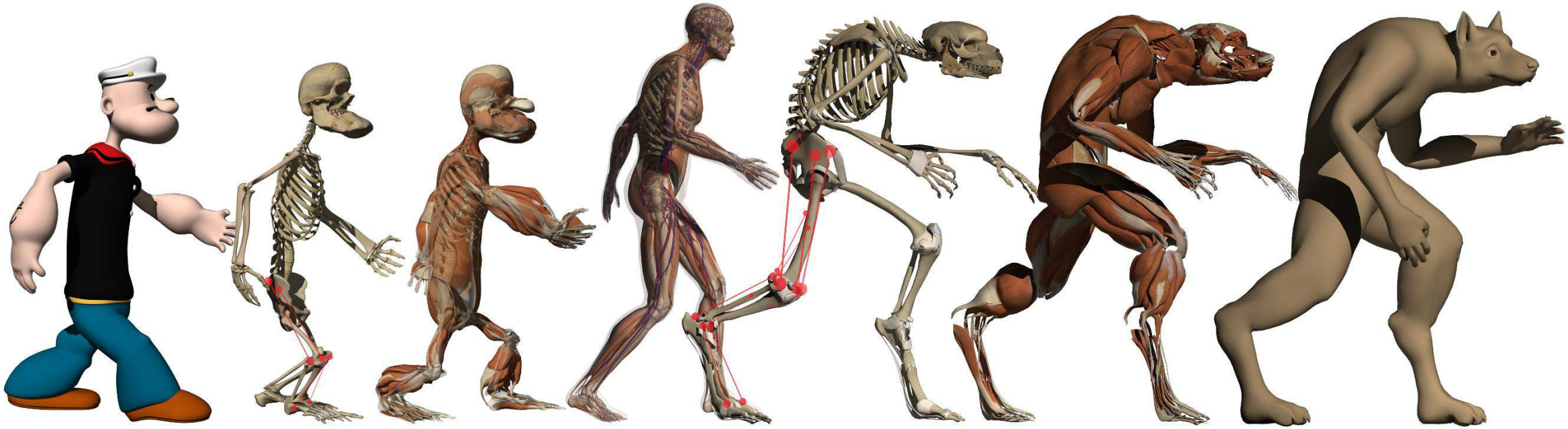
MyCorporisFabrica : Making Anatomy Easy

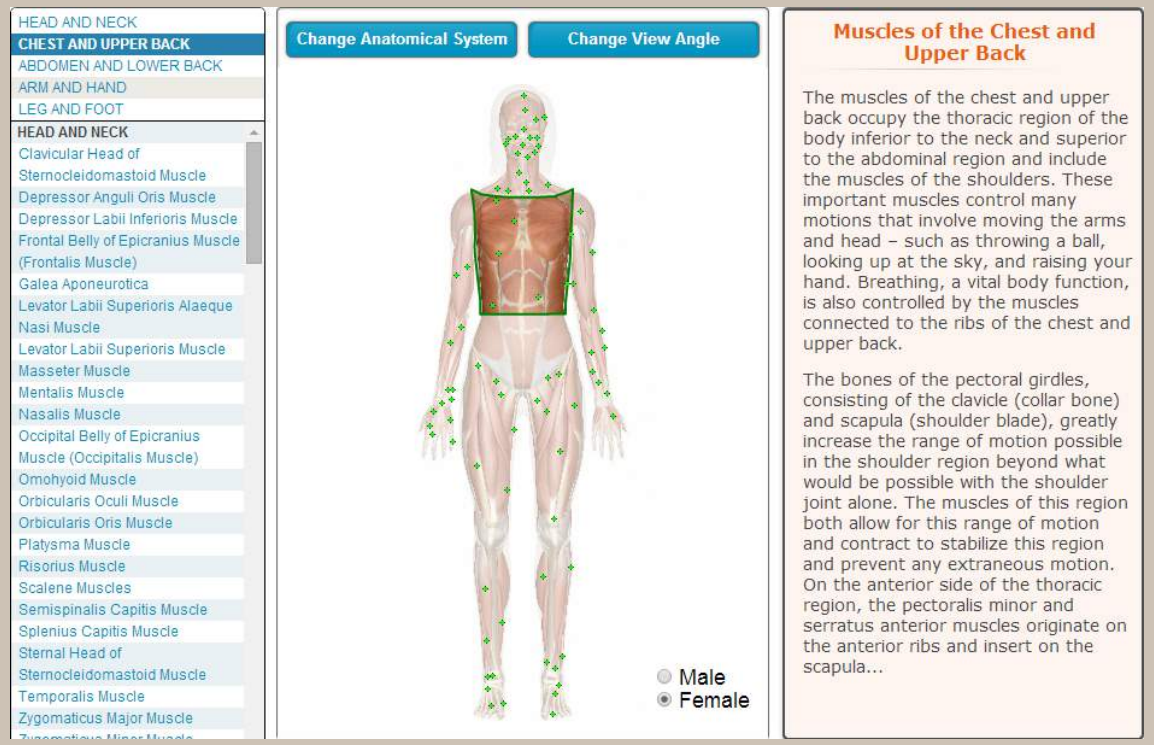


Armelle Bauer, Federico Ulliana, Ali-Hamadi Dicko, Benjamin Gilles, Olivier Palombi, François Faure

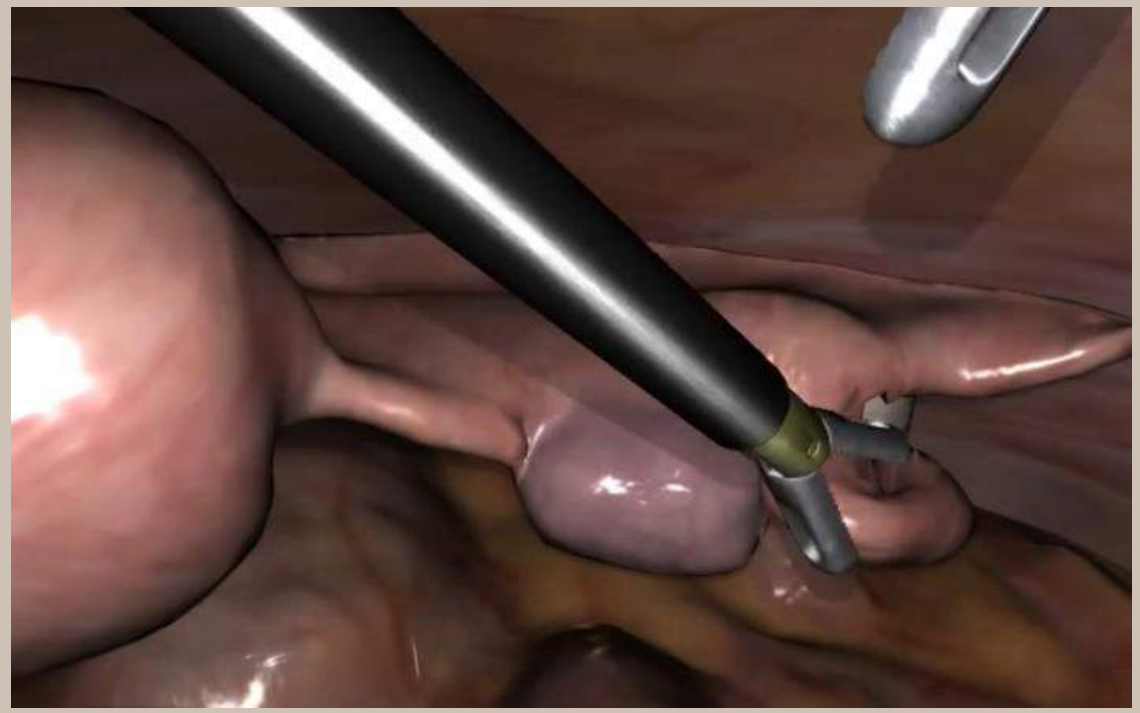
INRIA, LJK-CNRS, TIMC-IMAG, Persyval-Lab, Univ. Grenoble Aples

SIGGRAPH2014 Vancouver NATURALLY DIGITAL

Context : Medical



Medicine [*InnerBODY, 2013*]



Medical Simulator[LapSim, 2012]

Context : Animation

Animation [*Avatar, 2009*]

Anatomical Elements :

Bones, Muscles, Tendons, Fat, Trachea

Context : Visual Effects

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**

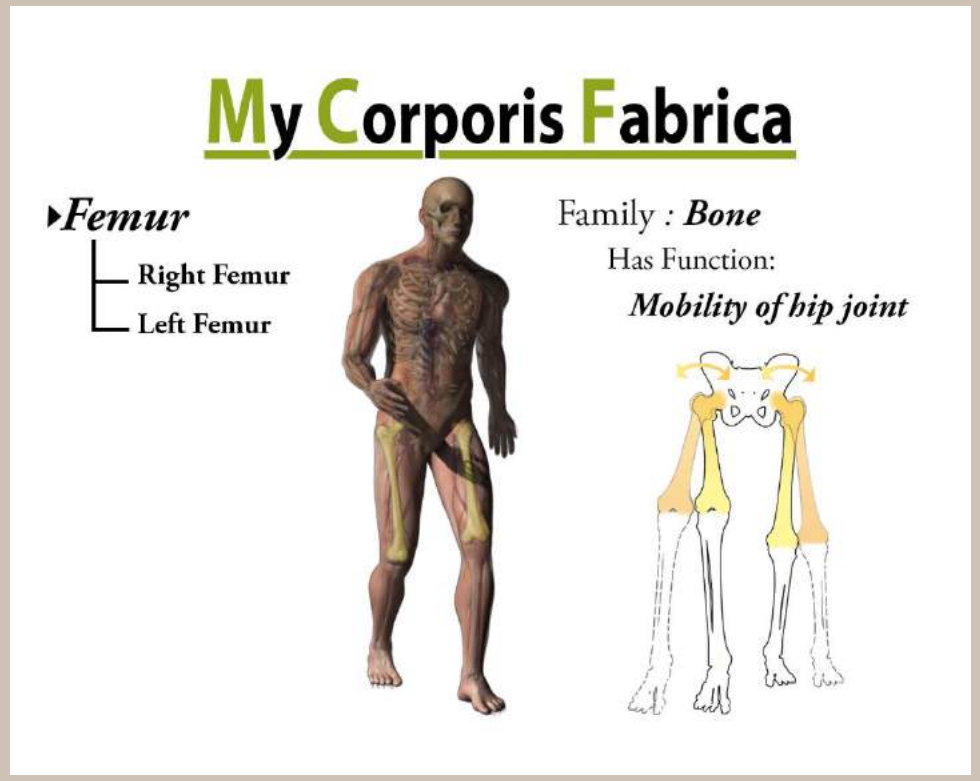
3D Shape Modeling

3- **Create Mechanical Model**

Physiological Properties

Mechanical Properties

Overview

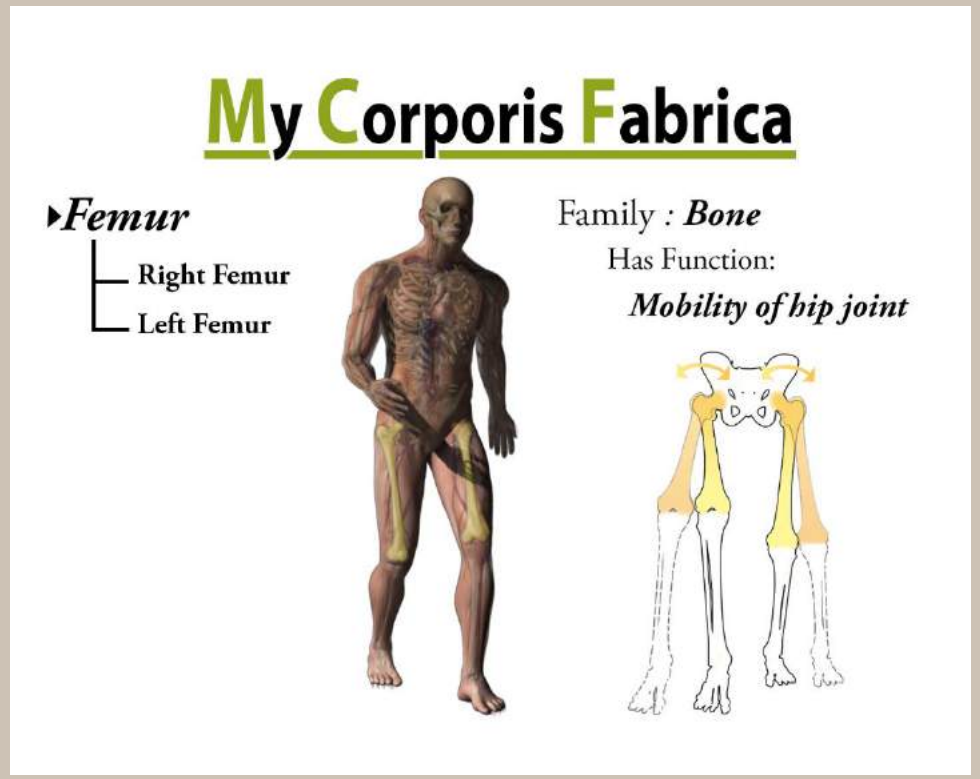


Related Work
- Related Applications
- Limitations

MyCF Architecture
- Ontology Navigation
- 3D Data
- Simulation Models

Conclusion

Overview



Related Work

Related Work
- Related Applications
- Limitations

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Conclusion

Related Applications

Zygote BODY [*http://www.zygotebody.com/*]

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

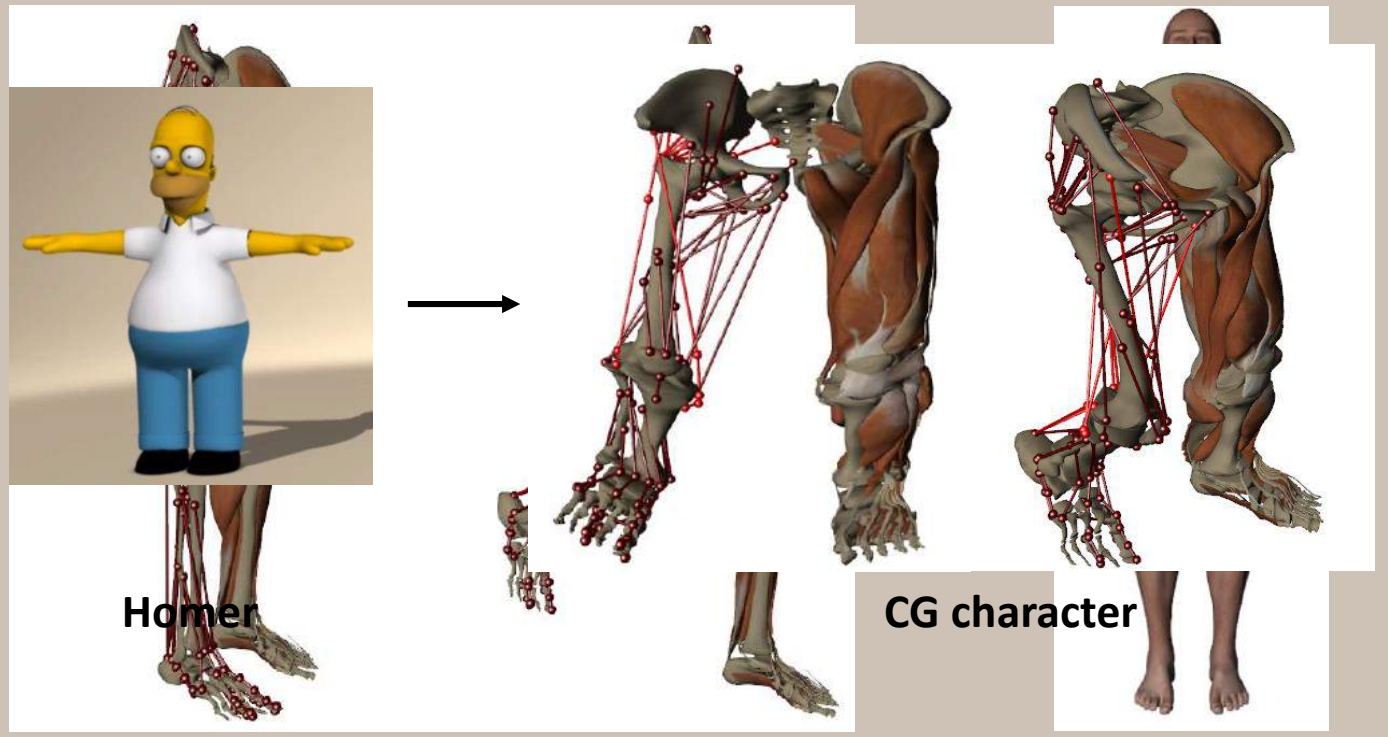
BioDigital Human [*https://www.biodigitalhuman.com/*]

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

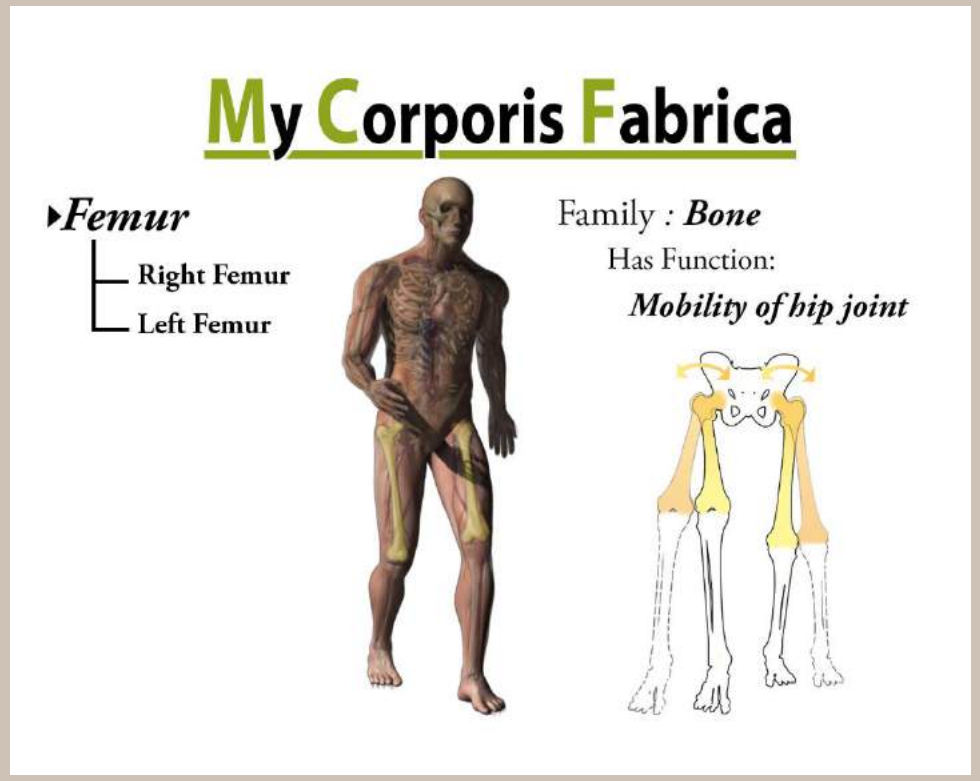
Limitations

What is missing?

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



Overview



MyCF Architecture

Related Work
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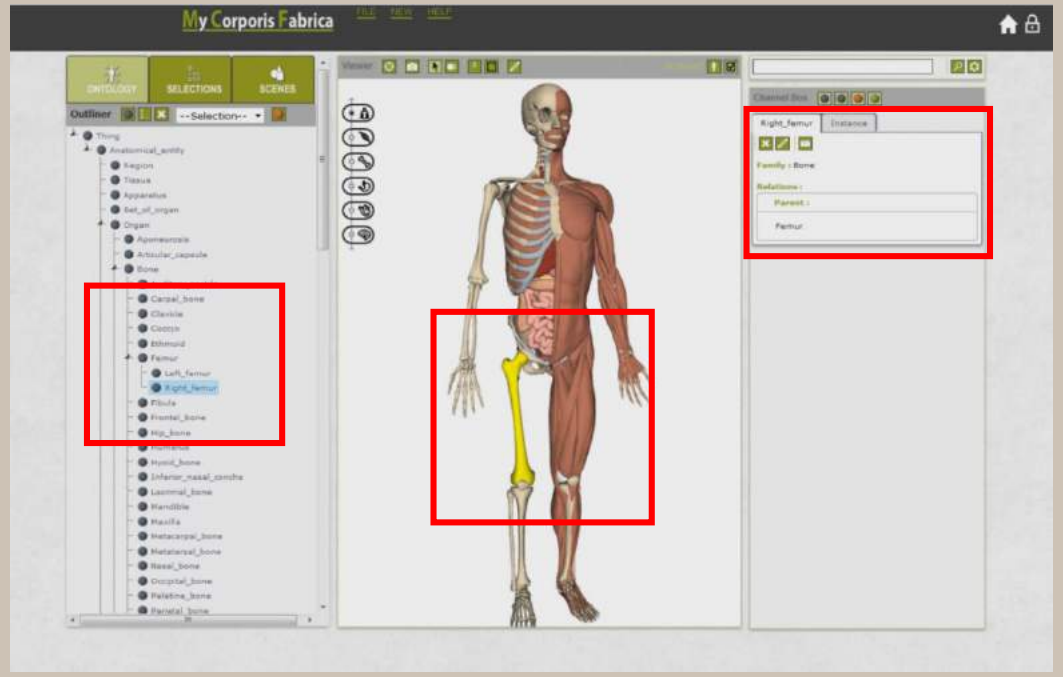
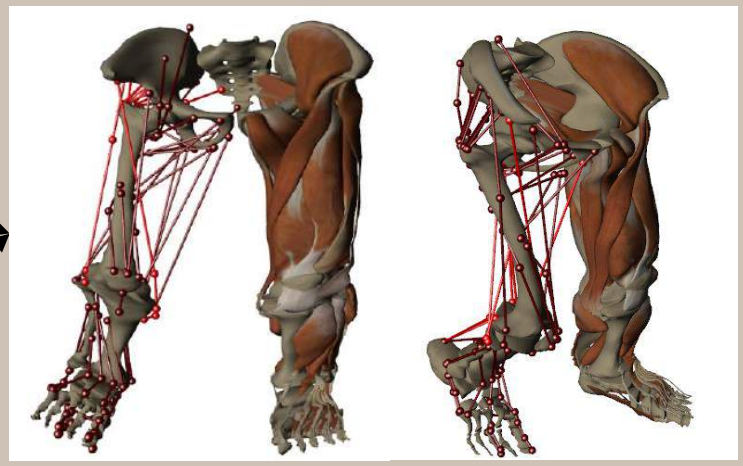
MyCF Overview



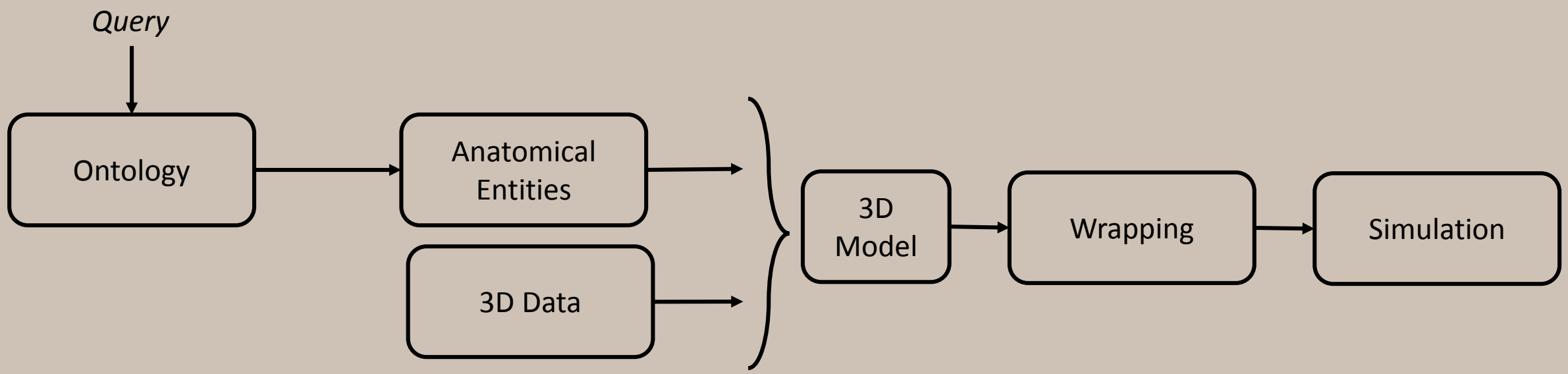
Anatomy Knowledge

3d shape : Customisation

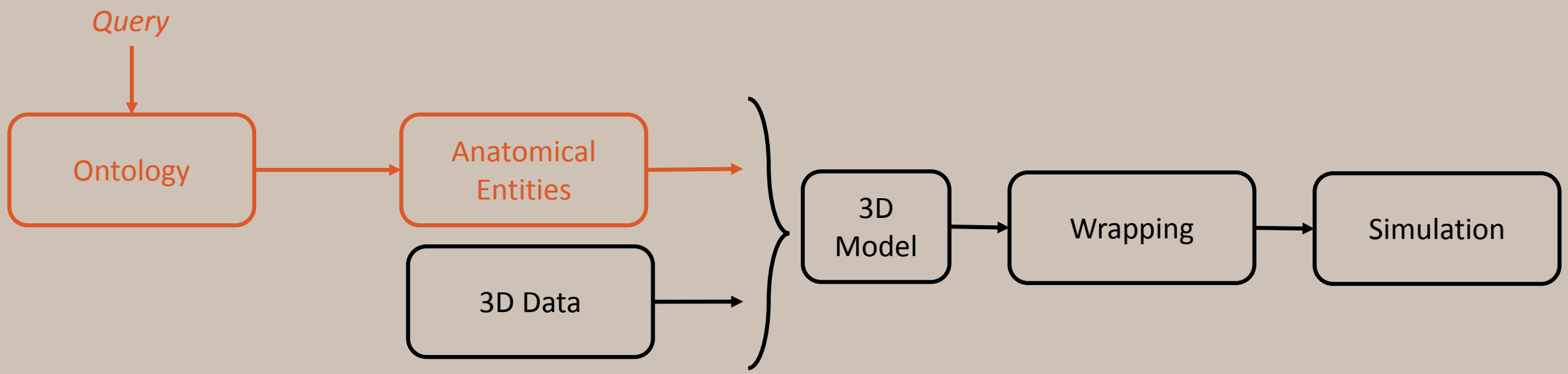


Simulation

Pipeline


Query
Ontology
Anatomical Entities
3D Data
3D Model
Wrapping
Simulation

Pipeline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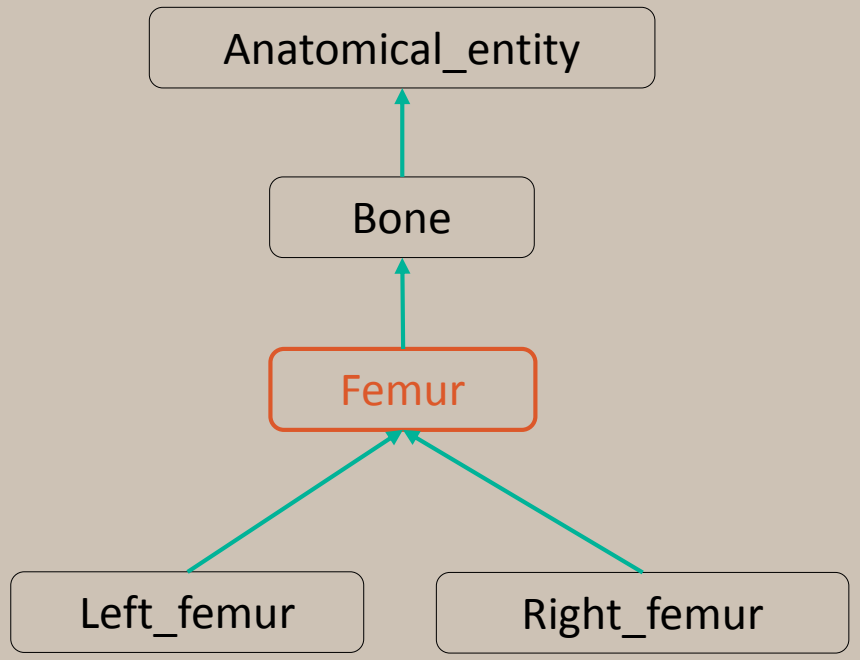
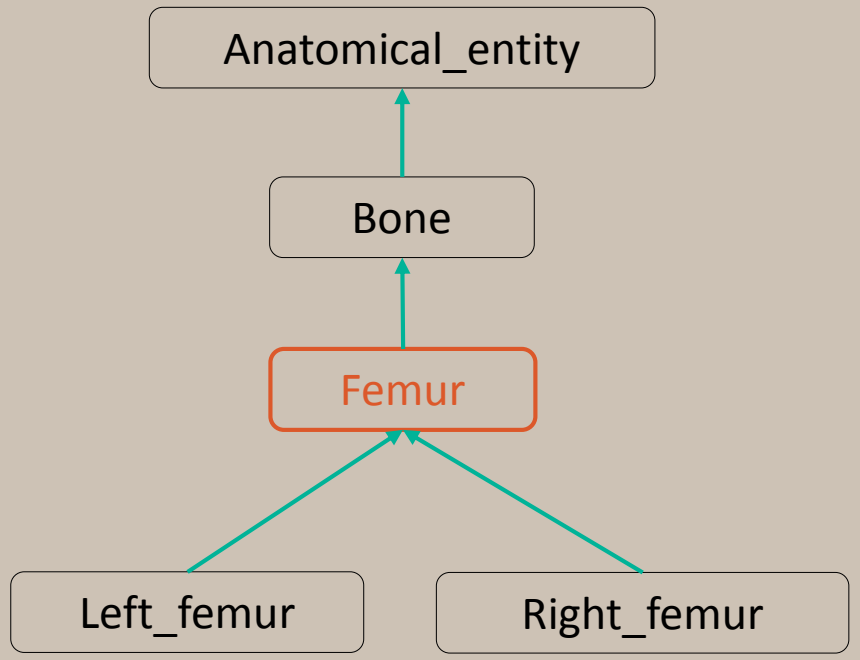
Anatomy Knowledge

"The femur is a bone"



Ontology (FMA)

"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)

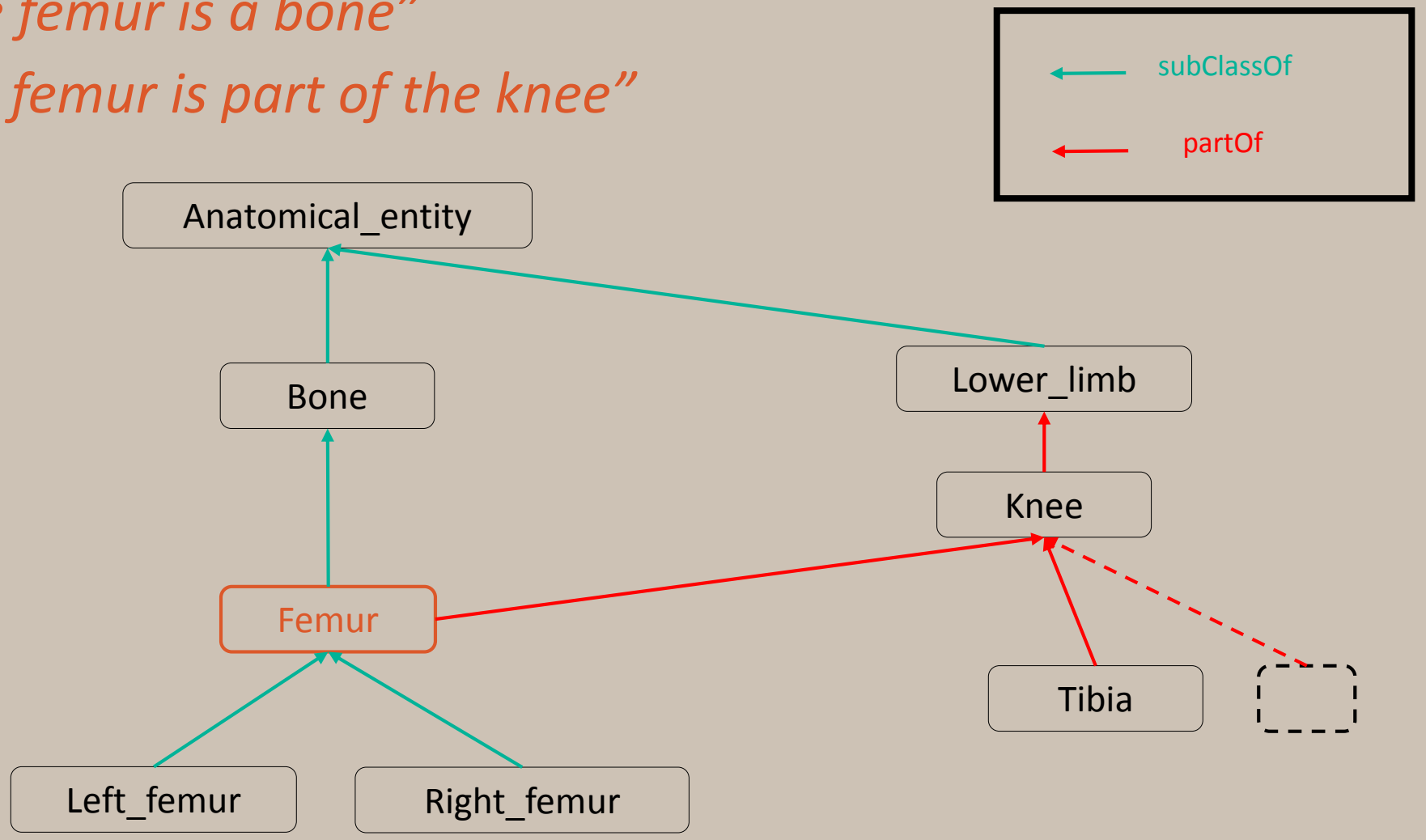
- Full-Body Anatomy Ontology Standard
- 80 000 entities

A reference ontology for biomedical informatics the foundational model of anatomy (FMA)
Rosse C, Mejino JLV
J Biomed Inform 2003, **36**:500

FMA : IsA & PartOf Relations

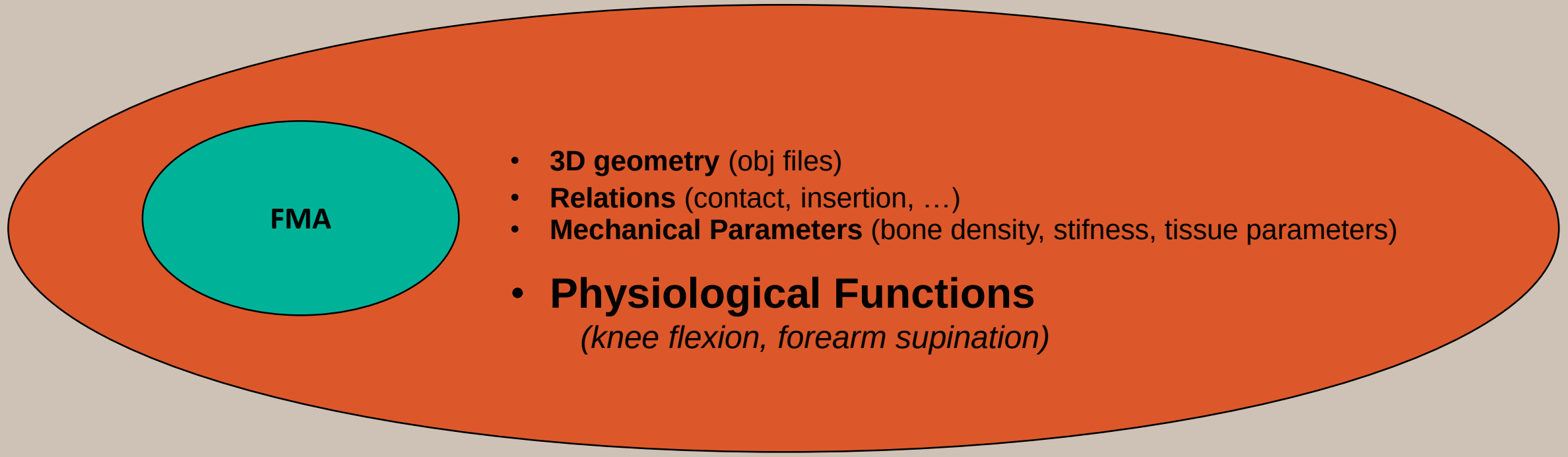
"The femur is a bone"

"The femur is part of the knee"



MyCF Ontology

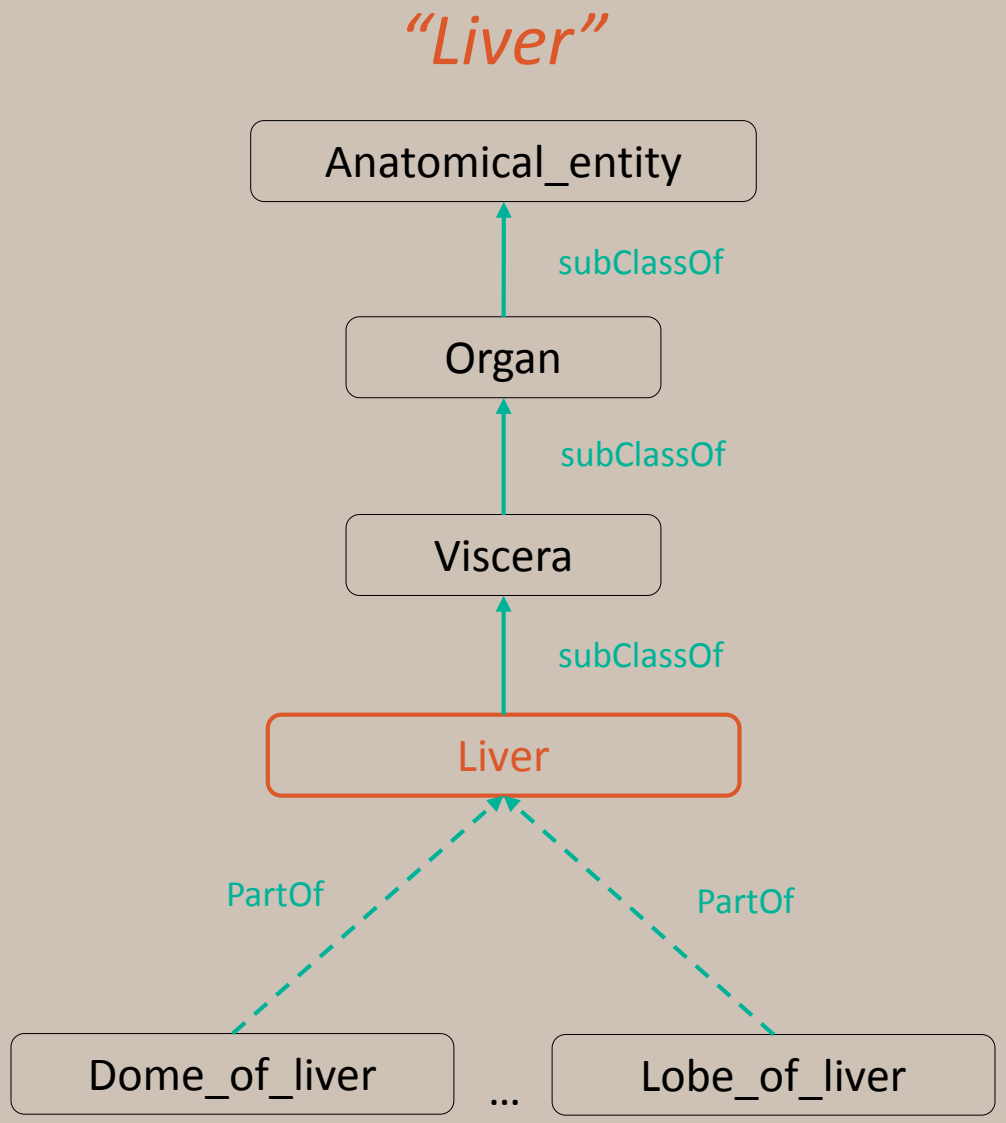
MyCF (INRIA, Grenoble University Hospital)

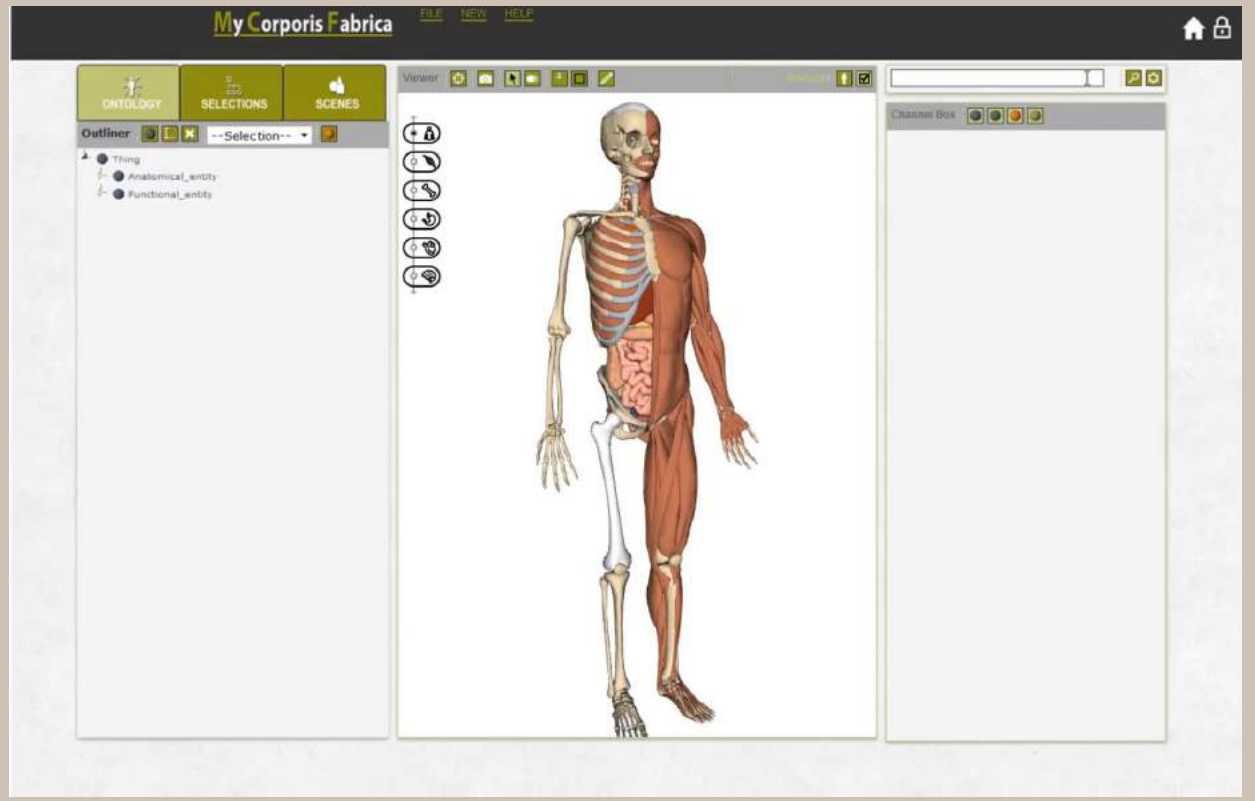


From Generic to Specific Musculoskeletal Simulation using an Ontology-based Modeling Pipeline
Ali-Hamadi DICKO, Benjamin GILLES, François FAURE, Olivier PALOMBI
Intelligent Computer Graphics, 2012

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

MyCF Navigation

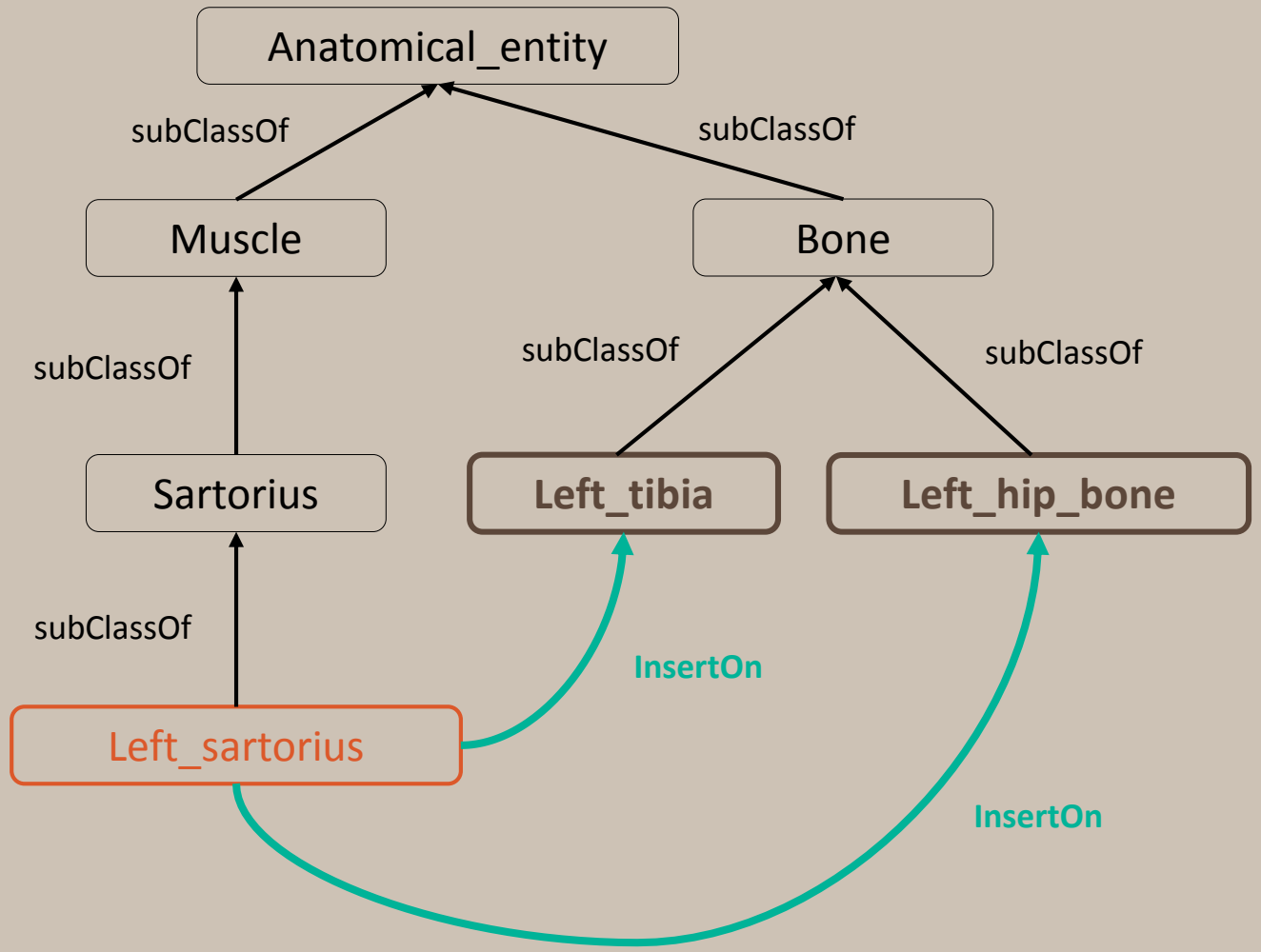


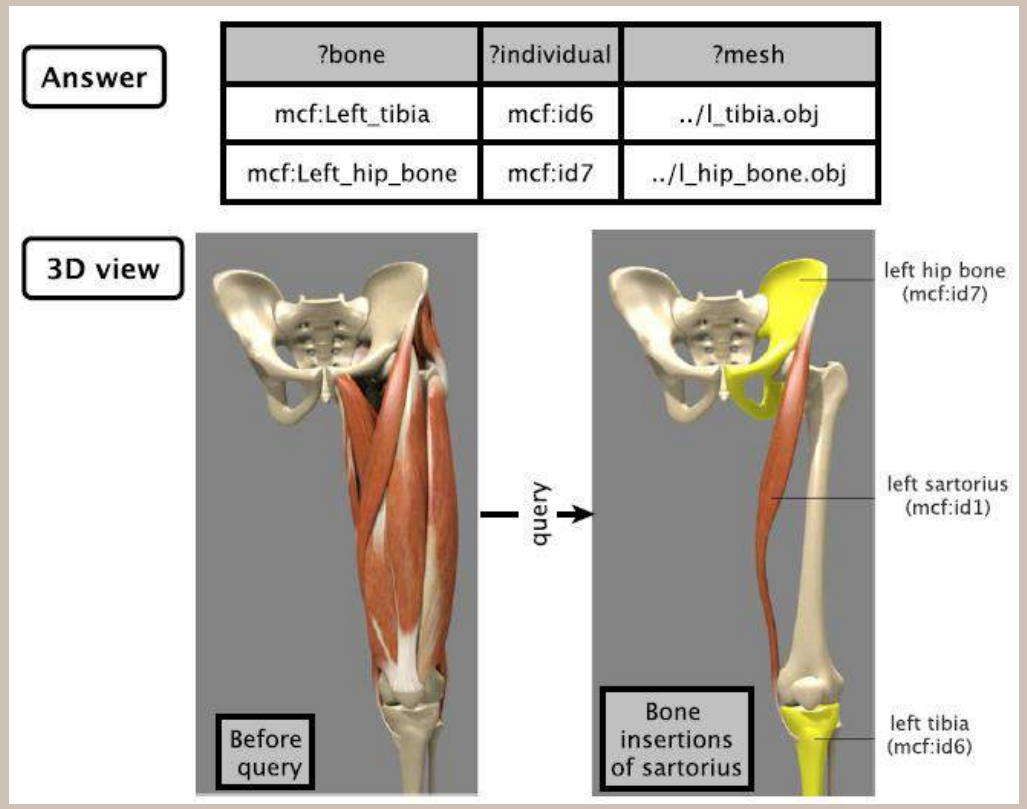


- 3D mesh associated
- Access to Anatomical Properties (type, description, …)
- Relation with other Anatomical Entities (dome, lobe, …)

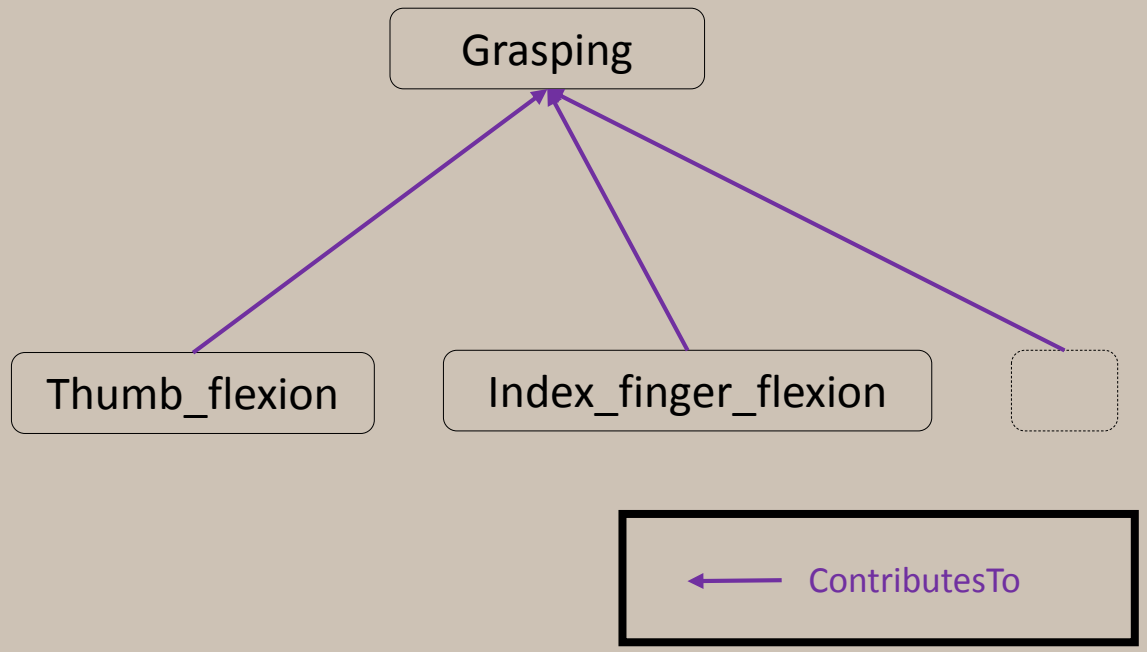
Relation InsertOn

"Bones on which the left sartorius muscle is inserted ?"

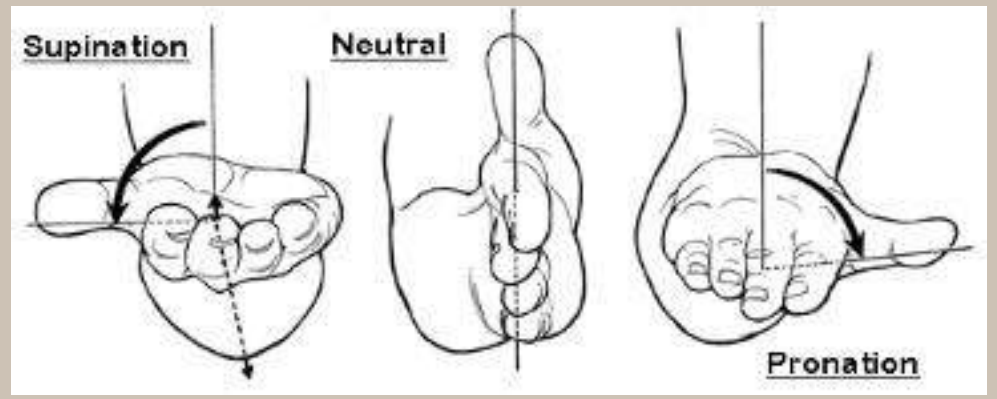




"Grasping"

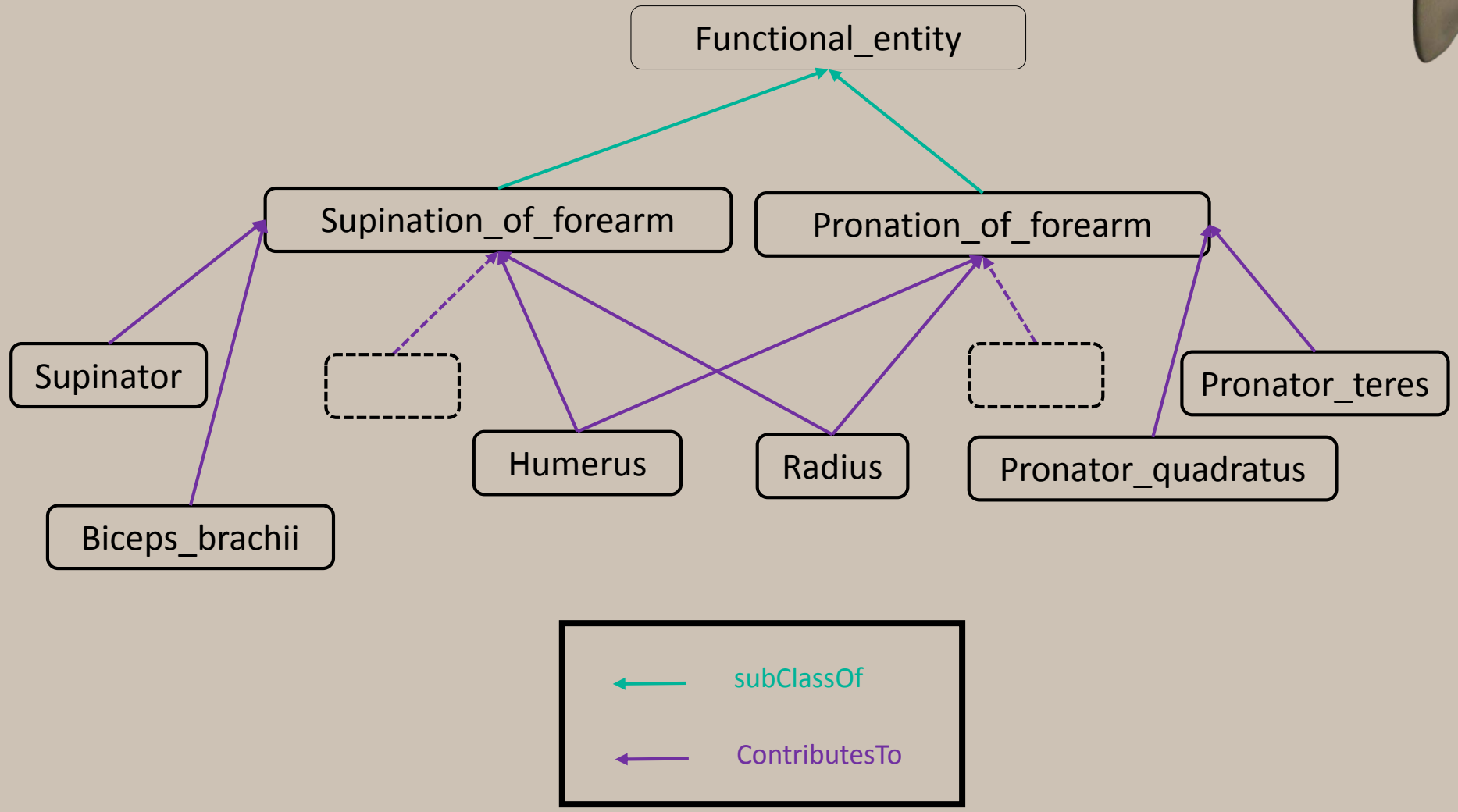


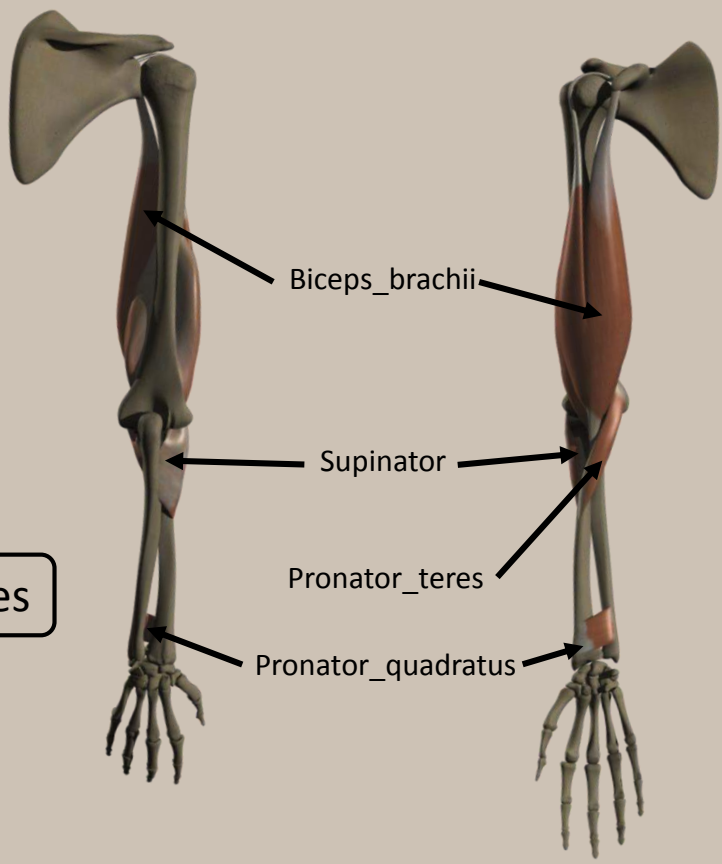
"Supination & Pronation"

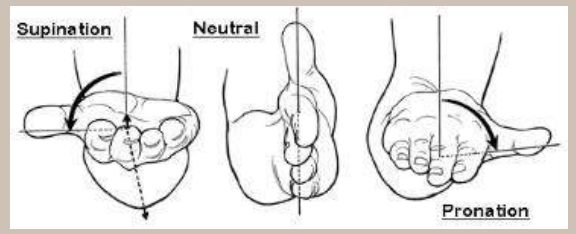


Ontology Functions

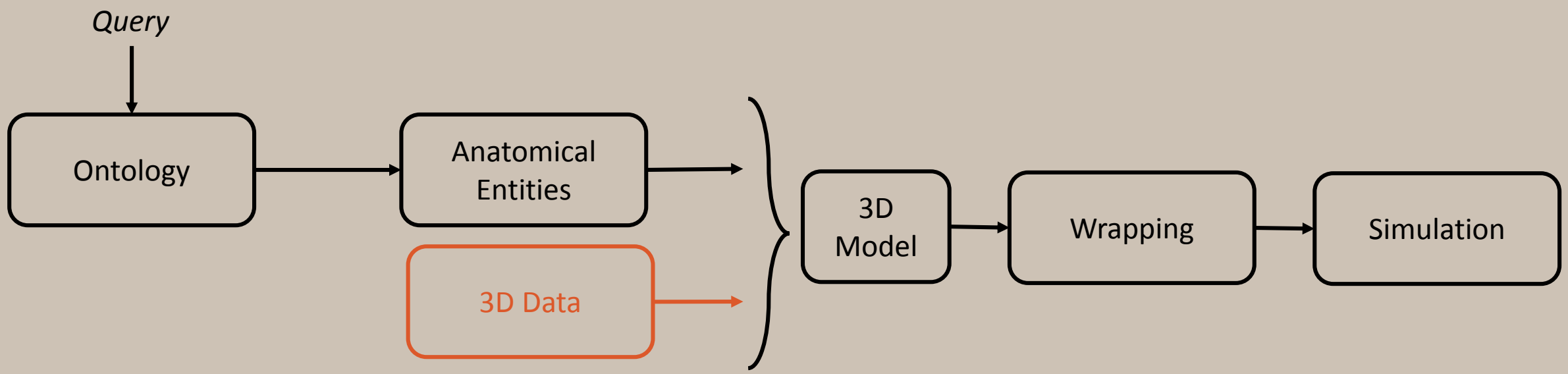
"Entities Contributing to Forearm Supination-Pronation"







Pipeline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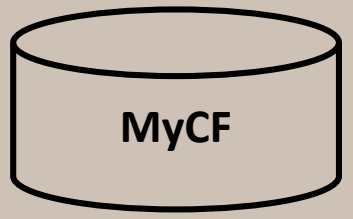
Character Mapping

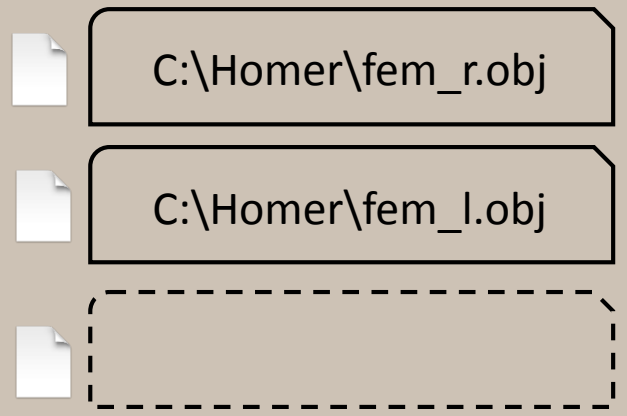
Mapping : XML file

Anatomical Entities :

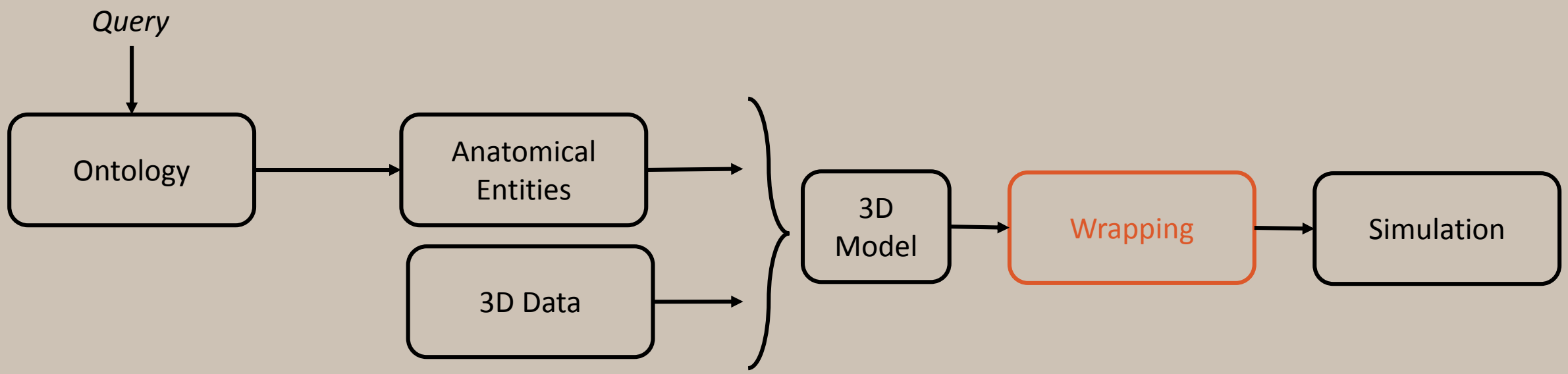


Standard Name	3D File
Right_femur	C:\Homer\fem_r.obj
Left_femur	C:\Homer\fem_l.obj

3D Anatomical Model



Pipeline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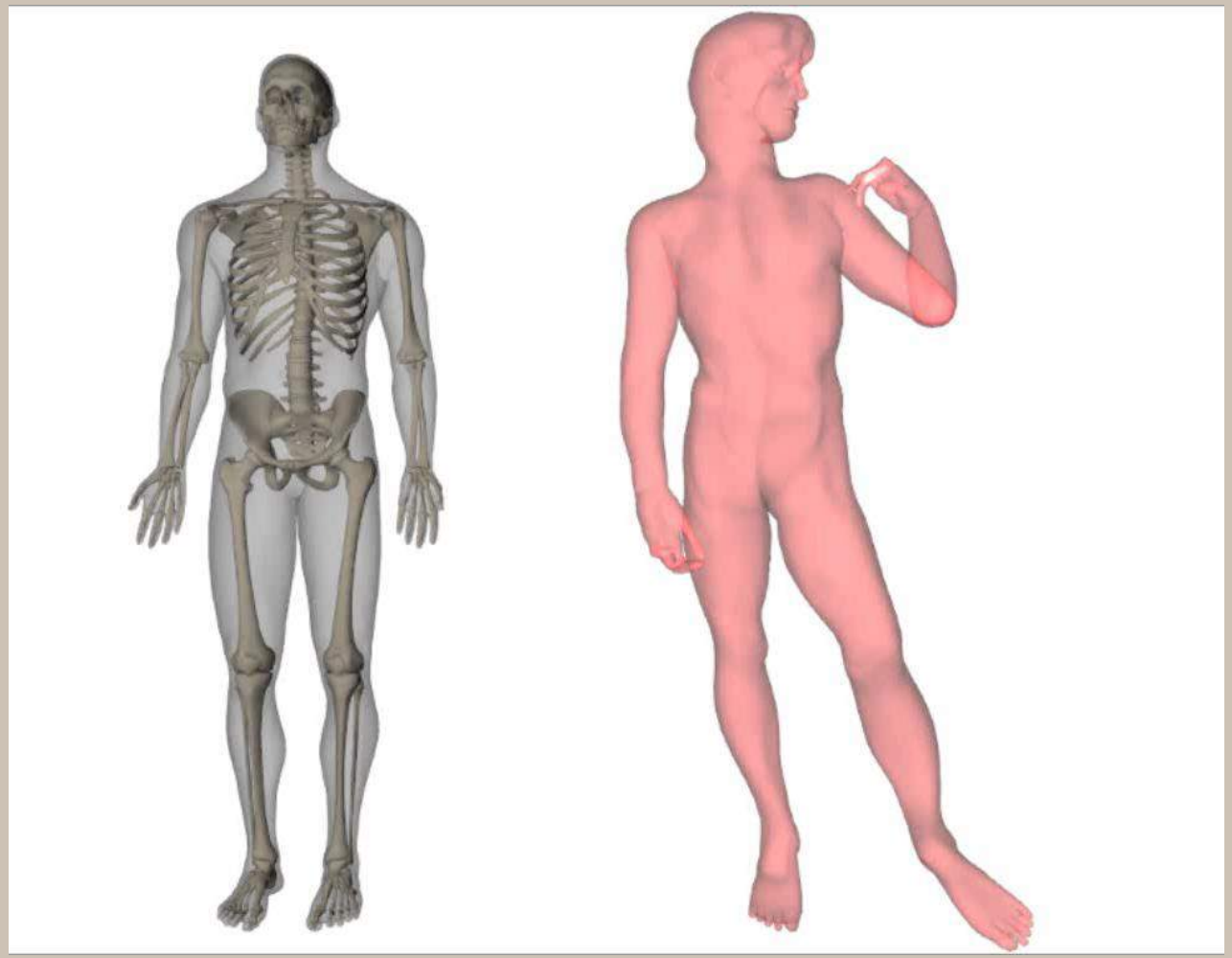
Character Wrapping

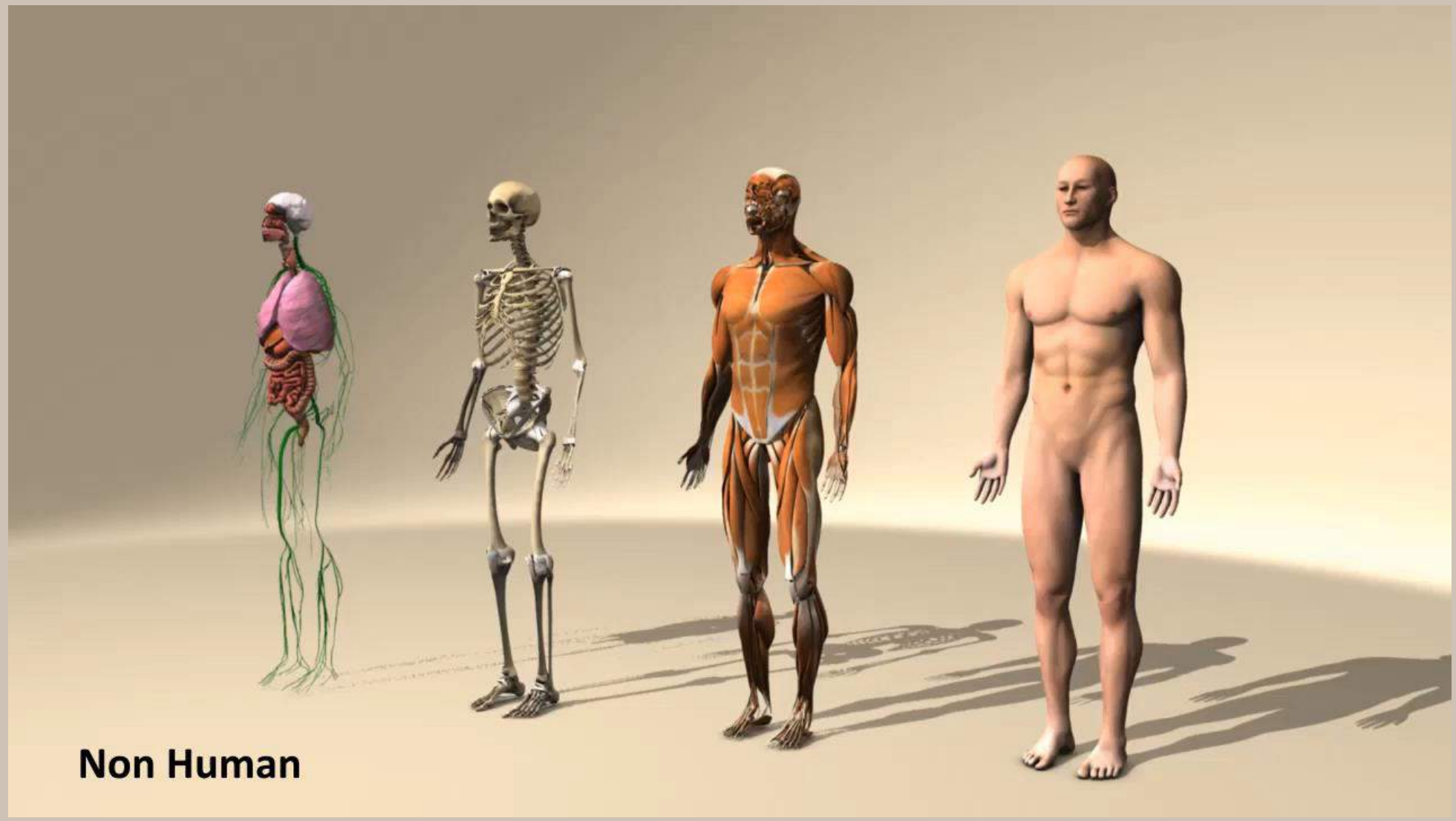


Anatomy Transfer

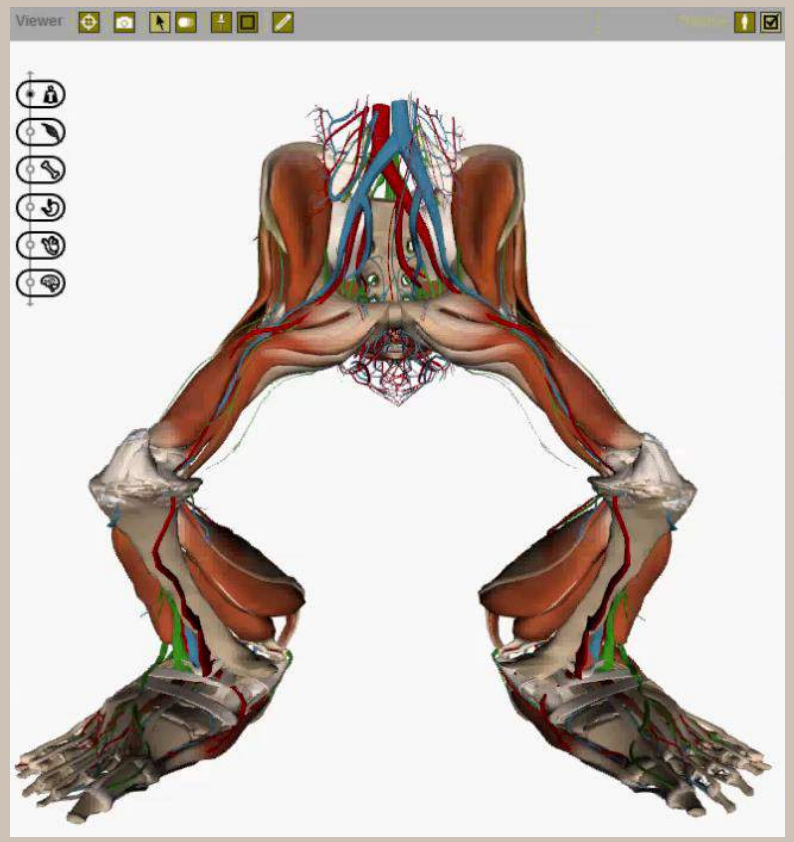
Ali-Hamadi DICKO, Tiantian LIU, Benjamin GILLES, Ladislav KAVAN, François FAURE, Olivier PALOMBI, Marie-Paule CANI

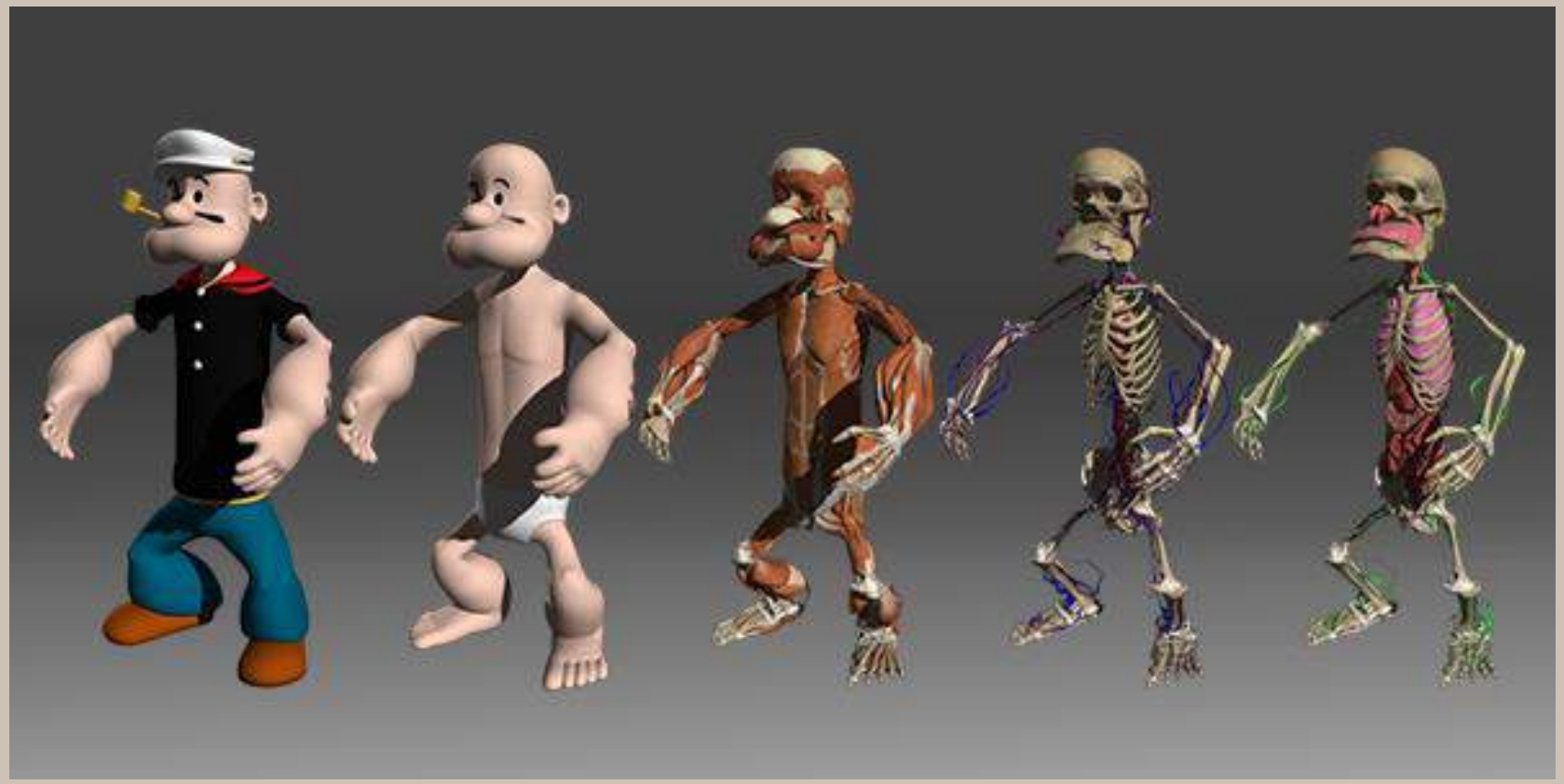
ACM Transactions on Graphics, 2013

Werewolf Example



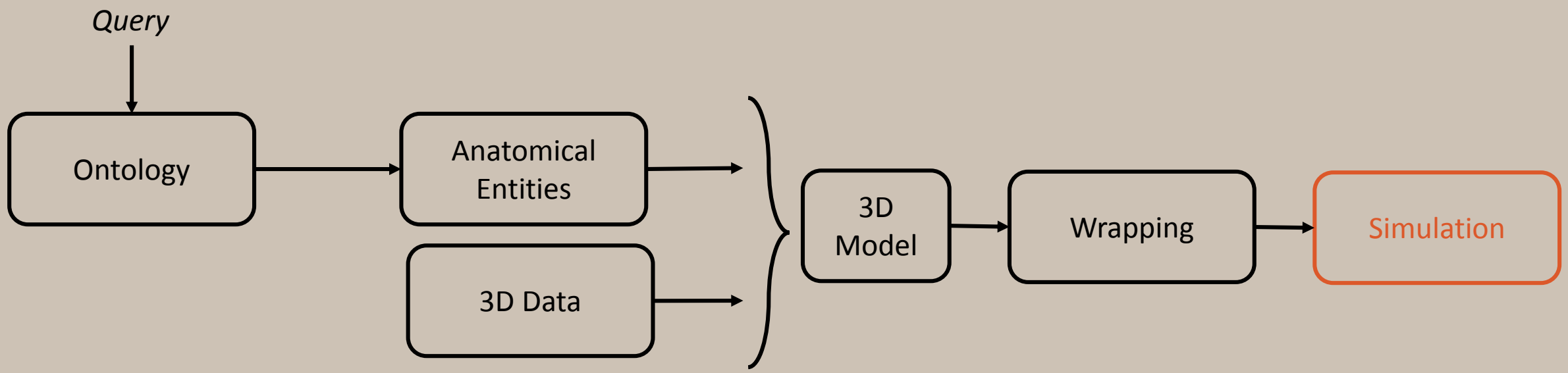
Popeye Example





Popeye [Anatomy Transfer, 2013]

Pipeline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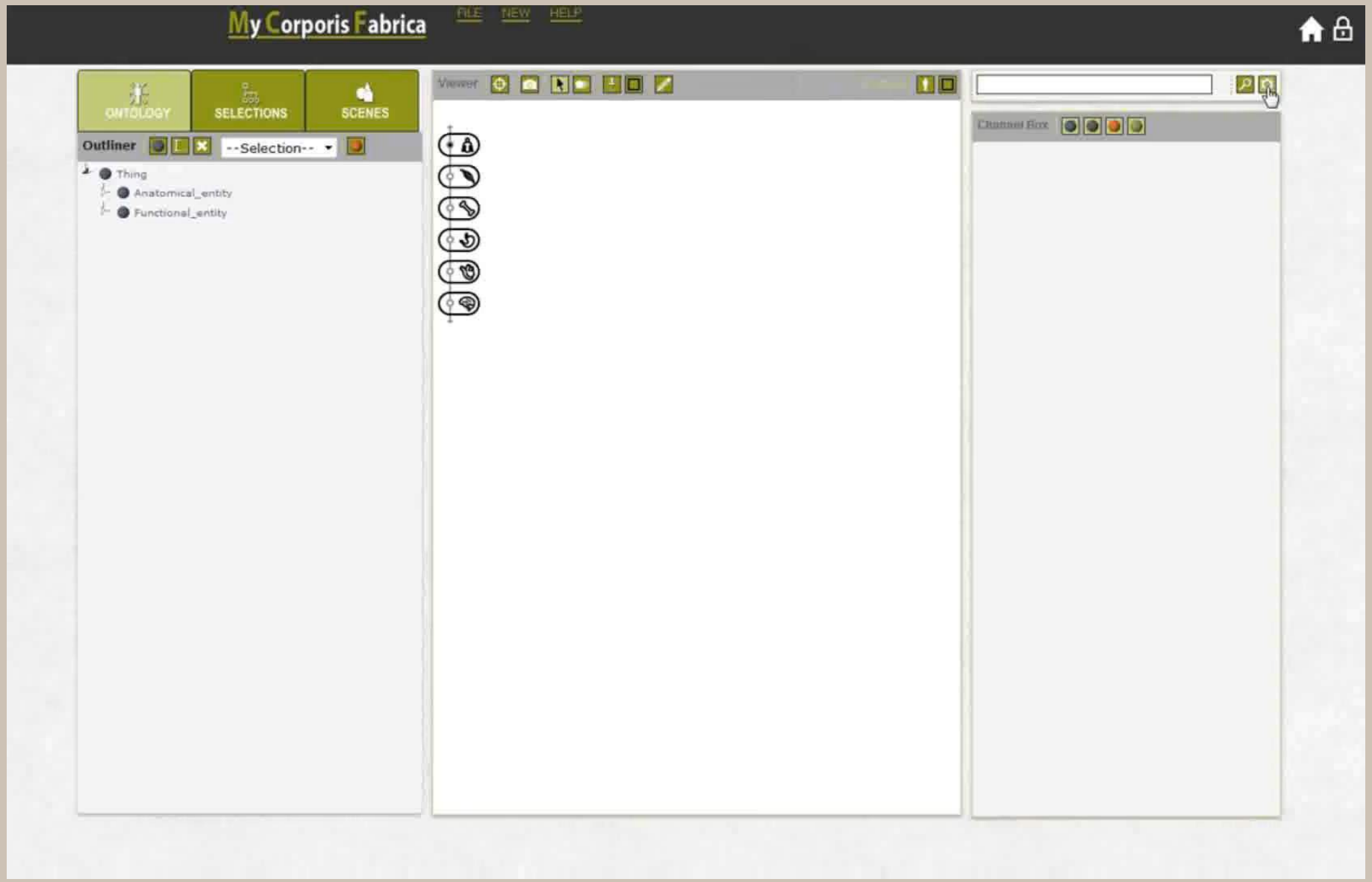
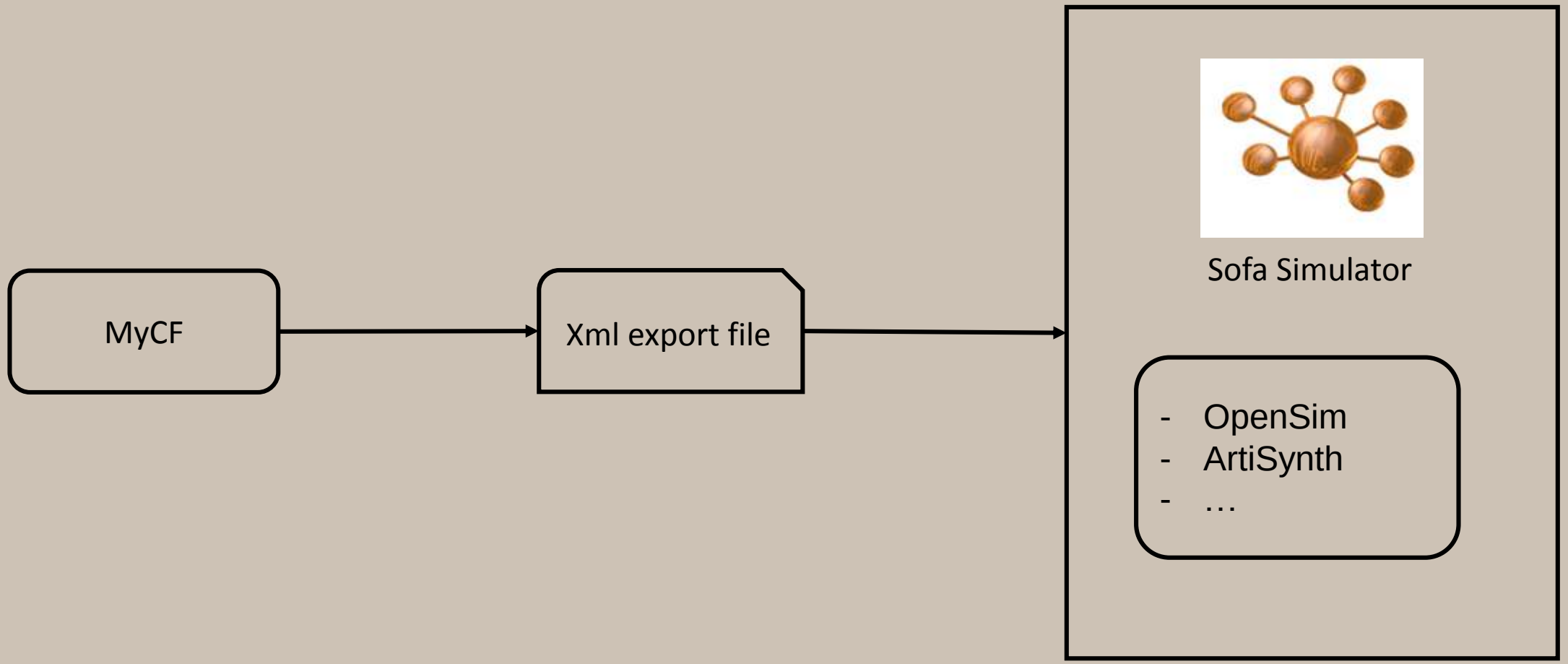
Knee Flexion on MyCF

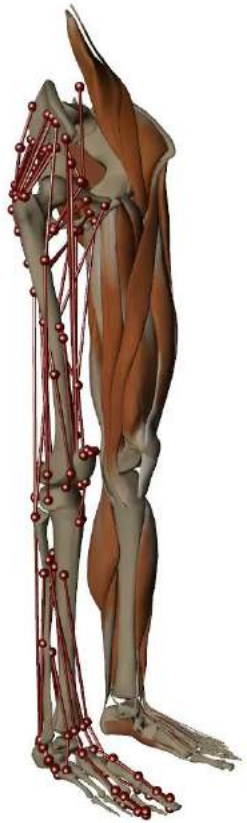


Simulable Model

"How to obtain a simulable model ?"



Knee Flexion Simulations



Zygote [*1D Muscle*]

Use : Study Muscle Activity

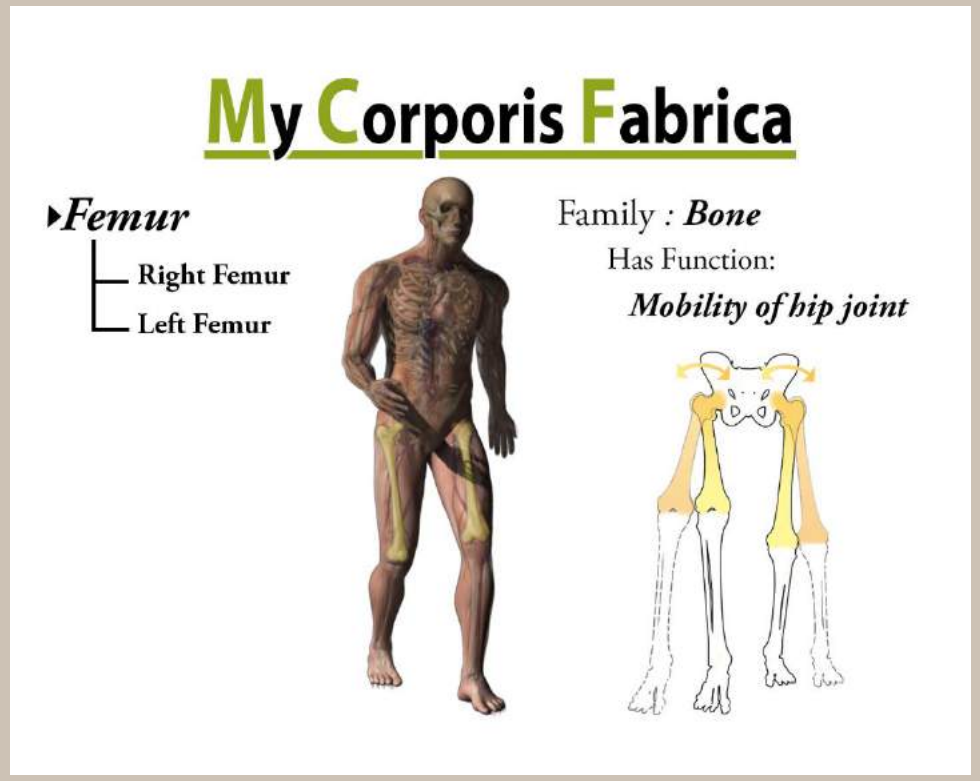
Muscles :
- Modeled using action lines
- Standard Model : OpenSim

Zygote [*3D Muscles*]

Use : Illustrate role of ligaments

Muscles, **Bones** and **Ligaments** :
- 3D Shapes
- Material Properties

Overview



Conclusion

Related Work
- Related Applications
- Limitations

MyCF Architecture
- Ontology Navigation
- 3D Data
- Simulation Models

Conclusion

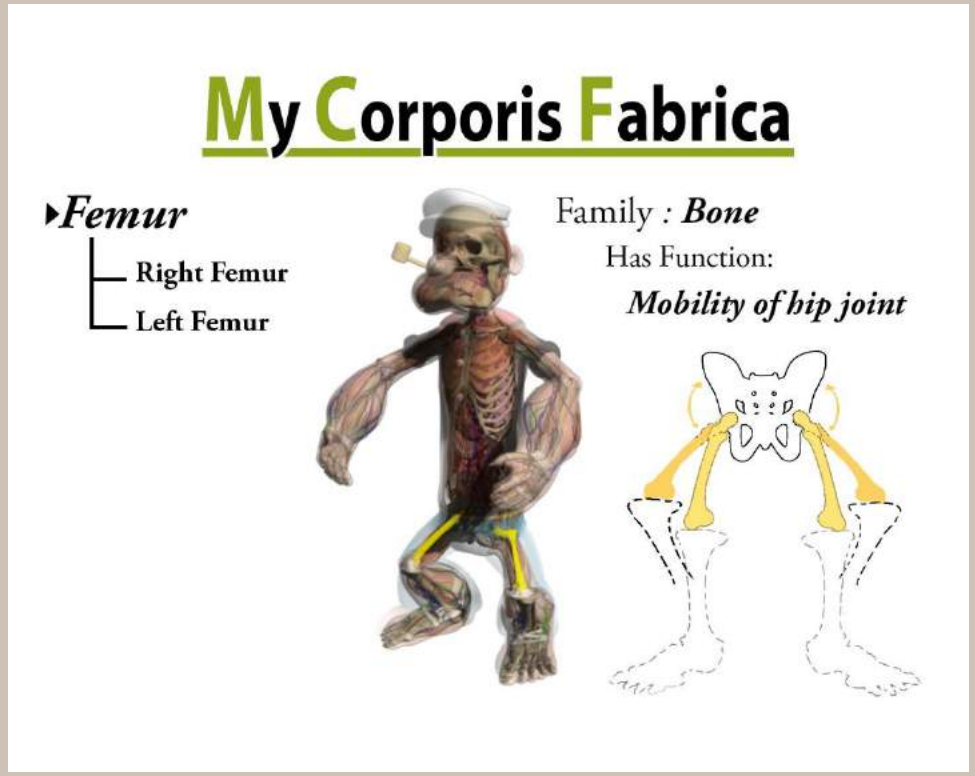
Conclusion

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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