# Lecture 3 - Simulation of Techniques and Tools

Julius Martensen

DFKI Bremen & Universität Bremen

Robotics Innovation Center

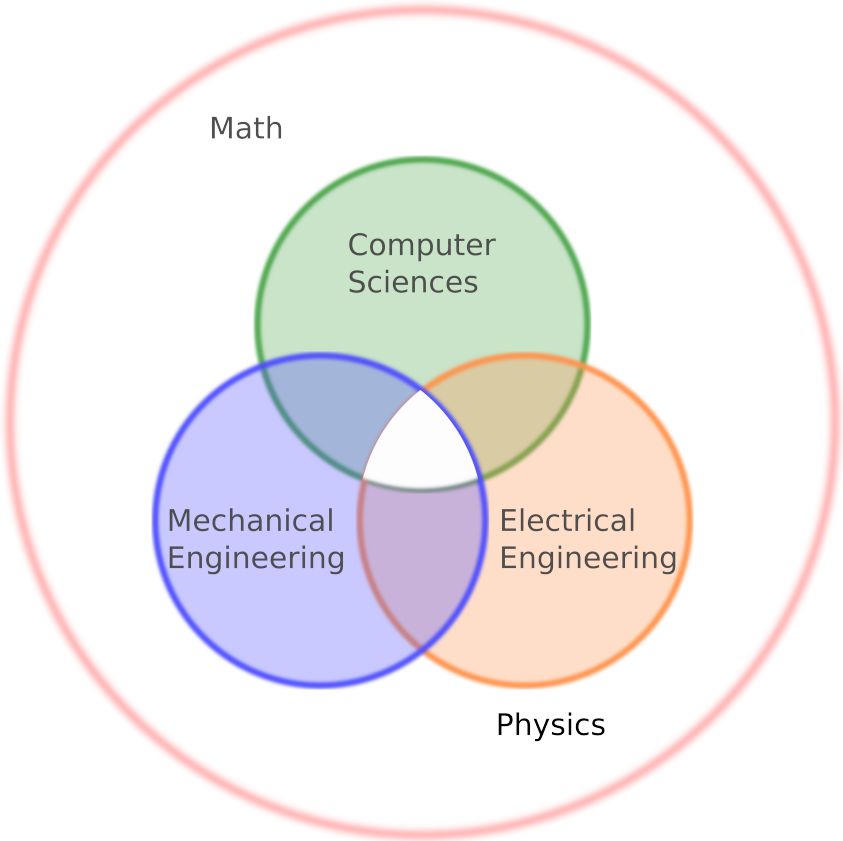
Director: Prof. Dr. Frank Kirchner

www.dfki.de/robotics

robotics@dfki.de

# A holistic perspective

## Robotics - An Interdisciplinary Science



# A holistic perspective

## Modeling Approaches

Bottom Up

- A model consists of submodels
- Every parameter is considered
- High physical accuracy

Top Down

- A model consists of an input-output behavior
- A subset of parameters are needed
- Efficient simulation

# A holistic perspective

Bottom Up

- (Low Level) Controller Design
- Learning more than I/O relations
- More "realistic" behavior

Top Down

- (High level) controller design
- Learning basic I/O relations
- Visual behavior / Gaming

# A holistic perspective

## Motivating Example

Task
Model a factory worker which can step in the working cell of a robot. The robot is able to identify a worker via visual detection.

Abstraction
Model a visual of the factory worker that is able to "walk" in the simulation.

More Abstraction
Model a visual of the factory worker that is able to change its position smoothly.

# A holistic perspective

## Motivating Example II

Task
Estimate the forces acting on each joint during a given walking gait.

Abstraction
High accuracy simulation of a robots lower body.

Questions
Is a rigid body simulator sufficient for the task?

# Opportunities and Limitations

## Soft Body Dynamics

Examples from BulletPhysics

# Opportunities and Limitations

## Good Questions

How to model clearance in joints?

How to make objects grippable?

How to avoid self collisions?

# Opportunities and Limitations

## "Nonphysical" Models

Task
Model a factory worker which walks around naturally.

Abstraction
Give a model a walking like behavior.

Needs
Ray Tracing: Detects objects in front of it.
Target Generator: Creates a (reachable) target.

# Opportunities and Limitations

## "Nonphysical" Models

Task
Model a factory worker which walks around naturally.

Abstraction
Give a model a walking like behavior.

Solutions
Look at gaming AI. Many algorithms are present.
Maybe a simple control strategy is sufficient?

# Opportunities and Limitations

## "Nonphysical" Models

Task
Model a current for underwater simulations.

Solution
Create a vectorfield of current forces and add some degree of randomness!

Hint
Same goes for for aerial forces.

# Coupling of Domains

## Interdisciplinary Modeling

IMAGE OF MODEL CHAIN HERE

# Coupling of Domains

## Model of an IMU

# Coupling of Domains

## Connect a DC Motor

# Simulationtools

## MARS

## Gazebo

Gazebo Overview

# Simulationtools

## Simulink

# Simulationtools

## OpenModelica