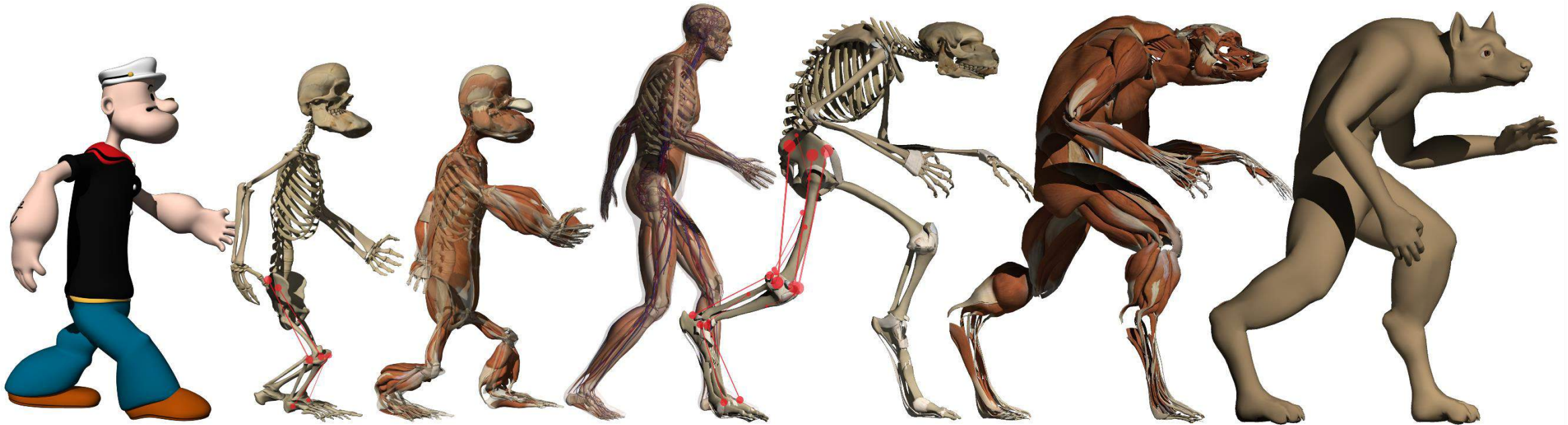


MyCorporisFabrica : Making Anatomy Easy



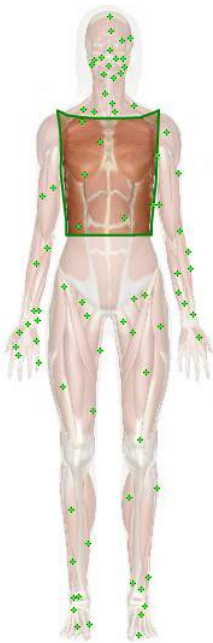
Armelle Bauer, Federico Ulliana, Ali-Hamadi Dicko, Benjamin Gilles, Olivier Palombi, François Faure

INRIA, LJK-CNRS, TIMC-IMAG, Persyval-Lab, Univ. Grenoble Alpes

HEAD AND NECK
CHEST AND UPPER BACK
ABDOMEN AND LOWER BACK
ARM AND HAND
LEG AND FOOT
HEAD AND NECK
Clavicular Head of
Sternocleidomastoid Muscle
Depressor Anguli Oris Muscle
Depressor Labii Inferioris Muscle
Frontal Belly of Epicranii Muscle
(Frontalis Muscle)
Galea Aponeurotica
Levator Labii Superioris Alaeque
Nasi Muscle
Levator Labii Superioris Muscle
Masseter Muscle
Mentalis Muscle
Nasalis Muscle
Occipital Belly of Epicranii
Muscle (Occipitalis Muscle)
Omoxyoid Muscle
Orbicularis Oculi Muscle
Orbicularis Oris Muscle
Platysma Muscle
Risorius Muscle
Scalene Muscles
Semispinalis Capitis Muscle
Splenius Capitis Muscle
Sternal Head of
Sternocleidomastoid Muscle
Temporalis Muscle
Zygomaticus Major Muscle
Zygomaticus Minor Muscle

Change Anatomical System

Change View Angle

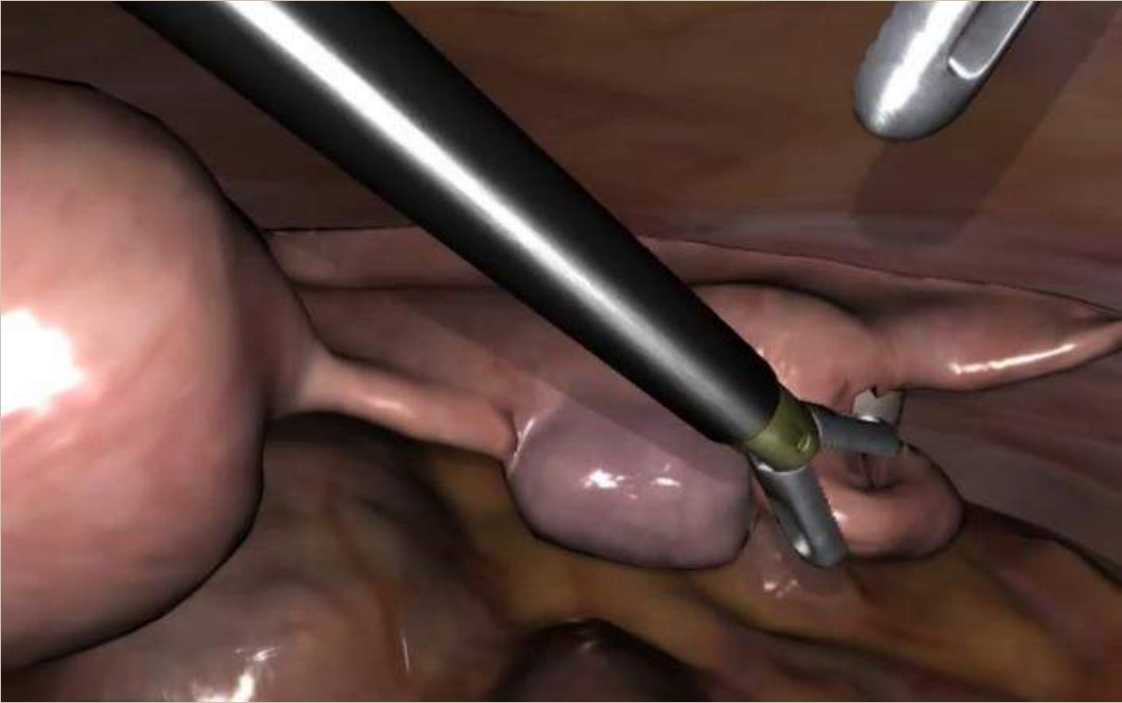


Muscles of the Chest and Upper Back

The muscles of the chest and upper back occupy the thoracic region of the body inferior to the neck and superior to the abdominal region and include the muscles of the shoulders. These important muscles control many motions that involve moving the arms and head – such as throwing a ball, looking up at the sky, and raising your hand. Breathing, a vital body function, is also controlled by the muscles connected to the ribs of the chest and upper back.

The bones of the pectoral girdles, consisting of the clavicle (collar bone) and scapula (shoulder blade), greatly increase the range of motion possible in the shoulder region beyond what would be possible with the shoulder joint alone. The muscles of this region both allow for this range of motion and contract to stabilize this region and prevent any extraneous motion. On the anterior side of the thoracic region, the pectoralis minor and serratus anterior muscles originate on the anterior ribs and insert on the scapula...

Medicine [InnerBODY, 2013]



Medical Simulator[LapSim, 2012]



Animation [*Avatar*, 2009]

Anatomical Elements :

Bones, Muscles, Tendons, Fat, Trachea

To deform **realistically** the skin layer :
Create and simulate an Intern Anatomy model



Visual Effects [*Immortals*, 2011]

Modeling Anatomy

1- **Select** : bones, muscles, ...

Anatomy Knowledge

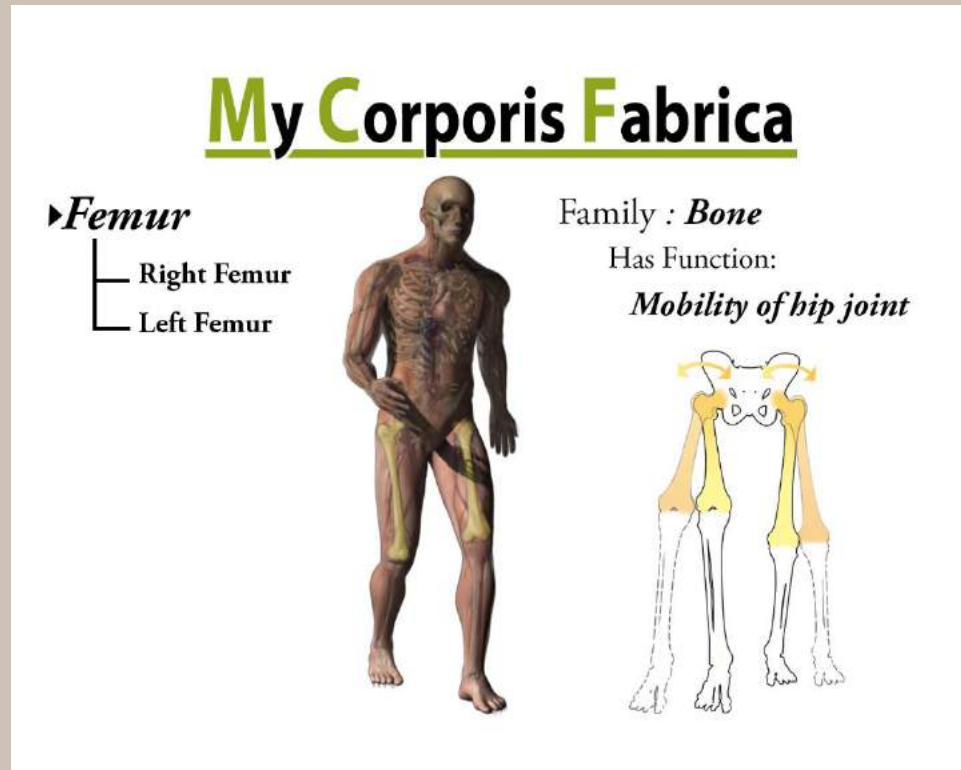
2- **Create 3D Shapes**

3D Shape Modeling

3- **Create Mechanical Model**

Physiological Properties

Mechanical Properties



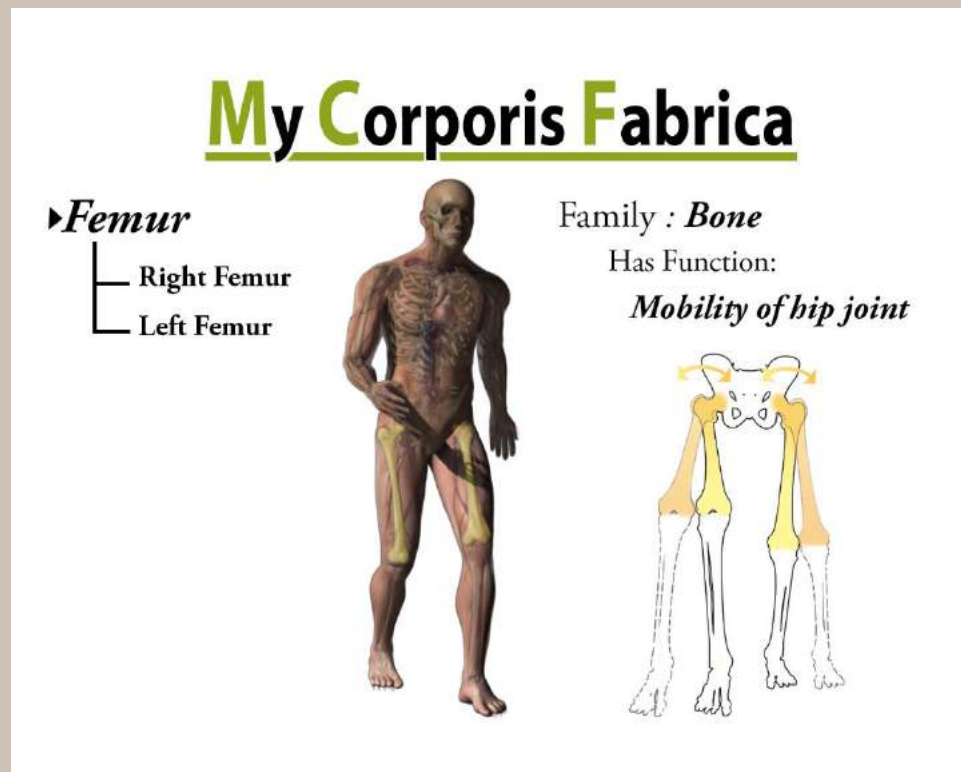
Related Work

- Related Applications
- Limitations

MyCF Architecture

- Ontology Navigation
- 3D Data
- Simulation Models

Conclusion



Related Work

- Related Applications
- Limitations

MyCF Architecture

- Ontology Navigation
- 3D Data
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Conclusion

Related Applications



Zygote BODY [<http://www.zygotebody.com/>]

- Navigation by Layers (Skin, Muscles, ...)
- Simple Search by KeyWord (« femur », ...)

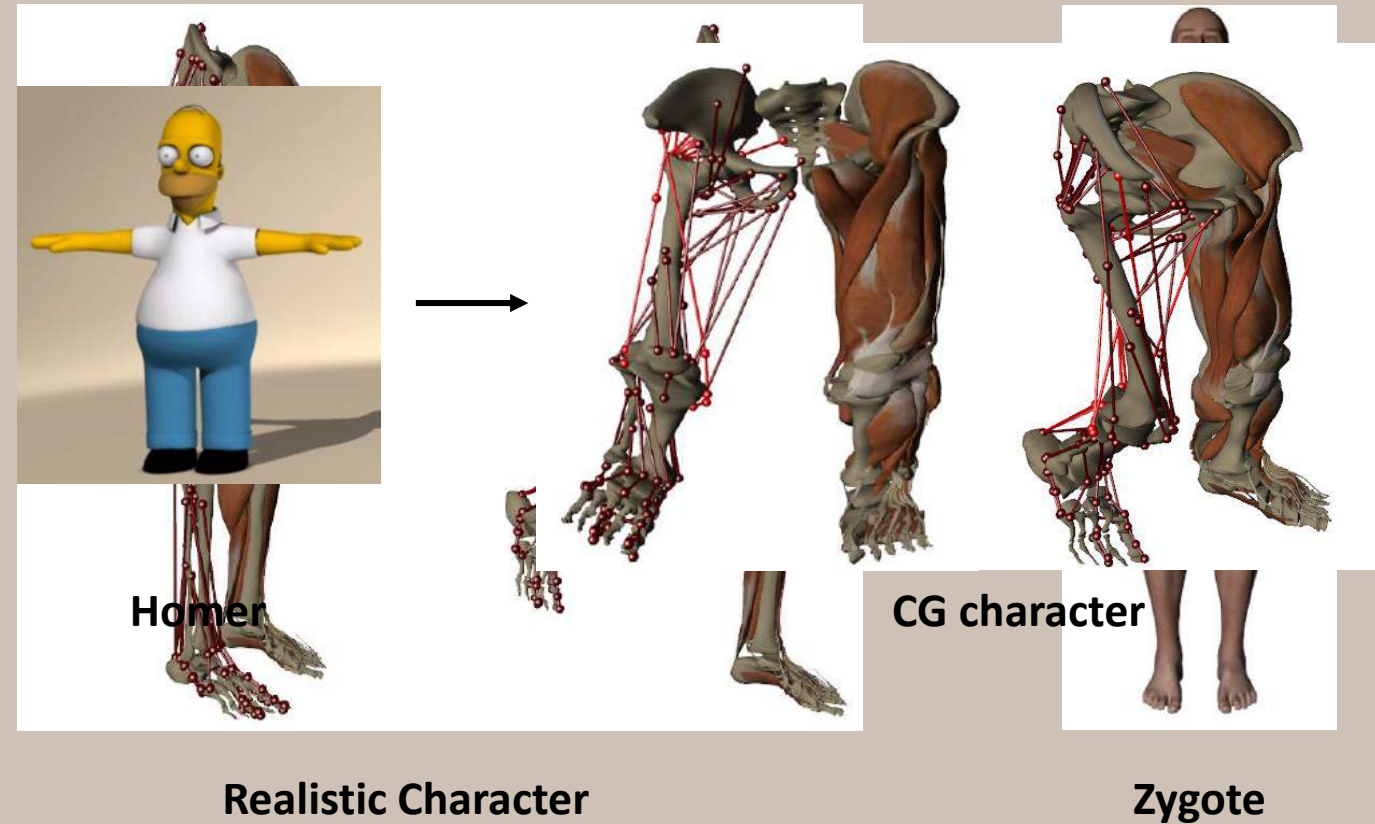


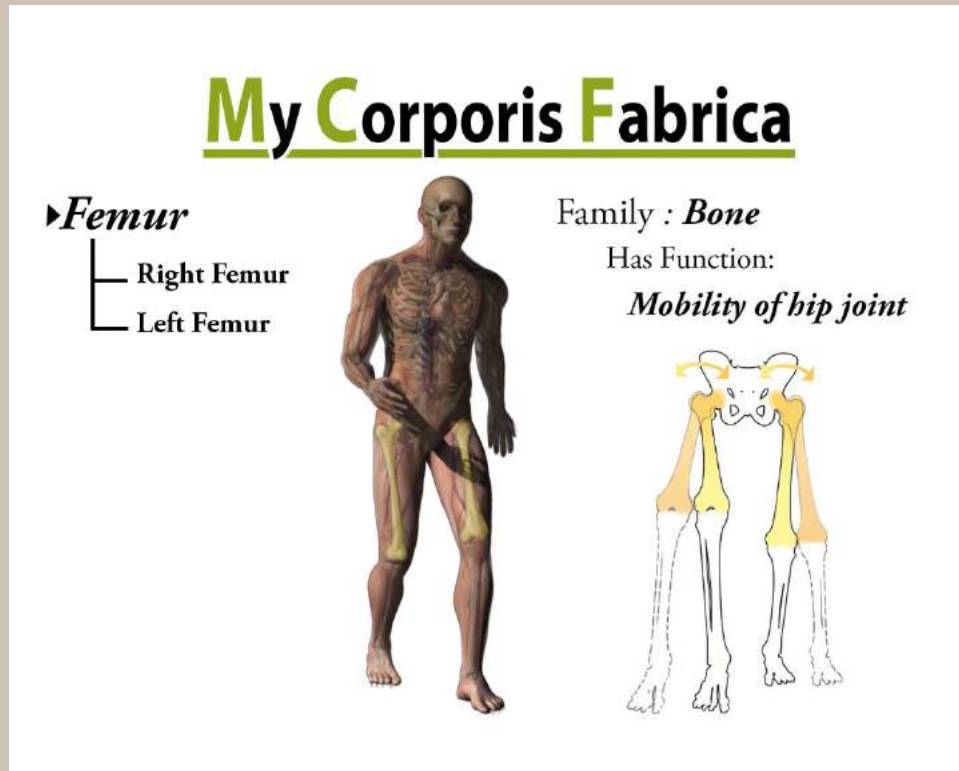
BioDigital Human [<https://www.biodigitalhuman.com/>]

- Anatomical System Navigation (musculoskeletal, nervous, ...)
- Simple Search by KeyWord (« femur », ...)
- Conditions Selection (knee arthrosis, ...)
- Precomputed Animation (breathing, heart beating, ...)

What is missing?

- **Selections** (bones, muscles, ...)
- **Mechanical Properties** (stiffness, mass, ...)
- **Connections** (muscle insertion, contacts, ...)
- **Wrapping** (zygote, homer, ...)





Related Work

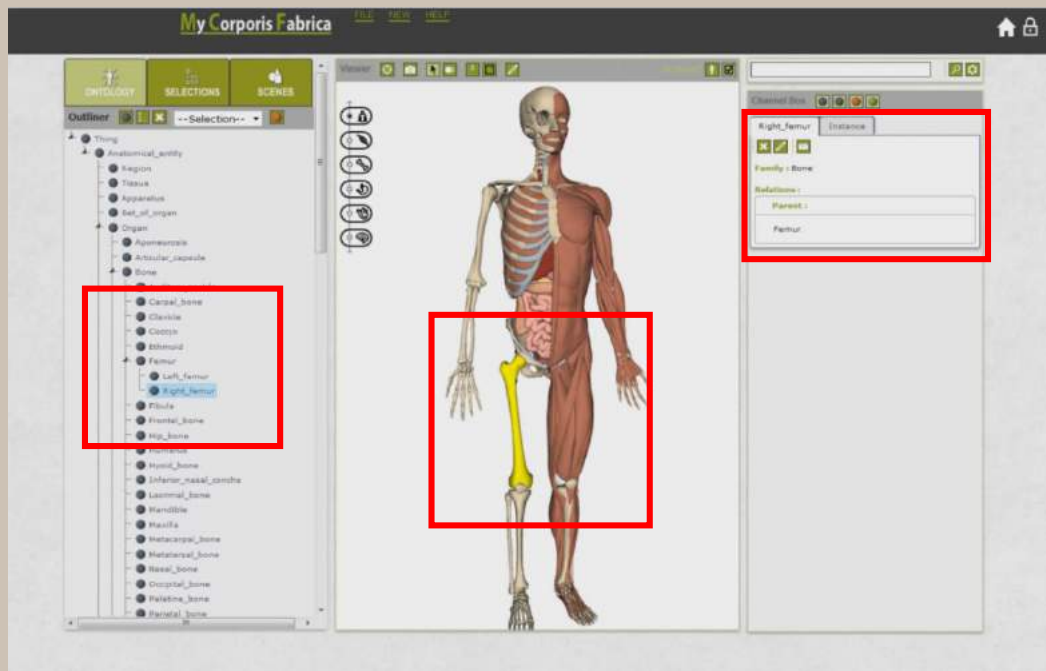
- Related Applications
- Limitations

MyCF Architecture

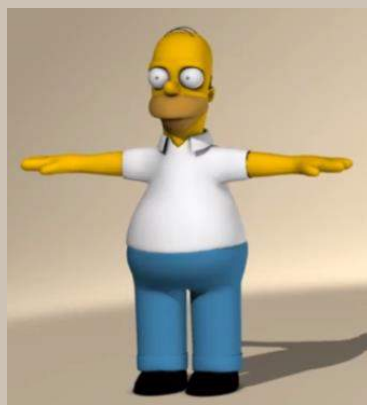
- Ontology Navigation
- 3D Data
- Simulation Models

Conclusion

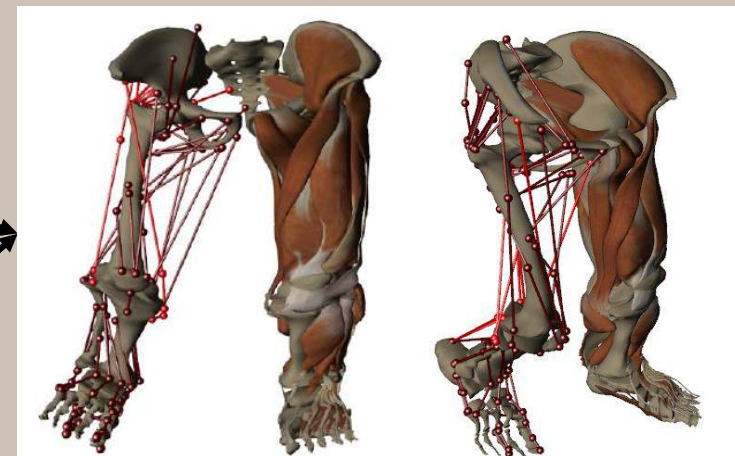
MyCF Overview



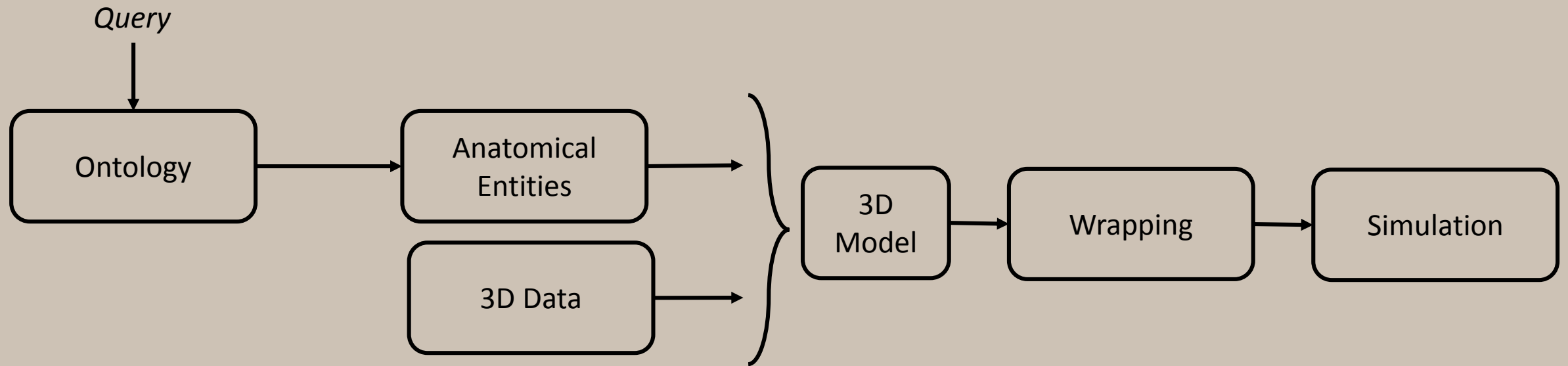
Anatomy Knowledge

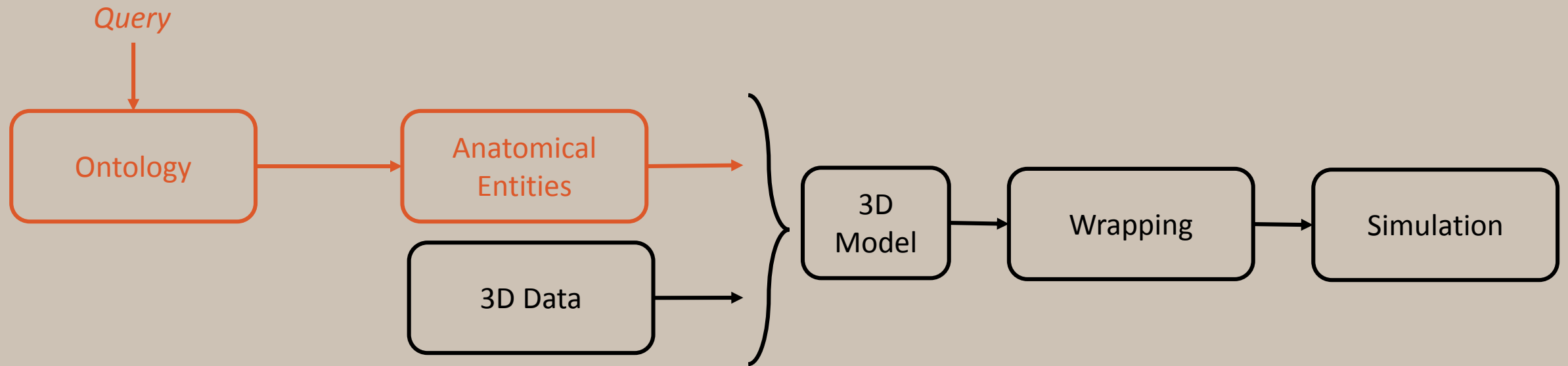


3d shape : Customisation

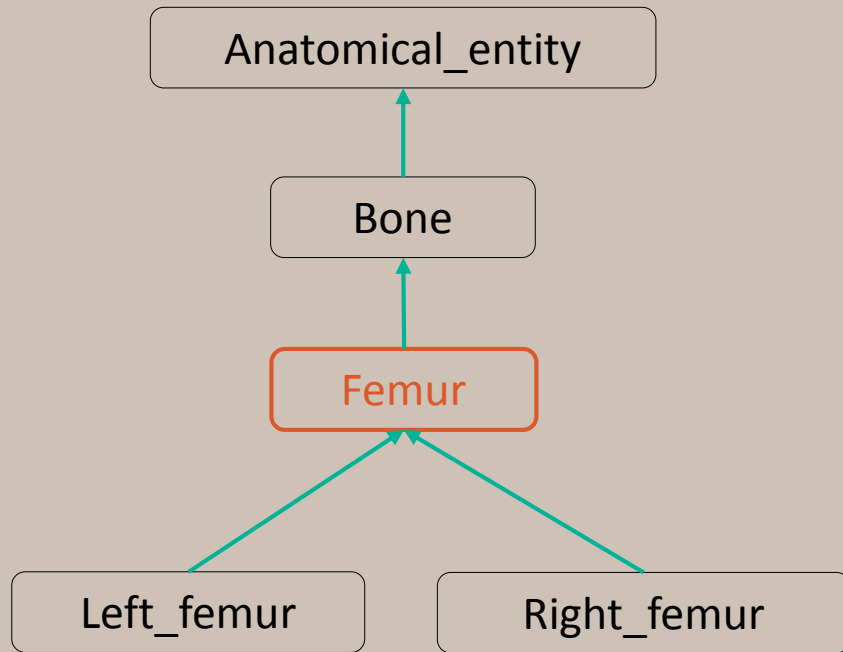


Simulation

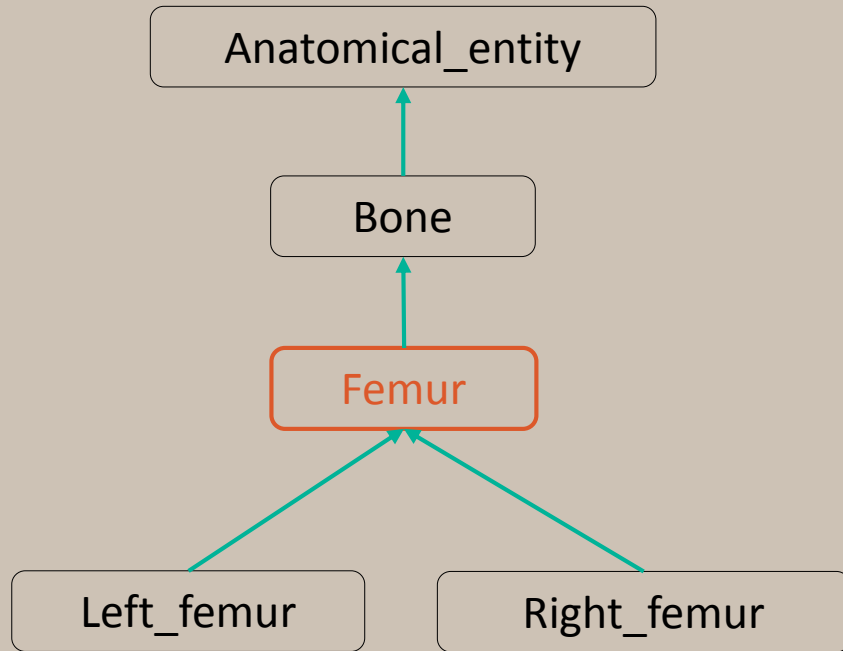




“The femur is a bone”



“The femur is a bone”



Ontology definition

An **Ontology** formally **represents knowledge** as a hierarchy of concepts within a domain, using a shared vocabulary to denote the types, properties and interrelationships of those concepts.

FMA (Foundational Model of Anatomy)

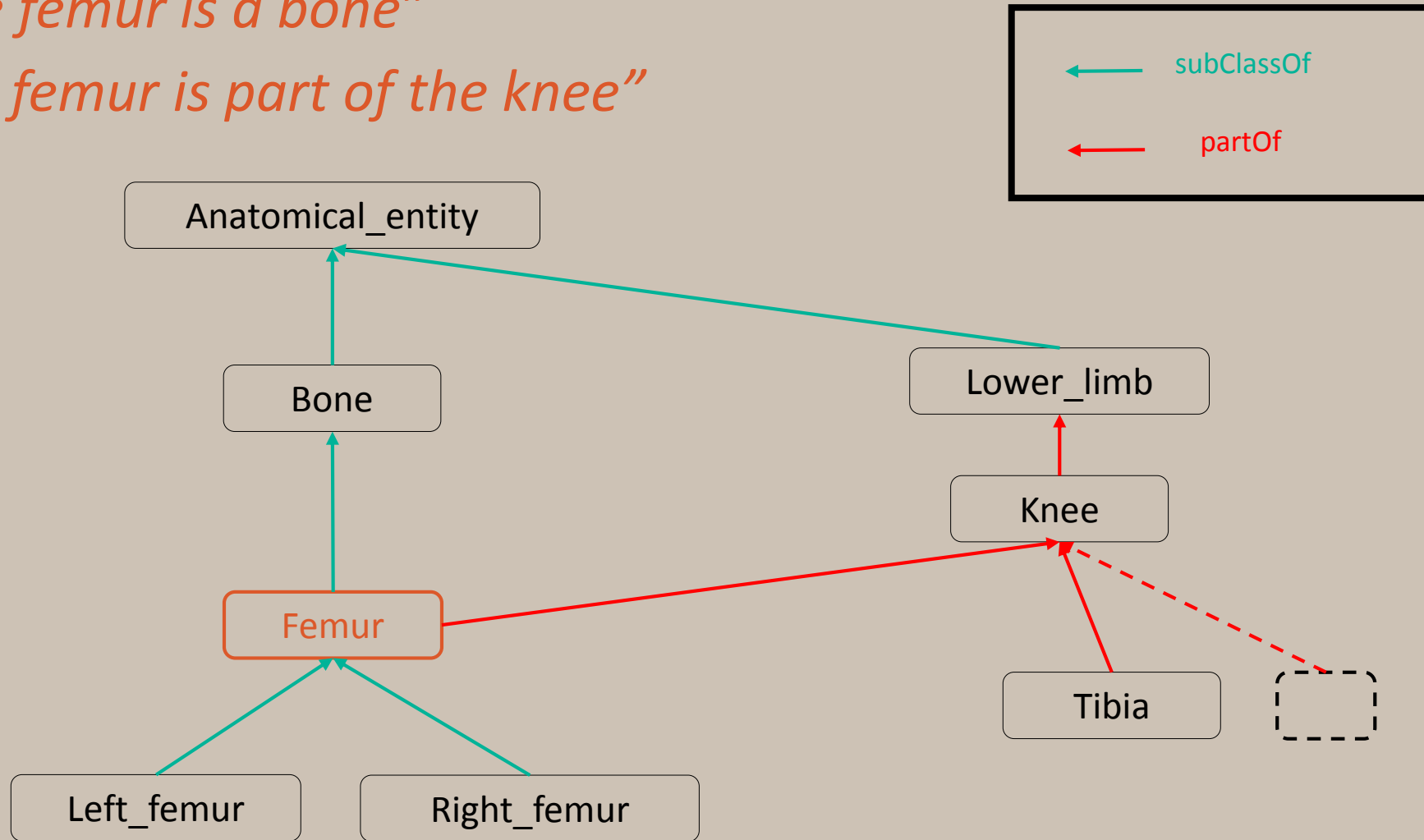
- Full-Body Anatomy Ontology Standard
- 80 000 entities

A reference ontology for biomedical informatics the foundational model of anatomy (FMA)

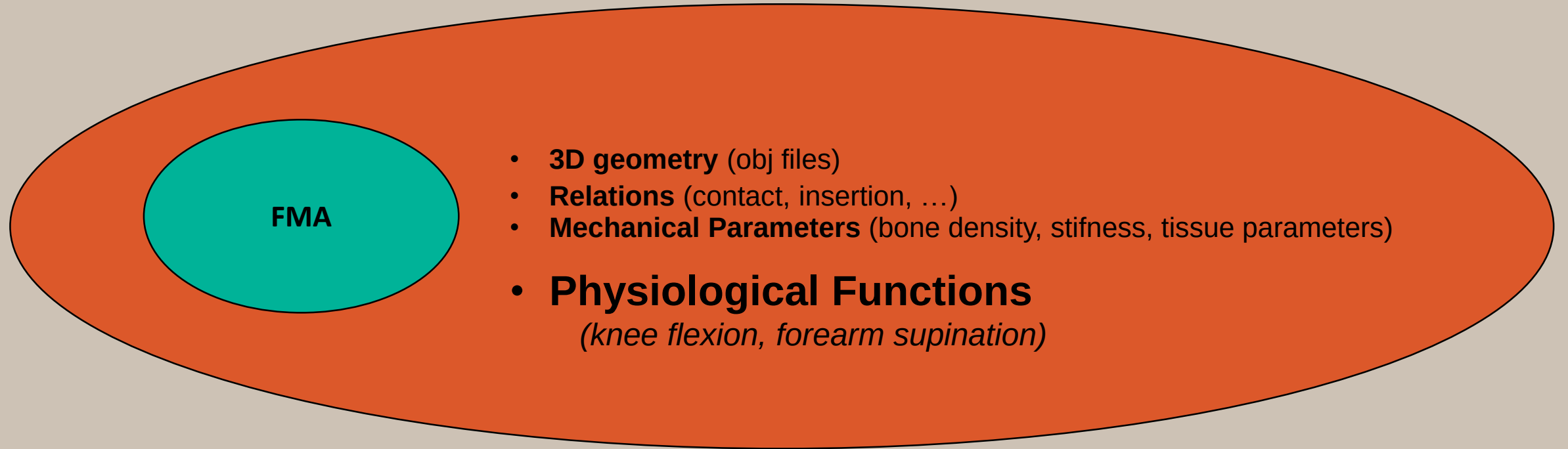
Rosse C, Mejino JLV
J Biomed Inform 2003, **36**:500

“The femur is a bone”

“The femur is part of the knee”



MyCF (INRIA, Grenoble University Hospital)

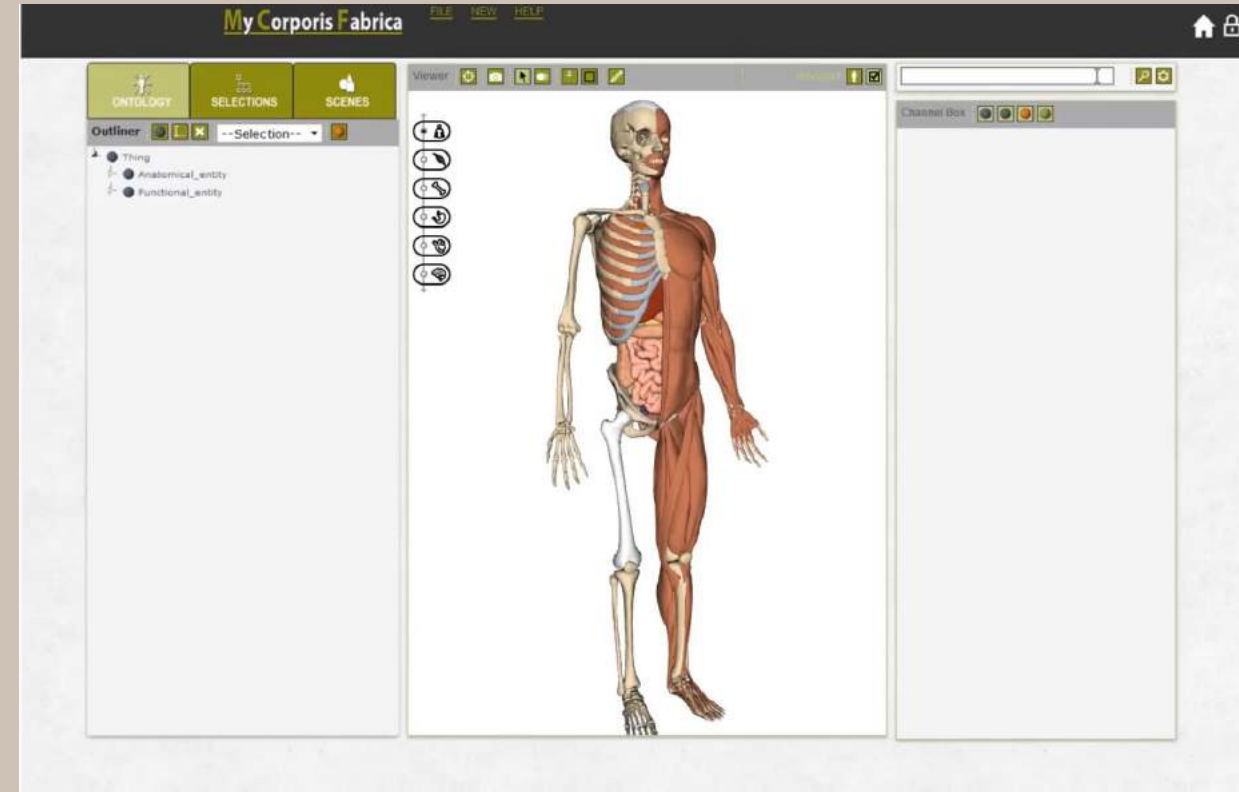
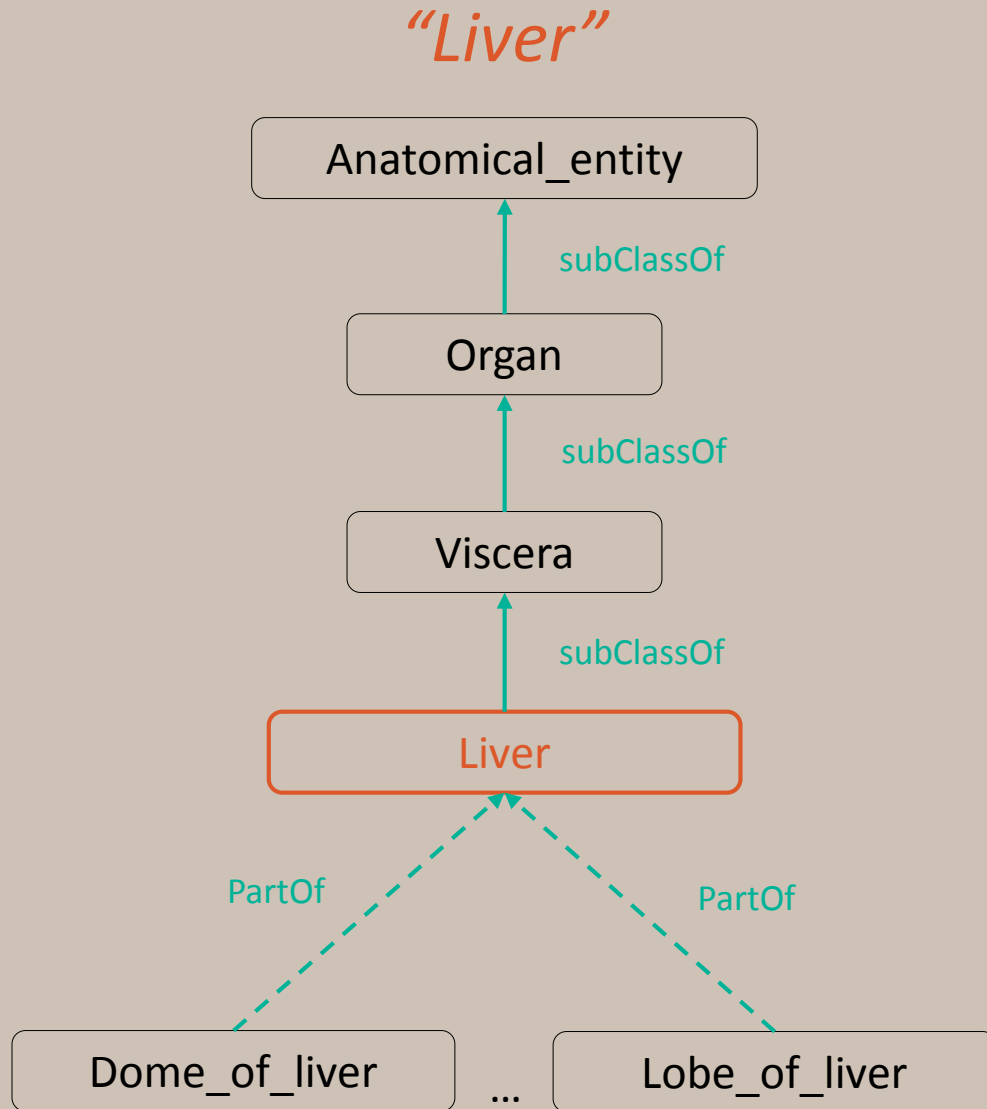


From Generic to Specific Musculoskeletal Simulation using an Ontology-based Modeling Pipeline

Ali-Hamadi DICKO, Benjamin GILLES, François FAURE, Olivier PALOMBI
Intelligent Computer Graphics, 2012

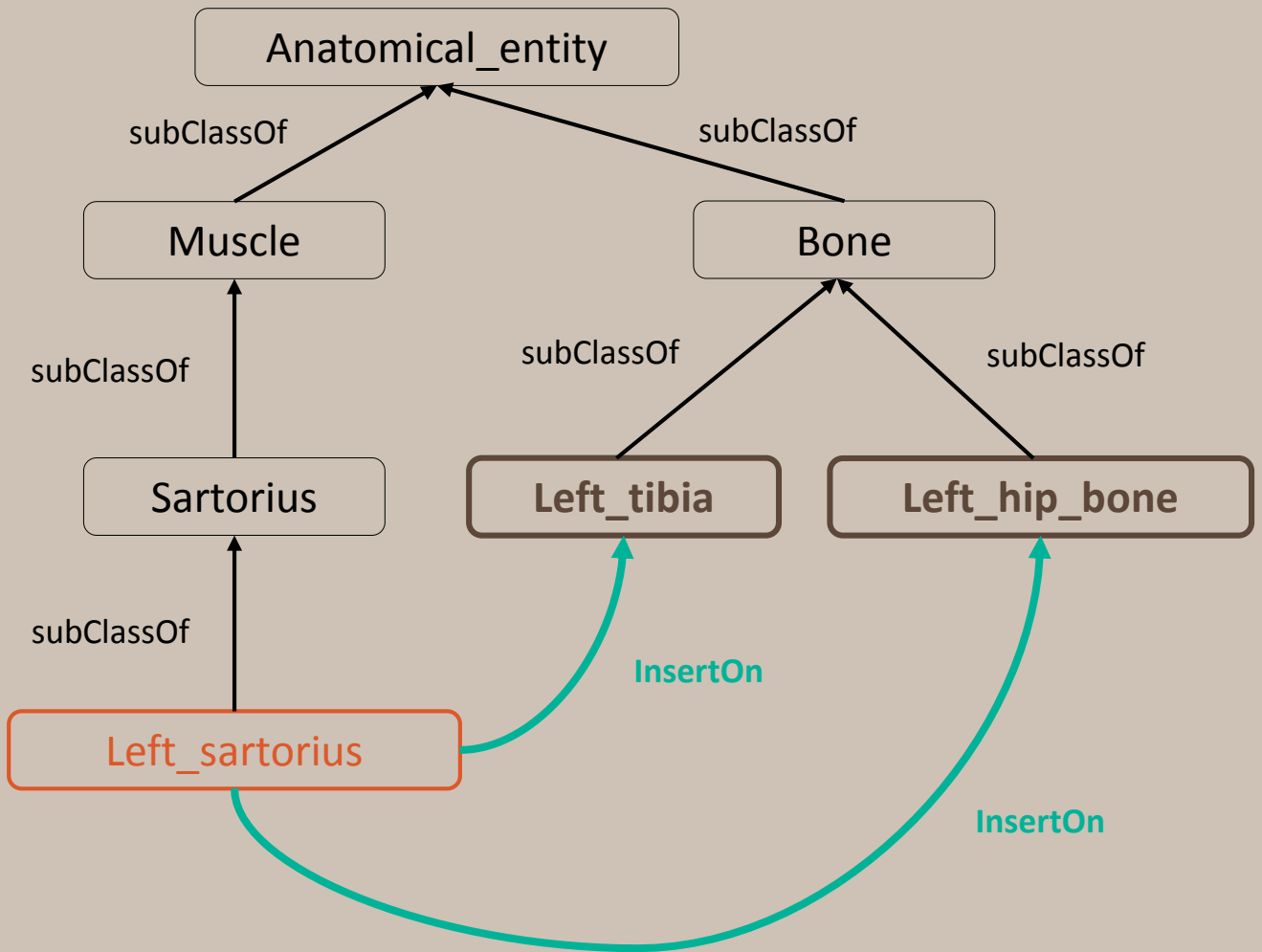
My Corporis Fabrica : an ontology-based tool for reasoning and querying on complex anatomical models

Olivier PALOMBI, Federico ULLIANA, Valentin FAVIER, Jean-Claude LEON, Marie-Christine ROUSSET
Journal of Biomedical Semantics, 2014



- 3D mesh associated
- Access to Anatomical Properties (type, description, ...)
- Relation with other Anatomical Entities (dome, lobe, ...)

“Bones on which the left sartorius muscle is inserted ?”



Answer

?bone	?individual	?mesh
mcf:Left_tibia	mcf:id6	../l_tibia.obj
mcf:Left_hip_bone	mcf:id7	../l_hip_bone.obj

3D view

Before query

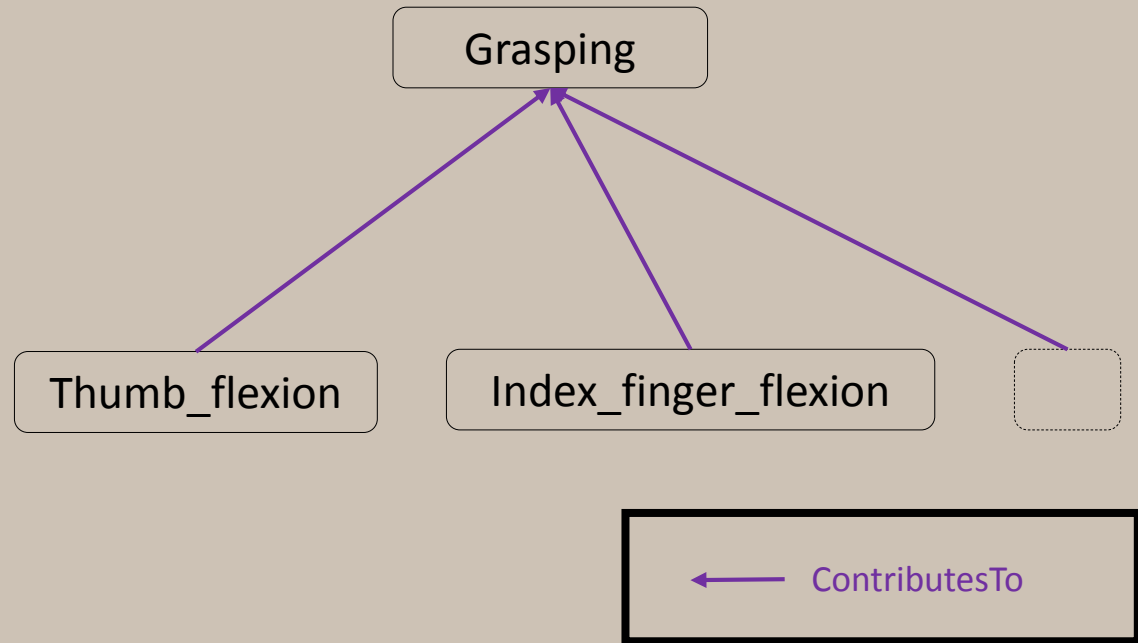
Bone insertions of sartorius

left hip bone (mcf:id7)

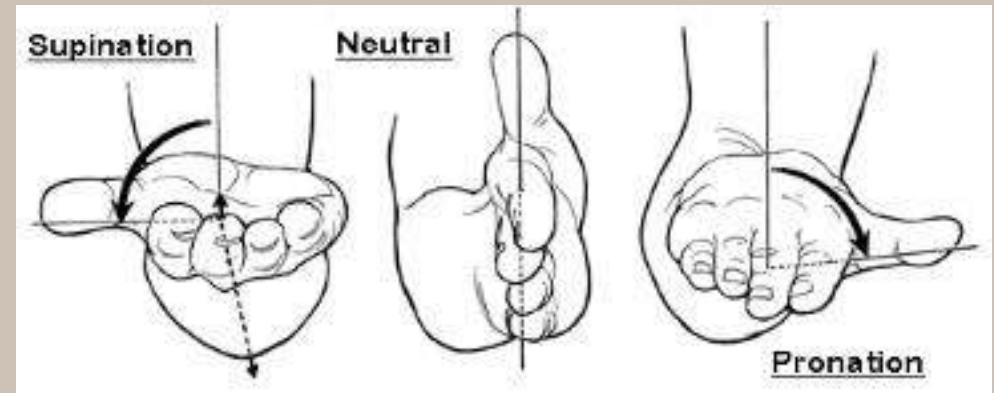
left sartorius (mcf:id1)

left tibia (mcf:id6)

“Grasping”

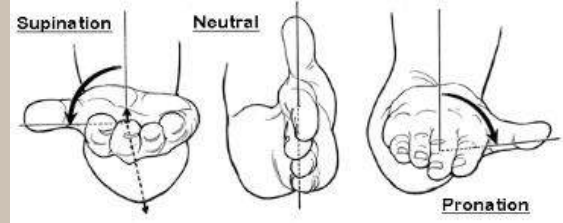
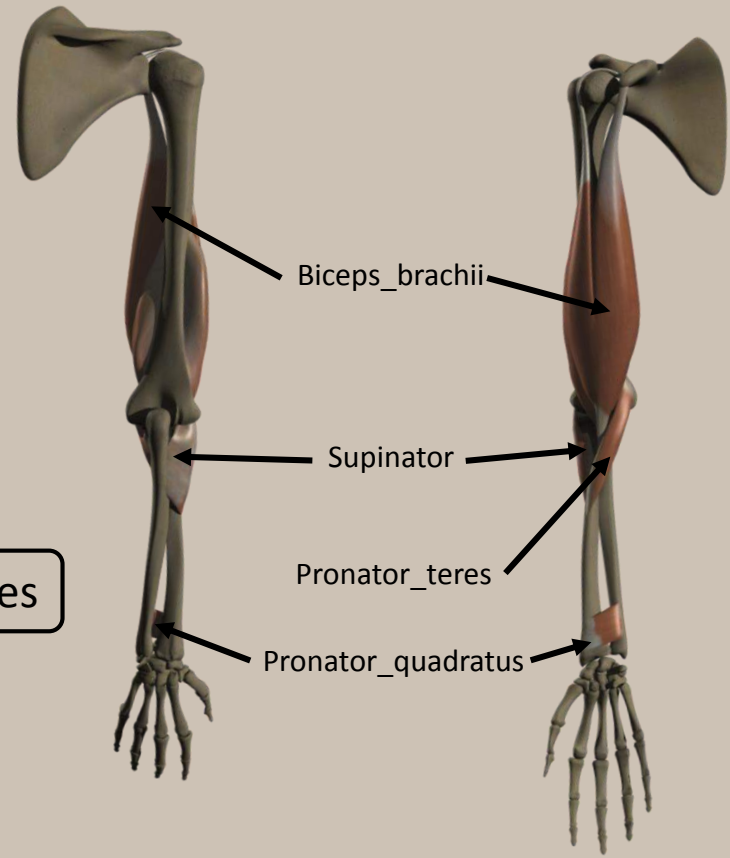
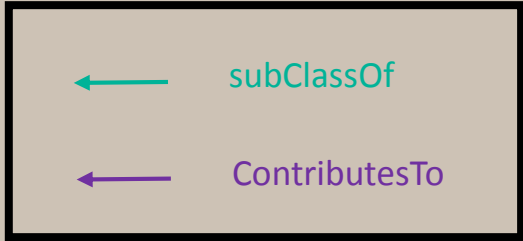
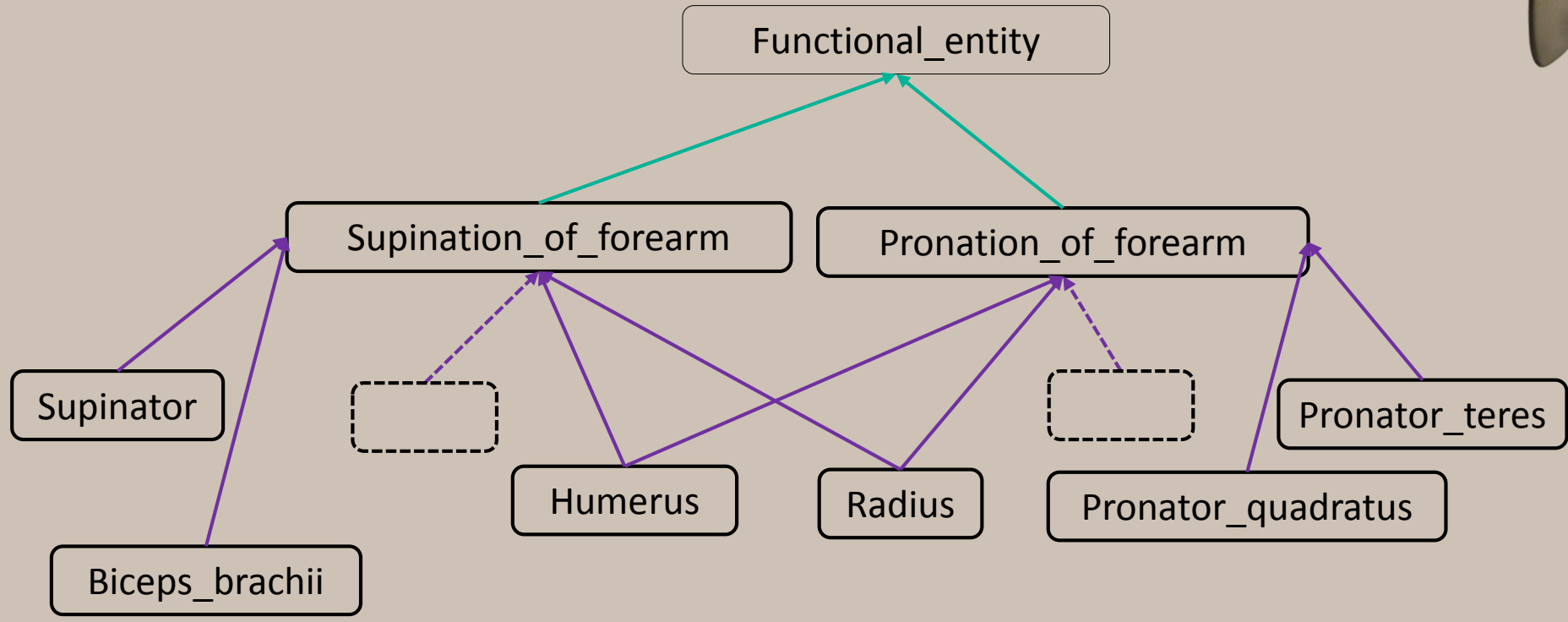


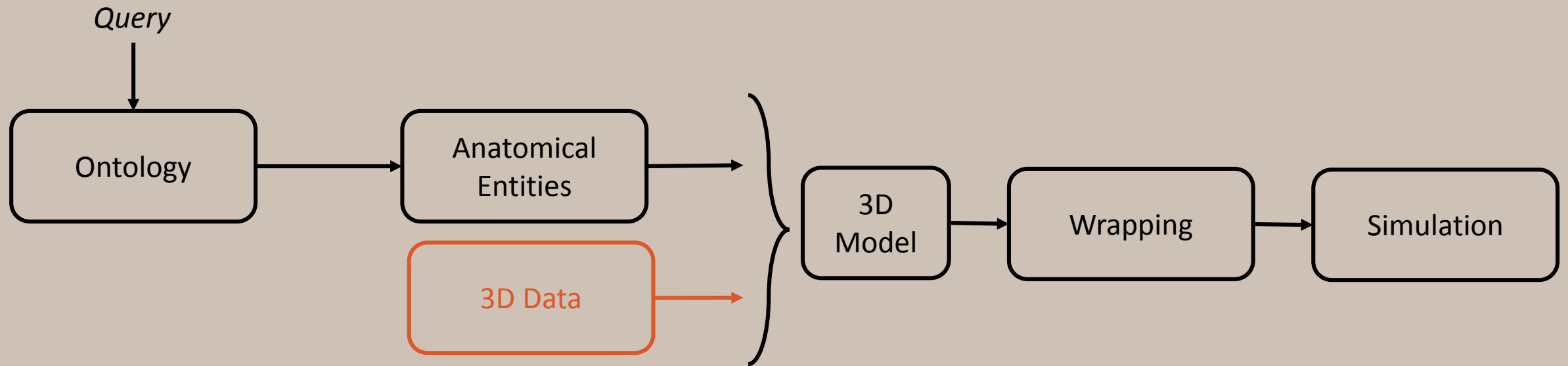
“Supination & Pronation”



Ontology Functions

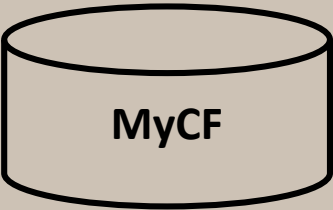
“Entities Contributing to Forearm Supination-Pronation”





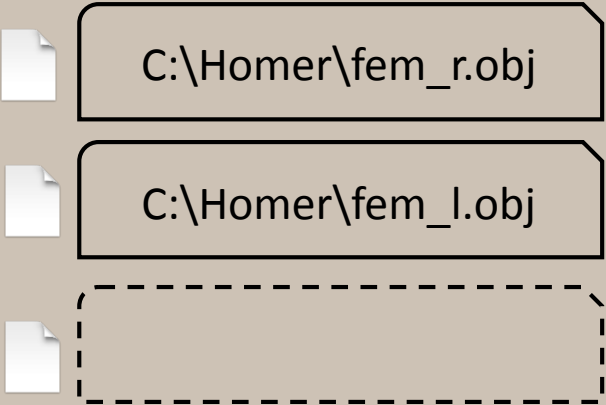
Mapping : XML file

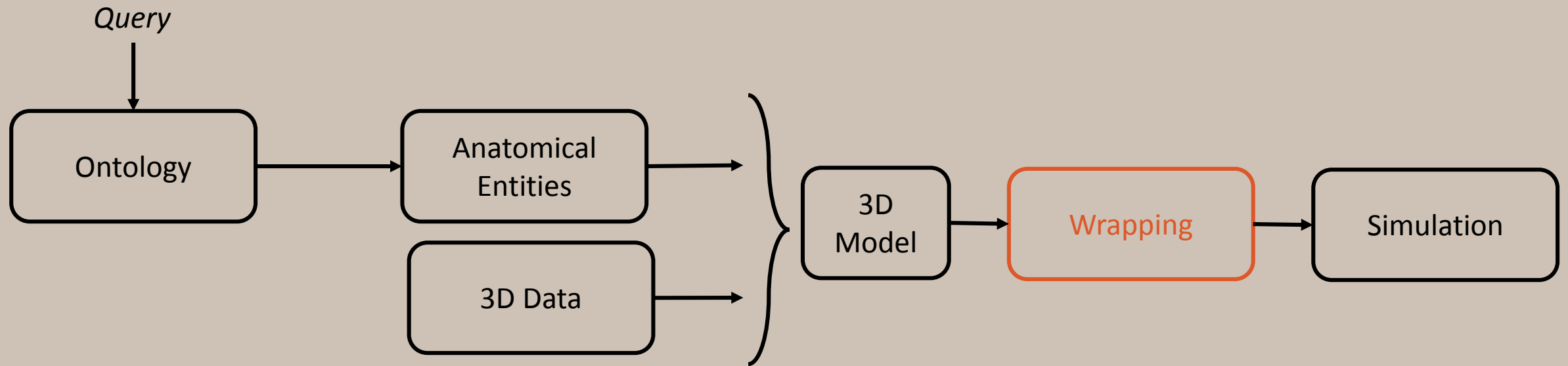
Anatomical Entities :

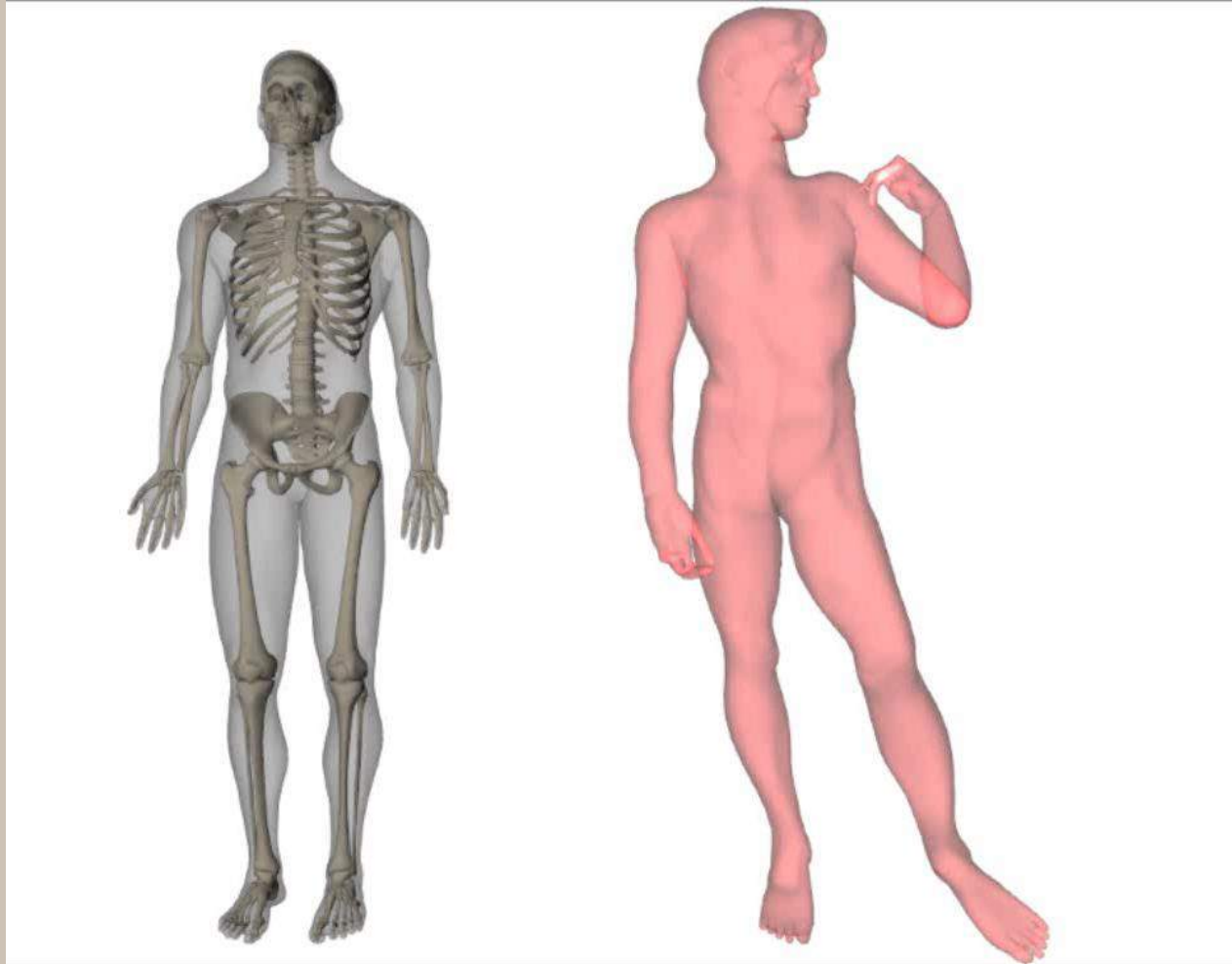


Standard Name	3D File
Right_femur	C:\Homer\fem_r.obj
Left_femur	C:\Homer\fem_l.obj

3D Anatomical Model

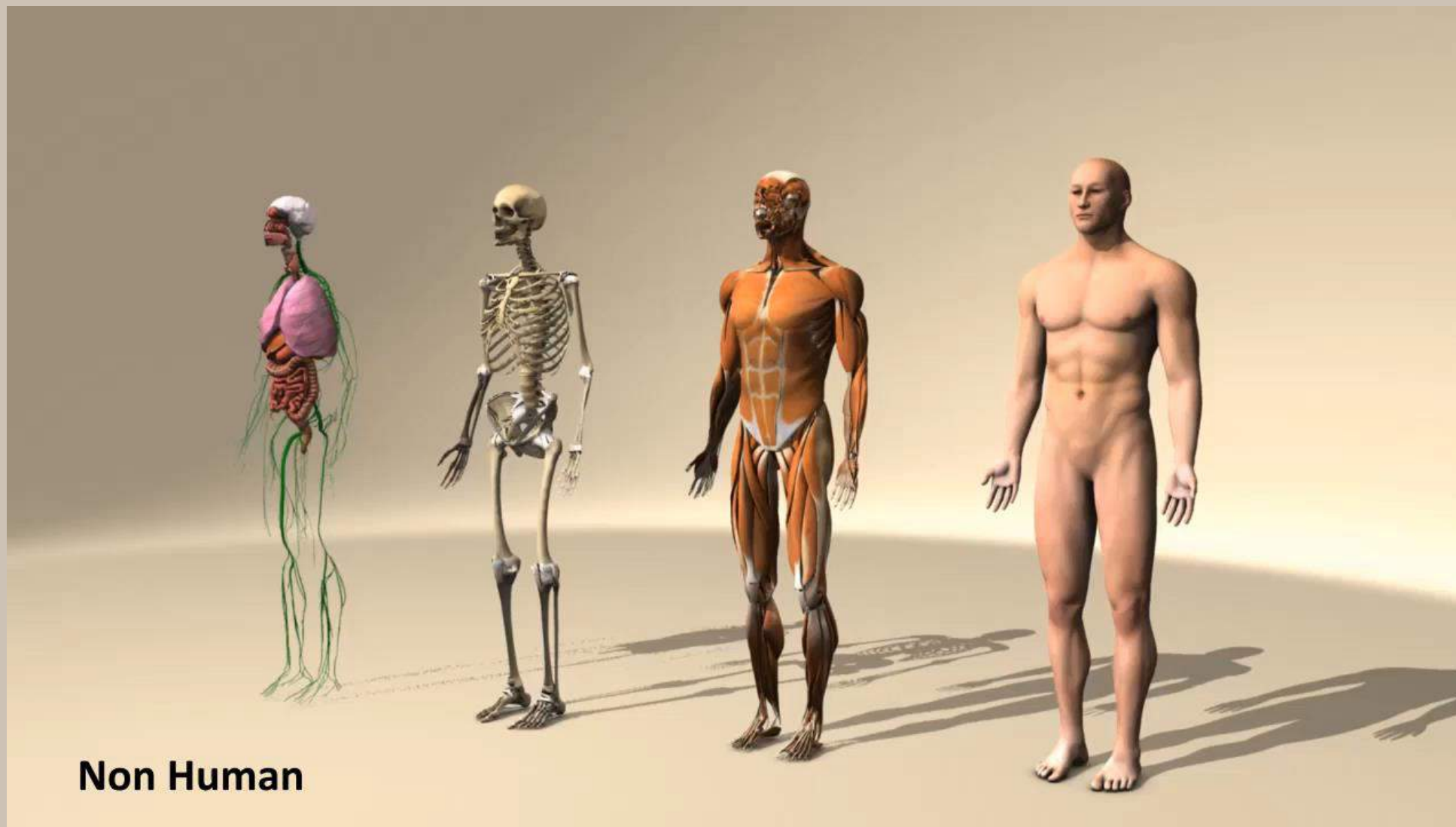






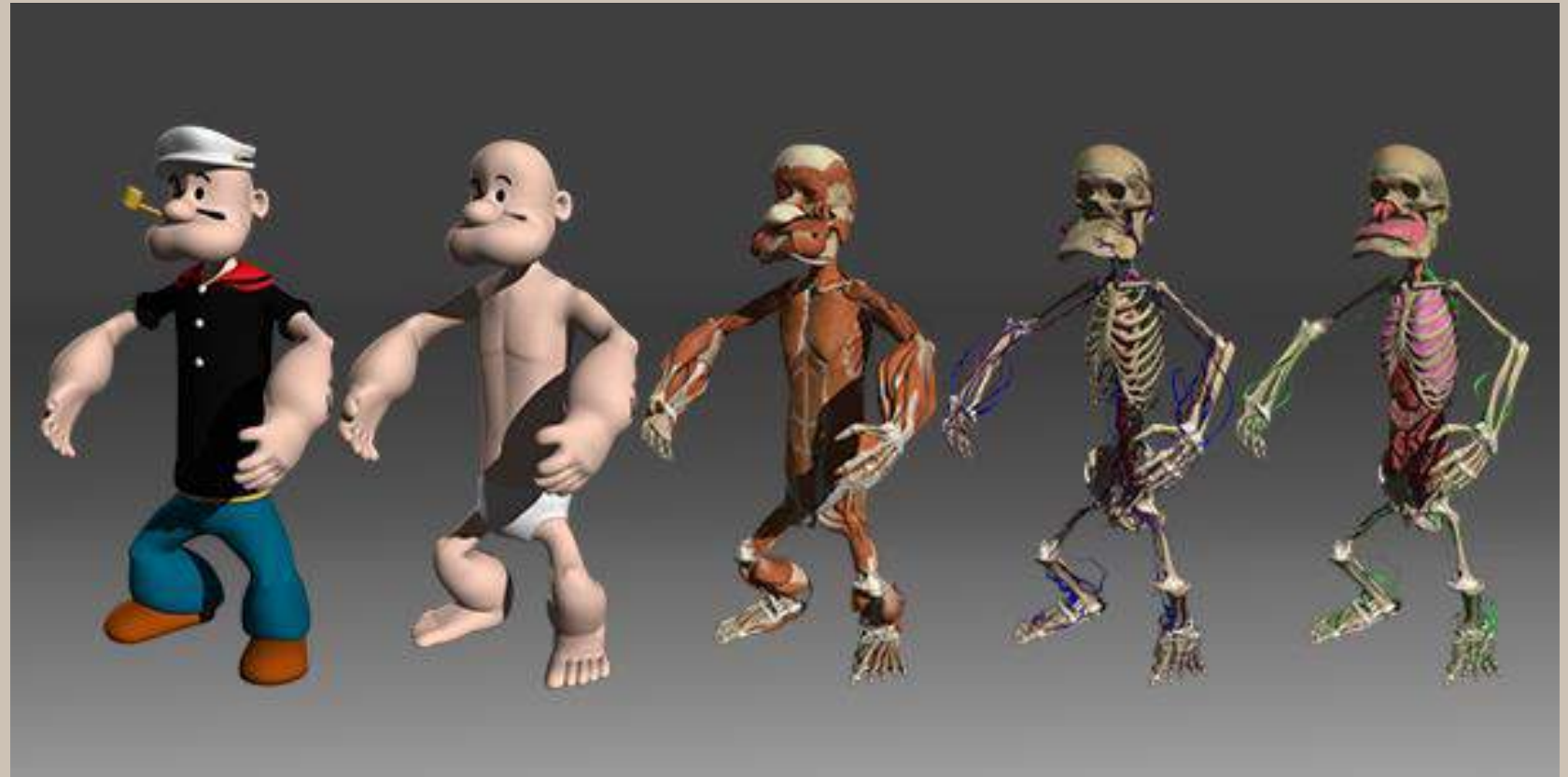
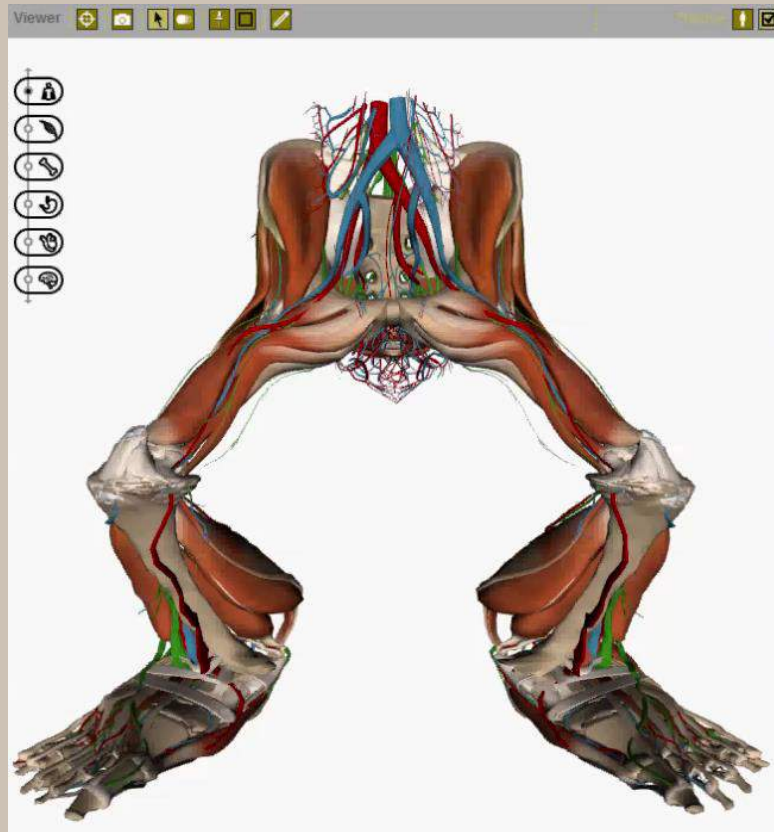
Anatomy Transfer

Ali-Hamadi DICKO, Tiantian LIU, Benjamin GILLES, Ladislav KAVAN, François FAURE, Olivier PALOMBI, Marie-Paule CANI
ACM Transactions on Graphics, 2013

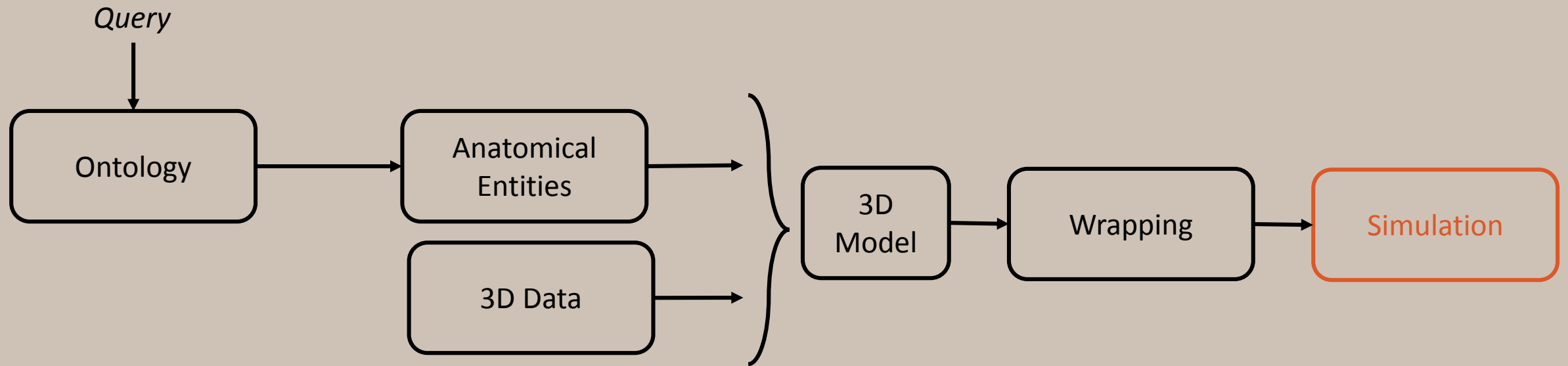


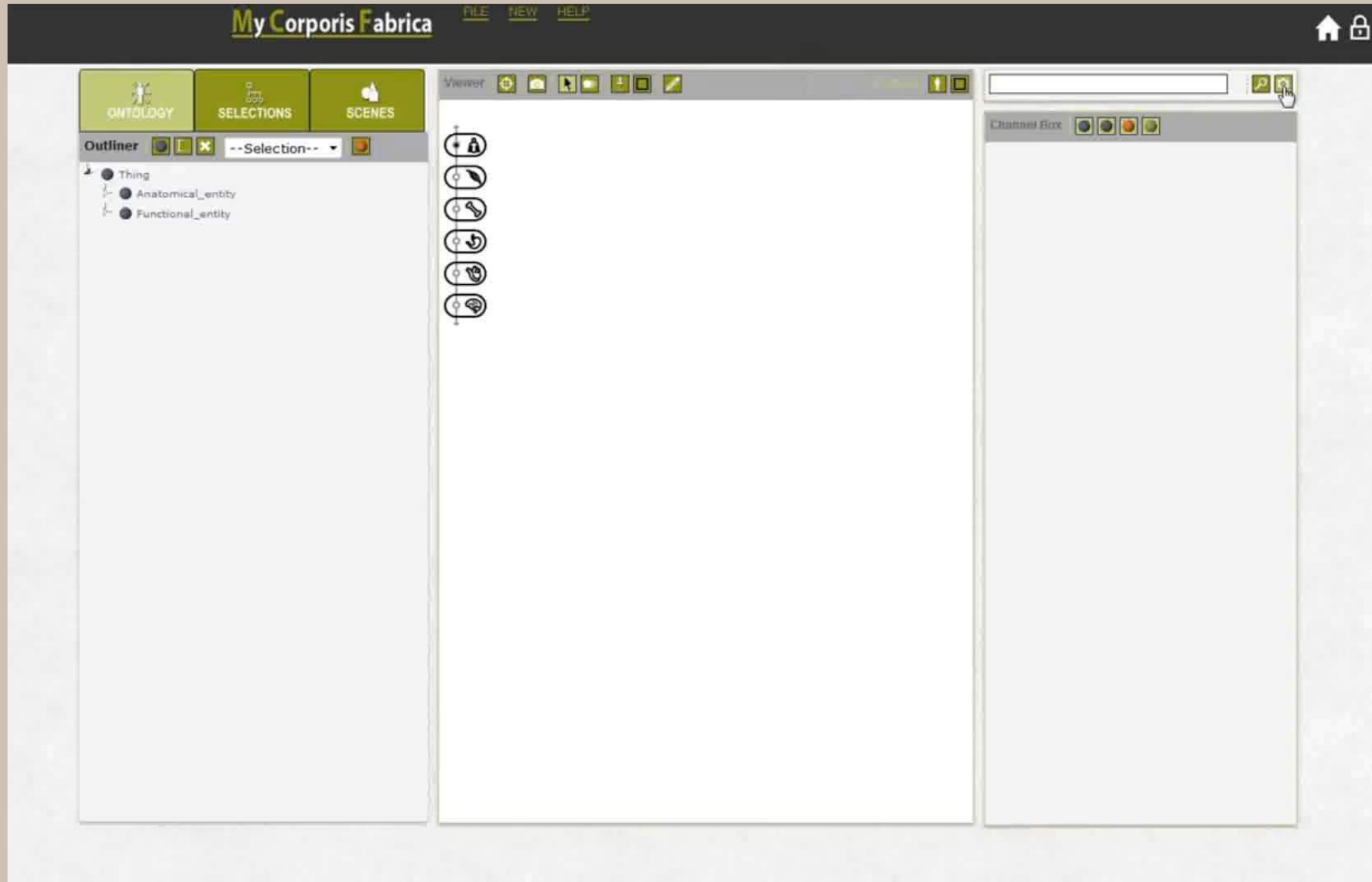
Non Human

Popeye Example

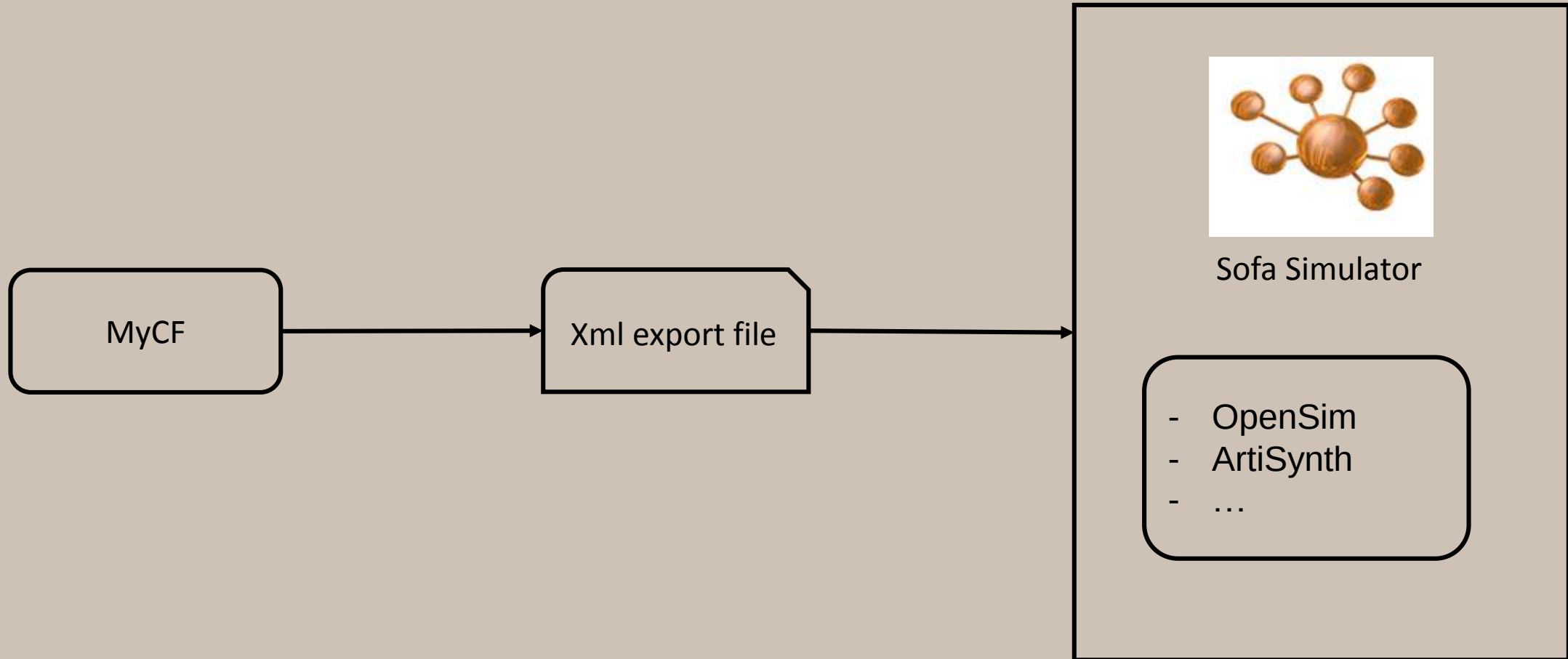


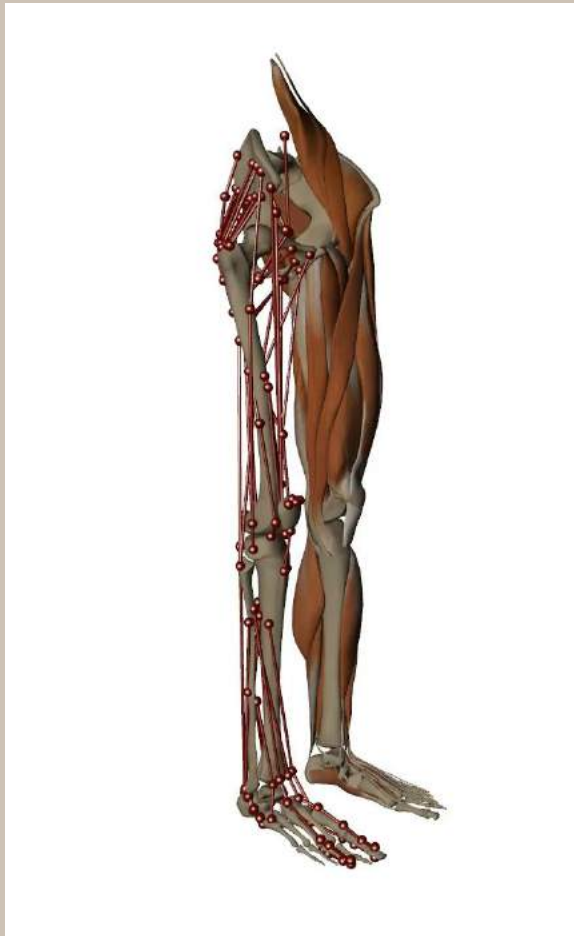
Popeye [Anatomy Transfer, 2013]





“How to obtain a simulable model ?”



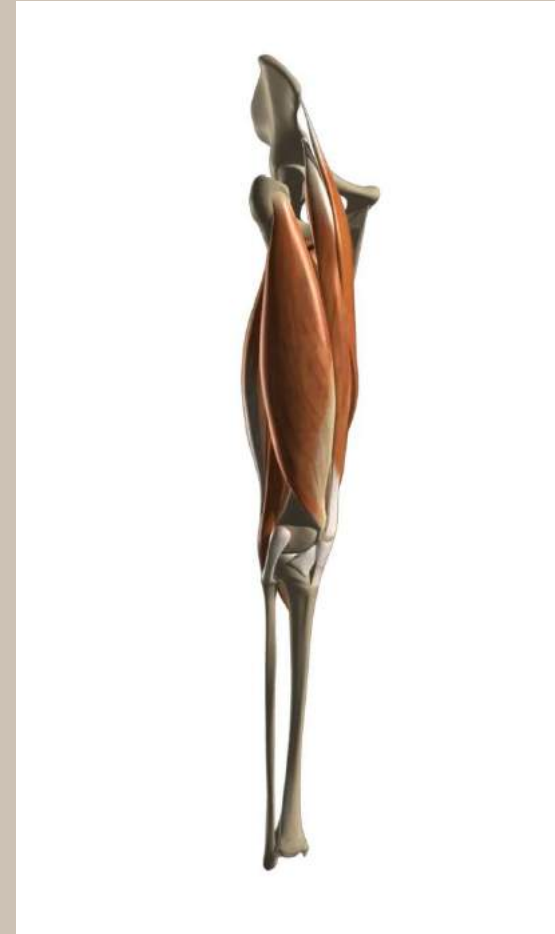


Zygote [1D Muscle]

Use : Study Muscle Activity

Muscles :

- Modeled using action lines
- Standard Model : OpenSim

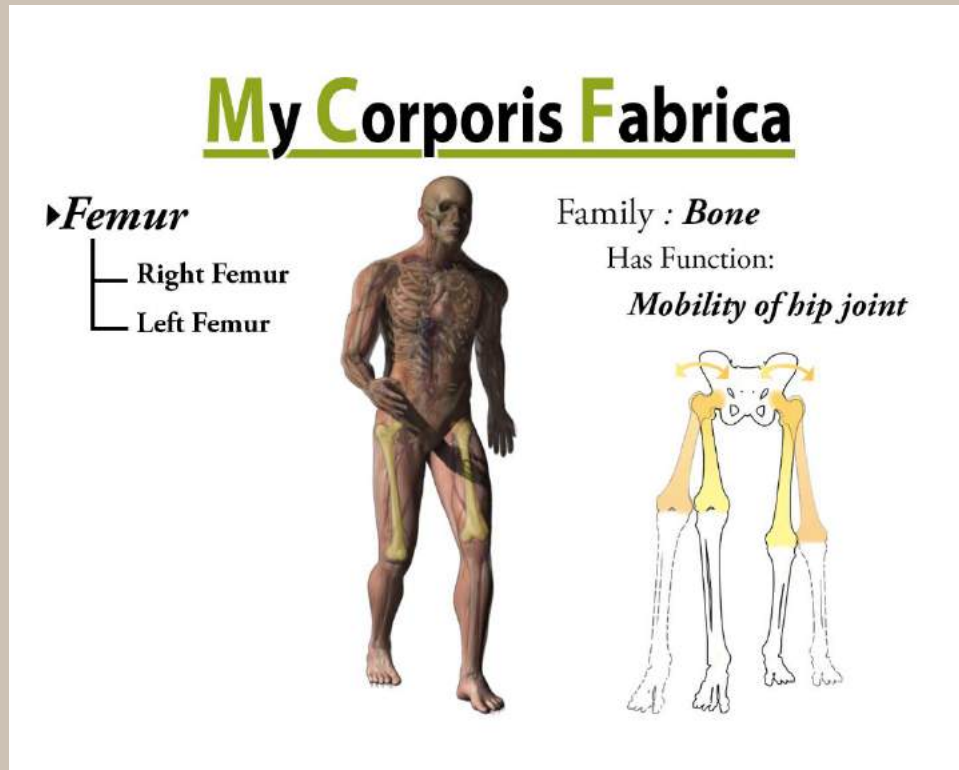


Zygote [3D Muscles]

Use : Illustrate role of ligaments

Muscles, Bones and Ligaments :

- 3D Shapes
- Material Properties



Related Work

- Related Applications
- Limitations

MyCF Architecture

- Ontology Navigation
- 3D Data
- Simulation Models

Conclusion

Conclusion

Conclusion :

- Custom 3d models
- Complex reasoning on Anatomical Knowledge
- Usable by everyone (general public to medical practioners)
- Useful for Learning and Simulating Anatomy

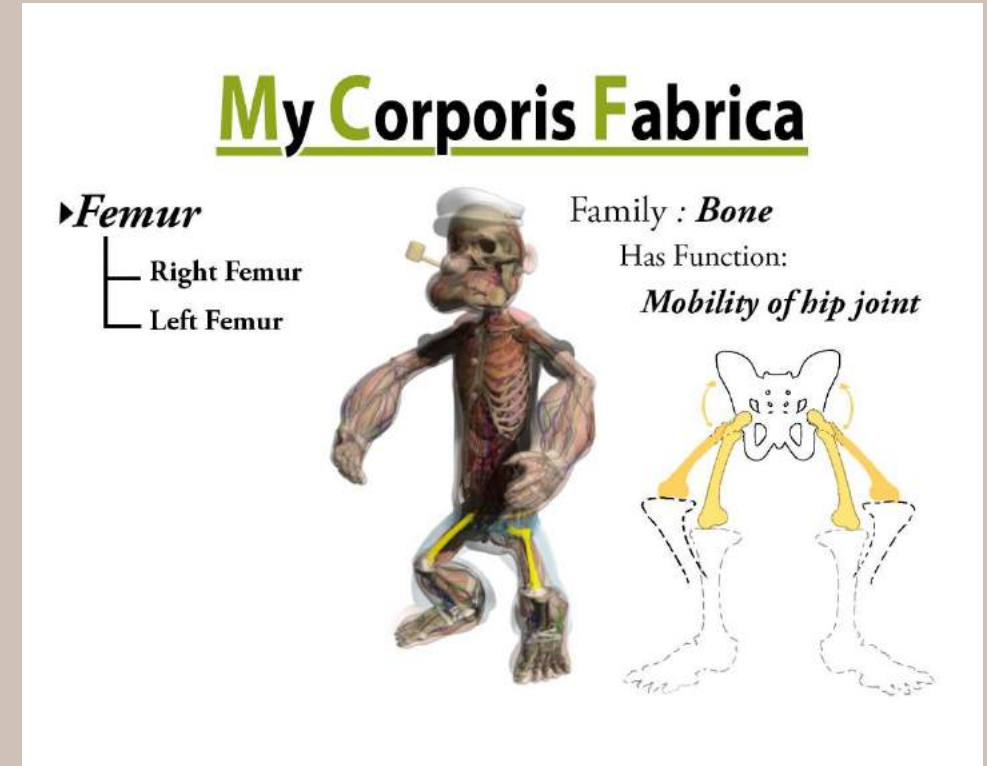
Future Work :

- Levels of detail
- Integrated entities (joints, ...)
- Type of models (1d muscles, 3d muscles, ...)

Test MyCF yourself :

a VirtualBox is ready at

<http://mycfbrowser.inrialpes.fr/mycf/>



Oops... Missing Something ?



Acknowledgements :

Vincent Douchez
Thomas Lemaire
Laura Paiardini
Estelle Charleroy
Jean-François Scariot

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