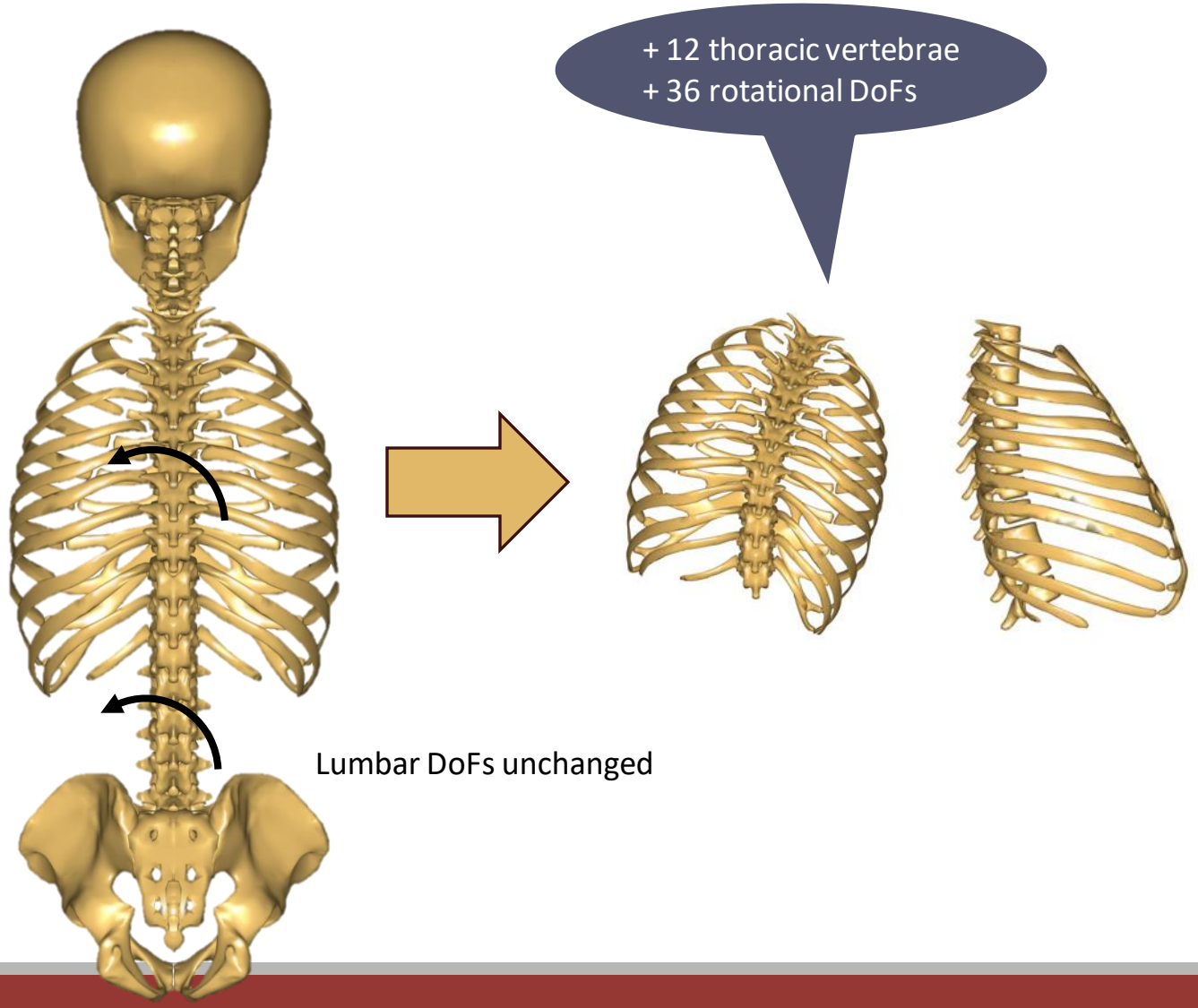
- Model in development and validation
- Available on GitHub: https://github.com/anybody/ammr4-beta
- Multiple papers underway:

1. **Shayestehpour, H**., Rasmussen, J., Galibarov, P., Wong, C.: An articulated spine and ribcage kinematic model for simulation of scoliosis deformities. Multibody Syst. Dyn. 53, 115–134 (2021). https://doi.org/10.1007/s11044-021-09787-9 (Published)
2. A generic detailed multibody thoracic spine and ribcage model. **Hamed Shayestehpour**, Søren Tørholm, Michael Damsgaard, Morten Lund, Christian Wong, John Rasmussen, Multibody Syst. Dyn.
3. A generic detailed multibody abdominal and diaphragm model. **Hamed Shayestehpour**, Søren Tørholm, Michael Damsgaard, Morten Lund, Christian Wong, John Rasmussen, Multibody Syst. Dyn.
4. Kinetic investigation of a thoracolumbar spine model including the ribcage. **Hamed Shayestehpour**, Mohammad Amin Shayestehpour, Christian Wong, John Rasmussen, Journal of Biomechanics.

2,3,4: Not published yet.



Spine DoFs

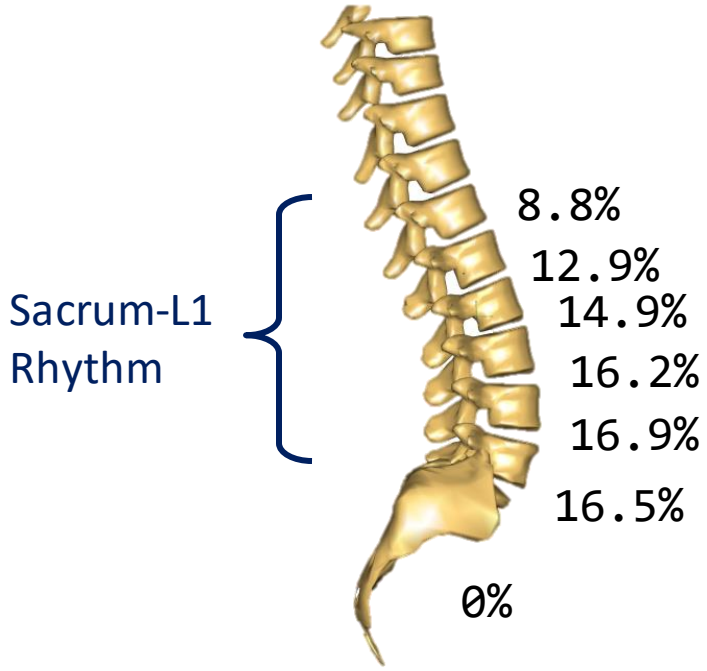


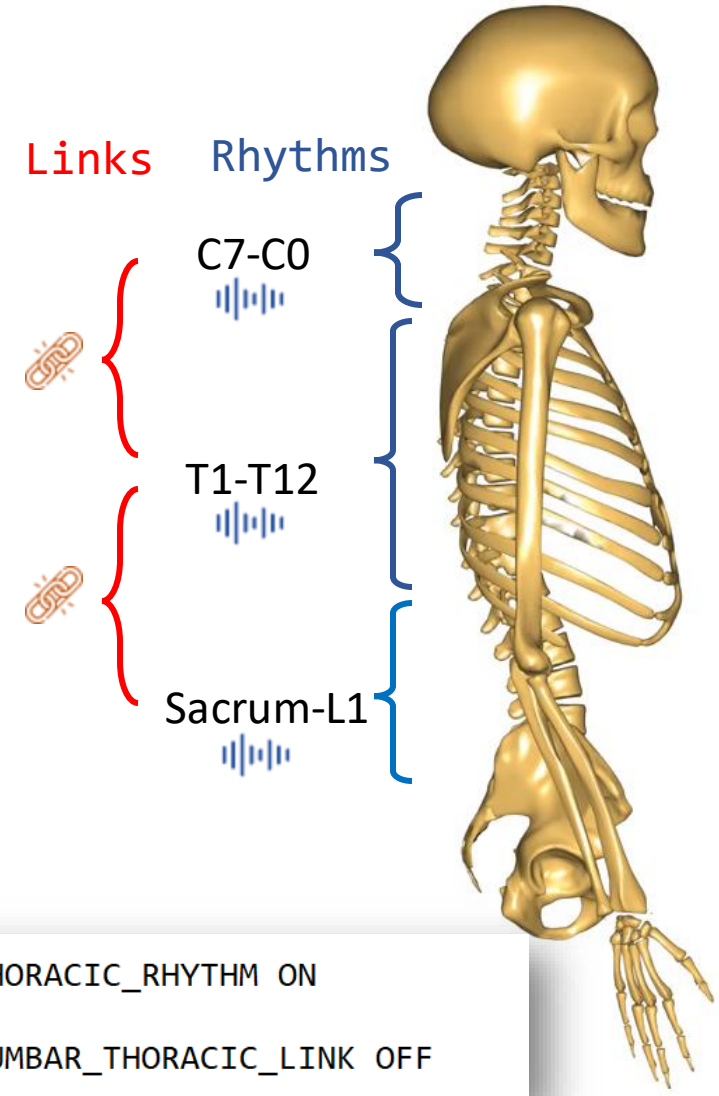
✨ Key highlights:

1. Detailed ribcage simulations since ribs and sternum are separate
2. Determinate ribcage kinematics → no need for extra input DoFs
3. Freely specify entire spinal posture → ribs and sternum will follow.

Spine Rhythms

- Full Thoracic model has more Dofs
  - + 228 extra total DoFs
- Rhythms make models easy to use.



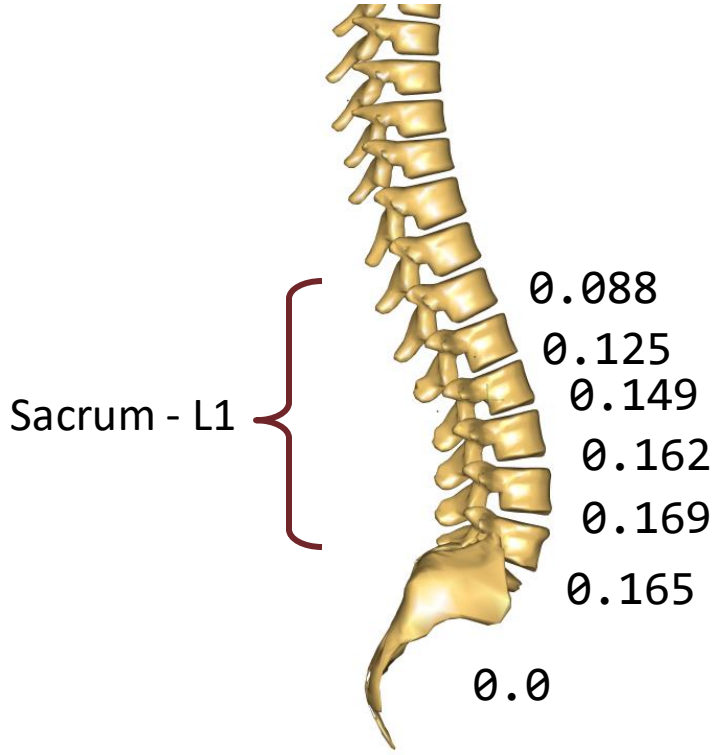



```
#define BM_TRUNK_THORACIC_RHYTHM ON

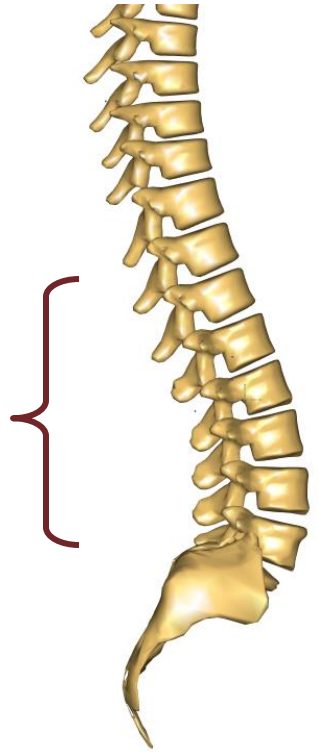
#define BM_TRUNK_LUMBAR_THORACIC_LINK OFF
```

New #class_template tool

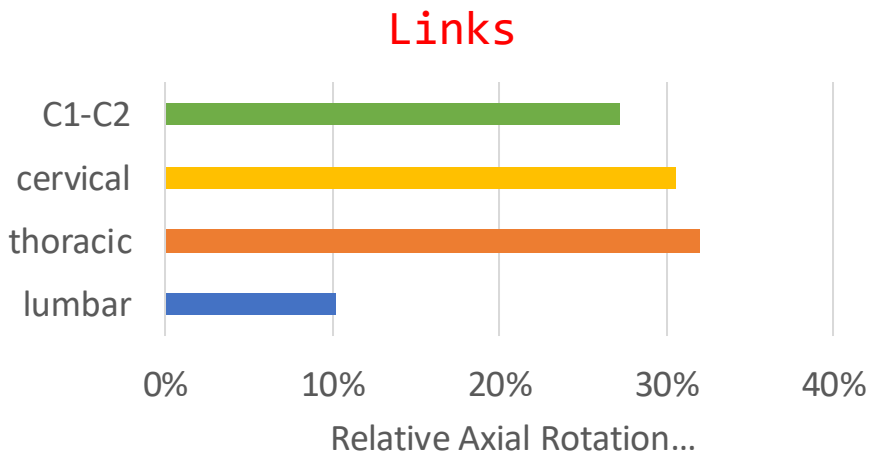
```
RhytmDriverLinear SpineRhythmDrvFlexion() = {
    RhythmCoefficients = {};
    Measures.Input = {
     AnyJoint &u1 = ...SacrumPelvis;
     AnyJoint &u2 = ...L5Sacrum;
     AnyJoint &u3 = ...L4L5;
     AnyJoint &u4 = ...L3L4;
     AnyJoint &u5 = ...L2L3;
     AnyJoint &u6 = ...L1L2;
     AnyJoint &u7 = ...T12L1;
     MeasureOrganizer = {2, 5, 8, 11, 14, 17, 20};
    };
};
```



```
RhytmDriverLinear SpineRhythmDrvFlexion() = {
     RhythmCoefficients = { 0.0, 0.165, 0.169, 0.162, 0.149, 0.125, 0.088};
     Measures.Input = {
      AnyJoint &u1 = ...SacrumPelvis;
      AnyJoint &u2 = ...L5Sacrum;
      AnyJoint &u3 = ...L4L5;
      AnyJoint &u4 = ...L3L4;
      AnyJoint &u5 = ...L2L3;
      AnyJoint &u6 = ...L1L2;
      AnyJoint &u7 = ...T12L1;
      MeasureOrganizer = {2, 5, 8, 11, 14, 17, 20};
    };
  };
```



Rhythm coefficients – Axial rotation

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RhytmDriverLinear SpineRhythmDrvFlexion() = {
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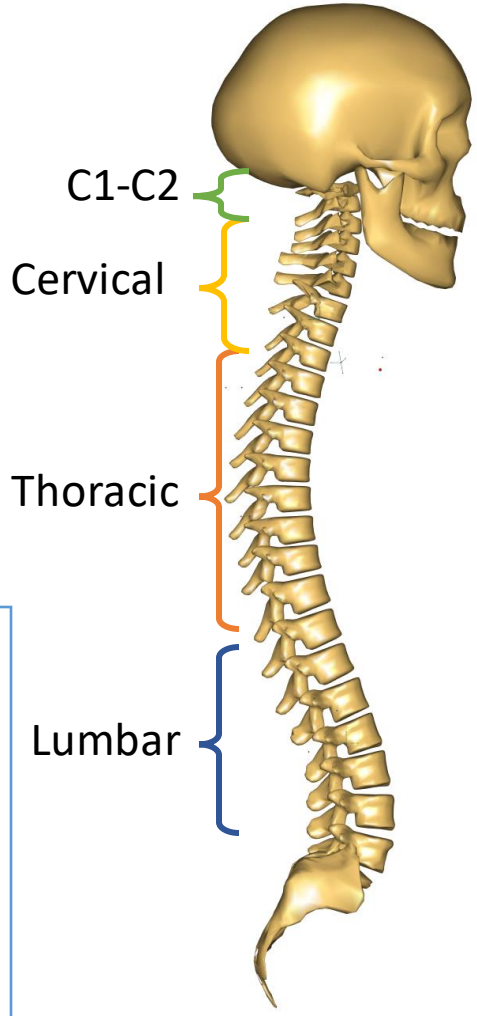
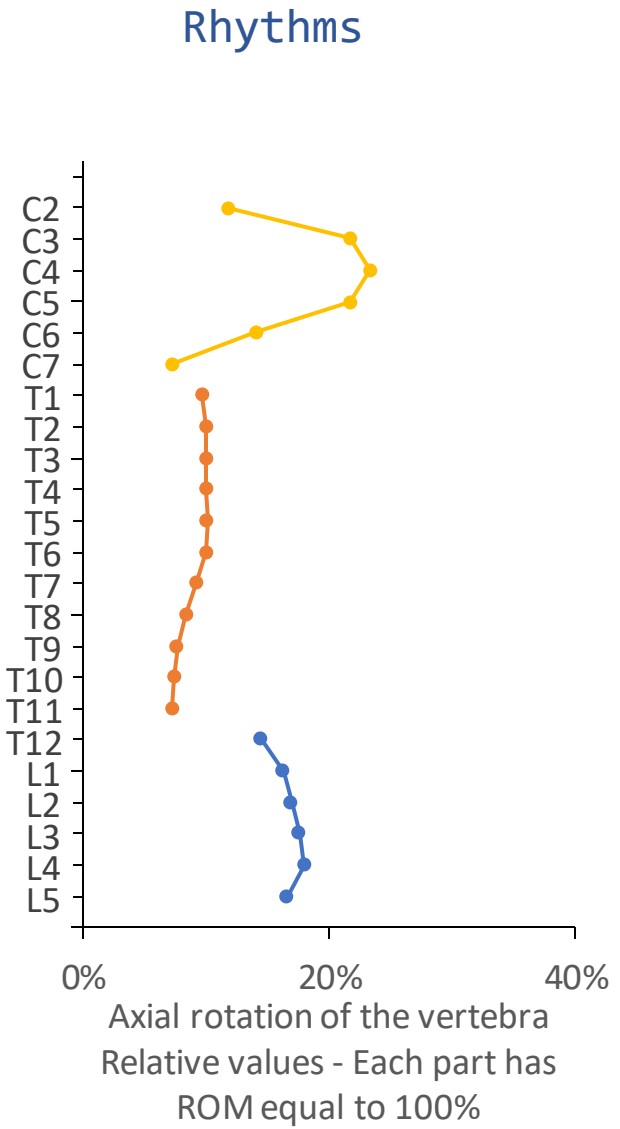
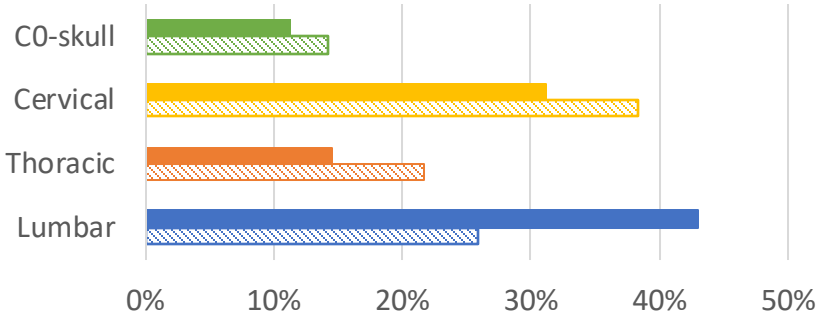
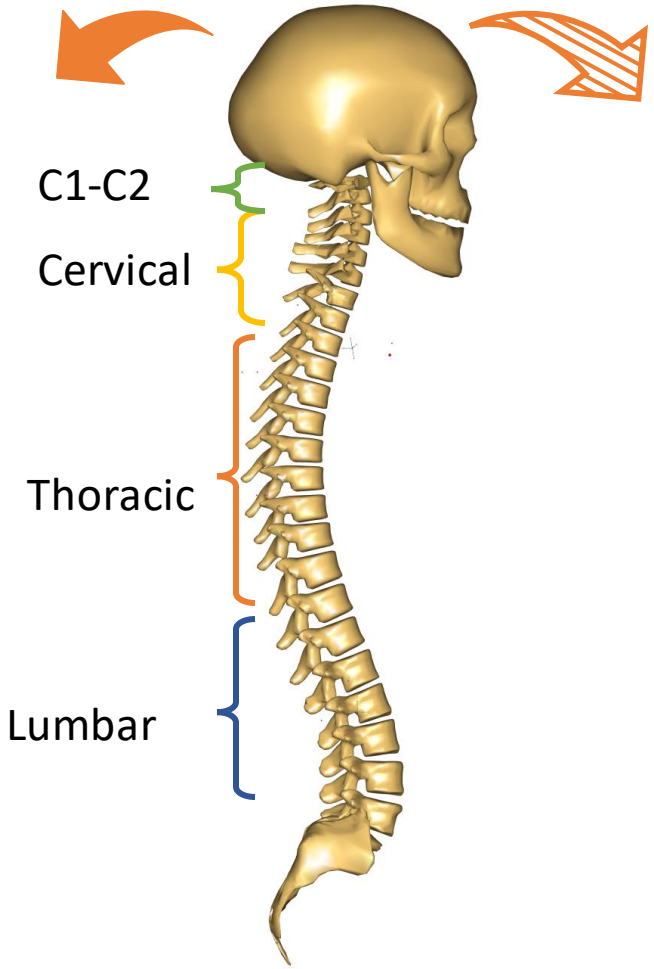
      AnyJoint &u6 = ...L1L2;
      AnyJoint &u7 = ...T12L1;
      MeasureOrganizer = {2, 5, 8, 11, 14, 17, 20};
    };
  };
```

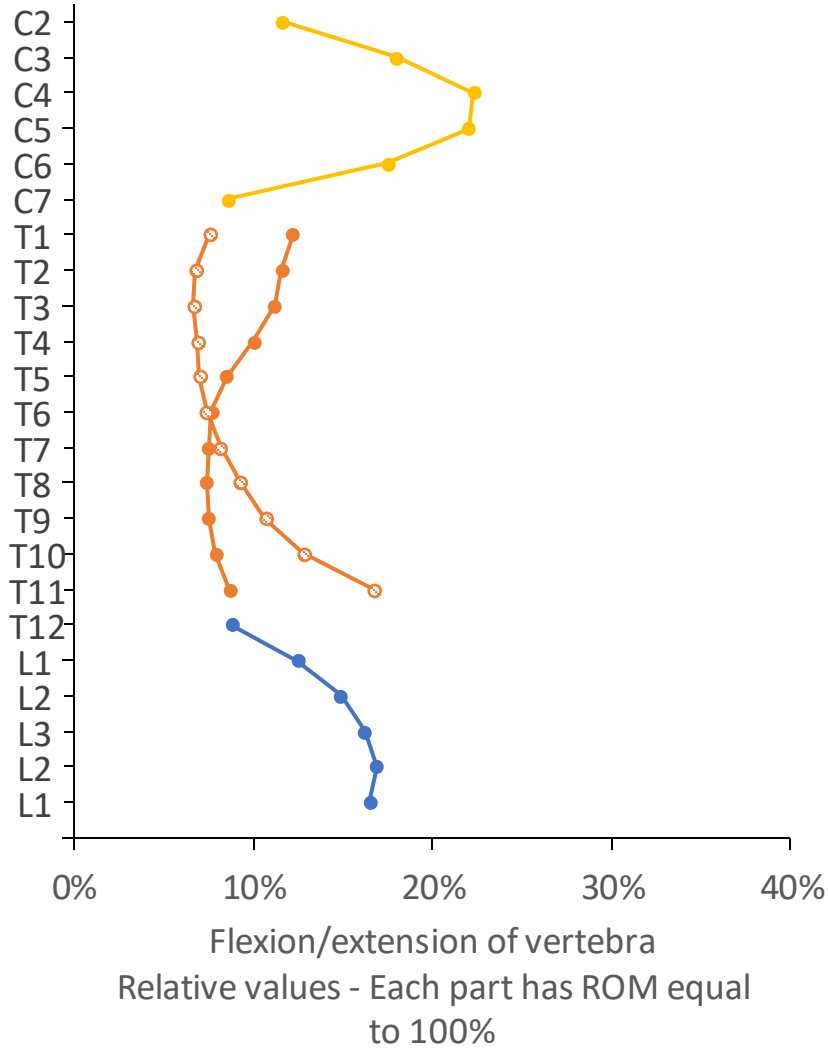




Rhythm coefficients - Flexion/extension

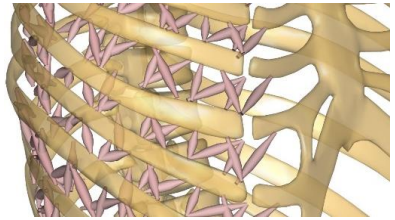




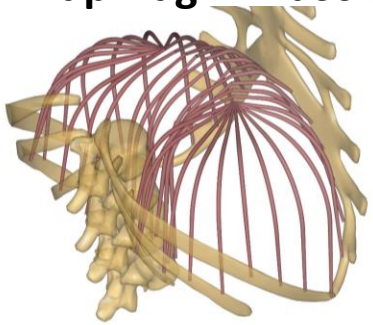


Detailed muscle and ligament configuration

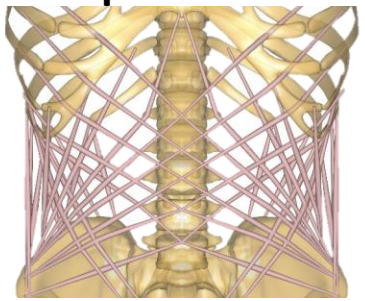
Intercostals muscles

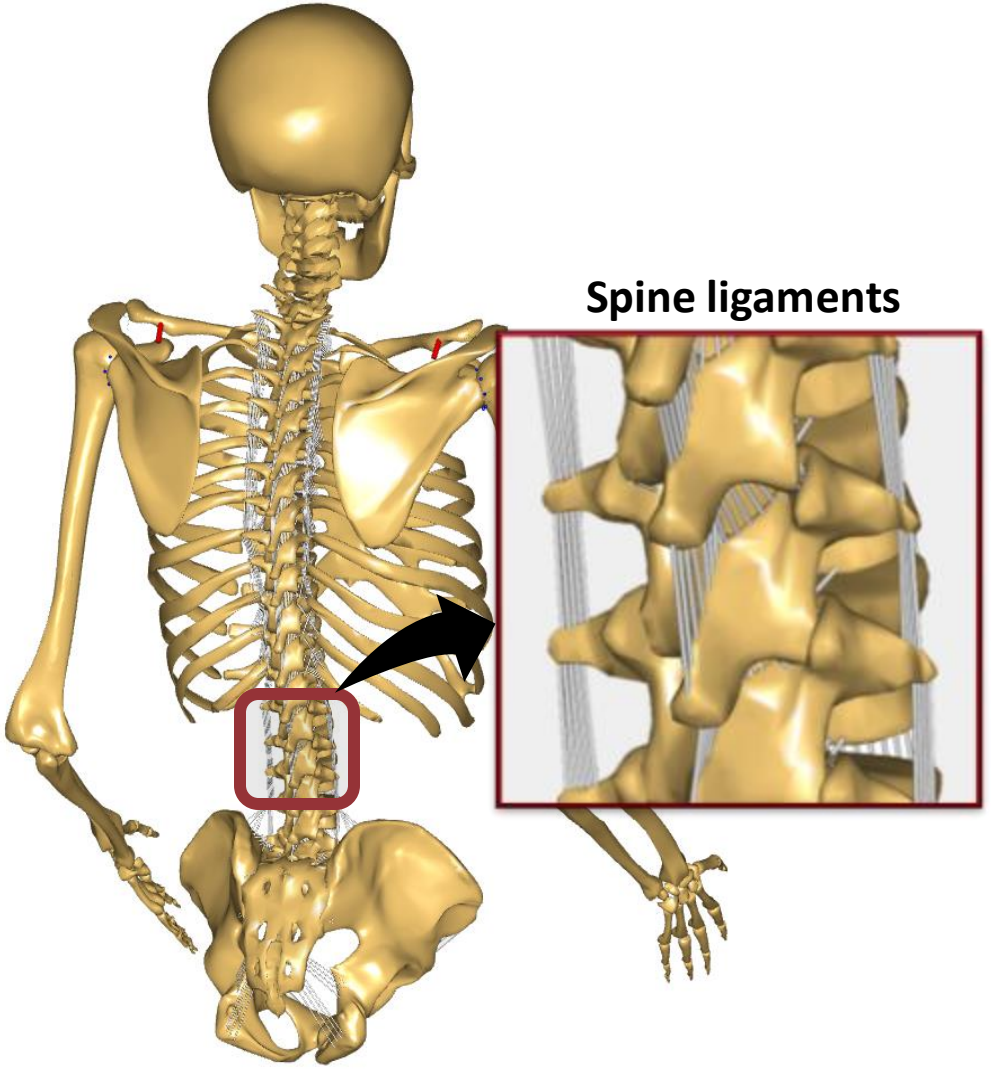


Diaphragm muscles



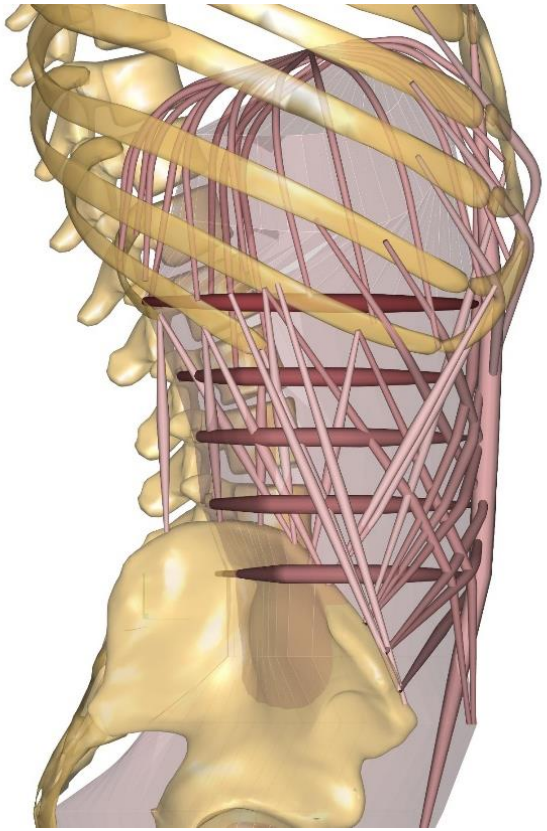
Obliquus muscles





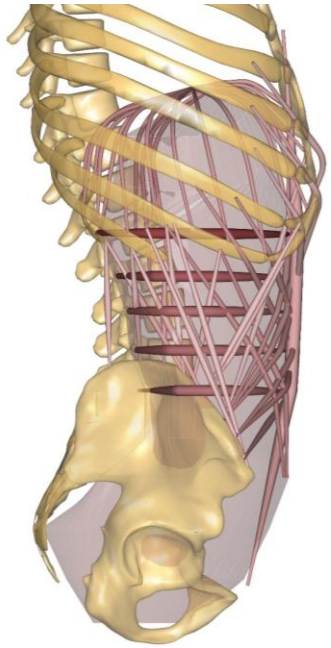
Spine ligaments

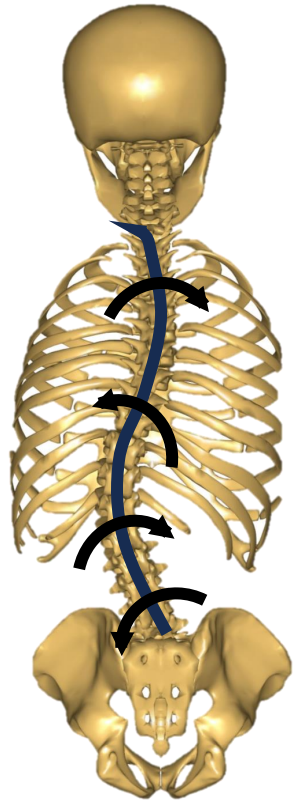
Abdominal pressure model



Upcoming Webcast: **New Thoracic Model**

Detailed thoracic model abdominal model





- Date: Announced soon.

- Presenters:
  - Søren Tørholm (cofounder of AnyBody)
  - Hamed Shayestehpour (Engineer at AnyBody)

Try it now: `https://github.com/anybody/AMMR4-Beta`

README License

Tests no status DOI 10.5281/zenodo.1250764 View Documentation

ANY MODEL REPOSITORY

AnyBody Managed Model Repository 4 ✨ Beta

> The beta version of the AMMR 4 with a full thoracic model and new abdominal pressure model

Questions

Meet us

- Send email to sales@anybodytech.com

Trial version

- Send email to sales@anybodytech.com

Presentation questions

- Send email to ki@anybodytech.com