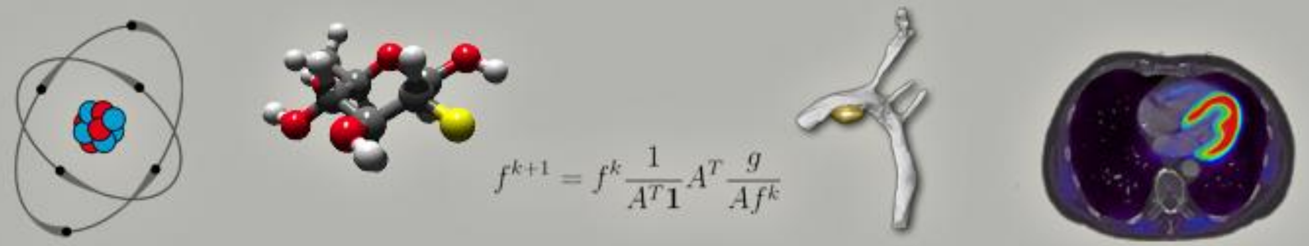


CiM
Cells in Motion

Pattern Recognition and Image Analysis @WWU

Xiaoyi Jiang

Faculty of Mathematics and Computer Science
Cluster of Excellence EXC 1003, Cells in Motion (CiM)

University of Münster, Germany

FB1 Evangelisch-Theologische Fakultät
FB2 Katholisch-Theologische Fakultät
FB3 Rechtswissenschaftliche Fakultät
FB4 Wirtschaftswissenschaftliche Fakultät
FB5 Medizinische Fakultät
Philosophische Fakultät
- FB6 Erziehungswissenschaft und Sozialwissenschaften
- FB7 Psychologie und Sportwissenschaft
- FB8 Geschichte/Philosophie
- FB9 Philologie

Mathematisch-Naturwissenschaftliche Fakultät
- FB10 Mathematik und Informatik
- **FB11 Physik**
- **FB12 Chemie und Pharmazie**
- FB13 Biologie
- FB14 Geowissenschaften

FB 15 Musikhochschule

WWU: Faculty of Mathematics and Computer Science

- The Mathematical Institute (4 winners of Leibniz Award)
- Institute for Stochastics
- Institute for Analysis and Numerics
- Institute for Mathematical Logic

- **Institute for Computer Science**

- Institute for Didactics of Mathematics and Computer Science

WWU: Institute for Computer Science

CiM
Cells in Motion

Research groups (basic research):

- Prof. Sergei Gorlatch (parallel and distributed computing)
- Prof. Xiaoyi Jiang (PRIA: pattern recognition, image analysis)
- Prof. Lars Linsen (visualization, computer graphics)
- Prof. Markus Müller-Olm (software development, verification)
- Prof. Anne Remke (saftey-critical systems)
- Prof. Jan Vahrenhold (algorithm engineering)
- Junior Professor N.N. (biomedical image analysis)
- Prof. N.N. (communication, networked systems)
- Prof. N.N. (IT security)

WWU: Computer Sciences

- **Institute for Computer Science (8)**
  (Faculty 10: Mathematics and Computer Science)
- Institute for Information Systems (7)
  (Faculty 4: Economics)
- Institute for Geoinformatics (3)
  (Faculty 14: Geosciences)
- Institute for Medical Informatics (1)
  (Faculty 5: Medicine)
- Bioinformatics (2; Biology, Medicine)

WWU: Institute for Computer Science

CiM
Cells in Motion

Multiscale Imaging Centre

CELLS IN MOTION
Cluster of Excellence

European Institute
for Molecular Imaging

(Siemens)

SFB 656
MoBil

2005 2007 2012 2014

WWU: PRIA research group

Basic research (application motivated):

- Biomedical imaging

- Image/video analysis
- Pattern recognition, machine learning

Understanding of data (images)
→ decision-making

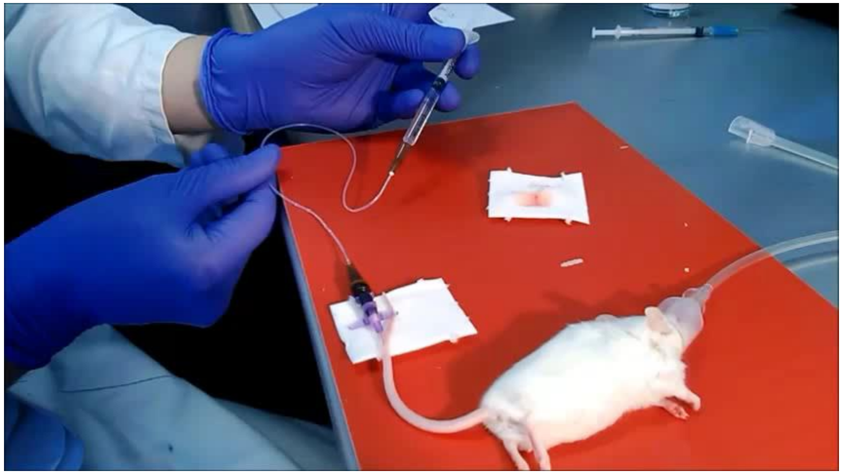
Biomedical imaging

Positron Emission Tomography (PET) imaging:

- PET data acquisition is long (e.g. 15 min)
- Animal preparation: anesthesia → tracer distribution is highly influenced

Novel PET imaging protocol (imaging of awake and freely moving mice)

- Video-based motion tracking
- Motion-compensated PET image reconstructionSSS

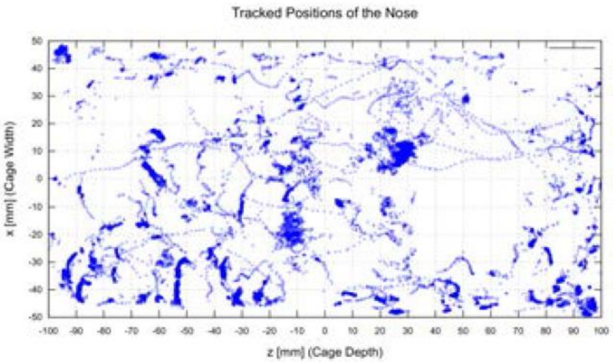


Biomedical imaging

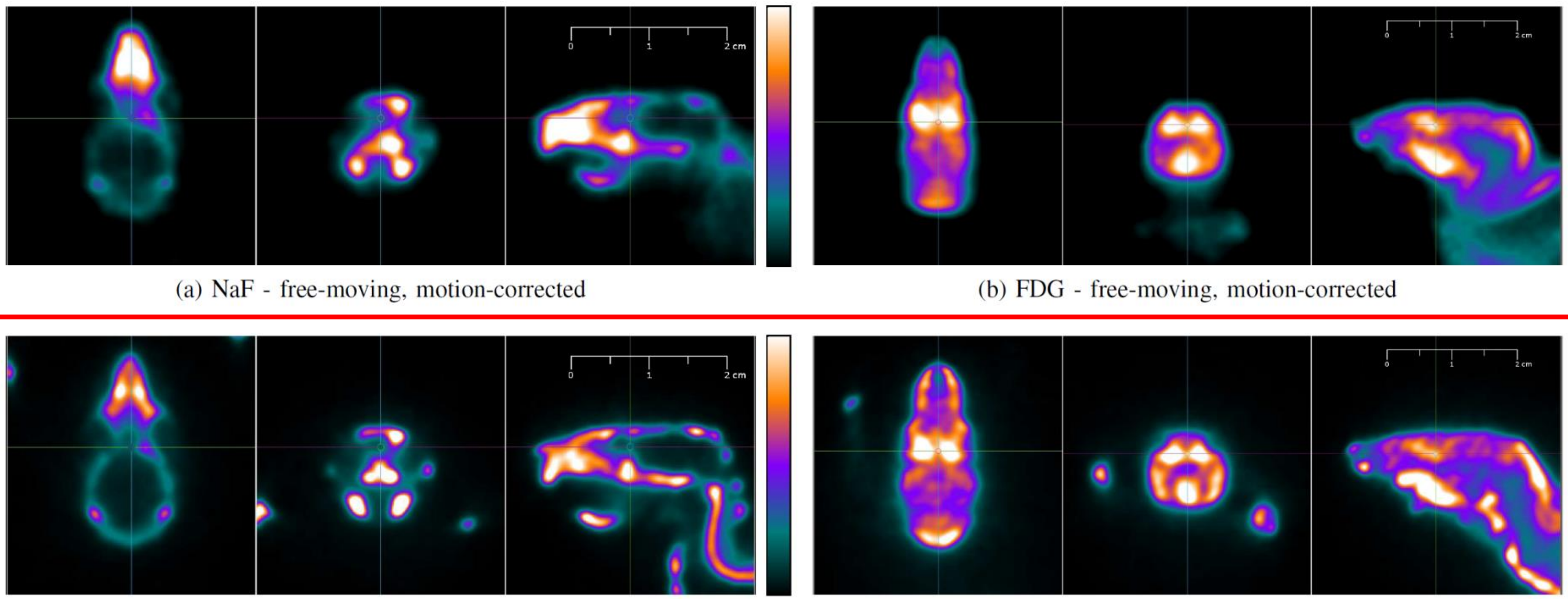
Challenges:

- High-precision camera calibration
- Robust tracking of 3D feature points
- Reliable estimation of whole-body motion
- → Motion-compensated PET image reconstruction

Biomedical imaging



Activity of the animal by showing the tracked positions of the nose tip (45 min)



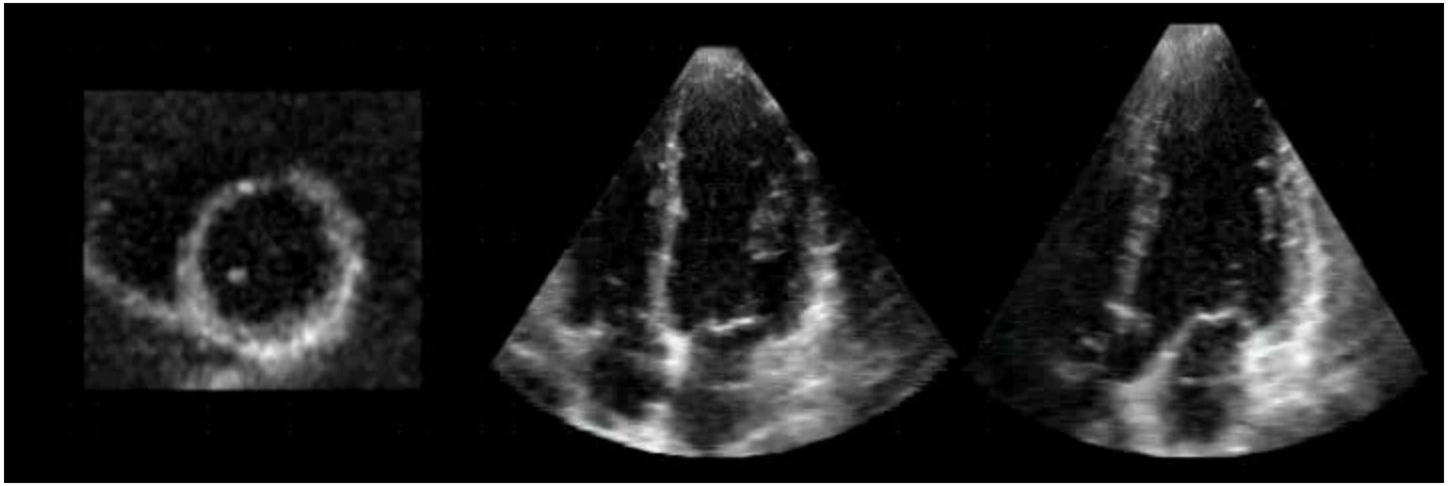
(a) NaF - free-moving, motion-corrected

(b) FDG - free-moving, motion-corrected

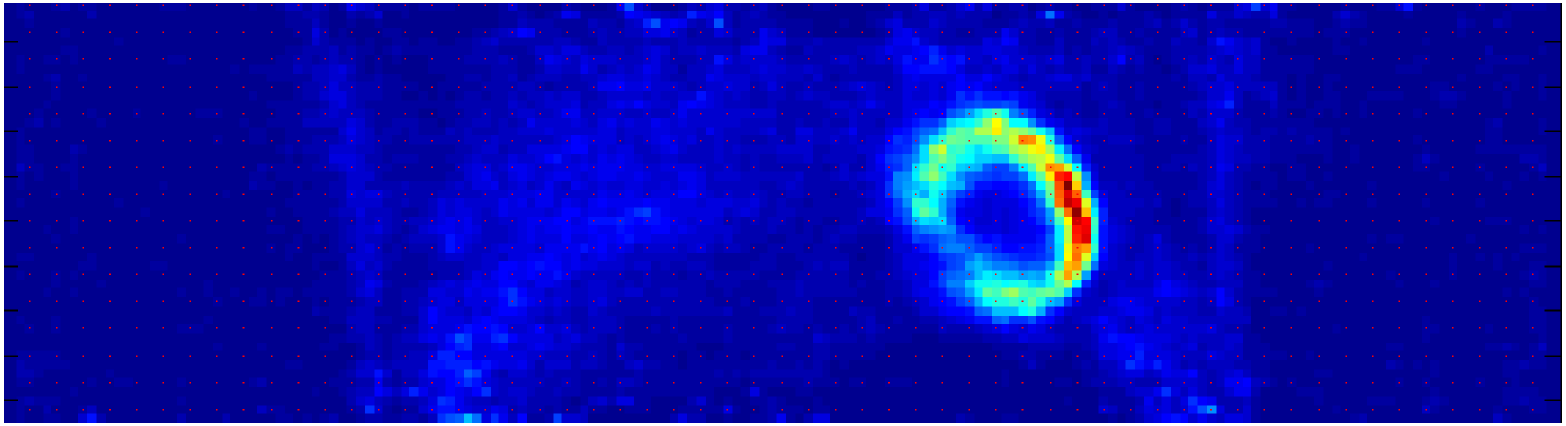
(c) NaF - anesthetized, reference

(d) FDG - anesthetized, reference

Image analysis: Motion analysis



Ultrasound: Heart movement, 2D optical flow vectors



PET: Heart movement, 3D optical flow vectors

Image analysis: Motion analysis

Application to motion correction in heart PET imaging:

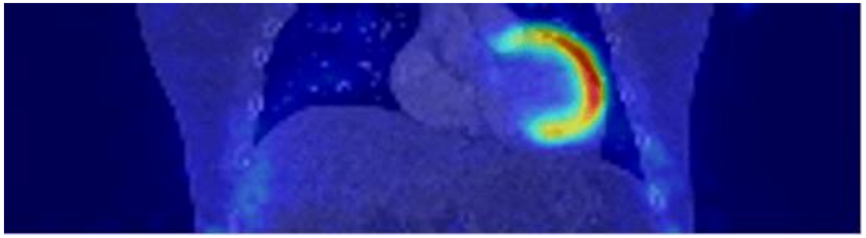
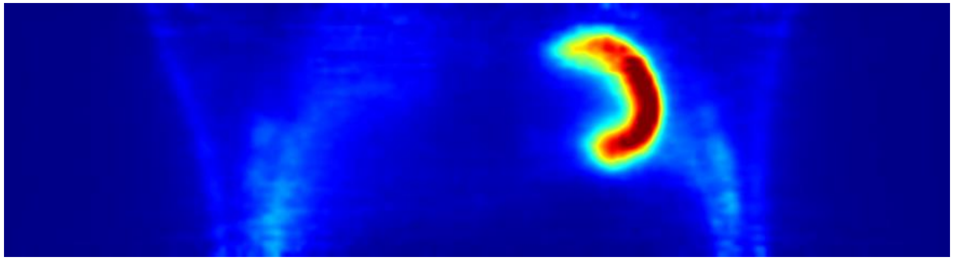


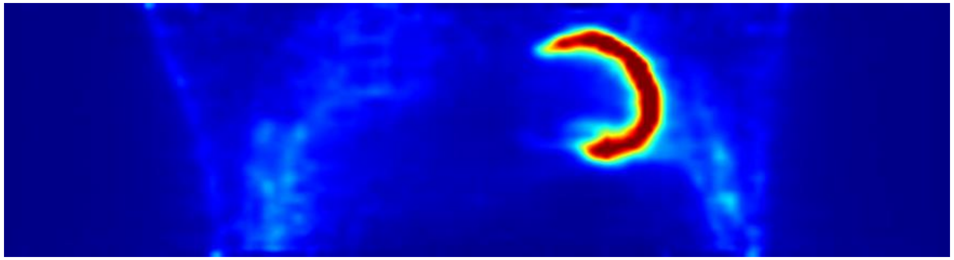
Image without motion correction



Patient: 20 min

Motion correction helps capture the correct shape of heart (for improved quantification)

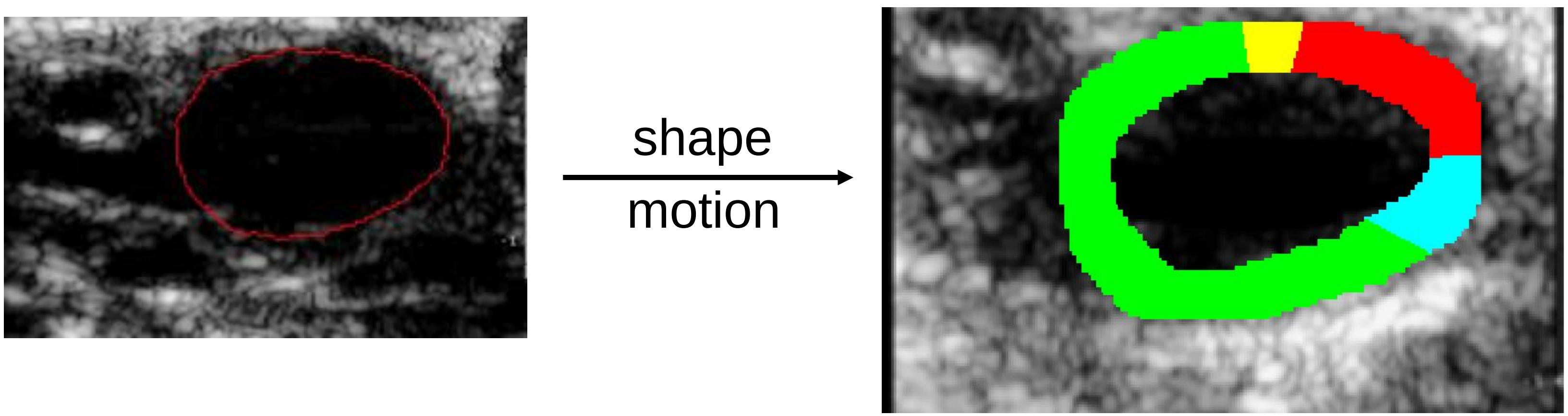
After motion correction



IEEE-TMI, 2006/2008/2012; Medical Physics, 2013

Image segmentation, decision-making

Heart remodelling: classification of regional left ventricular wall



- Green: normal
- Red: abnormal
- Cyan: false normal
- Yellow: false abnormal

Bundesministerium
für Bildung
und Forschung

IDEEN INNOVATION WACHSTUM
Die Hightech-Strategie für Deutschland

Jedes Alter zählt
Die Demografiestrategie der Bundesregierung

Grundlagen interaktions- und emotionssensitiver Assistenzsysteme (INEMAS)

BMBF-Fördermaßnahme im Rahmen des Förderschwerpunktes „Vom technischen Werkzeug zum interaktiven Begleiter – sozial- und emotionssensitive Systeme für eine optimierte Mensch-Technik-Interaktion (InterEmotio)"

Motivation

Interaktionskonzepte gängiger technischer Assistenzsysteme sind zumeist rein funktionsbezogen ausgestaltet und erlauben kaum nutzerspezifische Anpassungen. Dies gilt auch für Anzeige- und Warnkonzepte von Fahrerassistenzsystemen. Im Rahmen einer nutzerzentrierten Individualisierung könnten Fahrerassistenzsysteme analog eines menschlichen Beifahrers auf emotionale, soziale und kognitive Fahrerzustände reagieren und Warnausgaben optimieren.

Nutzerspezifische Anpassung von Warnmeldungen durch interaktions- und emotionssensitive Assistenzsysteme (Quelle: KU Eichstätt-Ingolstadt)

Ziele und Vorgehen

From images to semantics

data to semantics

methods

data

- images
- signals
- measurements
- networks
- records
- ……

Image Analysis:

- denoising
- segmentation
- registration
- motion analysis
- classification
- shape modeling
- ……

semantics

- Pattern Recognition
- Machine Learning
- Data Mining

Deep learning

Deep learning is a branch of **machine learning (learning models for decision-making)** based on a set of algorithms that attempt to model high level abstractions in data by using a deep graph with multiple processing layers, composed of multiple linear and non-linear transformations.

Lee Sedol und sein Gegner © Jung Yeon Je/AFP/Getty Images

AlphaGo: Using machine learning to master the ancient game of Go

10 BREAKTHROUGH TECHNOLOGIES 2013

MIT Technology Review

Deep Learning

With massive amounts of computational power, machines can now recognize objects and translate speech in real time. Artificial intelligence is finally getting smart. →

Temporary Social Media

Messages that quickly self-destruct could enhance the privacy of online communications and make people freer to be spontaneous. →

Prenatal DNA Sequencing

Reading the DNA of fetuses will be the next frontier of the genomic revolution. But do you really want to know about the genetic problems or musical aptitude of your unborn child? →

Additive Manufacturing

Skeptical about 3-D printing? GE, the world's largest manufacturer, is on the verge of using the technology to make jet parts. →

Baxter: The Blue-Collar Robot

Rodney Brooks's newest creation is easy to interact with, but the complex innovations behind the robot show just how hard it is to get along with people. →

Memory Implants

A maverick neuroscientist believes he has deciphered the code by which the brain forms long-term memories. Next: testing a prosthetic implant for people suffering from long-term memory loss. →

Smart Watches

The designers of the Pebble watch realized that a mobile phone is more useful if you don't have to take it out of your pocket. →

Ultra-Efficient Solar Power

Doubling the efficiency of a solar cell would completely change the economics of renewable energy. Nanotechnology just might make it possible. →

Big Data from Cheap Phones

Collecting and analyzing information from simple cell phones can provide surprising insights into how people move about and behave – and even help us understand the spread of diseases. →

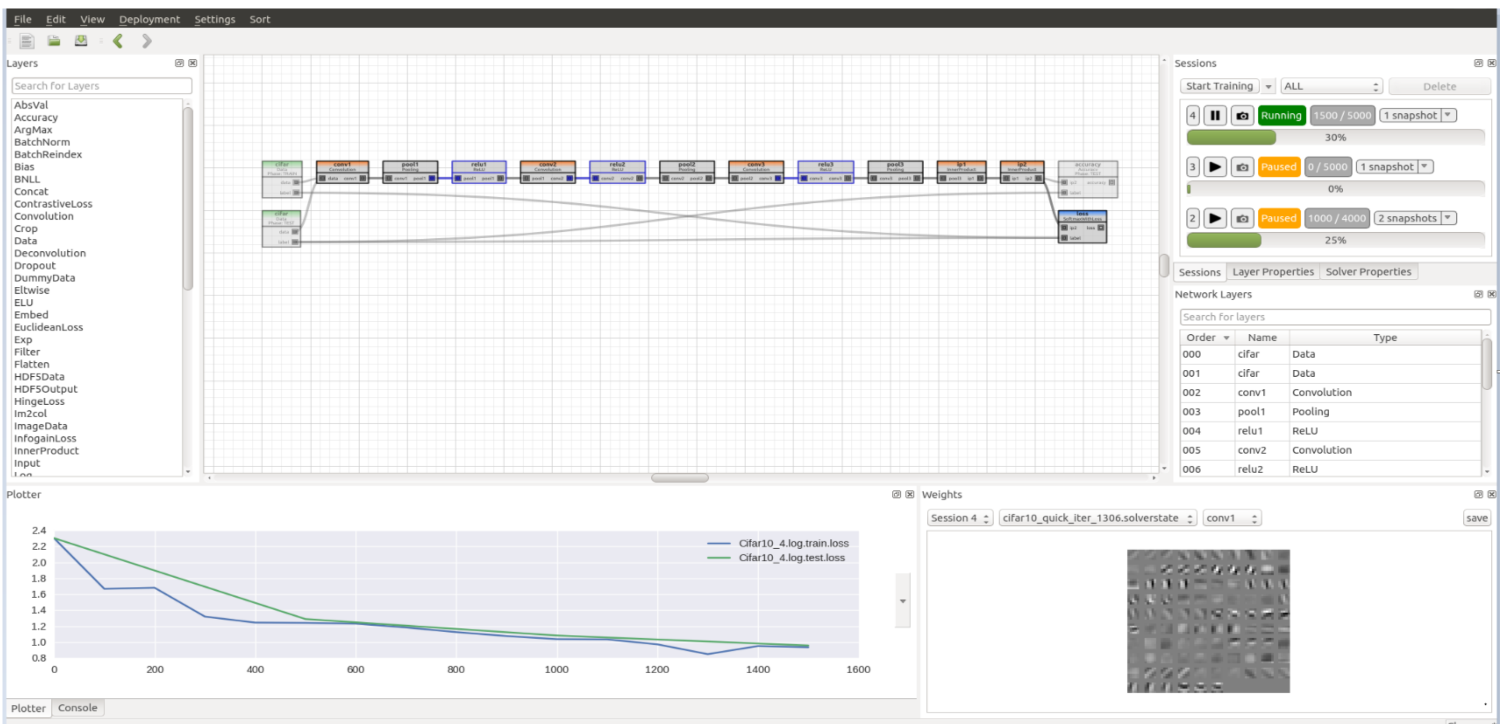
Supergrids

A new high-power circuit breaker could finally make highly efficient DC power grids practical. →

Pattern recognition, machine learning

CiM Cells in Motion

- Alternative methods of neural network learning
- **Barista:** Flexible deep learning tool (based on Caffe)
- Consensus learning / ensemble learning



Pattern recognition, machine learning

IEEE TRANSACTIONS ON MULTIMEDIA, VOL. 18, NO. 10, OCTOBER 2016 1929

Classification-Based Record Linkage With Pseudonymized Data for Epidemiological Cancer Registries

Yannik Siegert, Xiaoyi Jiang, *Senior Member, IEEE*, Volker Krieg, and Sebastian Bartholomäus

***Abstract*—Cancer is one of the widest spread diseases in human society. Therefore, the need has grown to monitor, evaluate, and predict its development. Cancer registries address this problem by collecting data on cancer cases, striving for high quality, accuracy, and completeness. One of the basic challenges in this context is the linkage of data from multiple sources. In order to link new cancer records with existing ones, the cancer registries typically use an algorithm referred to as record linkage. Although the algorithm has automated a significant amount of the linking process, there still is a certain percentage of records that cannot be linked automatically. This study addresses the problem of reducing the need of manually matching records with machine learning methods. The particular challenge is caused by pseudonymization of the data. The main contribution is thus finding ways to encode the—pseudonymized—data, i.e., feature extraction so that it can be interpreted by a classifier. Three classifiers (neural network, support vector machines, decision tree) manage to achieve at least 93% classification rate on a dataset of 73 000 cancer records extracted from the inventory of a cancer registry. In addition, ensemble techniques boost the performance further to over 95%. We present an in-depth discussion of the experimental results from a perspective of applying the classification-based record linkage in real practice. Two scenarios of translating to practice will be outlined with a potential of reducing the human workload by an order of magnitude of hundreds of hours.**

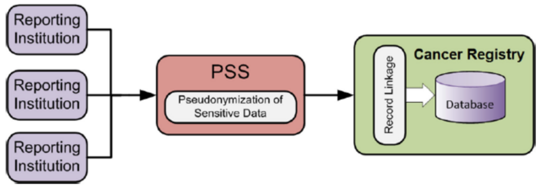


Fig. 1. Data flow from the reporting institutions to the cancer registry.

of cancer is the rapid growth of cells beyond their boundaries, which can then invade adjoining body parts and spread to other organs. In 2012, 14 million new cases of cancer were registered worldwide, while 8.2 million cancer related-deaths were counted [1]. In order to receive statistics on cancer development a central institution that collects cancer data is required. These data requires to be nationwide (in future perhaps even internationally) collected, accurate, complete, and of high quality. High-technical methods allow for an electronic registration of cancer incidents to satisfy these requirements. Institutions attacking these challenges are referred to as cancer registries. Epidemiological cancer registries hold statistics on cancer-related deaths as well as a database for quantity and distribution of can-

Interdisciplinary research