TG-Health Stakeholder Workshop

PTB-Berlin

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Summary Talk Olaf Dössel

Examples for multiparametric measurements:
Flow cytometry, immunoasssays, cell microscopy with biomarkers, multiparametric MRI, multichannel ECG
-> uncover values, parameters & characteristics for cells, tissues, patients

Modelling: quantitative input-output predictions

Classification: specifity, selectivity

Computer-assisted data analysis:
Model selection, define error function
Physics vs. data-driven modelling

Validation of models & machine learning algorithms:
approved learning data sets

Inverse problems: e.g. localization of unhealthy tissue

Uncertainty quantification

Summary Talk Katja Ickstadt

Model challenges:
Hypothesis generation –> unsupervised learning -> supervised learning –> topology & causality
subgroup finding -> prediction & variable selection –> structure learning

Challenges data:
- Molecular date (genomics, proteomics ….)
- Different platforms (arrays, chips) & different biological units
- Pre-processing is necessary, statistics: find typical distributions

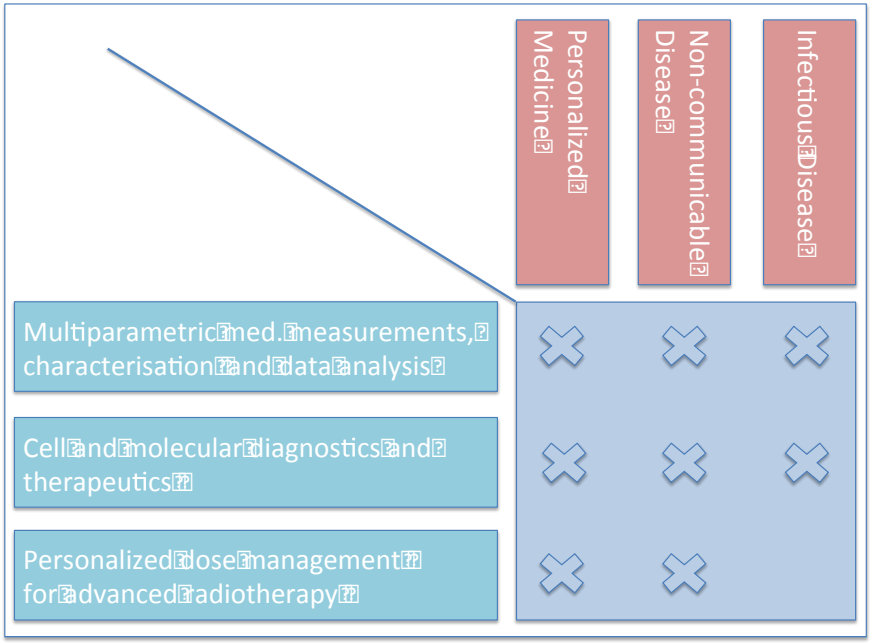
Goal:
- Treat all available data for a particular question in an integrative statistical analysis
- n = number of observations, p = number of variables, parameters

- Challenge large n: **Dimension reduction** by random projection or merge-and-reduce approach
- Challenge large p: Dimension reduction by **variable selection**, e.g. Bayesian PCA or sampling methods

Large-scale regression, e.g. magnetic resonance fingerprinting

State of the Art

- 71 abstracts
- 27 abstracts in “Multiparametric medical measurements, characterisation and data analysis”
- Most abstracts address the “personalized medicine” and non-communicable diseases (24), very few (~3-6) also apply directly or indirectly to infectious diseases.



Technology types – abstract distribution

- Type I) Characterisation of uncertainties by reference techniques or calibration devices to support multi-parametric measurements
- Type II) New quantitative imaging techniques that avoid interobserver variability
- Type III) Interoperability and standardization of different data to establish consistent large-scale data
- Type IV) New statistical approaches, dimensionality reduction and machine-learning techniques
- Type V) In-silico medicine for modelling disease processes

- Multiple types can apply to each abstract:
  - Type I 14/27
  - Type II 11/27
  - Type III 9/27
  - Type IV 14/27
  - Type V 5/27
  - Not directly matching any type: 2 abstracts

7 Major Lines of Thinking:

1. **Imaging CT, MR**

   CT: Image Quality improvement

   Simon (Frechou/Bordy), CEA

   Mathematical model observers; comparison to image quality phantom; cross-comparisons

   Büermann

   Registration of partial-body CT images to whole body atlas images; personalized CT-dosimetry; adjustments of precision

   Anton/Elster, PTB

   x-ray CT Diagnostics; develop quality metrics with uncertainties; Bayesian/Machine learning tools for more model observers; develop phantoms; validation

   Solc (Czech Metrology Institute)

   SPECT imaging improvement in resolution; decrease imaging time; dose reduction; personalized therapy; radiation protection

7 Major Lines of Thinking:

1. **Imaging CT, MR – MR Image Quality Improvement**

Fillmer (PTB)

Biomarker MR- Imaging and MR-Spectroscopy; Mild Cognitive impairment (dementia); NeuroMET; disease subgroup distinction; disease progression prediction

Koch, Körber (PTB)

Low frequency imaging (ULF MRI); SQUID Sensors; human brain neuronal current measurement; 3-D current density imaging; phantom models; simulation tools; reference material generation

Kolbitsch (PTB)

multi-modality and multi-parametric tissue characterisation; CT/MR and PET/SPECT; big data; mathematical approaches

Zilberti (INRIM)

MR-based Quantitative Imaging; MR-elastography; algortihm validation; uncertainty; statistical analyses

Troia (INRIM)

metrology of phantom and tissue mimicking materials; validation; phantom fabrication; MRQI

Quaglia (LGC)

Apply NeuroMET strategies to neurodegenerative disease biomarkers; contribute to IFCC CSF-WG; improve MRI/MRS protocols; clinical testing

7 Major Lines of Thinking:

2. Gas

Meuzelaar (VSL Delft)

Diagnostic **Breath Tests;** lung cancer; breath sampling technologies; reference materials; biomarker identification; standardization

7 Major Lines of Thinking:

3. Artificial Intelligence and Machine learning

Sadikov – **Disease Prediction**

Machine learning; artificial intelligence; statistical data analysis; lung cancer database; biomarkers;

Biometrology NPL – **Next generation antibiotics**

big data analytics; antibiotics prediction; cognitive metrology; IBM Watson Discovery Advisor; multiscale modeling;

7 Major Lines of Thinking:

4. Integration and Statistics

Karaböce

Multi-parameter medical device traceability; patient simulators; Europe-wide

Gülbakan

Mutli-omics data integration; RARE-MET; large-p small-n; standardized methodologies

Wübbler, Bär, Elster, PTB

Statistical Data Analysis / Modeling – Interested in collaborations with JRP/EMPIR 2018

Douglas, Bratczak, Goenaga-Infante, LGC

Multi-technique Imaging Platform: spectroscopy, mircoscopy, MR; fusion algorithms, machine learning; big data

7 Major Lines of Thinking:

5. Circulation / Blood flow physics

Schakel

Blood solid particle clogging; traceable non-Newtonian fluids; optical and flow measurements; quantification blood clogging risks

Schakel

fluid phase injection risks during infusions, characterization of pressure, humidity, flow rate, air;

7 Major Lines of Thinking:

6. Radiopharmacology - Radionuclide metrology

Frechou (LNE-LHB, France)

Radiopharmaceuticals for Nuclear Medicine; Traceability; National Standards; Metrology

Bordy, Farah

Traceability interventional radiology; Standard Calibration beam quality; Phantoms

Bobin

Half-life measurements short-lived radiopharmaceuticals;

7 Major Lines of Thinking:

7. Medical Devices

Ramos (Carlos III Health Institute, Madrid)

Body worn dosimeters; exposure to electromagnetic fields; computational tools EMF dosimetry; validation of EMF-based applications in medicine

Zradzinski (CIOP-BIP, Poland)

Personalized medicine; human body impact on EMF distribution and propagation; phantoms

Simunic, Roic

Internet of Things Health Based System; node tracking, reputation tracking; database; for patient and doctors

Sander-Thömmes

portable magnetometers; neuronal signal recording; movement disorder; pot. Link to EEG/fNIRS

7 Major Lines of Thinking:

1. **Imaging (11)**
2. **Gas (1)**
3. **Artificial Intelligence and Machine learning (2)**
4. **Integration and Statistics (4)**
5. **Circulation / Blood flow physics (2)**
6. **Radiopharmacology - Radionuclide metrology (3)**
7. **Medical devices (4)**

Discussion starters:

- Under-representation of Class III/ infectious disease abstracts
- Relatively few nucleic acid analyses (~2) and new statistical approaches (~4)

EURAMET TG Health Workshop, 12/2017

- Markus Bär

MATHMET in short

- Founded 2016 by 4 NMIs (LNE, NPL, PTB, RI.SE) in the wake of EMRP project NEW04 and discussions in the Focus Group Math and Software of TC INTMET

- Based on Memorandum of Understanding, non-registered association

- Website www.mathmet.org

- Members: 7 European NMIs

Goals of MATHMET

- "Promote best practice in mathematics and statistics for metrology"
- "Coordinate mathematical activity within EURAMET"
- "Partner of NMIs & EU industry, academia, projects"

Future MATHMET Activities

EURAMET Joint Network Project (Call Network) 2018:

Expanding the scope of MATHMET

- **Guidelines for uncertainty evaluation, key comparison**
- **Strengthening links to academic community in mathematics & statistics, stakeholders in industry & regulation**

Challenges from digitalisation:

- Virtual experiments
- Uncertainty quantification for complex models
- High-dimensional systems, big data, machine learning

  -> Network for **Large-Scale Metrology**

MATHMET Meeting in January 2018

Future MATHMET Activities

Potential applications to health:

Quantitative MRI imaging, fingerprinting (INRIM, PTB)

Flow cytometry (PTB,....)

Mass spectroscopy

CT Image quality (CEA, PTB)

Cardiac biosignals

Immunoassays, digital PCR

Thank you for your attention

www.euramet.org