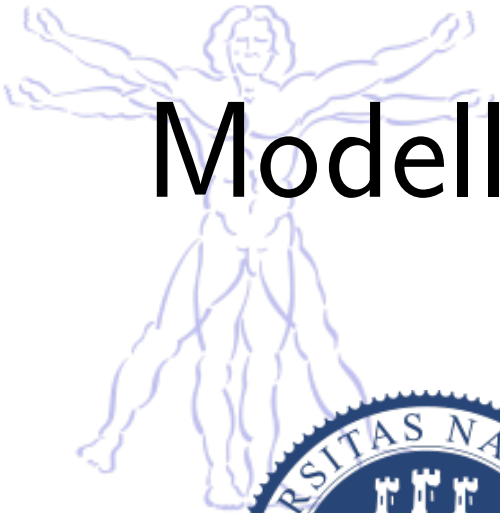

Modelling in Biomechanics

Just an introduction

UNIVERSITATEA BABEȘ-BOLYAI

Last update: February 27, 2023

Agenda

- Short introduction
- What is biomechanics?
- History of the field
- Course overview
- Practicalities and evaluation

Introduction

Introduction

Name: Tassos Natsakis

Introduction

Name: Tassos Natsakis
Citizenship: Greek

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Introduction

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Mechanical engineering (AUTh)

Introduction

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But... I've always wanted to be a Physicist!

Etymology

Blame the Greeks

Bio - Mechanics

Etymology

Blame the Greeks

Bio - Mechanics

- Bios

Etymology

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Bio - Mechanics

- Bios
- Michaniki

Etymology

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The study of living organisms using concepts and principles of physics and mechanics.

Etymology

Blame the Greeks

Bio - Mechanics

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The study of living organisms using concepts and principles of physics and mechanics.

It is not an exact science... it is Engineering

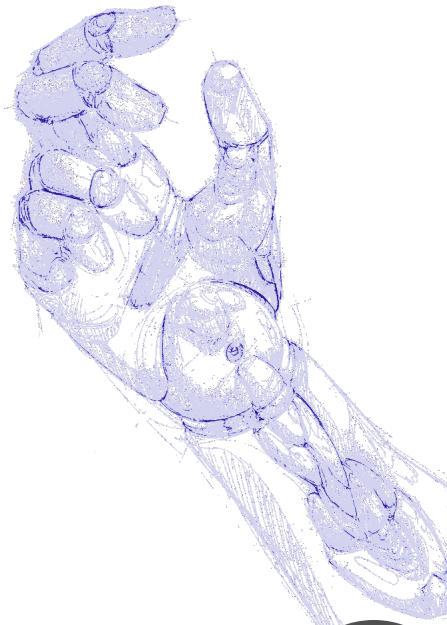
A quick note on engineering

Engineer

A quick note on engineering

Engineer

Noun. [en-juh-neer]
An individual who does precision guesswork based on unreliable data provided by those of questionable knowledge.



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Biomechanics

Areas of study

Biomechanics is a very broad topic!

Biomechanics

Areas of study

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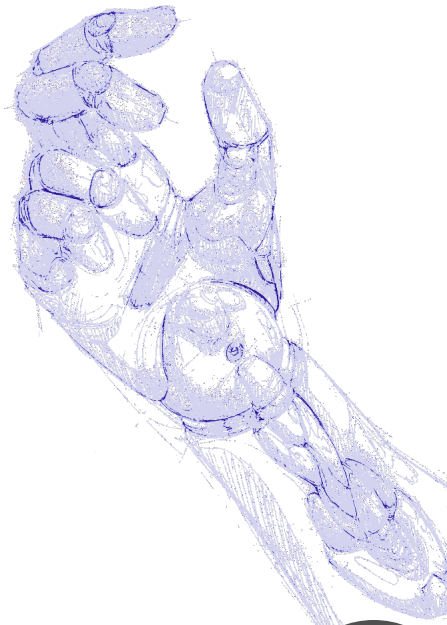
- Biofluid mechanics

Biomechanics

Areas of study

Biomechanics is a very broad topic!

- Biofluid mechanics
- Biotribology



Biomechanics

Areas of study

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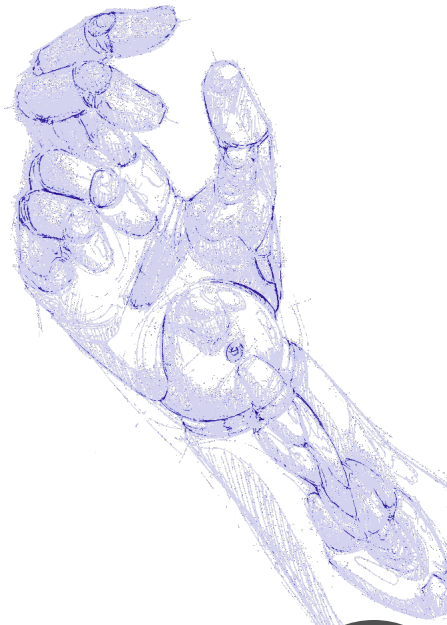
- Biofluid mechanics
- Biotribology
- Computational biomechanics



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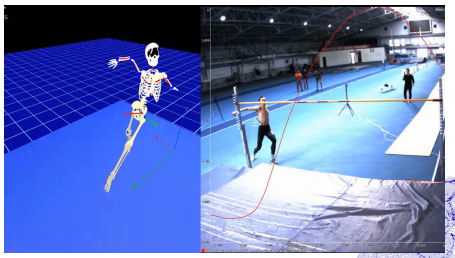
- Sports biomechanics



Biomechanics

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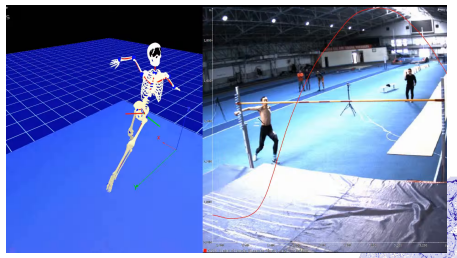

- Biofluid mechanics
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And it spans many scales

Biomechanics

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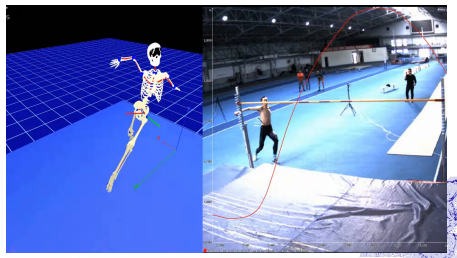

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And it spans many scales

- Organism level

Biomechanics

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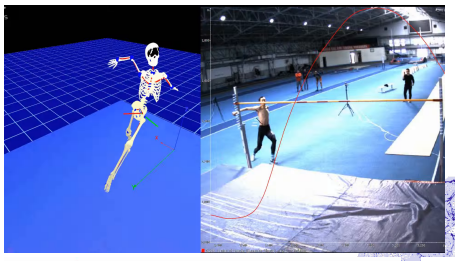
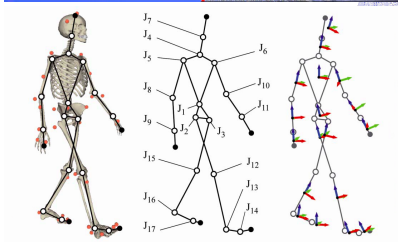
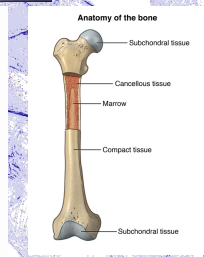
And it spans many scales

- Organism level
- Organ level







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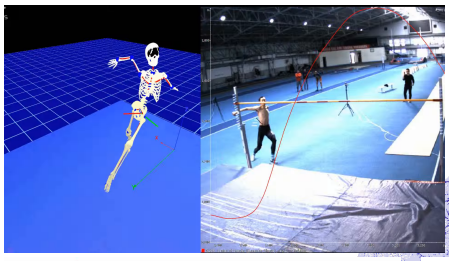
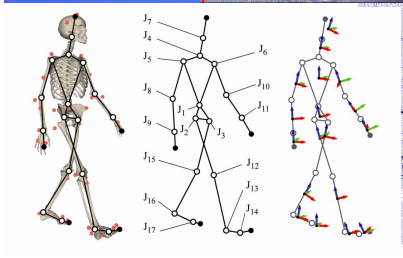
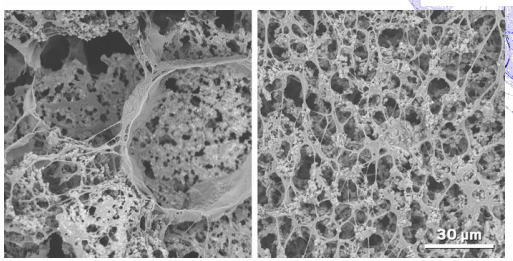
And it spans many scales

- Organism level
- Organ level
- Cell level







Biomechanics

A bit of history

- Antiquity: Aristotle and *On the Movement of Animals*

Biomechanics

A bit of history

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- Romans: Galen and *On the function of the parts*

Biomechanics

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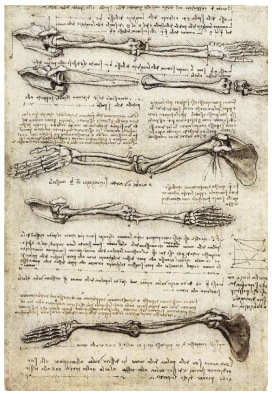

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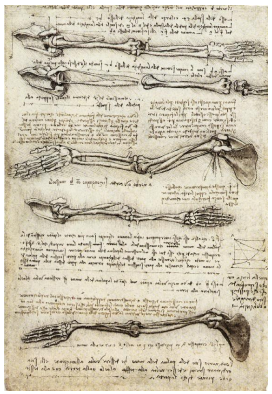

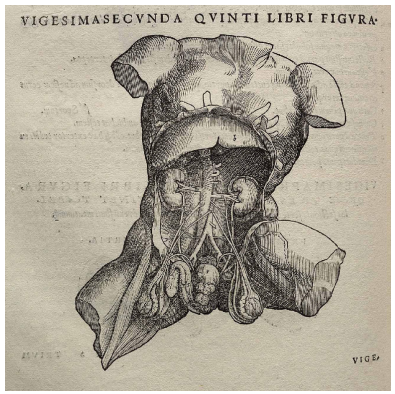

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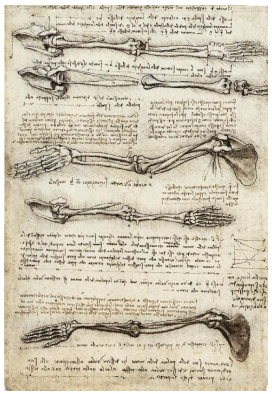

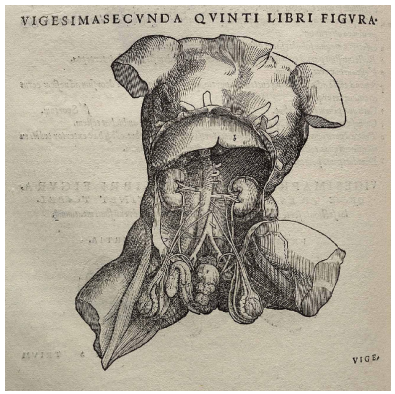

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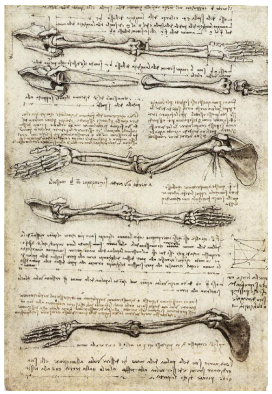

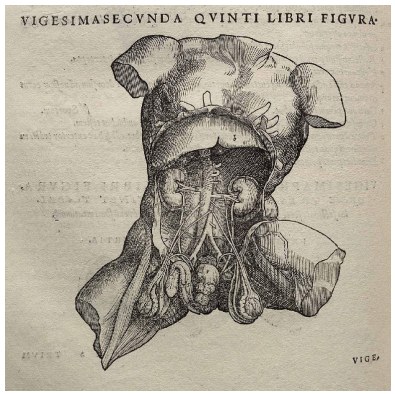

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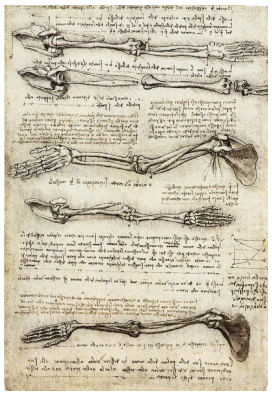

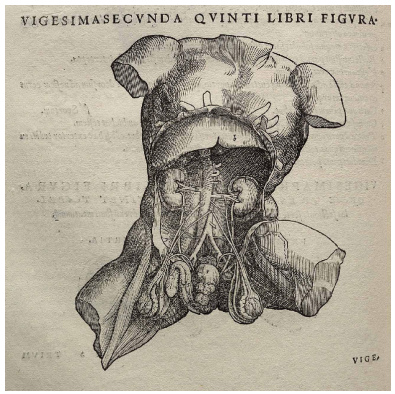

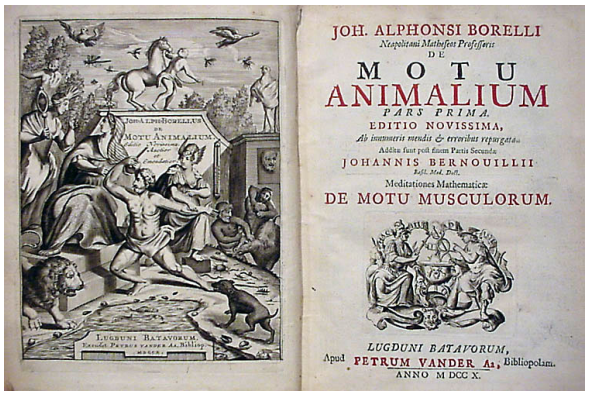

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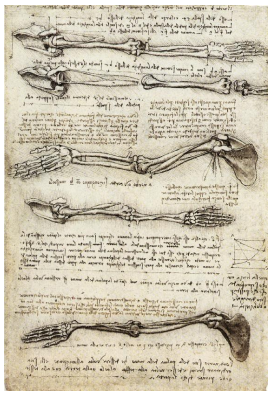
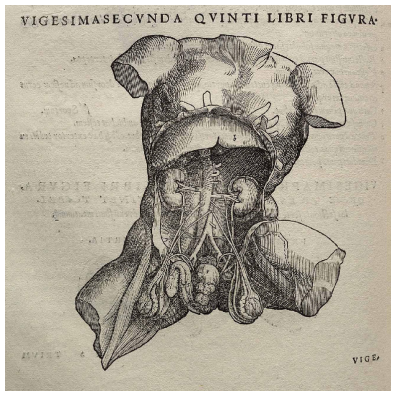
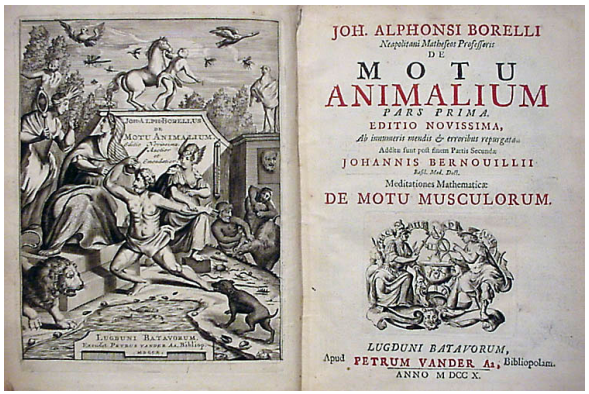






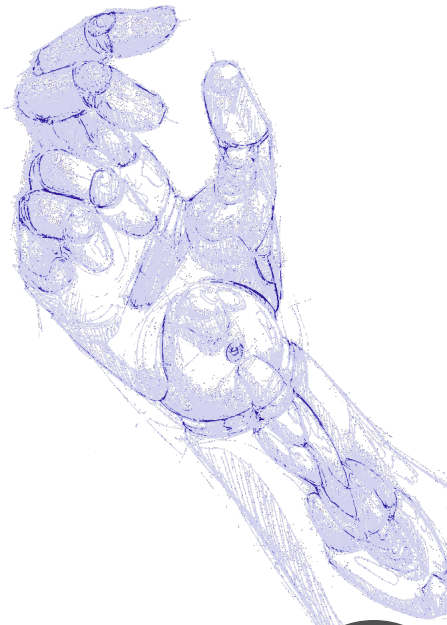
Biomechanics

Current lines of research

Biomechanics

Current lines of research

- Multi-scale heart modelling



Biomechanics

Current lines of research

- Multi-scale heart modelling
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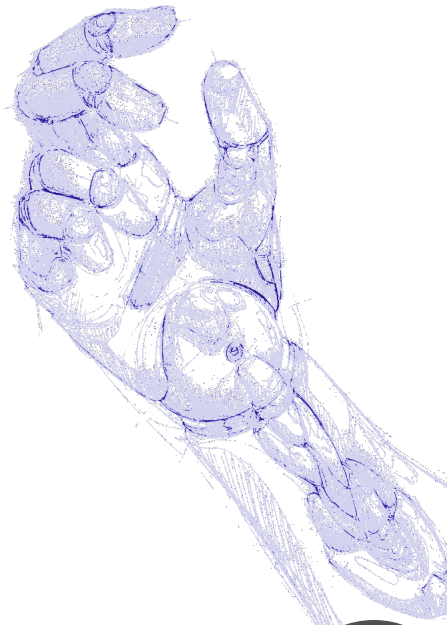


Biomechanics

Current lines of research

- Multi-scale heart modelling
- Material properties characterisation
- Physical Rehabilitation

Biomechanics

Resources and events

Biomechanics

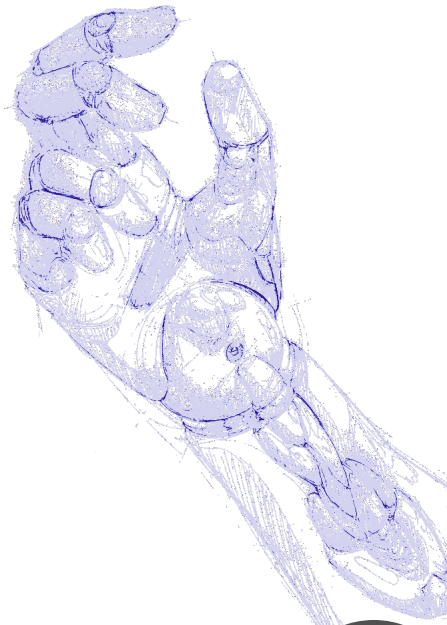
Resources and events

- Journal of biomechanics
- Computer Methods in Biomechanics and Biomedical Engineering

Biomechanics

Resources and events

- Journal of biomechanics
- Computer Methods in Biomechanics and Biomedical Engineering
- Biomechanics On Our Minds podcast



Biomechanics

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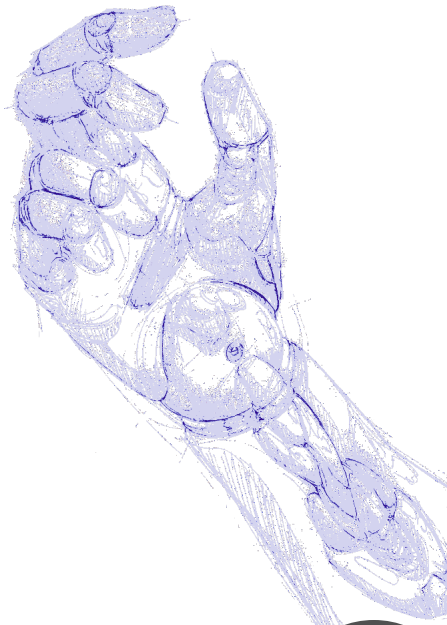
- Biomch-L forum

Biomechanics

Decomposing the human body

- Skeletal system



Biomechanics

Decomposing the human body

- Skeletal system
- Muscle system

Biomechanics

Decomposing the human body

- Skeletal system
- Muscle system
- Cardiovascular system

Biomechanics

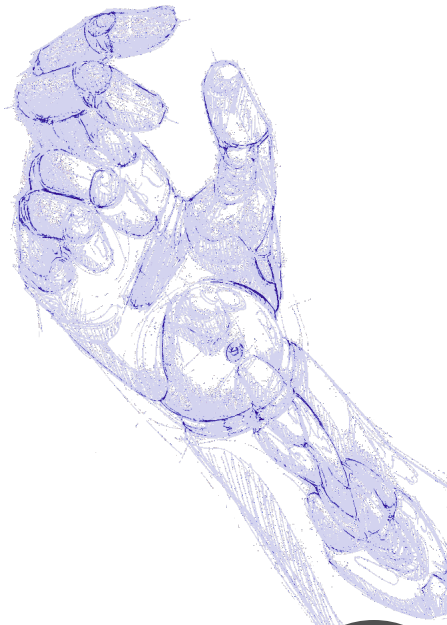
Decomposing the human body

- Skeletal system
- Muscle system
- Cardiovascular system
- Pulmonary system

Biomechanics

Decomposing the human body

- Skeletal system
- Muscle system
- Cardiovascular system
- Pulmonary system
- Brain



Biomechanics

Decomposing the human body

- Skeletal system
- Muscle system
- Cardiovascular system
- Pulmonary system
- Brain
- Nervous system

Modelling in Biomechanics

Scope of this course

We will see the principles of modelling:

Modelling in Biomechanics

Scope of this course

We will see the principles of modelling:

- Blood vesels and blood flow

Modelling in Biomechanics

Scope of this course

We will see the principles of modelling:

- Blood vesels and blood flow
- Bones

Modelling in Biomechanics

Scope of this course

We will see the principles of modelling:

- Blood vesels and blood flow
- Bones
- Muscles

Modelling in Biomechanics

Scope of this course

We will see the principles of modelling:

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We will use the following tools:

Modelling in Biomechanics

Scope of this course

We will see the principles of modelling:

- Blood vesels and blood flow
- Bones
- Muscles

We will use the following tools:

- Finite element methodology

Modelling in Biomechanics

Scope of this course

We will see the principles of modelling:

- Blood vesels and blood flow
- Bones
- Muscles

We will use the following tools:

- Finite element methodology
- Fluid dynamics

Modelling in Biomechanics

Scope of this course

We will see the principles of modelling:

- Blood vesels and blood flow
- Bones
- Muscles

We will use the following tools:

- Finite element methodology
- Fluid dynamics
- Multi-body dynamics

Modelling in Biomechanics

Lecture structure

Modelling in Biomechanics

Lecture structure

- Materials and modelling techniques

Modelling in Biomechanics

Lecture structure

- Materials and modelling techniques
  - Introduction to materials
  - Finite Element Analysis
  - Modelling of human soft and hard tissues

Modelling in Biomechanics

Lecture structure

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Modelling in Biomechanics

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  - Applications

Modelling in Biomechanics

Lecture structure

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  - Applications
- Locomotion

Modelling in Biomechanics

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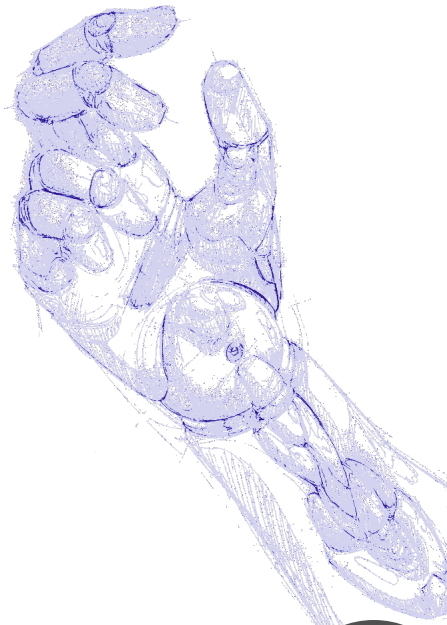
- Locomotion
  - Introduction to Muscoloskeletal modelling
  - Muscles
  - Forward and Inverse kinematics
  - Forward and Inverse Dynamics



Modelling in Biomechanics

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Modelling in Biomechanics

Labs structure

Finite element modelling

- FEBio installation and familiarization

Modelling in Biomechanics

Labs structure

Finite element modelling

- FEBio installation and familiarization
- Bone modelling

Modelling in Biomechanics

Labs structure

Finite element modelling

- FEBio installation and familiarization
- Bone modelling
- Soft tissue modelling

Modelling in Biomechanics

Labs structure

Finite element modelling

- FEBio installation and familiarization
- Bone modelling
- Soft tissue modelling
- Blood flow simulations

Modelling in Biomechanics

Labs structure

Finite element modelling

- FEBio installation and familiarization
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- Combination of models

Modelling in Biomechanics

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- FEBio installation and familiarization
- Bone modelling
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- Blood flow simulations
- Combination of models
- OpenSim installation and familiarization

Modelling in Biomechanics

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- Model of the human arm

Modelling in Biomechanics

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- Model of the human arm
- Forward and Inverse Kinematics

Modelling in Biomechanics

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Modelling in Biomechanics

Labs structure

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- Combination of models
- OpenSim installation and familiarization
- Model of the human arm
- Forward and Inverse Kinematics
- Forward and Inverse Dynamics
- Dynamic walking challenge

Course details

- Lecture notes will be made available
- Laboratories are compulsory, will be graded (50% of grade)
- Exam at the end of the semester

Questions?