NAFEMS AMERICAS CONFERENCE 2016

TOWARDS COGNITIVE COMPUTER AIDED ENGINEERING

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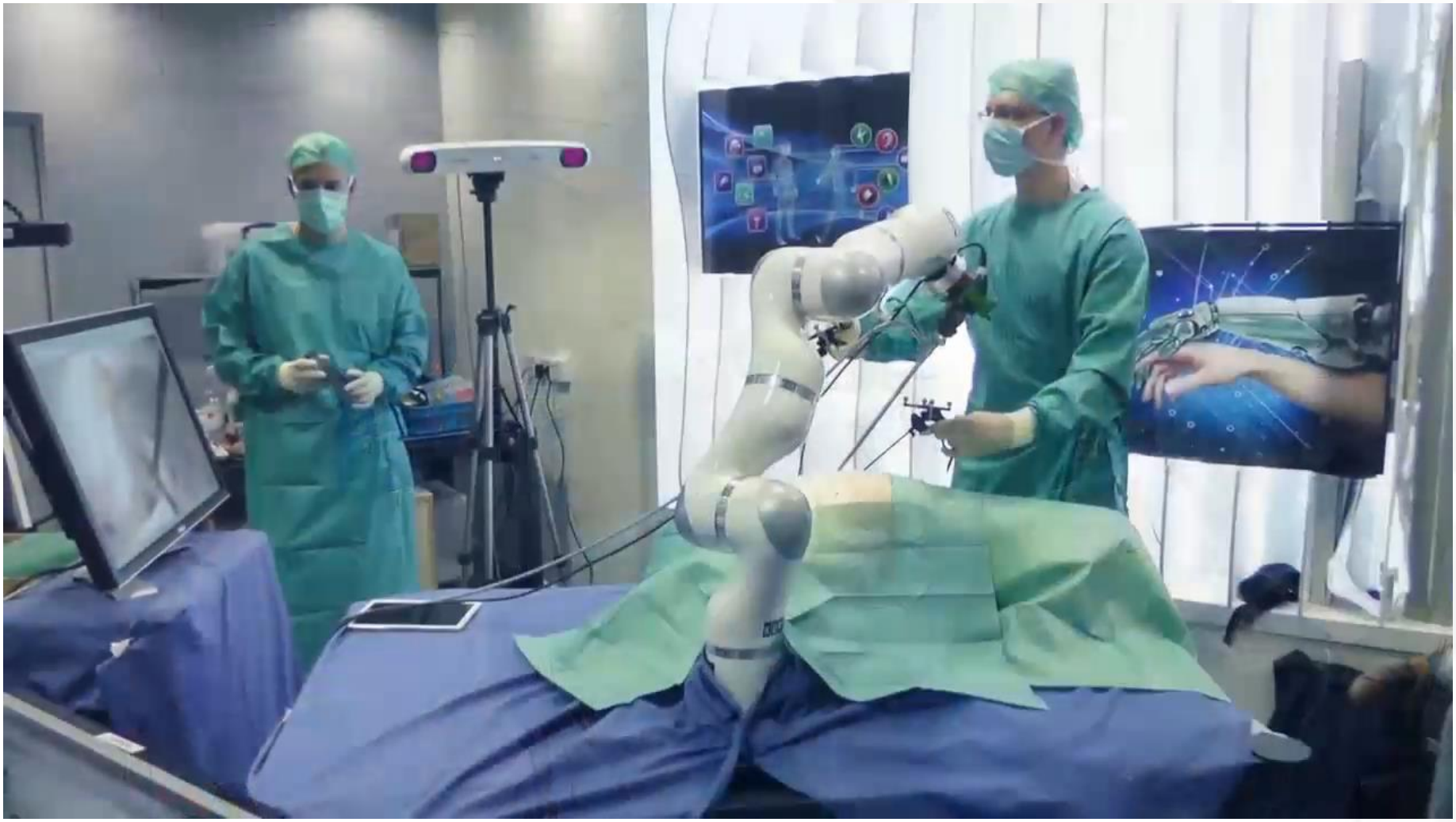
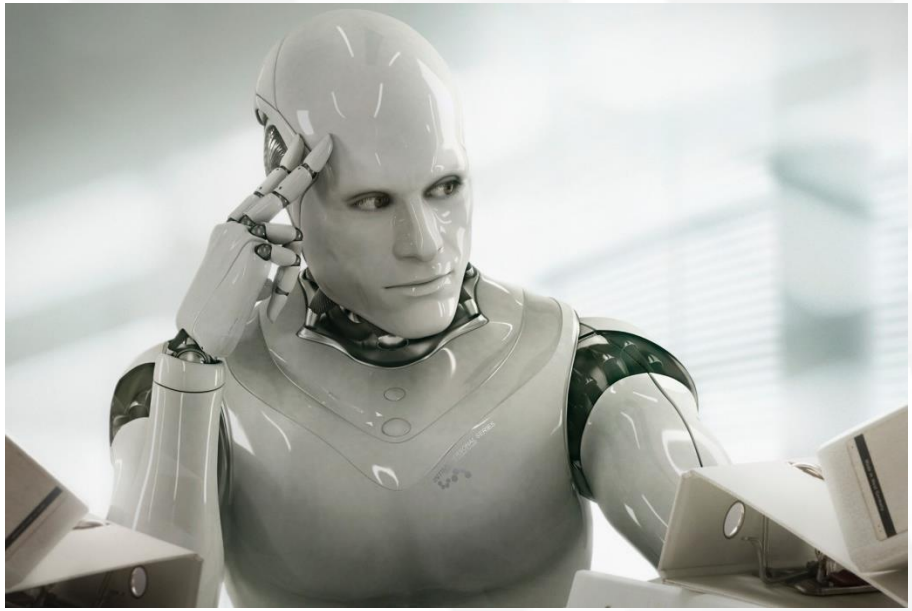
Cognition-Guided Surgery



Cognition-Guided Surgery



Surgeon

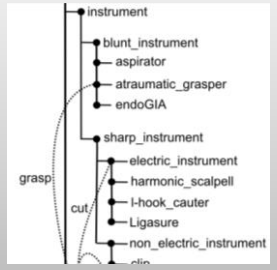
Cognitive Surgical Assistant

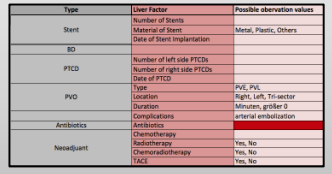
Knowledge Base

Semantics

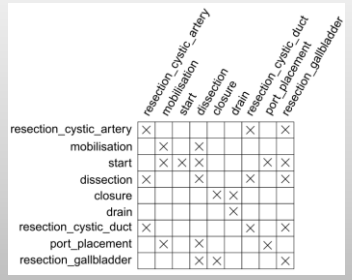
Data

Factual Knowledge



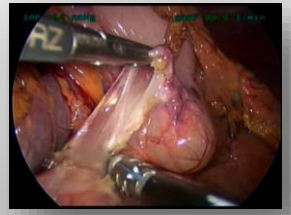


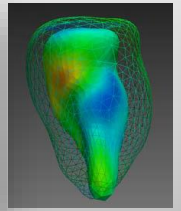
Type	Liver Factor	Possible observation values
Stent	Number of Stents	
	Material of Stent	Metal, Plastic, Others
	Date of Stent Implantation	
BD		
PTCD	Number of left side PTCDs	
	Number of right side PTCDs	
	Date of PTCD	
PVO	Type	PVE, PVL
	Location	Right, Left, Tri-sector
	Duration	Minuten, größer 0
	Complications	arterial embolization
Antibiotics	Antibiotics	
Neoadjuant	Chemotherapy	
	Radiotherapy	Yes, No
	Chemoradiotherapy	Yes, No
	TACE	Yes, No

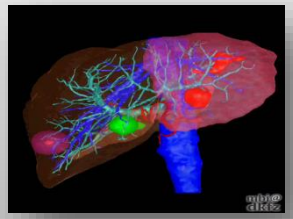


describes

Experience

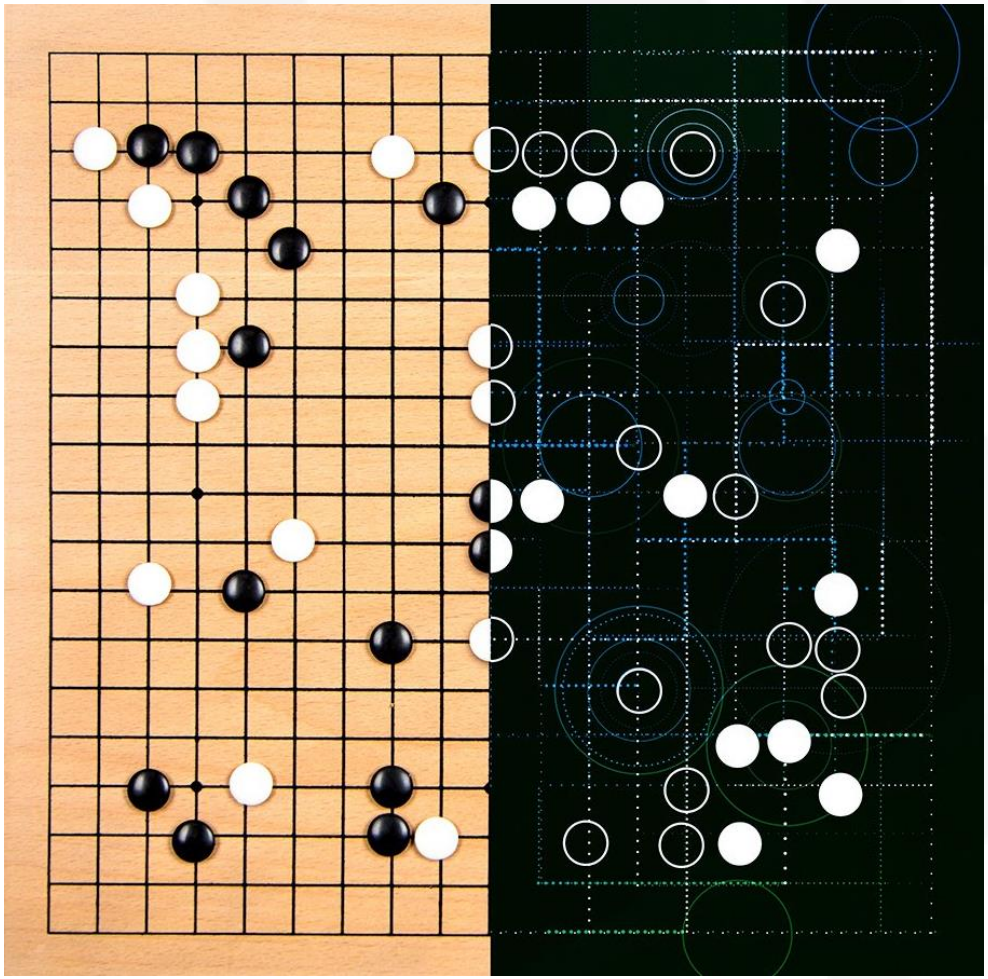






Cognitive Computing

- Deep Blue 1997
- DARPA Grand Challenge 2007
- Watson 2011
- AlphaGo 2016



Cognitive Computing: Deep Learning

"Two pizzas sitting on top of a stove top oven"

Vision: Cognitive Simulation Assistant

Challenges in CAE

License Cost

SIMULIA

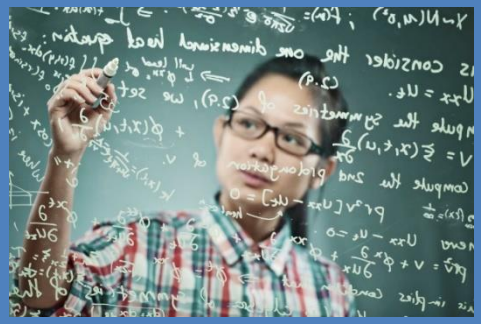
ANSYS

CST

COMSOL

Hardware Cost

CAE-Experience



SaaS

PAASAGE

SIMSCALE

FORTISSIMO

CAE AAS

cloudflow

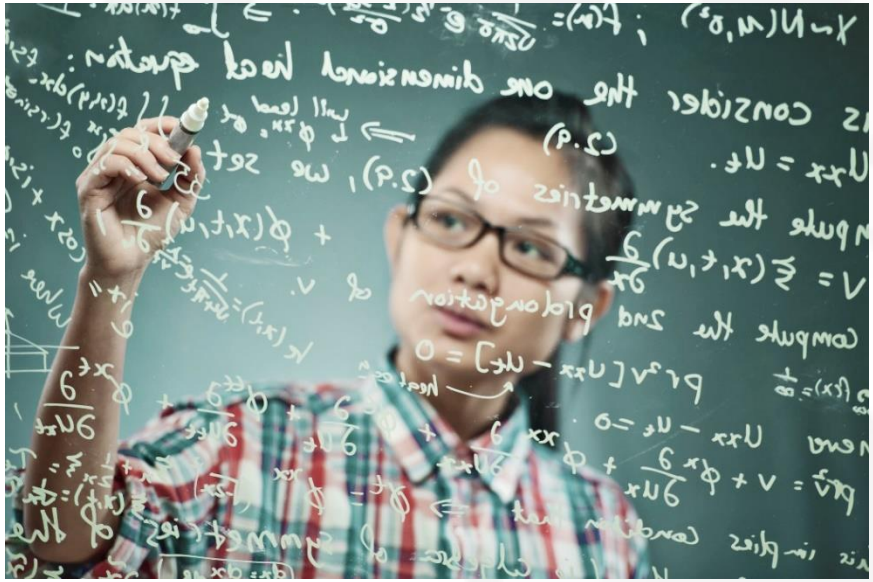
cloudSME

NUBERISIM

Cognitive Computing

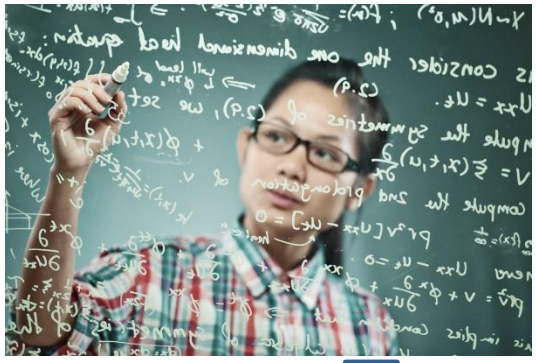
CAD und CAE Today

Design-engineer

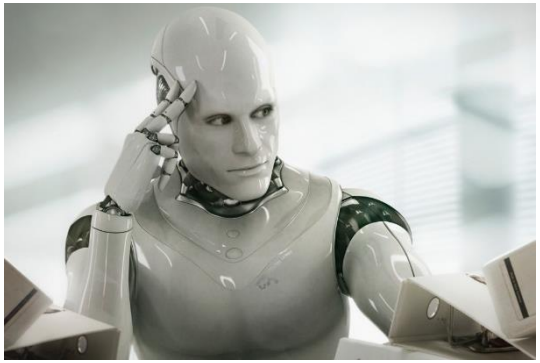


Numerical analyst

Cognitive CAE



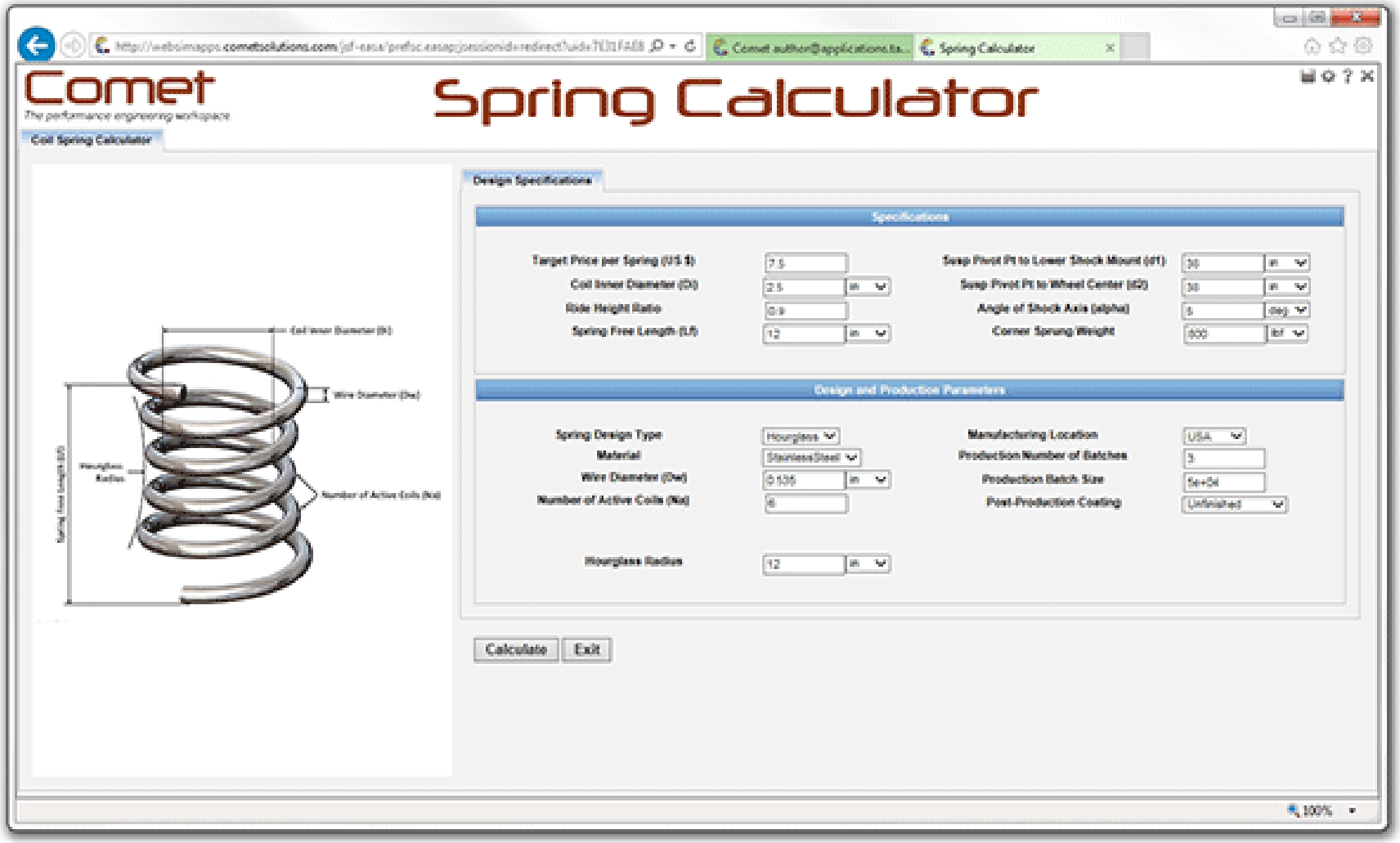
Numerical analyst



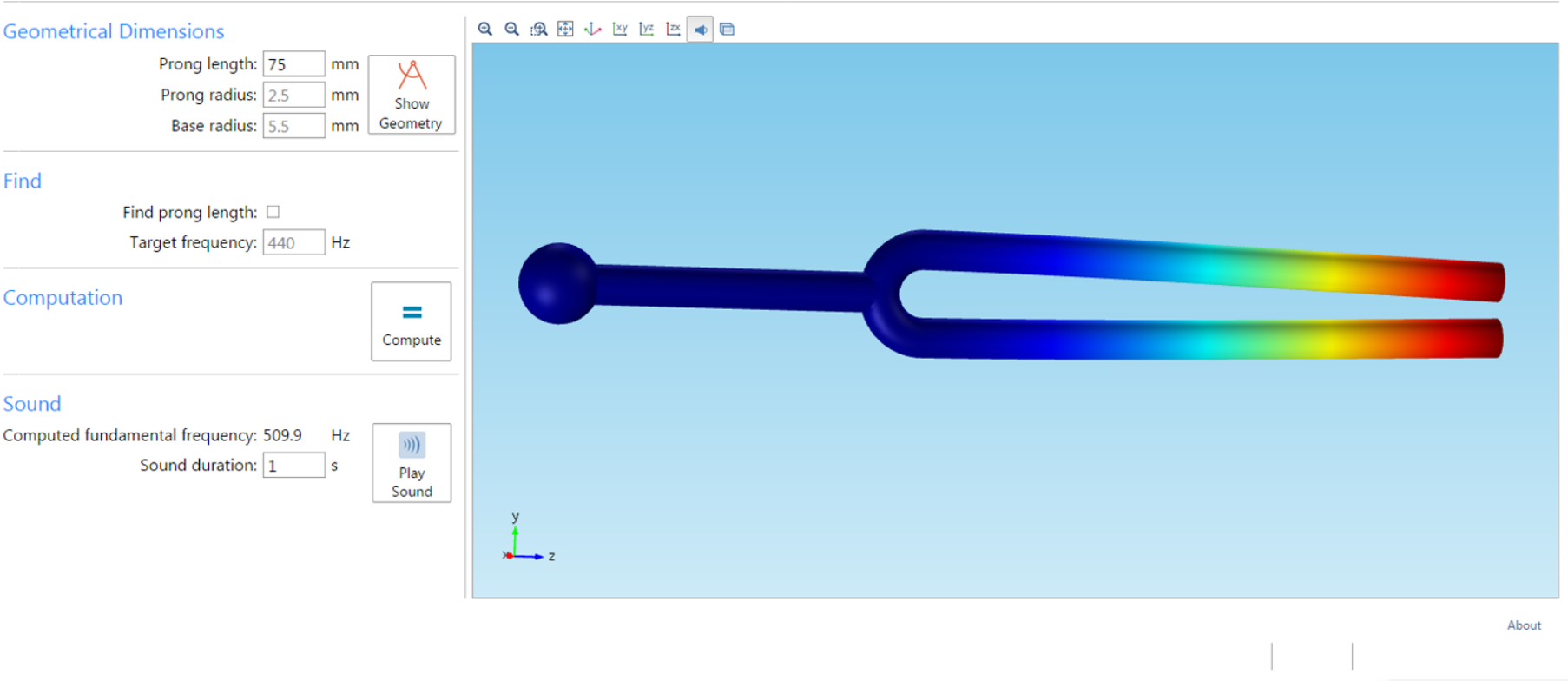
Cognitive Simulation Assistant

Design-engineer

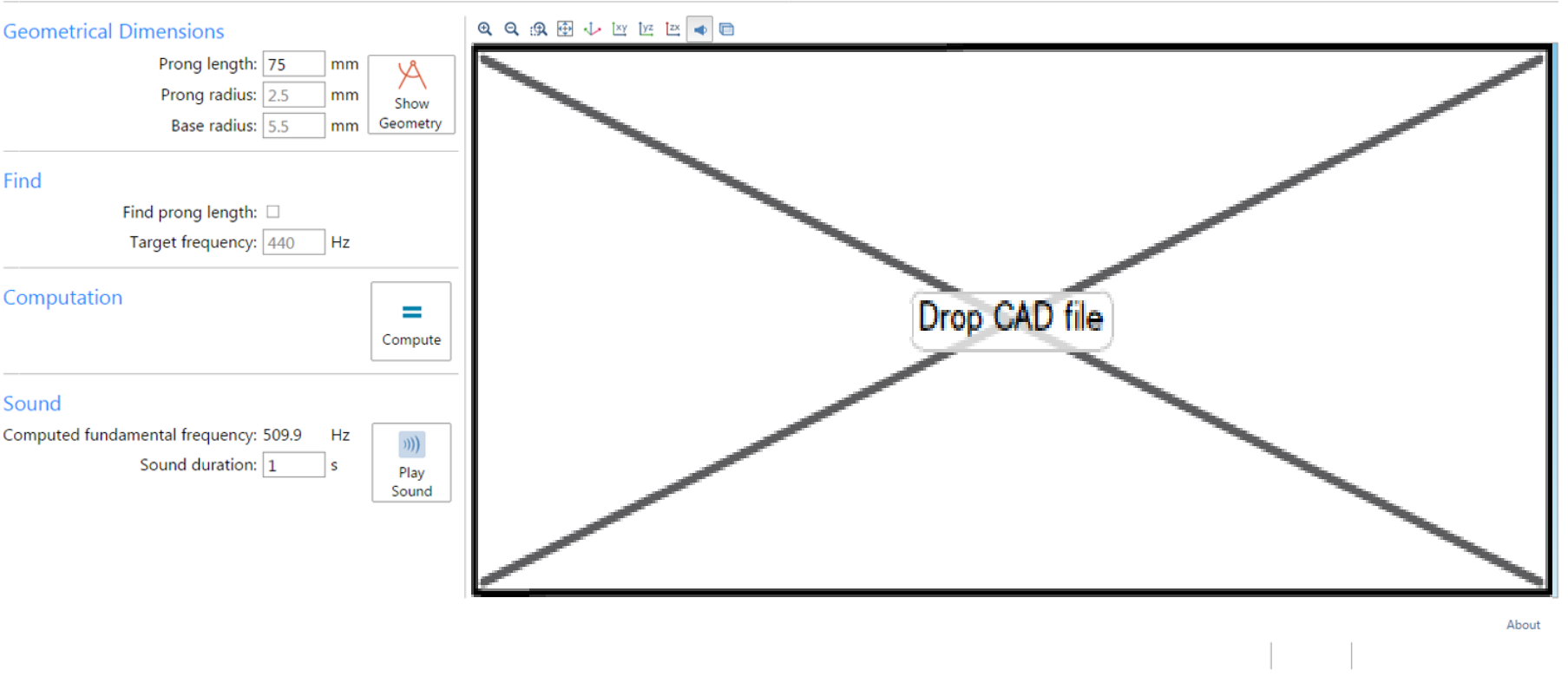
Simulation Apps I



Simulation Apps II

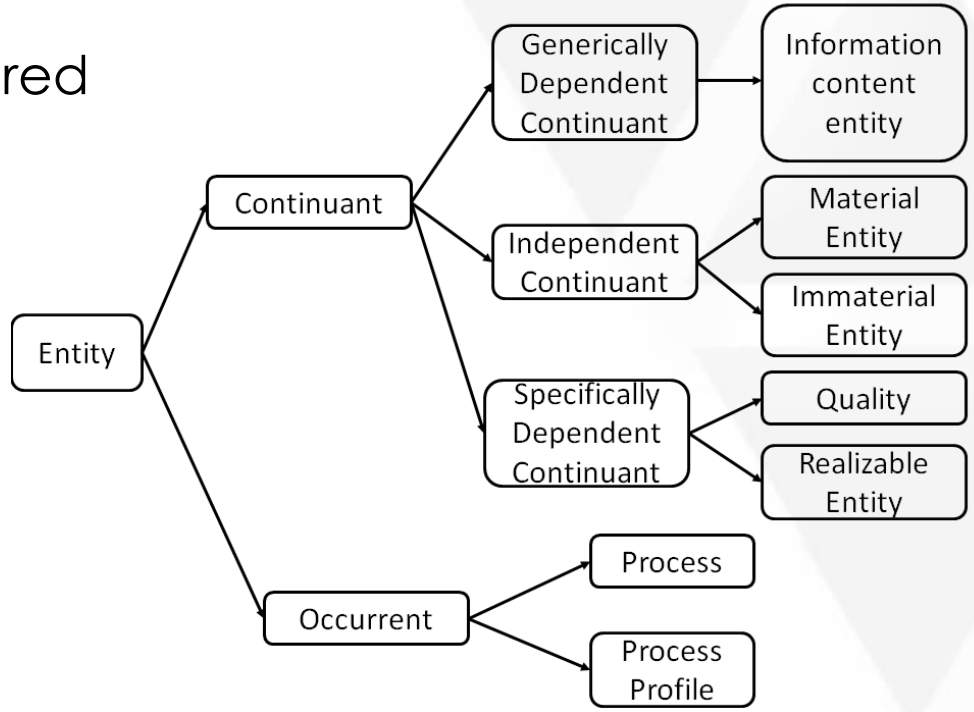


Generalized Cognitive Simulation App



Model Factual CAE Knowledge

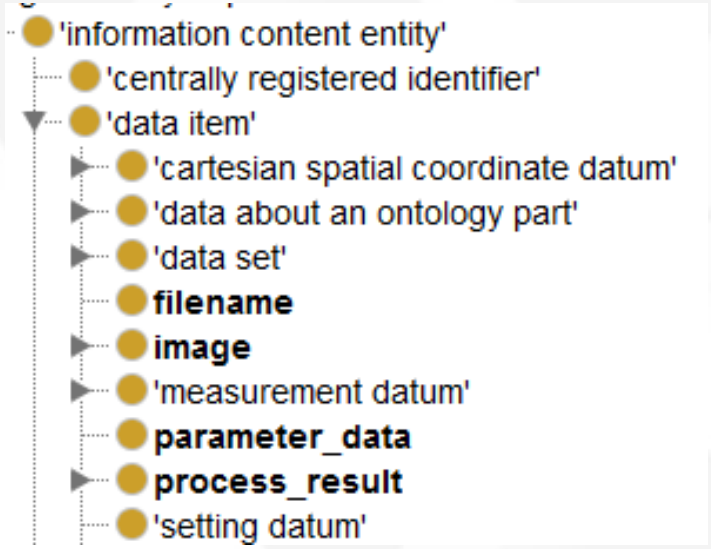
- Philosophie: Study basic categories of being
- Computer science: Knowledge representation
- Compatibility through shared *Upper Ontologies*
- Well suited for data integration



Data ontology

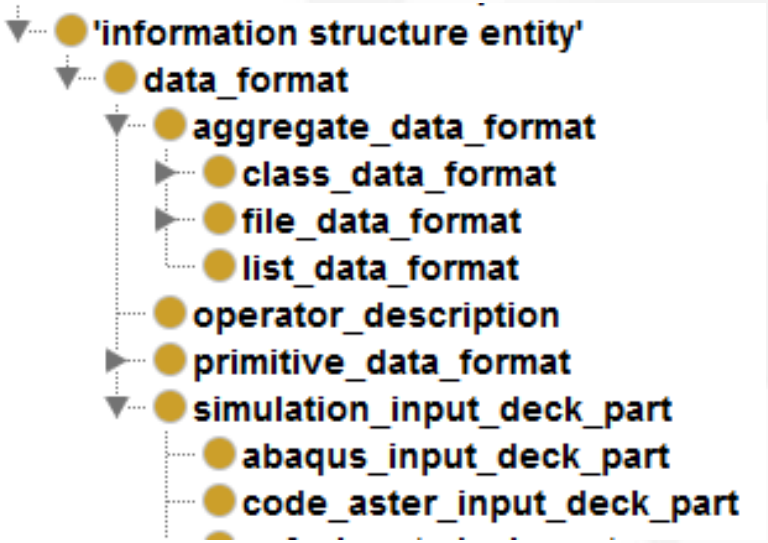
What is represented by the data?

- Information content entity



How is the data represented?

- Information structure entity



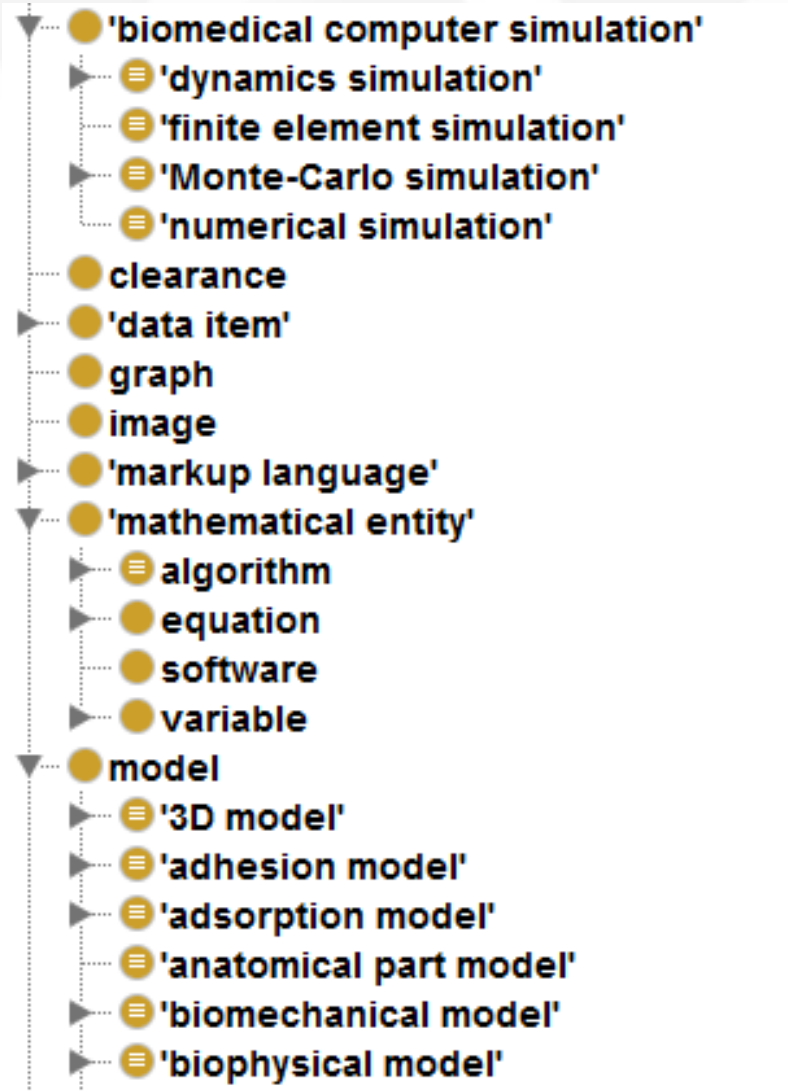
Algorithm ontology

- Draws on existing standards, e.g. OpenAPI model
- Based on data ontology
- Integrates different software modules and services
- Alternative representation by YAML/JSON

```yaml
#version number of the specification file
caeml: "1.0"
#software module
module:
  name: TetgenVolumeMesher
  version: 1.0.0
  description: This module contains the i
  keywords: volume meshing, tetrahedral m
  contributors: Stefan Suwelack, Markus S
  #this is the software interface specifi
  api:
    type: PythonModule
    namespace: msml.ext.tetgen
    #option terms of service for web apis
    termsOfService:
  contact:
    name: Stefan Suwelack
    email: suwelack@kit.edu
    url:
  license:
    name: AGPLv3
    url: http://www.gnu.org/licenses/agpl
  externalDocs:
    description: Find more information he
    url: www.msml.org
# here is the list of operators (i.e. alg
```

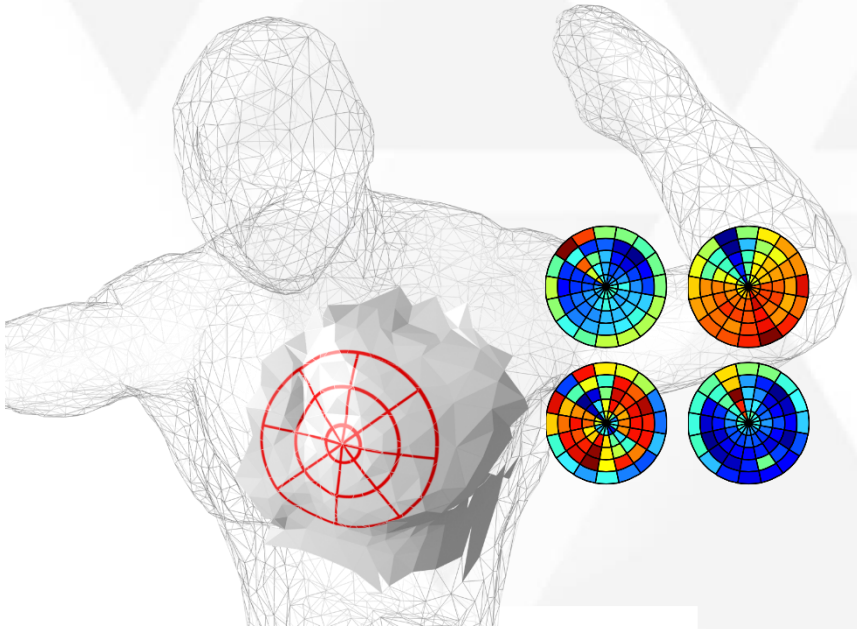
Simulation ontology

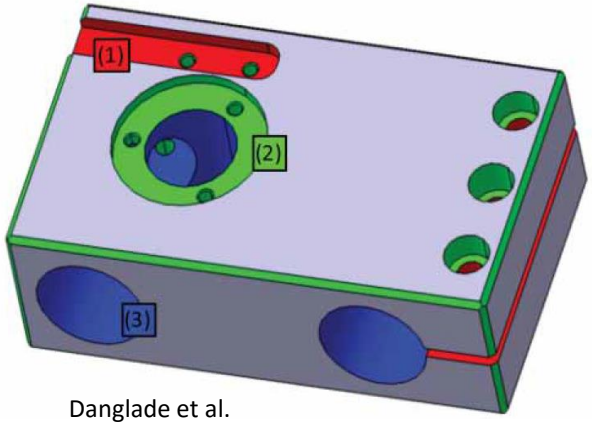
- Representation of simulation knowledge
- Models, boundary conditions, solvers…
- Based on existing work, e.g. HuPSON ontology, Step AP 209
- Workflow representation and simulation automatization



Current work: Learn from experience

- Semantic database of simulation data
- Use machine learning to extract knowledge
- Deep learning for shape understanding
- Enables: BC transfer, automate defeaturing, meshing etc.





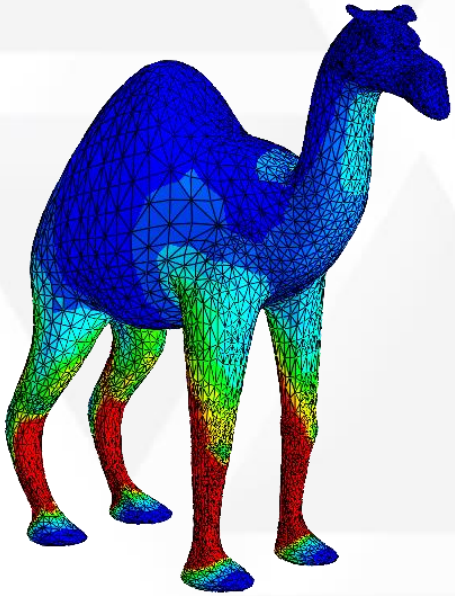
Danglade et al.

Life is cheap.

It's the accessories that kill you!

Computer Aided Engineering modeling language

- Semantics-based CAE middleware
- Interfaces, converters and runtime for CAE modules
- Simulation data management
- Open source license (autumn 2016)
- Vision: Help to create OSS stack for CAE



CAEML

openstack™

ROS

Open Source Robotics Foundation

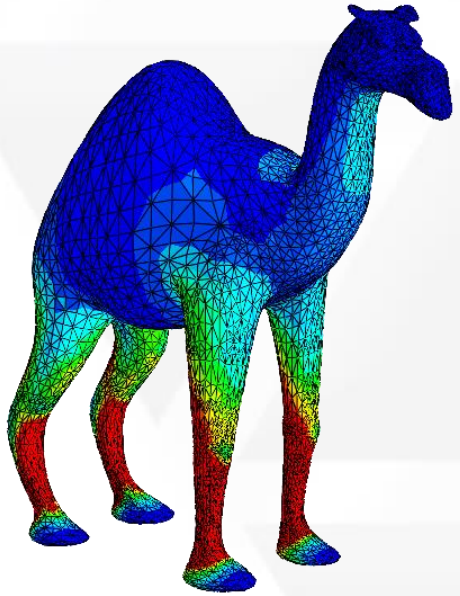
Computer Aided Engineering Modeling Language

CAEML Runtime Python API

YAML

Python Data API

Simulation Ontology



CAEML

CAEML core features

- Framework for data conversion
  - Data is represented as acyclic directed graph
  - Format conversion is graph matching
  - Easy creation of new convertes
- Definition of simulation workflows
- Runtime for simulation workflows
- Simulation data management

Applications

- Intuitive visual programming of simulation workflows
- Cloud-based simulation services
- Cognitive Computer Aided Engineering

Towards Cognitive CAE

Cognitive
Simulation Apps

Lifelong
learning,
data analytics

CAEML
middleware

Cognition-Guided Surgery

KIT Karlsruher Institut für Technologie

dkfz.

IPEK