Health analytics is transforming health services owing to the advent of digitization and new information collection systems (e.g. patient portals, IoT, cloud computing, big data, and wearables), so that health innovation is driven by analyzing, processing and acting on health data.
Scope

Information technology, IoT, cloud computing, big data and data analytics have a large impact on the health services. While advances in medical knowledge result in better diagnosis and more and better treatment solutions, patient-centricity, self-care, integrated care delivery and shared decision making are appearing as new trends. The way health services are delivered is being revolutionized by sharing and integrating large volumes of health data. Health analytics is the key element of this revolution, allowing to merge, analyze and process all health related data to gain more actionable insight, understanding and knowledge at individual and population level. This provides the basis for modern innovation and value addition in evidence-based medicine.

We have 3 main focus themes:

• **Decision support for better health**
  Data analysis, computerized modeling, clinical decision support, personalized models

• **Visual health analytics**
  Visualization, visual analytics, medical image analysis, decision support based on image analysis

• **Healthcare process and environment innovation**
  Process mining, environmental factors, organizational aspects, privacy

Vision

In the future, the availability of large volumes of health data is an important asset for health organizations. Data, controlled by the citizens, are collected ubiquitously throughout the care continuum, connected seamlessly and interpreted within the right context. Data are used to improve health solutions and to advance medical knowledge, leading to better outcomes while increasing efficiency. For instance, data are continuously used to analyze and improve workflows and medical guidelines, thereby providing stronger evidence for best practice solutions. For this purpose, health analytics enables personalized care delivery throughout the care continuum. Using personalized health records citizens are empowered to control their own health better, such that the collected data is of service to the individuals and to the society at large.

Research challenges

**Data handling**

a) Collect and integrate health data (at the broad scale)
   How can we collect, integrate and harmonize data to create consistent models across organizations, regions and nations, taking into account semantic interoperability aspects?

b) Collect and examine health data to examine the interaction between the environment and persons
   Environment has a large influence on peoples’ health. How can we use environment data (e.g. indoor and outdoor climate data) to improve health solutions?

c) Techniques and algorithms for federated or distributed data analysis
   Can we run all data analysis methods fast and accurate in a federate way, when data can not be pooled in one location?

**Personal healthcare**

d) Develop data-driven decision-support models
   How can data-driven and consistent multi-scale decision-support models be developed to support both individuals and health professionals in the whole care continuum?

e) Develop data analytics solutions to optimize and personalize care workflows
   Can we analyze the effectiveness of clinical protocols and clinical pathways to suggest individualized treatment paths?

f) Personalized decision support models
   How can we create data driven models that allow personalization of recommendations and treatments?

**Models**

g) Developing and improving techniques for process analytics in healthcare
   How can we improve process modeling under different sources of personalized heterogeneity and how do we estimate the influences of the risk factors?

h) Integrate data analytics into continuous medical improvements for value based healthcare
   How to facilitate the deployment of the models in practice? Can those models continuously learn and adapt to increase their prediction quality?
Project examples

**BrainBridge program, Philips, TU/e and Zhejiang University**
Clinical Pathway Analysis - Develop tools to analyze and study the performance of clinical pathways and clinical workflows.
Cardiovascular Risk Assessment - Develop an intelligent system for long-term cardiovascular risk assessment and prediction.

**Creating healthy environments in hospitals, Meander Medical Centre Amersfoort and Jeroen Bosch Hospital in 's-Hertogenbosch**
Collecting and analyzing indoor climate data to understand the interaction between the environment and staff's performance and patients' safety.

**Creating healthy lighting environments in offices, Philips and Deloitte**
Collecting and analyzing light data to understand the interaction between light and staff performance while taken in consideration energy savings.

**Philips Data Science for health flagship, Philips, Catharina hospital, TU/e**
A joint initiative by Philips, Catharina hospital and TU/e.
Continuous personal health - Develop data-driven, predictive solutions for the whole care continuum.
Optimizing Healthcare Workflows stream - develop process analytics techniques and interactive visualizations to analyse and improve process performance.

**Gamebus, EIT Digital and MUMC+ Maastricht**
Valorization focused project to stimulate physical, cognitive and social healthy behavior across communities and generations of people.

Scientific staff involved

**Core team**

- **Prof. Uzay Kaymak (RP leader)**
  - Business process analytics for healthcare
- **Dr. Joos Buijs**
  - Process mining in healthcare
- **Prof. Edwin van den Heuvel**
  - Longitudinal health studies
- **Prof. Helianthe Kort**
  - Health in the built environment
- **Prof. Natal van Riel**
  - Computational biology
- **Dr. Anna Wilbik**
  - Linguistic summarization
- **Chris Knighting**
  - Project development officer

**Selection of other staff involved**

- **Dr. Elizabeth O'Neill**
  - Ethics
- **Prof. Mykola Pechenizkiy**
  - Data mining, predictive analytics
- **Dr. Bert Sadowski**
  - Users and business models
- **Prof. Bettina Speckmann**
  - Applied geometric algorithms
- **Dr. Mitko Veta**
  - Biomedical image analysis
- **Dr. Michel Westenberg**
  - Data visualization and visual analytics in life sciences and healthcare

**External cooperation**

Within the Research Program we work actively together with companies like Philips, Rabobank, Adversitement, StudyPortals, Achmea, and Interpolis. We also collaborate with Tilburg University in the Jheronimus Academy of Data Science (JADS).
DSC/e research programs

The DSC/e consists of over thirty research groups, each of which is working on their own topic and/or technique, across six involved departments. This wide distribution of research efforts creates many opportunities for new collaborations. By setting up research programs the DSC/e aims to connect these efforts to initiate and align joint research. The research programs are centered around key topics where there is a strong researcher base, with a high impact in research and society.

The program provides a meeting place for researchers and industry to get together and have discussions, workshops or research meetings. The goal is to let novel ideas emerge and collaborations between researchers and external parties to be started or strengthened. It is also important for researchers to be aware of the current industrial challenges, and for industry to be aware of the state of the art of research. Existing external contacts can easily be shared to further increase external collaboration.

Running research programs

- **Customer Journey** – Prof Mykola Pechenizkiy
  *Informed and responsible analytics to understand and improve the customer journey*

- **Health Analytics** - Prof Uzay Kaymak
  *Improving your health through data analytics*

- **Internet of Things** - Prof Antonio Liotta
  *Computational intelligence and network science for the Internet of Things*

- **Quantified Self** - Prof Aarnout Brombacher
  *Human Vitality & Technology*

- **Smart Manufacturing and Maintenance** – Prof Geert-Jan van Houtum
  *Exploit the full potential of your data to boost manufacturing and maintenance!*

More information regarding the research programs can be found on our website: [www.tue.nl/dsce/rp](http://www.tue.nl/dsce/rp)

You can also contact us directly at dsce@tue.nl